Southeast Florida Coral Reef Evaluation and Monitoring Project

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Florida Fish and Wildlife Conservation Commission

Florida Department of Environmental Protection

Florida's Coral Reef

NOAA
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NOAA CORAL REEF CONSERVATION PROGRAM

Southeast Florida Coral Reef Evaluation and Monitoring Project

2022 Year 20 Draft Final Report

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LIST OF ACRONYMS

CRCP …………………………………..………… (DEP) Coral Reef Conservation Program
CREMP ………………………………..… Coral Reef Evaluation and Monitoring Program
DEP ……………………………..…… Florida Department of Environmental Protection
FKNMS ……………………………………….. Florida Keys National Marine Sanctuary
FWC ………………………………. Florida Fish and Wildlife Conservation Commission
FWRI ……………………………………………...Fish and Wildlife Research Institute
SECREMP ……………………. Southeast Coral Reef Evaluation and Monitoring Project
SCTLD ……………………………………...………. Stony Coral Tissue Loss Disease
FCR …………………………………………………………..…… Florida's Coral Reef
Coral ECA …………………..… Southeast Florida Coral Reef Ecosystem Conservation Area
LTA………………………………………………….……………………Live Tissue Area

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Executive Summary

The Southeast Florida coral reef ecosystem is offshore a highly urbanized mainland (population > 6 million) influenced by numerous human activity-related local and global stressors. To document changes potentially related to increasing stressors, the Florida Department of Environmental Protection (DEP) working with Florida Fish and Wildlife Conservation Commission (FWC) and Nova Southeastern University (NSU) initiated a long-term annual coral reef monitoring program in 2003 along the Southeast Florida coast. To provide continuity in monitoring efforts along all of Florida's Coral Reef (FCR), the Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP) was established as an expansion of the FWC managed Coral Reef Evaluation and Monitoring Project (CREMP) in the Florida Keys. SECREMP provides local, state, and federal resource managers annual reports on the status and condition of the Southeast Florida (Miami-Dade, Broward, Palm Beach, and Martin counties) coral reef system as well as information on temporal changes in resource condition. Survey methods include photographic transects to quantify percent cover of major benthic taxa (stony corals, sponges, octocorals, macroalgae, etc.) and demographic surveys to quantify abundance, size distribution, and overall condition of stony corals, octocorals, and the giant barrel sponge. SECREMP is also a partnership between DEP, FWC, and NSU that facilitates collaboration and knowledge sharing benefiting coral reef ecosystems nationwide.

The Kristin Jacobs Coral Reef Ecosystem Conservation Area (Coral ECA) experienced significant stony coral assemblage declines across the study period, with significant losses determined for all stony coral metrics examined (cover, Live Tissue Area (LTA), and density). These losses were predominately driven by a significant increase in Stony Coral Tissue Loss Disease (SCTLD), which peaked in 2016 but has subsequently decreased in prevalence every year since. As regional disease prevalence has dropped to < 1% starting in 2018 and continuing through 2022, recovery can start to be addressed. No significant decline in stony coral LTA or density was identified from 2018 through 2022, and density in 2022 was significantly higher than density in 2013-2017. However, this increase in density is predominantly driven by increases in non-SCTLD susceptible species, such as *Porites astreoides*. Although the majority of SCTLD susceptible species had juvenile colonies in the sample sites, these juveniles were again dominated by generalist, low relief species. This disease event does not appear to have had any significant impact on the octocoral and barrel sponge, *Xestospongia muta*, communities.

The chronic nature of disturbances to and the significant economic value of the coral reefs within the Kristin Jacobs Coral Reef Ecosystem Conservation Area requires comprehensive, long-term monitoring to define and quantify change and to help identify threats to the ecosystem. Both continual region-wide monitoring (i.e., SECREMP) and improved incident-specific monitoring are necessary if resource managers are to develop sound management plans for coral reefs that allow continued use and realization of the economic value of these fragile marine ecosystems. The value for a long-term region-wide monitoring program is highlighted by the information in this report, which will be vital in planning and monitoring the potential future recovery of this resource.

Introduction

Florida's Coral Reef (FCR) is an important aesthetic and economic resource that extends approximately 577 km from the Dry Tortugas in the south to the St. Lucie Inlet in the north. The northern third of this reef system is comprised within the Kristin Jacobs Coral Reef Ecosystem Conservation Area (Coral ECA) extending from the northern boundary of Biscayne National Park in Miami-Dade County to the St. Lucie Inlet in Martin County (approximately 170km) and within 3 km off the mainland Atlantic coast of Florida. These reefs support diverse benthic organisms and fish communities. Additionally, Coral ECA reef habitats are an important economic asset for the region. The reef system has been estimated to protect nearly 6,000 people, over $500 million in infrastructure and $300 million in economic activity from storm-related flooding (Storlazzi et al. 2019). These reefs have also been estimated to generate more than $3 billion in sales and income and support more than 35,000 jobs (Johns et al. 2001, 2004). While the reefs within the Coral ECA are clearly an important resource, their location offshore a highly urbanized area (population > 6 million) drives ever-increasing human activity-related stress on the reefs.

Prior to 2003, most coral reef monitoring efforts (e.g., Gilliam et al. 2015) along the mainland southeast coast were associated with impact and mitigation studies (dredge impacts, ship groundings, pipeline and cable deployments, and beach renourishment). The temporal duration and spatial extent of these monitoring efforts were limited, being defined by an activity permit and focused on monitoring for effects specific to a given impact. In 2003, the Florida Department of Environmental Protection (DEP) was awarded funding for the inception of a long-term coral reef monitoring program along the Southeast Florida coast. Prior to this the primary focus for long-term coral reef monitoring was limited to the Florida Keys and Dry Tortugas in Monroe County. Coral reef monitoring efforts in the Keys grew with the establishment of the Florida Keys National Marine Sanctuary (FKNMS) in 1990. Since 1996, the Coral Reef Evaluation and Monitoring Project (CREMP) has documented changes in reef resources along the Keys portion of the Florida's Coral Reef (FCR) from Key West to Carysfort Reef (Ruzicka et al 2010; Ruzicka et al. 2013). In 1999 the project was expanded to sites in the Dry Tortugas. To provide continuity in monitoring efforts along the FRC from the Keys through Southeast Florida, DEP established the Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP) as an expansion of CREMP. The goal of SECREMP has been to provide local, state, and federal resource managers an annual report on the status and condition of the Southeast Florida (Miami-Dade, Broward, Palm Beach, and Martin counties) reef system as well as information on temporal changes in resource condition.

Survey Sites

Off the mainland coast of Southeast Florida from Miami-Dade County north to central Palm Beach County, in particular offshore Broward County, the reef system within the Coral ECA is described as a series of linear reef complexes (referred to as reefs, reef tracts, or reef terraces) running parallel to shore (Moyer et al. 2003; Banks et al. 2007; Walker et al. 2008) (Figure 1). The Inner Reef (also referred to as the "First Reef") crests in 3 to 7 m depths. The Middle Reef ("Second Reef") crests in 12 to 14 m depths. A large sand area separates the Outer and Middle Reef complexes. The Outer Reef ("third Reef") crests in 15 to 21 m depths. The Outer Reef is the most continuous reef complex, extending from Miami-Dade County to northern Palm Beach County. Inshore of these reef complexes, there are extensive nearshore ridges and colonized pavement areas. From Palm Beach County to Martin County, the reef system is comprised of limestone ridges and terraces colonized by reef biota (Walker and Gilliam 2013). Since the inception of SECREMP, sites have been spread across these four habitats.

SECREMP began monitoring in 2003 at 10 sites, three each in Palm Beach and Miami-Dade counties and four in Broward County, including a nearshore monotypic stand of *Acropora cervicornis*. In 2006, two sites were added in Martin County extending efforts to the northernmost area of FCR. Four additional sites were added in 2010, two each in Palm Beach County and Miami-Dade County. Finally, in 2013 six sites were added, three each in Broward and Miami-Dade counties. Currently SECREMP monitors 22 sites from Miami-Dade County to Martin County distributed across all four described habitats. Figures 2 and 3 show the location of the 22 current sites along the Southeast Florida coast. Project sampling occurs annually between May and August. Table 1 provides reef type, depths, locations, and the 2022 sample date of each of the SECREMP sites.

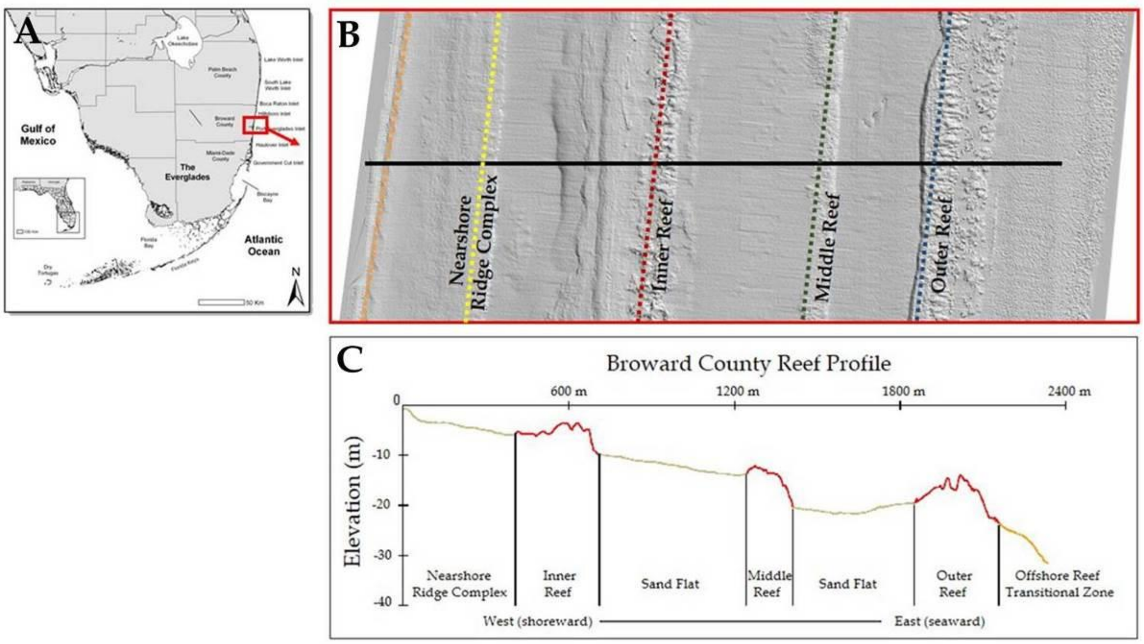

Figure 1. View of the Southeast Florida coastline. Panel A is a view of southern Florida showing an area off Broward County in red that corresponds to Panel B which is sea floor bathymetry from LIDAR (Light Detection and Ranging) data. The black line in Panel B shows the location of a bathymetric profile illustrated in Panel C.

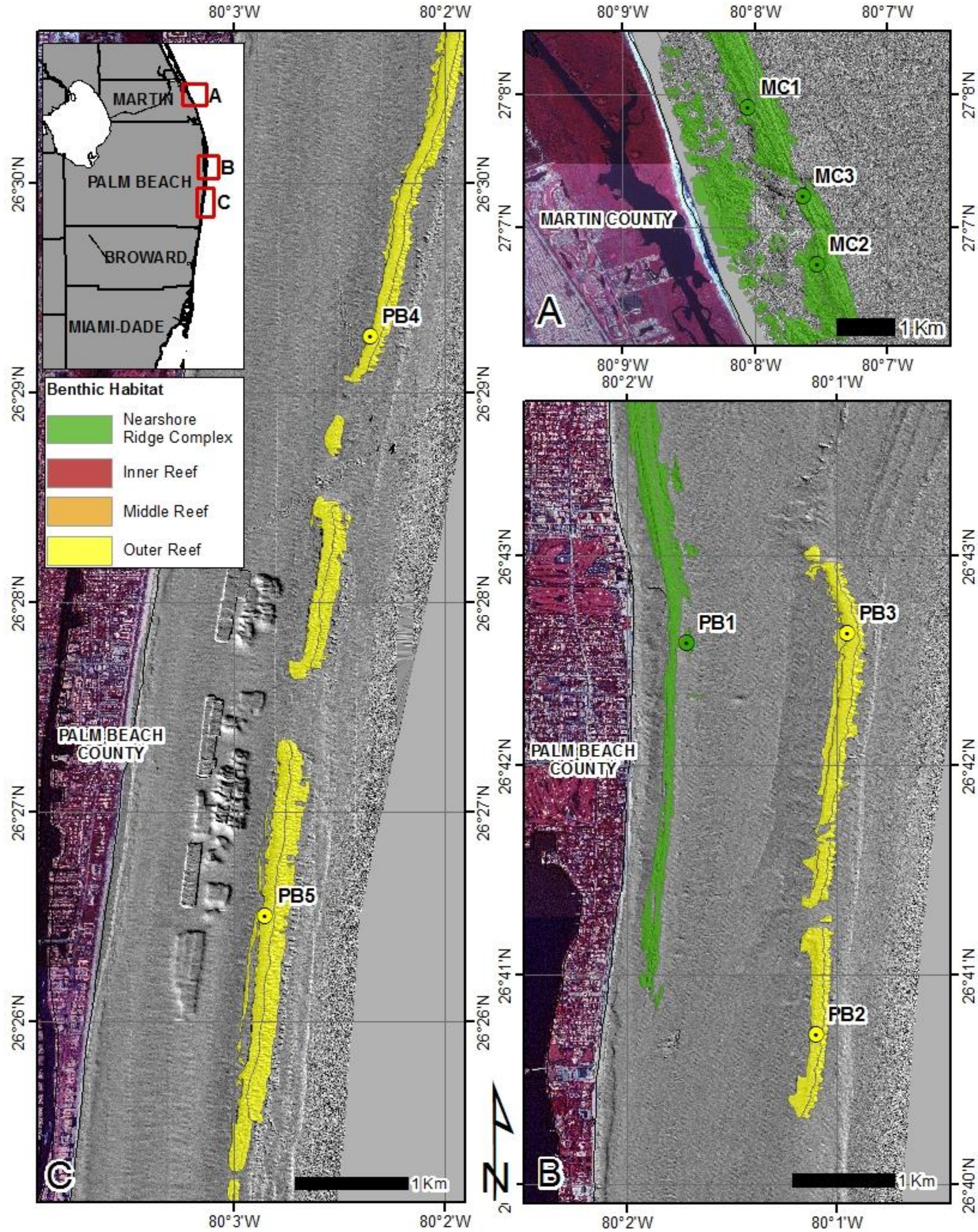

Figure 2. Site location and habitat map of Martin (Panel A) and Palm Beach (Panels B and C) counties.

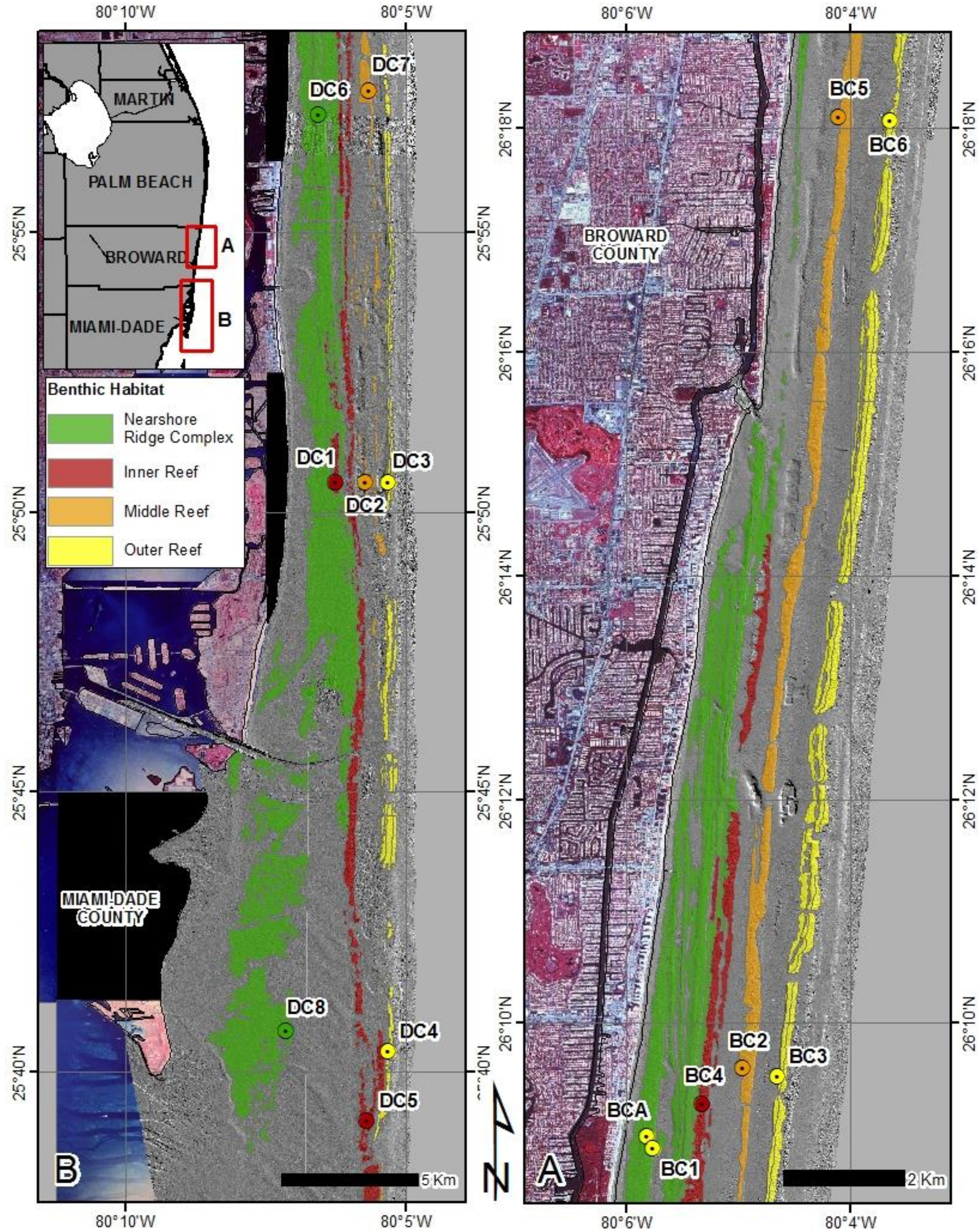

Figure 3. Site location and habitat map of Miami-Dade (Panel B) and Broward (Panel A) counties.

Table 1. Monitoring site reef types, depth (ft), location, and 2022 sample date (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County) (NRC = Nearshore Ridge Complex).

Site Code	Reef Type	Depth	Latitude (N)	Longitude (W)	Sample Date
DC1	Inner	25	25° 50.530’	80° 06.242’	15-Aug
DC2	Middle	45	25° 50.520’	80° 05.704’	24-Aug
DC3	Outer	55	25° 50.526’	80° 05.286’	15-Aug
DC4	Outer	41	25° 40.357’	80° 05.301’	17-Aug
DC5	Inner	24	25° 39.112’	80° 05.676’	16-Aug
DC6	NRC	15	25° 57.099’	80° 06.534’	17-Aug
DC7	Middle	55	25° 57.530’	80° 05.639’	24-Aug
DC8	NRC	15	25° 40.707’	80° 07.111’	16-Aug
BCA	NRC	25	26° 08.985’	80° 05.810’	8-Jun
BC1	NRC	25	26° 08.872’	80° 05.758’	8-Jun
BC2	Middle	40	26° 09.597’	80° 04.950’	3-Aug
BC3	Outer	55	26° 09.518’	80° 04.641’	3-Aug & 8-Aug
BC4	Inner	30	26° 08.963’	80° 05.364’	12-May
BC5	Middle	45	26° 18.100’	80° 04.095’	23-Aug
BC6	Outer	55	26° 18.067’	80° 03.634’	23-Aug
PB1	NRC	25	26° 42.583’	80° 01.714’	28-Jul
PB2	Outer	55	26° 40.710’	80° 01.095’	26-Jul
PB3	Outer	55	26° 42.626’	80° 00.949’	25-Jul
PB4	Outer	55	26° 29.268’	80° 02.345’	27-Jul
PB5	Outer	55	26° 26.504’	80° 02.854’	29-Jul
MC1	NRC	15	27° 07.900’	80° 08.042’	3-Jun
MC2	NRC	15	27° 06.722’	80° 07.525’	3-Jun

Methods

Each site consists of four monitoring stations demarcated by stainless steel stakes that are permanently placed in the substrate. Each station is 22 meters in length and has a north-south orientation, which is generally parallel to the reef tracts of Southeast Florida. Survey transects are delineated by a fiber glass tape stretched between the stainless-steel stakes at either end of a station. *In situ* sampling included photo transects at all site stations sampled each year (2003-2022). Starting in 2013, a stony coral population survey, an octocoral population survey, and a *Xestospongia muta* population survey, were conducted along the same transect covering a similar area of the substrate (Figure 4).

Image Transects

Transect images were taken at all stations at all sites sampled each year (2003-2022). All transect images were taken to the east of the fiberglass tape delineating a transect. In 2022, the images were taken using an Olympus TG-4 tough digital camera. Each image was captured at ~40 cm above the reef substrate to yield images approximately 40 cm wide by 30 cm in height. A constant distance above the substrate was maintained using an aluminum bar affixed to the bottom of the camera housing. Benthic features seen in the top border of the camera viewfinder and the fiberglass tape were used as visual reference points to take abutting images with minimal overlap. This results in a transect consisting of about 60 images and covering an area of approximately 0.4 m x 22 m.

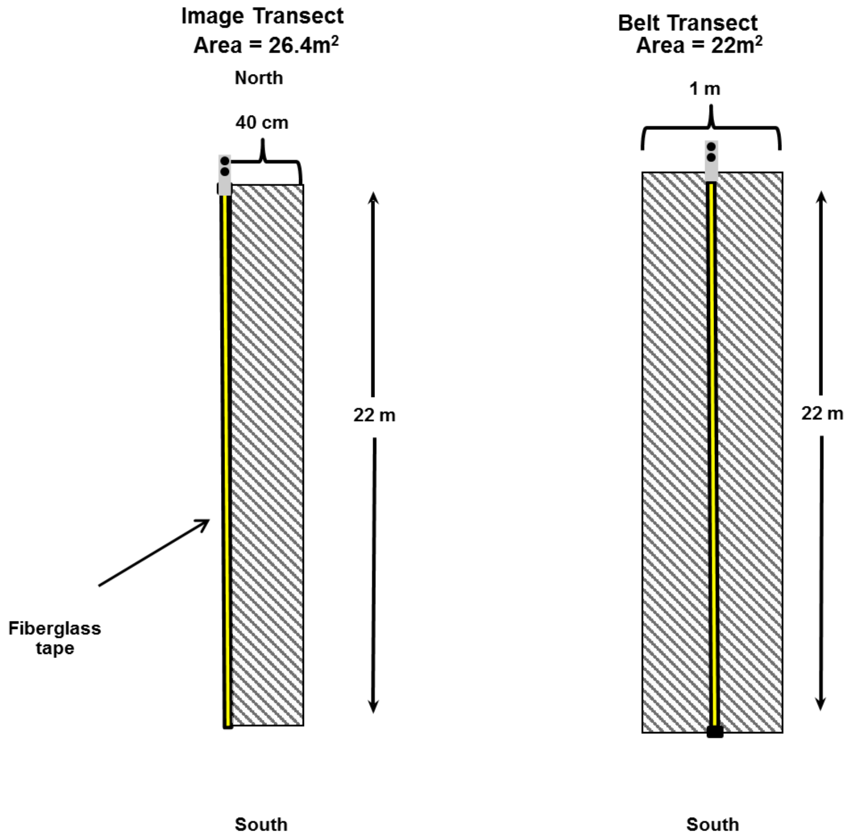

Figure 4. Layout of each SECREMP station showing the areas (hatched) within which the image and belt transect data were collected (note the gorgonian belt area is 1 m x 10 m).

In the lab, images were formatted for Point'ount '99 image analysis software. Fifteen random points were overlaid on each image, which is consistent with CREMP protocol. Underneath each point, select benthic taxa were identified to species (i.e., stony corals, *Gorgonia ventalina*, *Xestospongia muta*), genus (e.g., *Dictyota* spp., *Halimeda* spp., and *Lobophora* spp), or higher taxonomic levels (e.g. encrusting or branching octocoral, crustose coralline algae, zoanthid, sponge, and macroalgae). Uncolonized substrate was identified as sand or substrate (consolidated pavement or rubble). After all images were analyzed, the data were checked for quality assurance and entered into the Microsoft Access database managed by FWC.

Stony Coral Demographic Survey

Stony coral population surveys were performed at all site stations starting in 2013. Divers conducted a 1 m x 22 m belt transect from north to south along the transect tape identifying every stony coral colony to species (Figure 4). From 2013-2017, all colonies ≥ 4 cm in diameter were identified to species and the maximum diameter and the maximum height, perpendicular to the plane of growth, were measured. Each colony was then visually assessed for the presence of diseases, bleaching and other conditions (e.g., predation, damselfish, Clionaids etc.). Where these conditions resulted in partial mortality the percentage was visually estimated. Diseases include those with conditions that resulted in tissue mortality (i.e., Stony Coral Tissue Loss Disease (SCTLD) or black band disease) as well as conditions that may not visually result in tissue mortality (i.e., dark spot syndrome and tissue growth anomalies). Mortality was considered ‘‘recent’’ if the corallite structure was clearly distinguishable and there was minimal overgrowth by algae or other fouling organisms. Otherwise, mortality was classified as ‘‘old’’. In 2018, the minimum colony size for demographic data was reduced to ≥ 2 cm in diameter. Also starting in 2018, colonies < 2 cm were identified to lowest taxonomic level possible and tallied at each station. However, for this report, only colonies ≥ 4 cm in diameter were included in the demographic data analysis. All corals < 4 cm in diameter were presented as tallied data only. For *Millepora alcicornis* (fire coral) only colony presence or absence was recorded.

Octocoral Demographic Survey

Octocoral population surveys starting in 2013, were also conducted at all stations but covered a reduced survey area. Divers conducted a 1 m x 10 m belt transect starting at the northernmost stake for each station. Octocoral surveys were completed in two parts. First, all octocoral colonies within the belt transect were counted, regardless of species, to provide a measurement of overall octocoral density. Second, for three target species, *Antillogorgia americana* (formerly *Pseudopterogorgia americana*), *Eunicea flexuosa* (formerly *Plexaura flexuosa*), and *Gorgonia ventalina*, all colonies within the belt transect were recorded, the maximum height was measured and the colony was visually assessed for the presence of disease, bleaching and/or various other conditions (e.g., predation, overgrowths, etc.). These species were selected because they are generally more confidently distinguishable in the field and are relatively abundant in their preferred reef habitat along Florida’s Coral Reef. While colony conditions were assessed the condition data are not presented in this report.

Barrel Sponge Demographic Survey

A barrel sponge (*Xestospongia muta*) population survey, starting in 2013, was also conducted at each station. *Xestospongia muta* density was determined by counting all sponges within the 1 m x 22 m belt centered under the transect tape (Figure 4). For each sponge the maximum diameter, maximum base diameter, and maximum height were measured, and the sponge was visually assessed for the presence of disease, bleaching and other conditions (e.g., damage/injury, predation). The percent of the sponge affected by injury, disease, and/or bleaching was also recorded. Similar to octocorals, sponge conditions are not presented in this report.

Monitoring Site Temperature Record

The deployment of Onset (www.onsetcomp.com) temperature loggers has been part of the SECREMP sampling protocol since 2007. Temperature loggers were deployed at all existing sites annually and at new sites as they were established. Throughout the course of the project three models of temperature loggers have been deployed: StowAway TidbiT™, Hobo Pendant Temperature Data Logger, and Hobo Water Temp Pro v2. Two temperature recorders were deployed at each site and were replaced during each annual sampling event.

Two loggers were deployed at each site in order to provide redundancy in case one logger failed or was lost. The loggers were programmed to record data at a sampling interval of two hours. The two loggers were attached approximately 10 cm off the substrate to the ‘northern’ stakes identifying Stations 1 and 2 at each site. Data from both loggers were downloaded. If data from both loggers were successfully downloaded, the data from the logger attached to Station 1 was reported.

Analyses

To provide an additional metric to evaluate changes to the stony coral community (only colonies ≥ 4 cm diameter because colonies 2-4 cm were only first included in 2018), stony coral colony width, height, and percent mortality (sum of old and recent) were used to calculate total live tissue area (LTA) for each site for 2013-2022. Region-wide LTAs were also calculated for select stony coral species for 2013-2022. The LTA for each colony was calculated using the following equation:

$$SA = 2\pi\left(\frac{a^p\left(\frac{1}{2}b\right)^p + a^p\left(\frac{1}{2}b\right)^p + \left(\frac{1}{2}b\right)^p\left(\frac{1}{2}b\right)^p}{3}\right)^{\frac{1}{p}}$$

This equation was modified from Knud Thomsen’s formula for the estimated surface area (SA) of an ellipsoid. The original SA equation was multiplied by ½ to estimate the surface area of a coral as the equivalent of the top half of an ellipsoid. In this modified version a = maximum height of the colony, b = the maximum diameter of the colony, and p ≈ 1.6075, a constant yielding a relative error of at most 1.061%. Following calculation of the SA, the value was converted to LTA via the following formula:

$$LTA = SA\left(1 - \left(\frac{\%\ Old\ Mortality + \%\ Recent\ Mortality}{100}\right)\right)$$

Mortality was divided by 100 to convert to a proportion. Additionally, LTA was calculated in cm^2 and then converted to m^2.

Region-wide stony coral (colonies ≥ 4 cm diameter) density, LTA, and disease prevalence, octocoral density, and barrel sponge density were tested for differences between years 2013 – 2022. Additionally, stony coral species were grouped into SCTLD susceptibility groups, as defined in the SCTLD Case Definition (NOAA 2018). These groups included those species defined as ‘Highly Susceptible’, ‘Intermediately Susceptible’, ‘Low Susceptible’ and ‘Presumed Susceptible’ (NOAA 2018). These groups (High, Intermediate, Presumed, Low) were then examined for changes in LTA between years. Similar to stony corals, the three octocoral target species were tested for differences in density and mean height between years. For metrics meeting the assumptions of a repeated measures analysis of variance (ANOVA), the ANOVA was performed using the linear mixed-effects model (lme) and anova functions in the nlme (Pinheiro et al. 2017) and base R packages, respectively, in R (version 3.3.3 (2017-03-06)) (R Core Team 2017). The lme equation was “metric” ~ year with site as the repeated measure within Year. Following the lme function, the anova function was used to perform the ANOVA on the lme model. Significant differences between years for all metrics were identified by $p \leq 0.05$. For metrics analyzed via the lme and anova test and identified as significant, a general linear hypothesis (glht) and multiple comparisons "post-hoc" were performed to determine which years were significantly different. The "post-hoc" was performed using the glht function in the multcomp package (Hothorn et al. 2008) in R. Significant differences between years were identified by multiple comparison adjusted (Tukey single-step method) p-values ($p \leq 0.05$).

Region-wide stony coral disease prevalence was calculated for 2013 – 2022 (colonies ≥ 4 cm diameter). Regional prevalence was calculated by taking the total number of diseased stony coral colonies for the region and dividing it by the total number of all stony coral colonies and multiplying by 100% to get prevalence as a percent. Site level prevalence values were calculated by dividing the total number of diseased colonies within a site by the total number of colonies and multiplying by 100% to get prevalence as a percent. Disease was then grouped into SCTLD or Other, where Other consisted of all other diseases recorded within sample sites: black band disease, yellow band disease, dark spot disease, white band disease (for acroporids) and rapid tissue loss (for acroporids).

Temporal changes in percent cover were analyzed at the site level across multiple time periods. Because of high site to site variability in percent cover, statistical models that examine temporal changes by grouping data from multiple sites at various spatial scales (e.g., by region, subregion or habitat) can become complicated and difficult to fit. By limiting comparisons to the site level, the confounding effects of spatial variability are reduced and model estimates and statistical inference are strengthened. Changes occurring at the regional, subregional or habitat spatial levels can be drawn by evaluating the changes occurring at the sites within each spatial domain.

For all sites, the long-term analyses were conducted in one of two ways dependent upon inception of monitoring at a site. For the 10 sites dating back to 2003, survey data were blocked into two time intervals to compare benthic cover values at the inception of monitoring (2003-2005) versus a time period ten years after the start of SECREMP (2013-2015). A second series of analyses examined all 22 sites and compared benthic cover at this same midpoint and around the onset of SCTLD (2013-2015) to a post-SCTLD time period (2020-2022). Because many benthic taxa groups fluctuate in cover over time, fitting linear trends over 20- or 10-year project periods can be less informative because the trend can be heavily influenced by starting or ending points in the time series. Blocking the data into time intervals, as described herein, allows for two equally weighted comparisons that mark different points in time of the project. In addition, pooling survey data across multiple years lowers the influence of observer variability or ephemeral events and provides a more robust estimate on benthic condition during different snapshots in the 20 years of SECREMP monitoring. For short term analyses the same statistical approach was used but only single years were incorporated; 2021 compared to 2022.

For the analyses that evaluated changes the first 10 years of SECREMP (between 2003-2005 and 2013-2015), 10 sites that were first surveyed in 2003 (BC1, BC2, BC3, BCA, DC1, DC2, DC3, PB1, PB2, PB3) were compared. For the analyses that evaluated changes the most recent 10 years (between 2013-2015 and 2020-2022), sites first surveyed in 2006 (MC1, MC2) or in 2010 (PB4, PB5, DC4, DC5) or in 2013 (DC6, DC7, DC8, BC4, BC5, BC6) were included as well as the 10 original sites listed above. All sites were examined as part of the short-term analyses between 2021 and 2022.

For all comparisons the same statistical approach was used. All analyses were conducted using logistic regression in R 4.2.2 using the glmmTMB and the emmeans packages. All assigned random points identified in point count were included. Points were pooled for each year group in the two long-term analyses, or for individual years in the short-term analyses. Changes between year groups, or individual years, were examined for every site for each taxon (e.g., corals, sponges, octocorals, and macroalgae) with the stations within each site included as a random effect to account for the repeated measures survey design. Restricted Maximum likelihood (REML) was used as the estimation method for all models. To account for the multiple comparisons made when comparing different time periods, a Bonferroni adjustment was applied to the α value of 0.05 to reduce the potential for Type I errors. For the 10 sites that were included in the analysis of 2003-2005 versus 2013-2015 the α was adjusted to 0.005. For the 22 sites that were included in the analysis of 2013-2015 vs 2020-2022 the α was adjusted to 0.002273. For the short-term analyses, which also included all 22 sites, the α adjustment of 0.002273 was applied. This was a more conservative approach for identifying statistical differences for the two long-term analyses and the 2021 vs. 2022 comparisons. The R-code for analyses at each site is as follows.

```
glmmTMB(taxon ~ year grouping + (1|StationID), family = binomial(link = "logit"), site data, REML = T)
```

Year 20 (2022) Results

Stony Coral

When averaged across the region, stony coral cover has generally been decreasing across time (Figure 5). However, for the 10 sites evaluated between the 2003-2005 and the 2013-2015 time periods coral cover significantly increased at three sites, BC3, DC1 and DC2, significantly decreased at two sites, BCA and PB1, and was unchanged at five sites (Table 2, see Appendix 3 for site values and statistical p-values). While overall coral cover, averaged for all 10 sites, decreased from 5.59% ± 3.65% (SE) in the 2003-2005 period to 3.51% ± 0.19% in the 2013-2015 period, this change was primarily driven by the loss of coral cover at BCA. Cover at BCA decreased from 36.86% ± 1.70% in 2003-2005 to 11.33% ± 0.74% in 2013-2015. At PB1 coral cover also significantly decreased but was low to start, only averaging 0.50% ± 0.08% in 2003-2005. Beyond BCA and PB1, coral cover across the SECREMP region mostly increased from 2003-2005 to 2013-2015. Besides the three sites with significant gains in coral cover between the time periods, the five sites with no significant differences did show modest but insignificant increases in coral cover (Table 2, see Appendix 3 for site values and statistical p-values). The largest increase was observed at DC1 where cover increased from 2.35% ± 0.53% in 2003-2005 to 4.72% ± 1.00% in 2013-2015.

With the onset of observable SCTLD in 2014, the increase of coral cover at three of the original sites ceased and cover declined at most sites during the next 10 years. Between the 2013-2015 and the 2020-2022 time periods coral cover did not significantly increase at any site, it significantly declined at 15 of 22 sites and was unchanged at 7 sites (Table 2, see

Appendix 3 for site values and statistical p-values). Mean stony coral cover decreased across these time periods from 2.63% ± 0.69% in 2013-2015 to 1.28% ± 0.32% in 2020-2022. Most sites that had a significant decrease lost more than half of their stony coral coverage with the largest decreases observed at BC1, 12.12% ± 1.78% in 2013-2015 to 5.99% ± 0.96% in 2020-2022. BCA also had a large decrease, from 11.33% ± 0.74% in 2013-2015 to 4.43% ± 0.32% in 2020-2022. Of the seven sites that did not have a significant change in cover only two had cover above 1.00% in the 2013-2015 period, DC4 and DC8, and both decreased in cover, albeit not significantly.

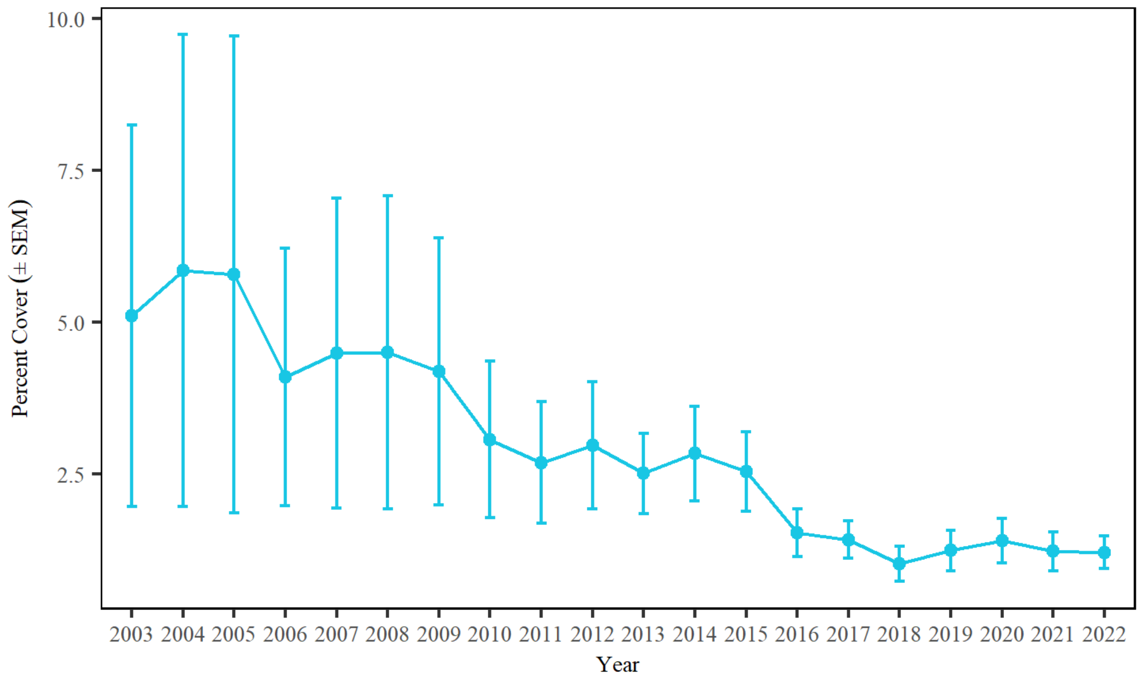

Figure 5. Mean stony coral percent cover (±SEM) for all sites combined

Over the last two years, coral cover was mostly stable. Short-term analyses (2021 vs. 2022) indicated a significant increase at one site, DC8, a significant decrease at one site, BCA, and no change at the other 20 sites (see Appendix 1 for region-wide and site mean values and Appendix 2 for statistical p-values). Mean coral cover, averaged for all sites was similar in both years; 1.23% ± 0.32% in 2021 and 1.21% ± 0.27% in 2022. At DC8 coral cover more than doubled from 0.48% ± 0.18% in 2021 to 1.14% ± 0.40% in 2022. At BCA coral cover decreased from 4.14% ± 0.67% in 2021 to 2.87% ± 0.48% in 2022 (see Appendix 1 for region-wide and site mean values and Appendix 2 for statistical p-values).

Regional live tissue area in 2017 (3.53 ± 1.09 m^2), 2018 (2.72 ± 1.01 m^2), 2019 (3.08 ± 1.08 m^2), 2020 (3.11 ± 1.03 m^2), 2021 (2.95 ± 0.96 m^2) and 2022 (3.16 ± 0.98 m^2) was significantly lower than the LTA in 2013 (6.11 ± 1.87 m^2), 2014 (6.38 ± 2.16 m^2), and 2015 (6.48 ± 2.38 m^2) (Figure 6, $p < 0.05$; see Appendix 4 for region-wide, site mean values and Appendix 5 for regional p-values). One site (PB2) had the lowest LTA recorded in 2020, four sites (BC1, DC8, PB1 and PB3) had their lowest recorded LTA in 2021, and no sites had their lowest recorded LTA in 2022 (Appendix 4). Ten sites (DC1, DC3, DC5, DC6, DC7, DC8, BC4, BC5, PB1, and PB3) had an increase in LTA from 2021 to 2022 of ≥ 5% (Appendix 4).

Table 2. Stony coral long term percent cover change for the 10 original SECREMP sites and the 22 current SECREMP sites. Increasing denotes the number of sites with a significant increase in cover, decreasing denotes the number of sites with significant increase and no change indicates sites that have not significantly changed between each time interval (2003-2005, 2013-2015, 2020-2022).

N	**Overall Mean 2003-2005**	**Overall Mean 2013-2015**	**Overall Mean 2020-2022**	**Increasing**	**Decreasing**	**No Change**
10	5.59% ± 3.65%	3.51% ± 0.19%		3	2	5
22		2.63% ± 0.69%	1.28% ± 0.32%	0	15	7

When comparing LTA between different groups of SCTLD susceptibility, only those species in the High and Intermediate Susceptibility groups had significant changes in regional LTA (linear mixed-effects model ANOVA: $p < 0.05$; see Appendix 5 for region-wide mean values and Appendix 6 for regional statistical p-values). Regional LTA for High Susceptibility was significantly lower in 2016 (0.59 ± 0.44 m^2), 2017 (0.57 ± 0.41 m^2), 2018 (0.03 ± 0.01 m^2), 2019 (0.04 ± 0.02 m^2), 2020 (0.04 ± 0.02 m^2), 2021 (0.04 ± 0.01 m^2) and 2022 (0.06 ± 0.01 m^2) than it was in 2013 (1.23 ± 0.35 m^2) and 2014 (1.14 ± 0.37 m^2); and 2019-2022 was significantly lower than in 2015 (0.93 ± 0.34 m^2) (Figure 7, linear mixed-effects model ANOVA: $p < 0.05$; see Appendix 5 for region-wide mean values and Appendix 6 for regional statistical p-values). Regional LTA for Intermediate Susceptibility was significantly lower in 2017 (2.13 ± 0.99 m^2), 2018 (1.83 ± 0.98 m^2), 2019 (1.90 ± 1.02 m^2), 2020 (1.90 ± 0.99 m^2), 2021 (1.79 ± 0.90 m^2) and 2022 (1.89 ± 0.90 m^2) than it was in 2015 (4.73 ± 2.39 m^2); and LTA in 2014 (4.28 ± 2.11 m^2) was significantly higher than in 2021 (Figure 8, linear mixed-effects model ANOVA: $p > 0.05$; see Appendix 5 for region-wide mean values and Appendix 6 for regional statistical p-values). For both the Presumed Susceptible and Low Susceptible species group, no significant change in regional LTA was identified across the study years (Figure 9, Figure 10 linear mixed-effects model ANOVA: $p > 0.05$; see Appendix 5 for region-wide mean values and Appendix 6 for regional statistical p-values).

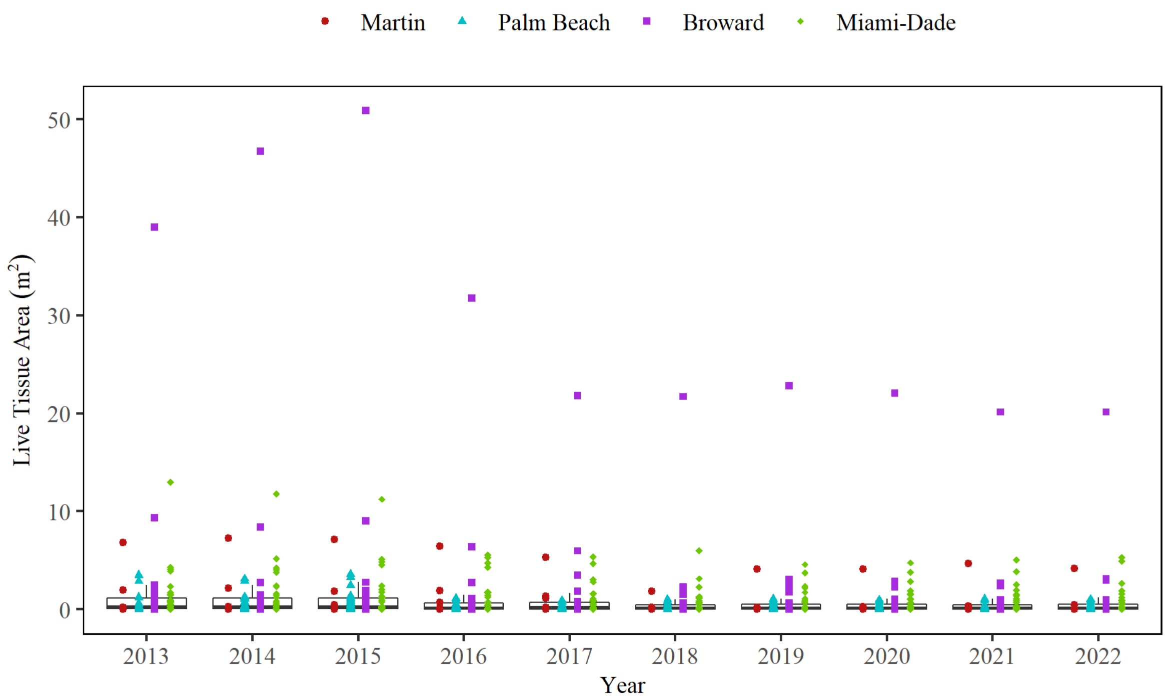

Figure 6. Live tissue area (LTA) for all stony corals summed by site (2013 – 2022). Each point is the LTA at a site colored by county. The middle bar in the boxplot is the median LTA for the region, the areas above and below the median, hinges, represent the 1st and 3rd quartiles, respectively. The whiskers, upper and lower, extend from the hinge to the largest value no greater than 1.5*IQR, where IQR is the inter-quartile range (distance between 1st and 3rd quartiles). Points lying beyond the whiskers are considered outliers. There was a significant LTA decrease in 2017, 2018, 2019, 2020, 2021, and 2022 compared to 2013, 2014 and 2015 (Tukey post-hoc: $p < 0.05$; see Appendix 4 for region-wide and site mean values and Appendix 6 for regional statistical p-values).

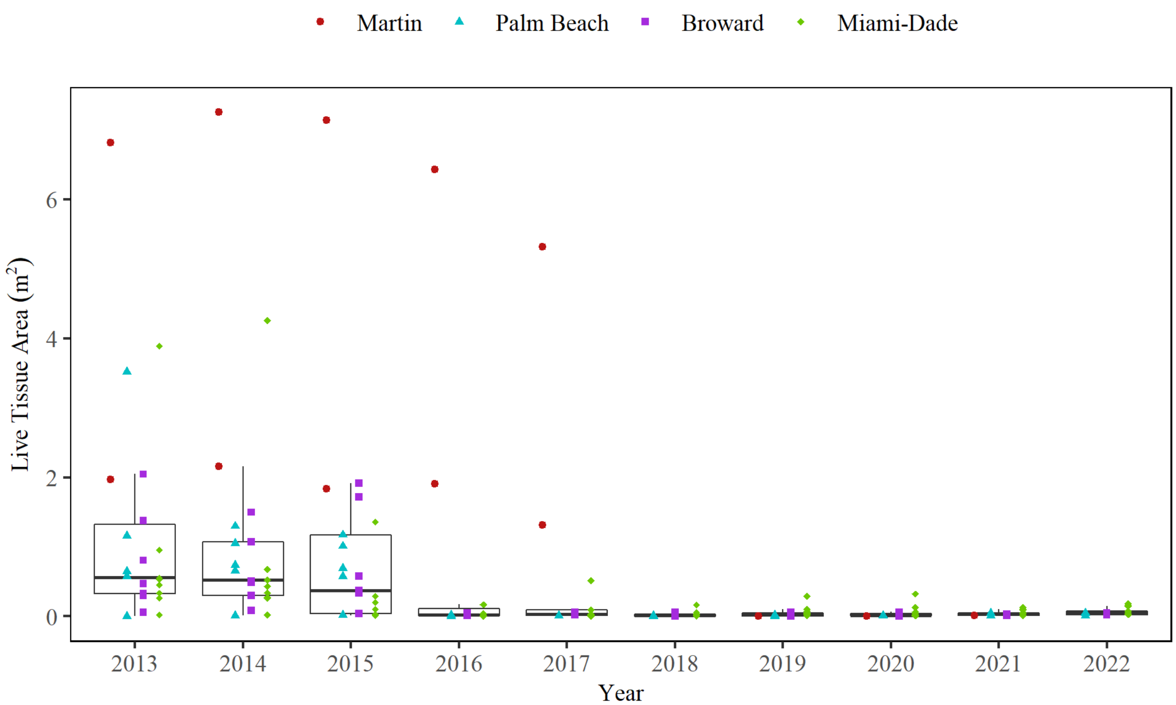

Figure 7. Highly SCTLD susceptible species regional LTA (2013 to 2022). Each point is the sum of the LTA at a site colored by county. For an explanation of the box and whisker components, see the caption for Figure 6. Only sites that contain the species were included. There was a significant LTA decrease in 2016, 2017, 2018, 2019, 2020, 2021 and 2022 compared to 2013 and 2014; additionally 2019-2022 LTA was significantly lower than in 2015 (Tukey post-hoc: $p < 0.05$; see Appendix 5 for species mean LTA values and Appendix 6 for statistical values).

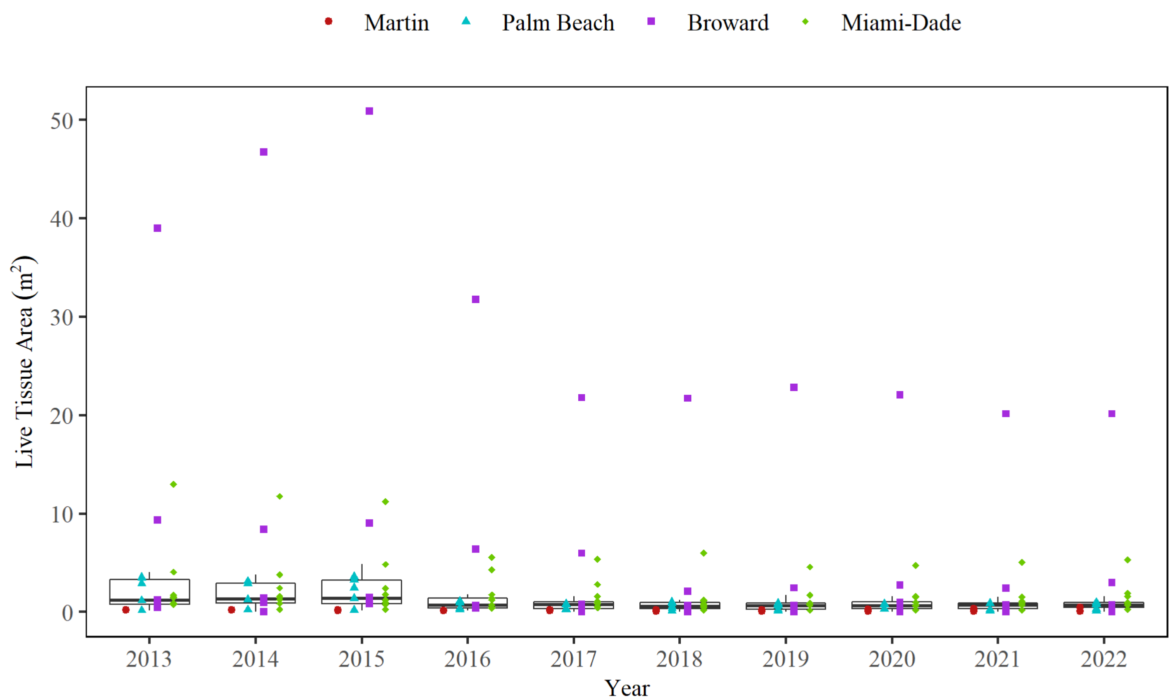

Figure 8. Intermediately SCTLD susceptible species regional LTA (2013 to 2022). Each point is the sum of the LTA at a site colored by county. For an explanation of the box and whisker components, see the caption for Figure 6. Only sites that contain the species were included. There was a significant LTA decrease in 2017, 2018, 2019, 2020, 2021, and 2022 compared to 2015; and LTA in 2021 was significantly lower than in 2014 (Tukey post-hoc: $p < 0.05$; see Appendix 5 for species mean LTA values and Appendix 6 for statistical values).

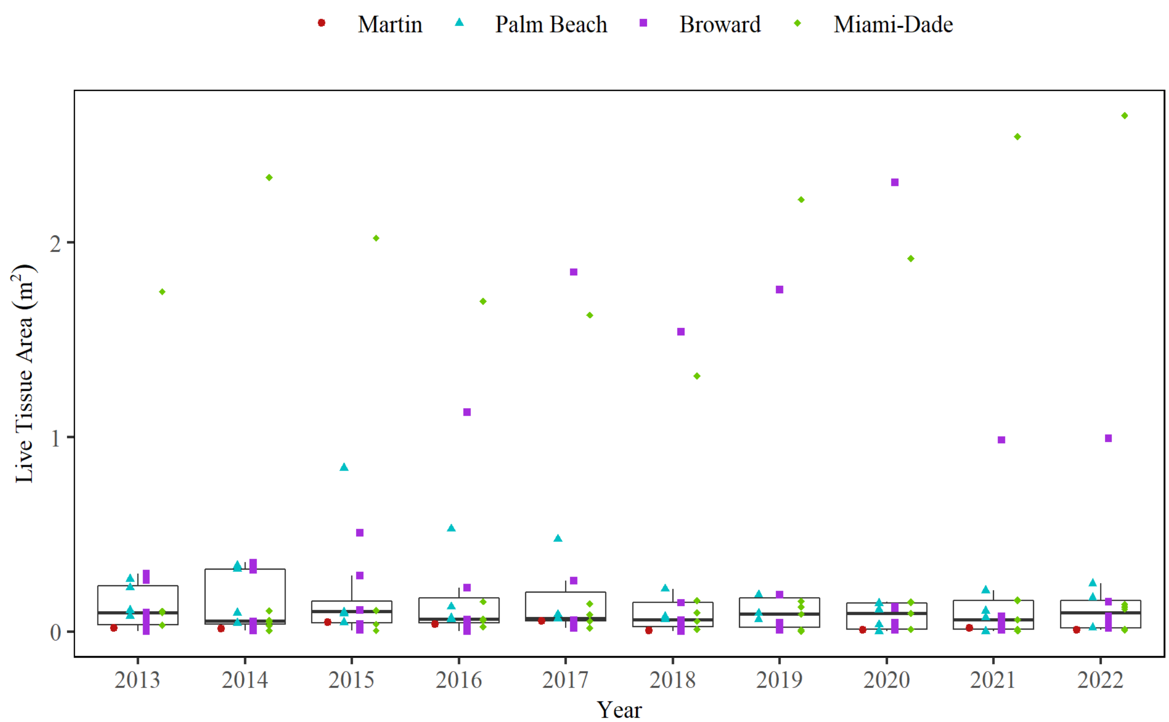

Figure 9. Presumed SCTLD susceptible species regional live tissue area from 2013 to 2022. Each point is the sum of the LTA at a site colored by county. For an explanation of the box and whisker components, see the caption for Figure 6. Only sites that contain the species were included. No significant change in LTA occurred across the study years (Tukey post-hoc: $p > 0.05$; see Appendix 5 for species mean LTA values and Appendix 6 for statistical values).

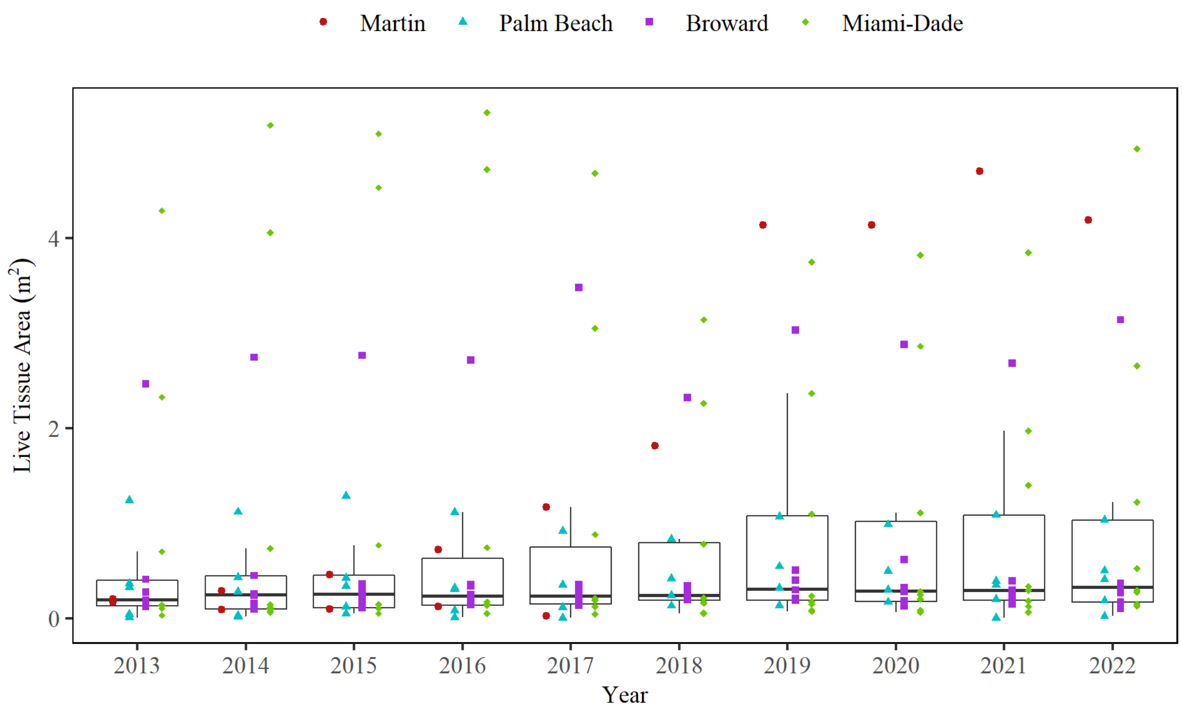

Figure 10. Low SCTLD susceptible species regional LTA from 2013 to 2022. Each point is the sum of the LTA at a site colored by county. For an explanation of the box and whisker components, see the caption for Figure 6. Only sites that contain the species were included. No significant change in LTA occurred across the study years (Tukey post-hoc: $p > 0.05$; see Appendix 5 for species mean LTA values and Appendix 6 for statistical values).

Figure 11 illustrates the site distribution of colony densities across the region for 2013-2022 (22 sites). The 2022 regional mean (±SE) stony colony density was 1.92 ± 0.36 colonies/m², the highest recorded density across study years, and was significantly higher than density in 2013 (1.21 ± 0.16 colonies/m²), 2014 (1.26 ± 0.18 colonies/m²), 2015 (1.29 ± 0.19 colonies/m²), 2016 (1.07 ± 0.17 colonies/m²), and 2017 (1.35 ± 0.25 colonies/m²) (repeated measure ANOVA: $p < 0.5$; see Appendix 7 for region and sites mean density values and Appendix 8 for statistical values). Density in 2022 ranged from a high of 5.69 ± 0.38 colonies/m² at site BC4 to a low of 0.45 ± 0.04 colonies/m² at site MC2 (see Appendix 7). While 14 sites had their lowest density in 2016, 2017 or 2018, 13 sites had their highest density recorded in 2021 or 2022 (Appendix 7).

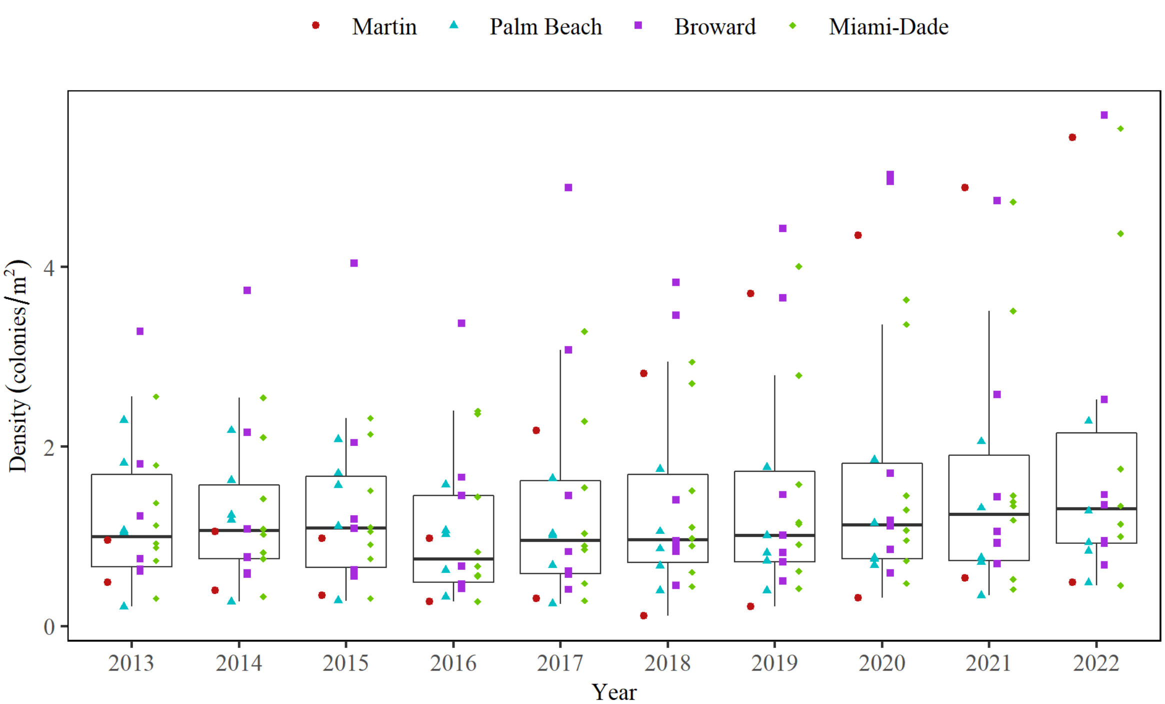

Figure 11. Region-wide stony coral density (colonies ≥ 4 cm) summed by site (2013 – 2022). Each point is the density at a site colored by county. See the caption for Figure 6 for explanation of the box and whisker components. Density in 2022 was significantly greater than in 2013-2017, density in 2020 and 2021 was significantly greater than in 2016 (Linear mixed-effects model: $p < 0.05$; see Appendix 7 for region and sites mean density values and Appendix 8 for statistical values).

Region-wide disease prevalence increased every year from 2013 to 2016 (Table 3). The greatest prevalence increase occurred from 2015 (1.4%) to 2016 (3.7%). Disease prevalence then dropped below 1% every year from 2017-2022, where it reached a low across the years surveyed of 0.2% in 2020 (Table 3). At the site level, 12 sites had their highest recorded disease prevalence in 2016, while four sites had their highest in 2015. By 2019, only three sites were recorded with active disease. In 2022, eight sites were recorded with disease, but prevalence at all sites was < 3% (Table 3). Changes in disease prevalence have been driven primarily by changes in SCTLD prevalence (Figure 12). Prevalence of SCTLD has varied across sites and counties; although SCTLD prevalence has remained low, it was still present in three of the four counties in 2022 (Figure 12). Prevalence of SCTLD was significantly higher in 2016 than in all other years see (Figure 12).

Table 3. Stony coral disease prevalence (%). Values are the percentage of total colonies identified with disease in each site and for the region values are the total number of diseased colonies for all sites combined divided by the total number of coral colonies for all sites.

Site	**2013 (%)**	**2014 (%)**	**2015 (%)**	**2016 (%)**	**2017 (%)**	**2018 (%)**	**2019 (%)**	**2020 (%)**	**2021 (%)**	**2022 (%)**
BC1	1.3	0.5	0.6	13.7	10.2	6.5	6.2	0.7	0.8	1.6
BC2	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	1.2	0.0
BC3	1.5	1.5	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0
BC4	2.1	0.9	0.6	1.7	0.5	0.6	0.0	0.5	0.0	0.4
BC5	0.9	4.2	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0
BC6	0.0	13.5	0.0	10.5	0.0	0.0	0.0	0.0	0.0	1.7
BCA	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.5	0.0	0.5
DC1	0.0	1.6	4.8	8.7	3.0	1.7	0.0	0.7	1.0	0.3
DC2	0.0	0.0	1.1	8.2	0.0	0.0	0.0	0.0	0.0	0.0
DC3	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
DC4	0.0	3.0	4.5	0.0	0.0	0.0	0.0	0.0	1.9	0.0
DC5	0.0	2.2	2.5	0.9	0.0	0.8	0.0	0.3	0.2	0.0
DC6	0.0	1.6	0.8	4.7	1.5	0.8	0.0	0.0	0.0	0.0
DC7	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.8	0.0
DC8	1.2	0.0	8.8	0.0	0.0	0.0	0.0	0.0	13.0	1.1
MC1	0.0	0.0	4.7	0.0	0.0	0.0	0.3	0.0	0.2	0.0
MC2	4.7	0.0	3.3	0.0	0.0	0.0	0.0	0.0	2.1	2.2
PB1	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	0.0
PB2	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
PB3	0.0	0.0	1.0	1.8	1.7	0.0	0.0	0.0	0.0	0.0
PB4	0.0	0.0	0.7	2.2	0.0	0.0	0.0	0.0	0.0	0.0
PB5	0.0	0.5	0.0	5.8	2.1	0.6	0.0	0.0	0.0	0.5
Region	0.6	1.2	1.4	3.7	1.1	0.8	0.4	0.2	0.5	0.3

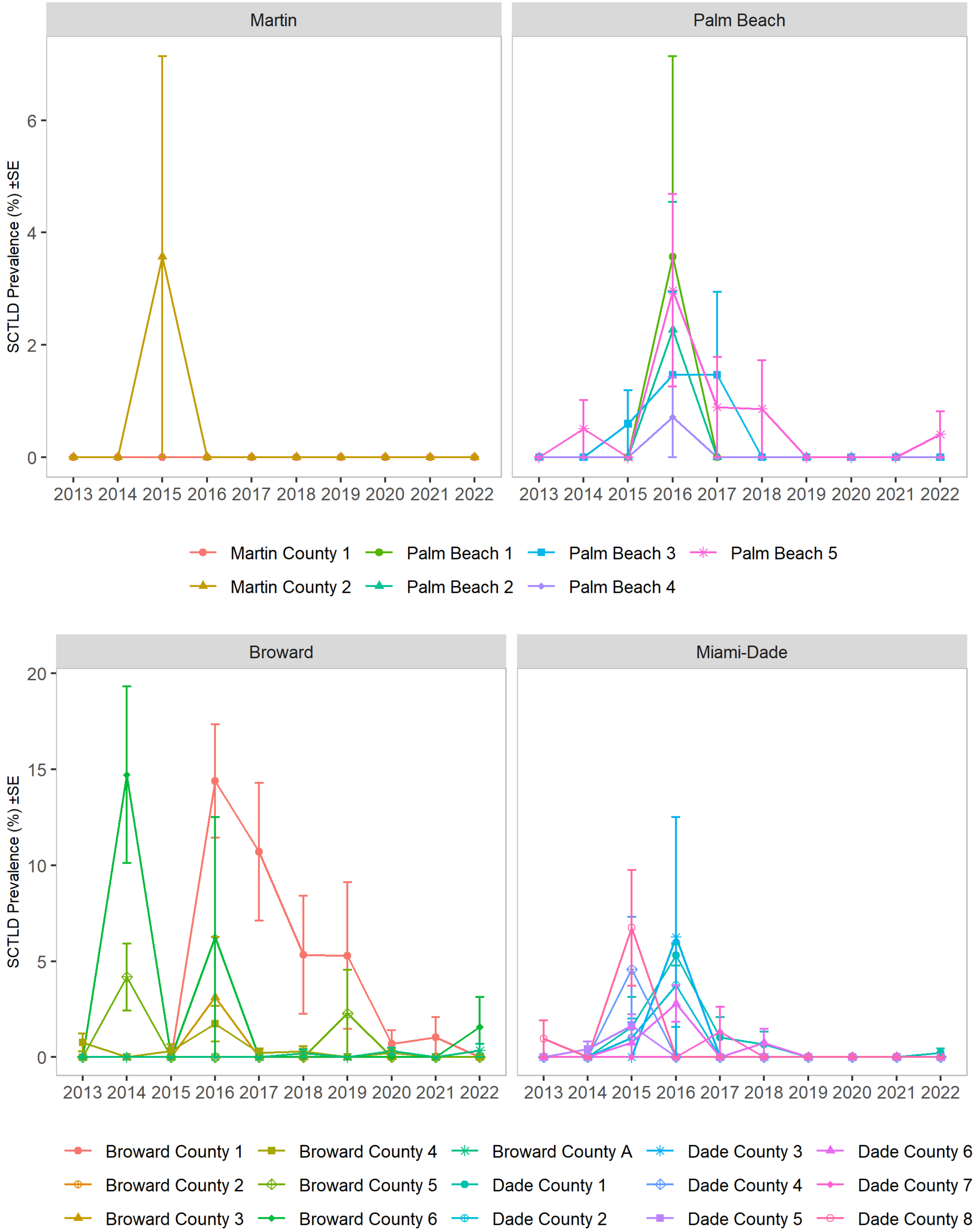

Figure 12. Mean (±SE) annual stony coral disease prevalence by site for SCTLD. Regional prevalence of SCTLD was significantly higher in 2016 than in all other years see (Linear mixed-effects model: $p < 0.05$; see Appendix 9 for statistical values).

A total of 3,292 stony coral colonies < 4 cm in maximum diameter were recorded across the 22 sites in 2022, which was higher than the total number in all previous years (2018-2021, Table 4). Across all years *Siderastrea siderea* was the most abundant species < 4 cm, with 2020 (1,926 colonies) having the highest number of *S. siderea* colonies < 4 cm since 2018. The next two most abundant species across the years surveyed were *Porites astreoides* and *Agaricia* spp. which in 2022 had 633 colonies and 263 colonies, respectively (Table 4). Of the colonies classified as High or Intermediate susceptibility to SCTLD within the dataset, all species had at least one colony < 4 cm identified region-wide across all years. *Montastraea cavernosa*, which was severely impacted by SCTLD, has shown an increasing number of colonies <4 cm (Table 4). Successful recruitment has also been observed for *Dichocoenia stokesii* and *Meandrina meandrites*, both highly susceptible SCTLD species (Table 4).

Table 4. Count of stony coral colonies < 4 cm diameter by year. The coral colonies are totaled by species and year, where identification occurred to the lowest taxonomic level possible.

Species or Genera	Colonies < 4 cm				
	2018	**2019**	**2020**	**2021**	**2022**
Acropora cervicornis	0	0	0	1	0
Agaricia spp.	162	325	375	190	263
Colpophyllia natans	1	0	1	1	2
Dichocoenia stokesii	33	21	27	24	23
Diploria labyrinthiformis	0	1	2	0	0
Eusmilia fastigiata	3	3	1	7	3
Helioseris cucullata	0	0	0	2	0
Isophyllia spp.	0	0	0	0	3
Madracis arenterna	16	5	3	3	2
Madracis decactis	7	6	5	10	6
Meandrina meandrites	14	12	8	9	5
Montastraea cavernosa	158	170	192	209	202
Mycetophyllia spp.	3	5	7	8	2
Oculina spp.	0	1	1	1	1
Orbicella spp.	0	0	0	0	1
Phyllangia americana	12	2	1	3	2
Porites astreoides	309	232	416	554	633
Porites porites	52	87	129	113	163
Pseudodiploria spp.	7	4	6	5	4
Scolymia spp.	1	8	5	5	8
Siderastrea spp.	1170	885	1926	1881	1844
Solenastrea bournoni	1	1	3	3	3
Stephanocoenia intersepta	122	94	110	106	120
Tubastraea coccinea	0	0	0	0	2
Scleractinia spp.	1	0	0	2	0
Total	2071	1862	3218	3137	3292

Octocoral

When averaged across the region, octocoral cover generally decreased through time (Figure 13). For the 10 sites evaluated between the 2003-2005 and the 2013-2015 time periods octocoral cover significantly increased at two sites, DC1 and BCA, significantly decreased at seven sites, BC2, BC3, DC2, DC3, PB1, PB2 and PB3, and was unchanged at one site (Table 5, see Appendix 3 for site values and statistical p-values). Mean octocoral cover, averaged for 10 sites, decreased from 12.01% ± 2.94% in 2003-2005 to 8.63% ± 0.38% in 2013-2015. The largest increase in cover occurred at DC1 where octocoral cover increased from 6.26% ± 0.46% in the 2003-2005 time period to 9.95% ± 0.63% in the 2013-2015 time period. The largest declines in octocoral cover were among the three Palm Beach sites. At PB3 cover changed from 28.27% ± 1.44% in 2003-2005 to 12.32% ± 0.78% in 2013-2015 (Table 5, see Appendix 3 for site values and statistical p-values). Similar decreases were observed at PB2 and PB1, and even though PB1 had much lower octocoral cover in 2003-2005, cover was nearly zero in 2013-2015, the lowest of the 10 sites analyzed across these time periods.

During the last 10 years octocoral cover has declined at most sites. Between the 2013-2015 and the 2020-2022 time periods, octocoral cover significantly increased at three sites, significantly decreased at 11 and was unchanged at six of 20 sites (Table 5,see Appendix 3 for site values and statistical p-values). Octocoral cover was not analyzed for the Martin County sites because octocorals are absent or extremely rare at these sites. For the ten sites that were first surveyed in 2003, three significantly increased, four significantly decreased and three were unchanged between the 2013-2015 and 2020-2022 time periods. While all three sites that significantly increased from 2013-2015 to 2020-2022 were sites first surveyed in 2003, none of these sites continued to increase in cover between the 2003-2005 and 2013-2015 comparisons. For most of the 10 sites, there does not appear to be a correlation with changes observed in the earliest comparison (2003-2005 vs. 2013-2015) and the more recent comparison (2013-2015 vs. 2020-2022). Only two sites that decreased in octocoral cover in the first 10 years, DC2 and PB2, decreased again between the 2013-2015 and 2020-2022 time periods. Mean octocoral cover, averaged for 20 sites, decreased from 9.52% ± 1.26% in 2013-2015 to 8.34% ± 1.06% in 2020-2022. The largest increase in octocoral cover occurred at DC3 where cover increased from 8.37% ± 0.96% in 2013-2015 to 10.03% ± 1.13% in 2020-2022. The largest declines in octocoral cover were at DC8 and PB4 which fell from 14.21% ± 1.10% to 9.11% ± 0.77% and 20.46% ± 1.36% to 15.39% ± 1.10%, respectively between the 2013-2015 and 2020-2022 time periods (Table 5).

Over the last two years (2021 and 2022) octocoral cover was mostly stable but did significantly increase at three sites, BC4, BCA and DC5, significantly decreased at one site, BC6, and was unchanged at 16 sites (see Appendix 1 for region wide and site mean values and Appendix 2 for statistical p-values). Mean octocoral cover, averaged for all 20 sites between the two years was similar (8.50% ± 1.12% in 2021 and 8.44% ± 1.11% in 2022). Between years, the largest increase in octocoral cover was at DC5, where cover increased from 11.38% ± 0.90% in 2021 to 17.46% ± 1.21% in 2022. At BC6 octocoral cover decreased from 14.45% ± 1.44% in 2021 to 8.92% ± 0.97% in 2022 (see Appendix 1 for region-wide and site mean values and Appendix 2 for statistical p-values).

Figure 13. Mean octocoral percent cover (±SEM) for all sites combined.

Table 5. Octocoral long term percent cover change for the 10 original SECREMP sites (N=10) and the 20 of the 22 current SECREMP sites (N=20). Both Martin County sites (MC1 and MC2) were not included because all values were zero. Increasing denotes the number of sites with a significant increase in cover, decreasing denotes the number of sites with significant increase and no change indicates sites that have not significantly changed between each time interval (2003-2005, 2013-2015, 2020-2022).

N	Overall Mean 2003-2005	Overall Mean 2013-2015	Overall Mean 2020-2022	Increasing	Decreasing	No Change
10	12.01% ± 2.94%	8.63% ± 0.38%		2	7	1
20		9.52% ± 1.26%	8.34% ± 1.06%	3	11	6

The 2022 regional mean (±SEM) octocoral colony density was 12.14 ± 1.60 colonies/m² (Figure 14). Density in 2022 ranged from a high of 27.05 ± 1.21 colonies/m² at site PB5 to a low of 0 colonies/m² at site MC1 and MC2. Regional octocoral colony density increased every year from 2013 to 2017, peaking in 2017 at 12.58 ± 1.85 colonies/m², with the first regional decrease in density recorded in 2018 where density was 10.36 ± 1.50 colonies/m². Mean regional octocoral density then peaked 14.05 ± 2.01 colonies/m² in 2020, decreasing slightly in 2021 (13.23 ± 1.87 colonies/m²) and further in 2022. A region-wide significant change in octocoral colony density was identified between years (Linear mixed-effects model: $p > 0.05$; see Appendix 7 for region and sites mean density values and Appendix 8 for statistical values). Following the linear mixed-effects model ANOVA, pairwise comparisons indicated 2015 (11.52 ± 1.76 colonies/m²), 2016 (11.85 ± 1.83 colonies/m²), 2017, 2019 (11.57 ± 1.61 colonies/m²), 2020, 2021 and 2022 had significantly higher densities than 2013 (8.68 ± 1.34 colonies/m²). Additionally, 2017, 2020, 2021 and 2022 had significantly higher densities than in 2014 (9.97 ± 1.55 colonies/m²), and density in 2018 (10.41 ± 1.50 colonies/m²) was significantly lower than in 2017 and 2021. Density in 2020 was significantly higher than in 2015, 2016, 2018, and 2019 (glht Tukey post-hoc: $p < 0.05$; see Appendix 8 for statistical p-values).

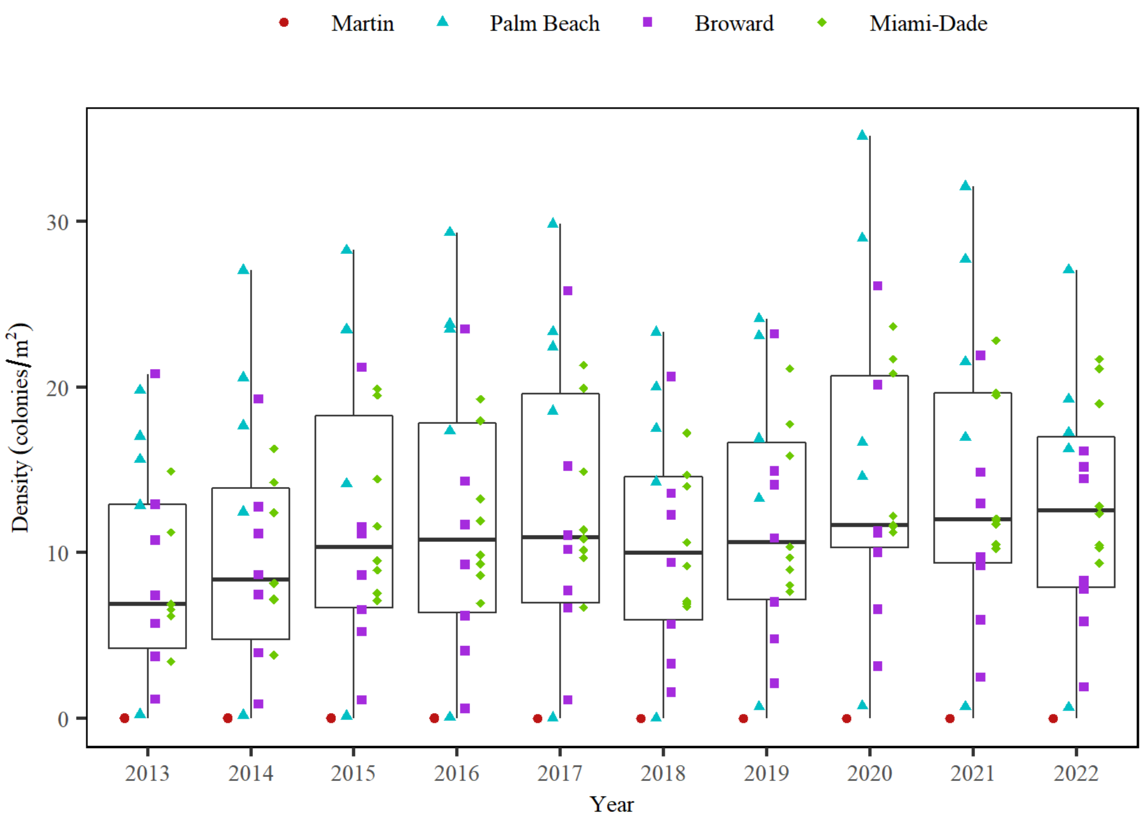

Figure 14. Region wide octocoral density (colonies/m²) distribution from 2013 to 2022. Each point is the density at a site colored by county. For an explanation of the box and whisker components, see the caption for Figure 6. Density in 2013 was significantly lower than 2015-2017 and 2019-2022; density in 2014 was significantly lower than in 2017 and 2020-2022. Density in 2017 and 2021 was significantly higher than in 2018, density in 2020 was significantly higher than 2015, 2016, 2018 and 2019 (Tukey post-hoc: $p < 0.05$; see Appendix 8 for statistical p-values).

None of the three octocoral target species (*A. americana*, *E. flexuosa*, and *G. ventalina*) were identified at either of the Martin County sites (MC1 and MC2). In 2022, regional *Antillogorgia americana* density (2.61 ± 0.45 colonies/m^2) was the greatest of the three species followed by *E. flexuosa* (0.78 ± 0.26 colonies/m^2) and *G. ventalina* (0.36 ± 0.08 colonies/m^2) (Appendix 9). *Eunicea flexuosa* (Figure 15) density peaked in 2015 and has been variable across years; however, no years were found to be significantly different from each other (linear mixed-effects model ANOVA & glht Tukey post-hoc: $p > 0.05$; see Appendix 9 for octocoral mean density values and Appendix 10 statistical p-values). *Gorgonia ventalina* (Figure 16) had significantly higher colony density in 2020 (0.35 ± 0.09 colonies/m^2), 2021 (0.41 ± 0.09 colonies/m^2) and 2022 (0.36 ± 0.08 colonies/m^2) than in 2013 (0.21 ± 0.05 colonies/m^2), and density in 2021 was also significantly higher than in 2014 (0.24 ± 0.05 colonies/m^2) (linear mixed-effects model ANOVA & glht Tukey post-hoc: $p < 0.05$; see Appendix 9 for octocoral mean density values and Appendix 10 statistical p-values). *Antillogorgia americana* (Figure 17) had significantly higher colony density in 2020 (2.54 ± 0.45 colonies/m^2), 2021 (2.64 ± 0.45 colonies/m^2), and 2022 (2.61 ± 0.45 colonies/m^2) than in 2013 (1.36 ± 0.24 colonies/m^2), 2014 (1.39 ± 0.26 colonies/m^2), 2015 (1.71 ± 0.28 colonies/m^2), 2016 (1.79 ± 0.31 colonies/m^2), 2017 (1.80 ± 0.31 colonies/m^2), and 2018 (1.70 ± 0.30 colonies/m^2). Additionally, density in 2019 (1.98 ± 0.37 colonies/m^2) was significantly higher than in 2013 and 2014; however, density in 2019 was significantly lower than in 2021 and 2022 (linear mixed-effects model ANOVA & glht Tukey post-hoc: $p < 0.05$; see Appendix 9 for octocoral mean density values and Appendix 10 statistical p-values).

Colony height in 2021 (13.0 ± 0.6 cm) and 2022 (13.9 ± 0.7 cm) was significantly lower than in 2013 (18.3 ± 1.1 cm) and 2018 (17.6 ± 0.9 cm) for *G. ventalina* (Figure 18; linear mixed-effects model ANOVA: $p < 0.05$; see Appendix 11 for target species mean heights and Appendix 12 for statistical p-values). Colony height for *E. flexuosa* was significantly lower in 2015 (21.5 ± 0.6 cm), 2020 (20.3 ± 0.5 cm), 2021 (20.9 ± 0.5 cm) and 2022 (20.6 ± 0.5 cm) compared to 2013 (24.9 ± 0.6 cm), and 2014 (24.4 ± 0.7 cm); additionally, height in 2020 (20.3 ± 0.5 cm) was significantly lower than in 2017 (22.9 ± 0.5 cm) and 2018 (Figure 18; linear mixed-effects model ANOVA: $p < 0.05$; see Appendix 11 for target species mean heights and Appendix 12 for statistical p-values). *Antillogorgia americana* colony height was significantly higher in 2013 (27.1 ± 0.5 cm) compared to all other years; height in 2014 (25.1 ± 0.5 cm) and 2016 (23.8 ±0.4 cm) was significantly higher than in 2018 (21.8 ± 0.5 cm), 2019 (19.1 ± 0.4 cm), 2020 (17.9 ± 0.3 cm), 2021 (19.3 ± 0.3 cm) and 2022 (20.9 ± 0.3 cm). Height in 2015 (23.2 ± 0.5 cm), 2017 (23.3 ± 0.4 cm) and 2018 was significantly higher than in 2019-2022; however, height in 2022 was significantly higher than in 2020 and 2021 (Figure 18; linear mixed-effects model ANOVA: $p < 0.05$; see Appendix 11 for target species mean heights and Appendix 12 for statistical p-values).

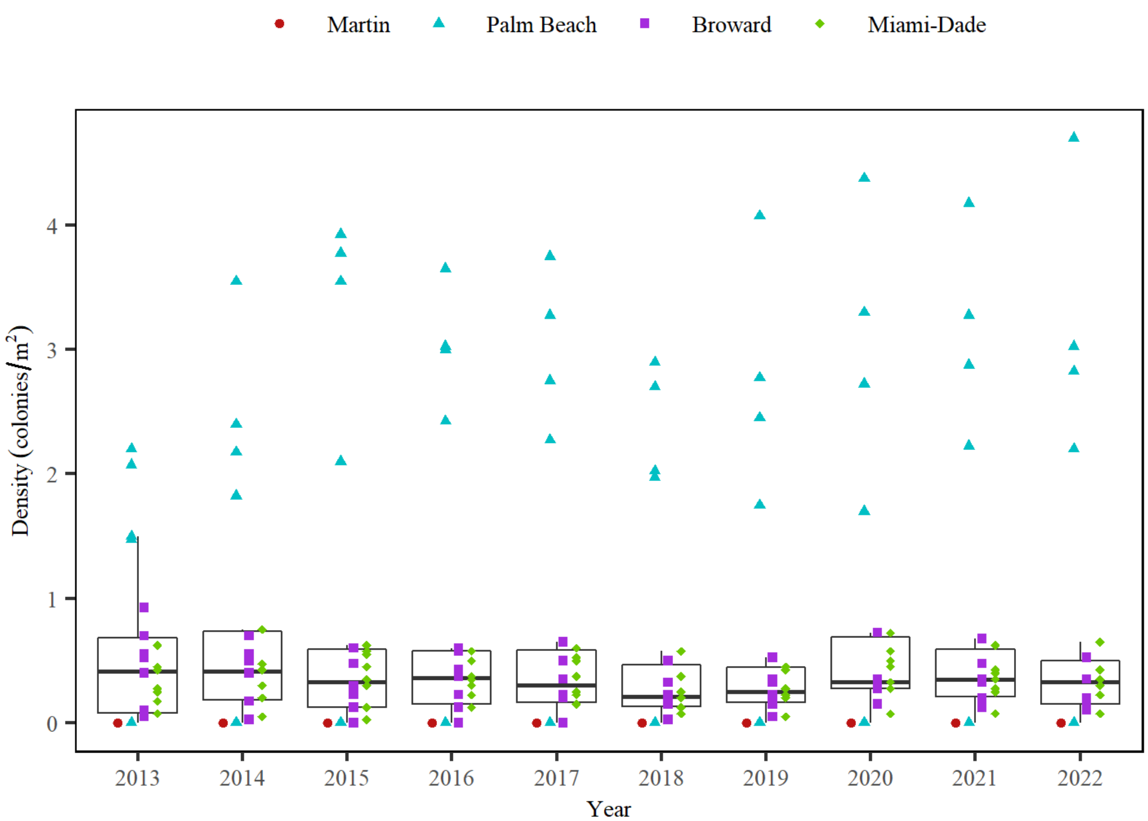

Figure 15. *Eunicea flexuosa* regional density (colonies/m^2) distribution from 2013 to 2022. Each point is the density at a site colored by county. For an explanation of the box and whisker components see the caption for Figure 6. An overall significant difference in density was identified, however there was no significant difference between years (Tukey post-hoc: $p < 0.05$; see Appendix 10 for statistical p-values).

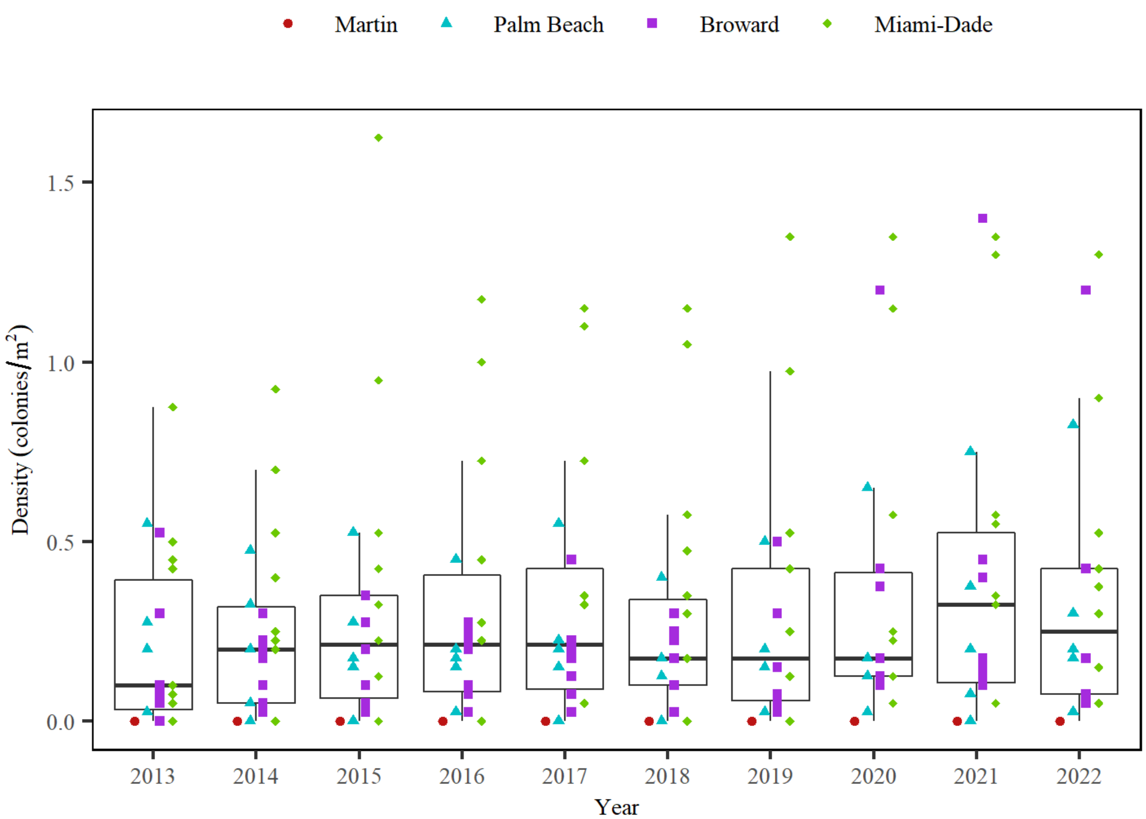

Figure 16. *Gorgonia ventalina* regional density (colonies/m^2) distribution 2013 to 2022. Each point is the density at a site colored by county. For an explanation of the box and whisker components, see the caption for Figure 6. Density in 2020-2022 was significantly higher than in 2013; density in 2021 was significantly higher than in 2014 (Tukey post-hoc: $p < 0.05$; see Appendix 10 for statistical p-values).

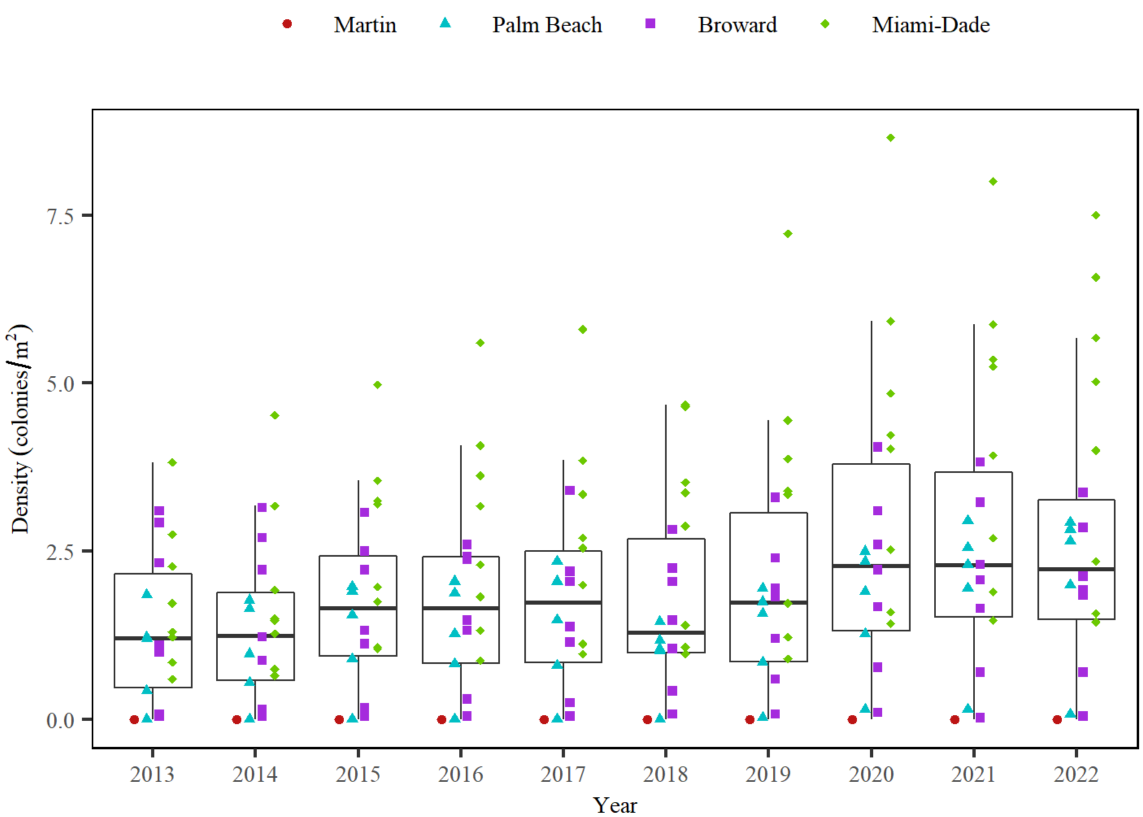

Figure 17. *Antillogorgia americana* regional density (colonies/m^2) distribution 2013 to 2022. Each point is the density at a site colored by county. For an explanation of the box and whisker components please see the caption for Figure 6. Density in 2020-2022 was significantly higher than in 2013-2018; density in 2019 was significantly higher than 2013 and 2014 but significantly lower than 2021 and 2022 (Tukey post-hoc: $p < 0.05$; see Appendix 10 for statistical p-values).

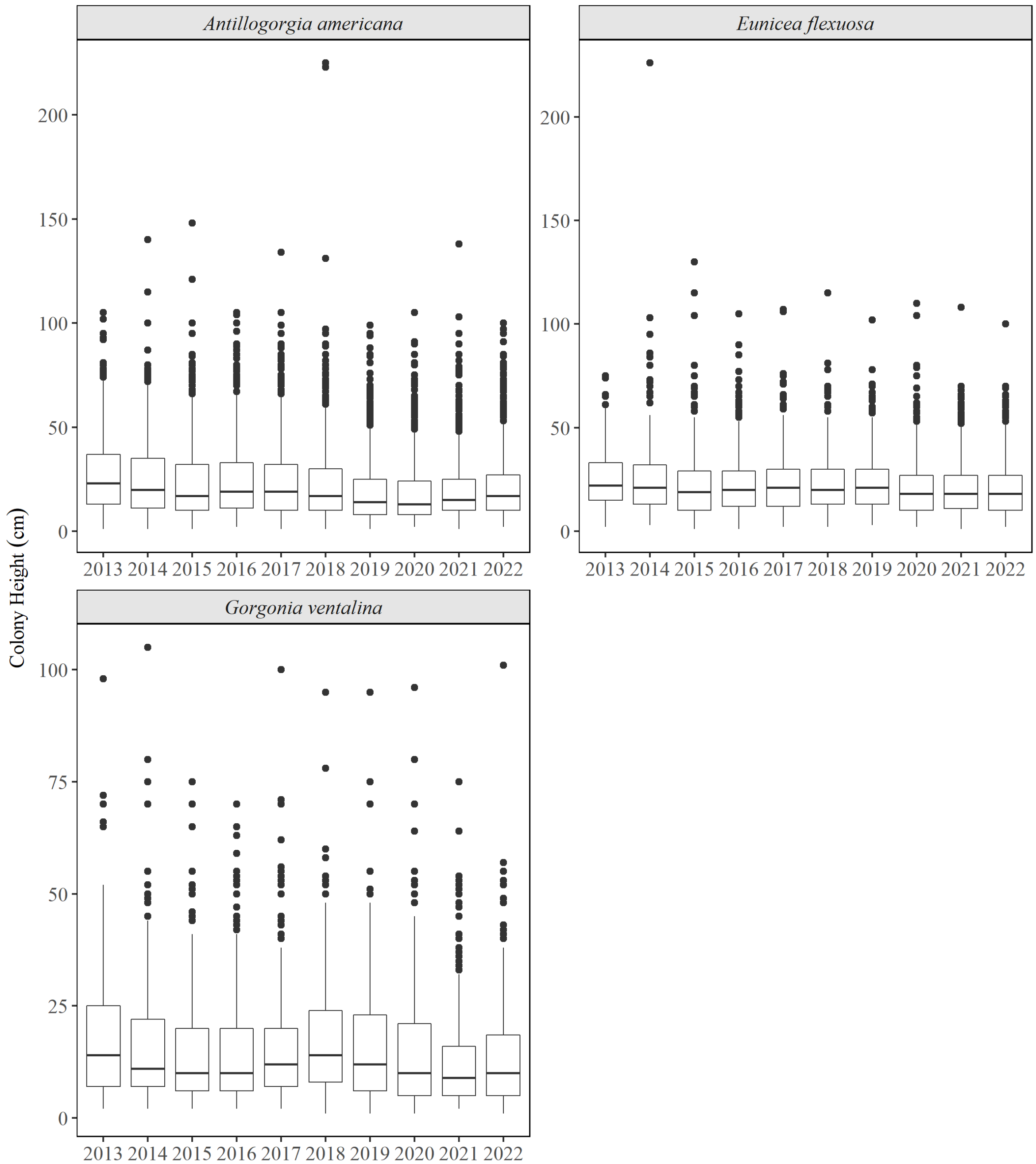

Figure 18. Octocoral target species colony height distribution 2013 to 2022. The middle bar in the boxplot is the median height for the region, the areas above and below the median, hinges, represent the 1st and 3rd quartiles, respectively. The whiskers, upper and lower, extend from the hinge to the largest value no greater than 1.5*IQR, where IQR in the inter-quartile range (distance between 1st and 3rd quartiles). Points lying beyond the whiskers are considered outliers.

Barrel Sponge (*Xestospongia muta*)

A significant region-wide change in *X. muta* density (Figure 19) was identified, where 2013 (0.24 ± 0.05 sponges/m²) was significantly lower than 2015 (0.30 ± 0.06 sponges/m²), 2016 (0.31 ± 0.06 sponges/m²), 2017 (0.35 ± 0.06 sponges/m²), 2019 (0.32 ± 0.06 sponges/m²), 2020 (0.32 ± 0.06 sponges/m²), 2021 (0.31 ± 0.06 sponges/m²) and 2022 (0.36 ± 0.06 sponges/m²). Additionally, 2017 was significantly higher than 2014 (0.28 ± 0.06 sponges/m²) and 2018 (0.28 ± 0.05 sponges/m²). Density in 2022 was significantly higher than in 2014, 2015 and 2018 (Linear mixed-effects model ANOVA: $p < 0.05$; see Appendix 7 or region mean values and Appendix 8 for statistical p-values). *Xestospongia muta* were identified at all sites in 2022 except those on the nearshore ridge complex habitat: MC1, MC2, PB1, DC6, and DC8. The three sites with the highest densities in 2022 were all located in Palm Beach County (PB5: 0.78 ± 0.11 sponges/m²; PB3: 0.78 ± 0.09 sponges/m²; and PB4: 0.73 ± 0.07 sponges/m²), and eight sites had densities greater than 0.5 sponges/m² (see Appendix 7 for site mean values).

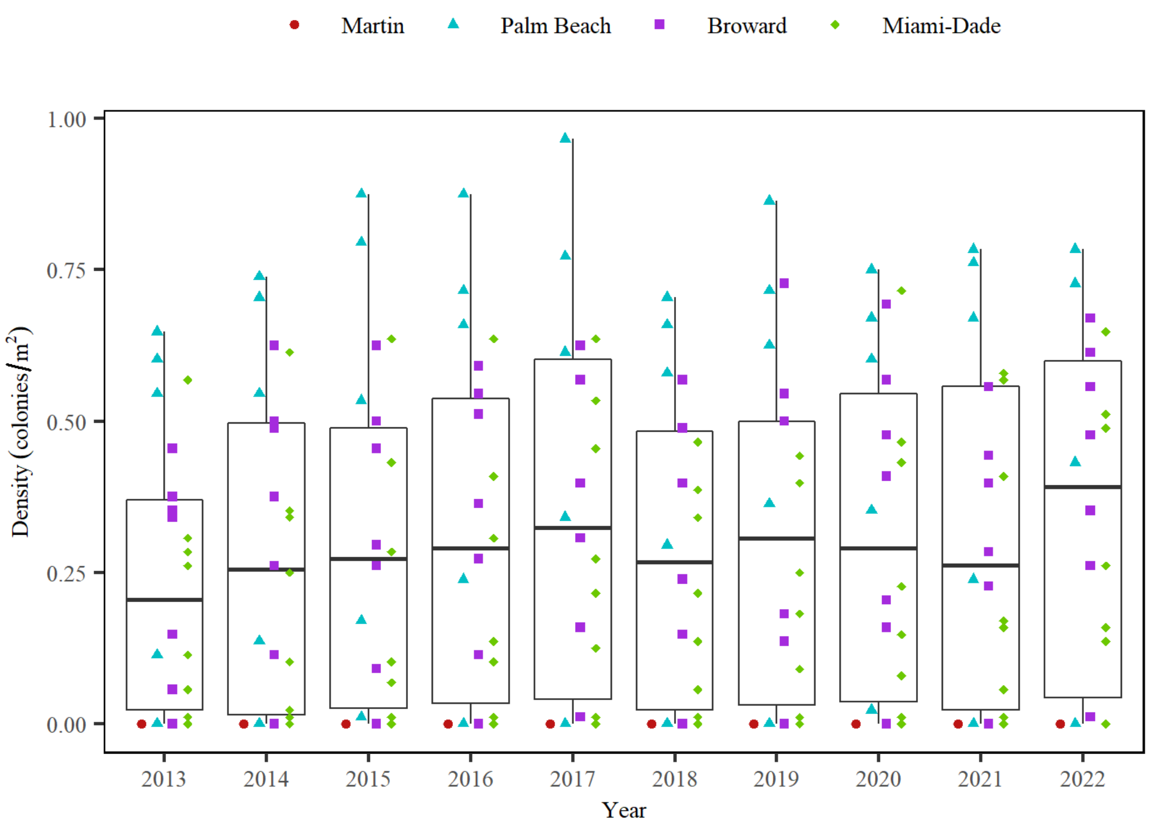

Figure 19. *Xestospongia muta* regional density (sponges/m²) distribution 2013 to 2022. Each point is the density at a site colored by county. For an explanation of the box and whisker components, see the caption for Figure 6. Density in 2013 was significantly lower than 2015, 2016, 2017, and 2019-2022; 2017 was significantly higher than 2014 and 2018. Density in 2022 was significantly higher than in 2014, 2015 and 2018 (Tukey post-hoc: $p < 0.05$; see Appendix 7 for region mean values and Appendix 8 for statistical p-values).

Sponge and Macroalgae Percent Cover

Macroalgal cover significantly increased at most sites in both long-term comparisons. Macroalgal cover is the most variable among the four major taxa and can fluctuate wildly from year to year due to ephemeral events like upwelling or localized weather patterns that may increase rainfall and the input of nutrients. (Figure 20). For the 2003-2005 time period macroalgal cover was low; all but one site had macroalgal cover below 5.0% (Table 6, see Appendix 3.for site values and statistical p-values). For the 10 sites evaluated between the 2003-2005 and the 2013-2015 time periods macroalgal cover significantly increased at eight sites, BC1, BC2, BC3, BCA, DC3, PB1, PB2 and PB3, significantly decreased at one site, DC1, and was unchanged at one site, DC2 (Table 6, see Appendix 3.for site values and statistical p-values). Mean macroalgal cover, averaged for the 10 sites, increased from 4.36% ± 1.78% in 2003-2005 to 5.50% ± 0.26% in 2013-2015. The largest increase in macroalgal cover occurred at BC1, where cover increased from 4.73% ± 0.76% in 2003-2005 to 9.77% ± 1.44% in 2013-2015. The only site with a significant decrease in cover wasDC1, which was the only site with macroalgae cover above 5.0% during the 2003-2005 time period. Cover at DC1 decreased from 19.34% ± 1.92% in 2003-2005 to 7.22% ± 0.84% in 2013-2015 (Table 6, see Appendix 3.for site values and statistical p-values).

Macroalgal cover increased at nearly all sites during the last 10 years. Between the 2013-2015 and the 2020-2022 time periods macroalgal cover significantly increased at 18 of 22 sites, significantly decreased at two sites, MC1 and MC2, and was unchanged at two sites, DC5 and PB5 (Table 6, see Appendix 3.for site values and statistical p-values). All ten sites first surveyed in 2003 increased in macroalgae cover between the 2013-2015 and the 2020-2022 time periods. These significant increases were in addition to the rise in macroalgal cover at eight sites during the first 10 years. Mean macroalgae cover, averaged for 22sites increased from 10.19% ± 1.87% in 2013-2015 to 18.76% ± 1.58% in 2020-2022. The largest increase in macroalgal cover occurred at DC6, where cover increased from 10.79% ± 0.55% in 2013-2015 to 41.82% ± 1.29% in 2020-2022. While not all increases in macroalgal cover were as substantial as at DC6, many sites more than doubled in macroalgal cover from 2013-201l to 2020-2022. The only two sites that declined in macroalgae cover were the two Martin County sites (Table 6, see Appendix 3.for site values and statistical p-values).

Over the last two years (2021 and 2022) macroalgal cover significantly increased at five sites, DC4, DC7, DC8, MC1, and PB4, significantly decreased at ten sites and was similar at seven (see Appendix 1 for region wide and site mean values and Appendix 2 for statistical p-values). Mean macroalgal cover, averaged for 22 sites, decreased from 20.27% ± 1.96% in 2021 to 17.66% ± 1.86% in 2022. The largest increase occurred at DC8 where cover increased from 0.58% ± 0.23% in 2021 to 12.26% ± 3.76% in 2022. The largest decrease occurred at PB1, where cover decreased from 25.59% ± 1.86% in 2021 to 4.55% ± 0.53% in 2022 (see Appendix 1 for region wide and site mean values and Appendix 2 for statistical p-values). Even though more sites declined in macroalgal cover than increased in the short-term analyses, the majority of sites significantly increased in both of the long-term comparisons. Due to the ephemeral nature of many macroalgae species year to year declines may not reflect longer term trends.

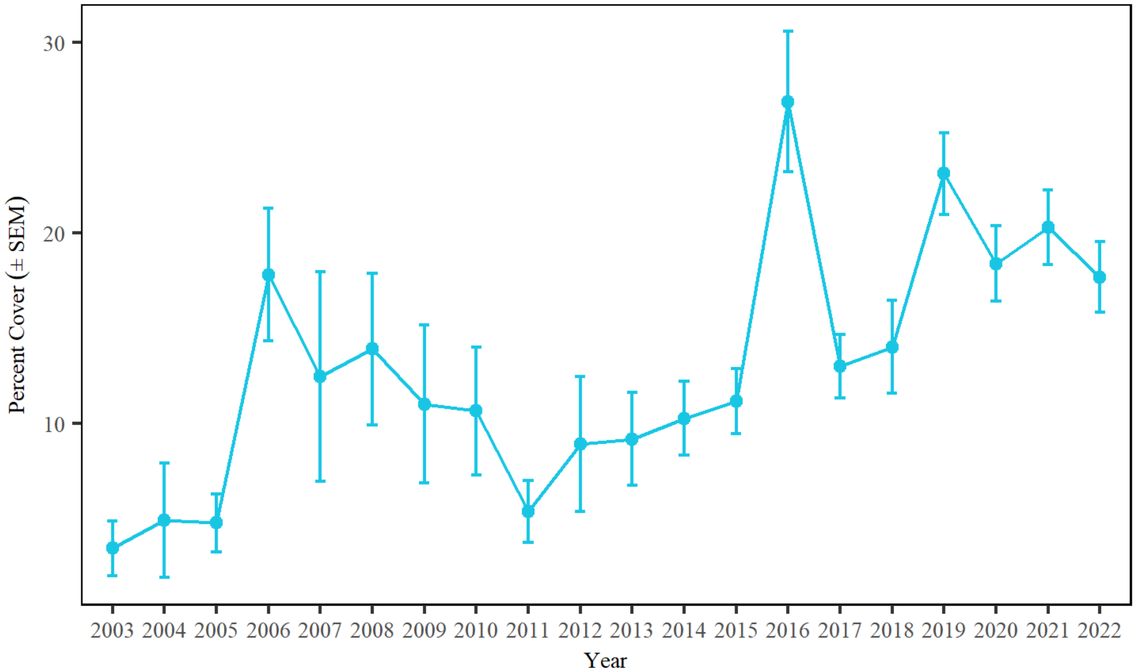

Figure 20. Mean macroalgae percent cover (±SEM) for all sites combined.

Table 6. Macroalgae long term percent cover change for the 10 original SECREMP sites (N=10) and the 22 current SECREMP sites (N=22). Increasing denotes the number of sites with a significant increase in cover, decreasing denotes the number of sites with significant increase and no change indicates sites that have not significantly changed between each time interval (2003-2005, 2013-2015, 2020-2022).

N	Overall Mean 2003-2005	Overall Mean 2013-2015	Overall Mean 2020-2022	Increasing	Decreasing	No Change
10	4.36% ± 1.78%	5.50% ± 0.26%		8	1	1
22		10.19% ± 1.87%	18.76% ± 1.58%	18	2	2

Sponge cover increased at many sites during the first 10 years but has been similar the last 10 years (Figure 21). Of the 10 sites evaluated between the 2003-2005 and the 2013-2015 time periods sponge cover significantly increased at seven sites, BC1, BC2, BC3, BCA, DC1, PB2 and PB3, significantly decreased at one site, PB1, and was unchanged at two sites, DC2 and DC3 (Table 7, see Appendix 3.for site values and statistical p-values). Mean sponge cover, averaged for the 10 sites increased from 3.95% ± 0.89% in 2003-2005 to 5.15% ± 0.11% in 2013-2015. The largest increase in sponge cover occurred at PB2 where cover changed from 3.92% ± 0.42% in 2003-2005 to 7.90% ± 0.74% in 2013-2015. The changes at other sites were more moderate, generally less than 2.00%. The only site with a significant decrease in cover, PB1 was relatively large in magnitude, declining from 7.15% ± 1.77% in 2003-2005 to 2.55% ± 0.67% in 2013-2015.

During the last 10 years, changes in sponge cover has varied considerably across sites, but averaged together for the 22 sites, sponge cover has been consistent during this time. (Table 7, see Appendix 3.for site values and statistical p-values). Between the 2013-2015 and the 2020-2022 time periods sponge cover significantly increased at six sites, BC2, BC6, DC1, DC3, DC7 and PB3, significantly decreased at five sites, BC1, BCA, MC2, PB2 and PB4, and was unchanged at 11 sites (Table 7, see Appendix 3.for site values and statistical p-values). Of the ten sites first surveyed in 2003, four significantly increased, three significantly decreased and three were unchanged between the 2013-2015 and 2020-2022 time periods. Three sites significantly increased in sponge cover in both long-term comparisons, BC2, DC1, and PB3, while another three sites that increased in sponge cover between 2003-2005 and 2013-2015 decreased between the 2013-2015 and the 2020-2022 time periods, BC1, BCA and PB2. Mean sponge cover, averaged for 22 sites, was similar: 5.48% ± 0.68% in 2013-2015 and 5.62% ± 0.70% in 2020-2022. The largest increase in sponge cover occurred at DC7 where cover increased from 7.69% ± 0.88% in 2013-2015 to 9.67% ± 1.08% in 2020-2022. The largest decrease in cover occurred at PB4 where cover decreased from 13.35% ± 1.71% in 2013-2015 to 11.36% ± 1.49% in 2020-2022. In general, significant changes occurring between the 2003-2005 and 2013-2015 time periods were greater in magnitude than those occurring between 2013-2015 to 2020-2022.

Over the last two years (2021 and 2022) sponge cover significantly increased at one site, DC8, significantly decreased at two sites, MC2 and PB2, and was unchanged at 19 sites see Appendix 1 for region wide and site mean values and Appendix 2 for statistical p-values). Mean sponge cover, averaged for 22sites decreased from 5.61% ± 0.73% in 2021 to 5.16% ± 0.67% in 2022. Sponge cover at DC8 increased from 2.17% ± 0.23% in 2021 to 3.52% ± 0.29% in 2022. PB2 had the greatest decrease in sponge cover decreasing from 6.31% ± 1.10% in 2021 to 4.45% ± 0.80% in 2022.

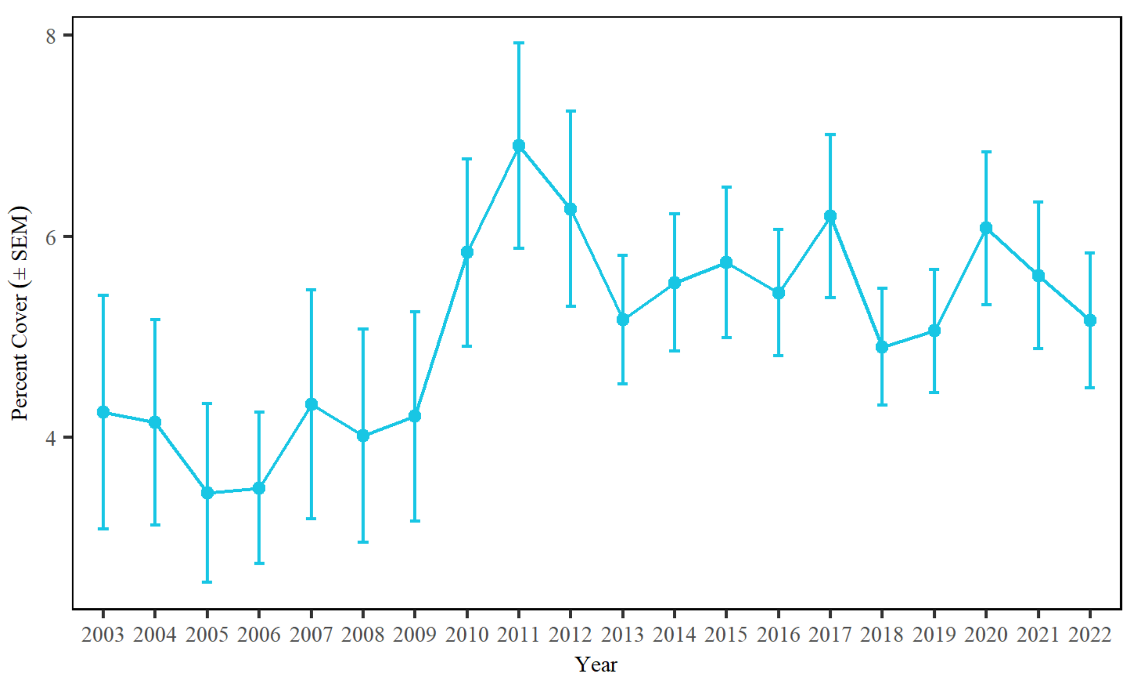

Figure 21. Mean sponge percent cover (±SEM) for all sites combined.

Table 7. Sponge long term percent cover change for the 10 original SECREMP sites (N=10) and the 22 current SECREMP sites (N=22). Increasing denotes the number of sites with a significant increase in cover, decreasing denotes the number of sites with significant increase and no change indicates sites that have not significantly changed between each time interval (2003-2005, 2013-2015, 2020-2022).

N	Overall Mean 2003-2005	Overall Mean 2013-2015	Overall Mean 2020-2022	Increasing	Decreasing	No Change
10	3.95% ± 0.89%	5.15% ± 0.11%		7	1	2
22		5.48% ± 0.68%	5.62% ± 0.70%	6	5	11

Site Benthic Temperature

During the 2022 sites visits, all but one temperature logger was successfully recovered. All sites had at least one logger that successfully recorded data in 2022 and data were downloaded for all 22 sites. The 2022 sample dates shown in Table 1 were the same dates that temperature loggers were collected and redeployed at each of the 22 sites. Table 8 presents the dates and maximum and minimum temperatures (°C) for each site from late winter 2007 into spring 2022. For 18 sites, the maximum temperature on record was recorded in August 2014 (all ≥ 30.9°C) with one additional site in September 2014 (MC1: 30.6°C) (Table 8). One site (DC8: 32.4 °C) had the maximum temperature recorded in August 2017. No maximum temperatures for sites were recorded in 2018-2022. Three sites had minimum recorded temperatures in January and February of 2018 (DC6, DC7, BC4) and one site (DC8: 20.8 °C) had minimum recorded temperature in February of 2021 (Table 8). In 2020 only seven sites had temperatures recorded over 30.5°C with only eight sites recorded in 2021, where five of those sites were in Miami-Dade. (Table 9; 2022 was not included because a full year of temperature data was not collected at the time each site was sampled). Site DC8 consistently has the most days over 30.5°C (Table 9).

Table 8. Maximum and minimum water temperatures (°C) and dates for the 22 sites with temperature loggers recording winter 2007 through May 2022.

	Maximum		Minimum	
Site	**Temp**	**Date**	**Temp**	**Date**
DC1	31.9	21 Aug 14	19.7	23 Jan 09
DC2	31.2	25 Aug 14	20.1	4 Mar 10
DC3	31.3	24 Aug 14	20.4	1 Feb 11
DC4	31.2	24 Aug 14	20.3	31 Jan 11
DC5	31.4	24 Aug 14	20.3	31 Jan 11
DC6	31.7	22 Aug 14	21.0	19 Jan 18
DC7	31.2	25 Aug 14	22.1	1 Feb 18
DC8	32.4	18 Aug 17	20.8	3 Feb 21
BCA	31.6	24 Aug 14	19.0	6 Feb 09
BC1	31.6	25 Aug 14	19.6	5 Mar 10
BC2	31.2	25 Aug 14	20.4	5 Mar 10
BC3	30.9	25 Aug 14	20.0	22 Feb 11
BC4	31.4	24 Aug 14	21.9	21 Jan 18
BC5	30.9	25 Aug 14	22.3	23 Mar 14
BC6	30.8	26 Aug 14	22.1	23 Mar 14
PB1	30.9	30 Aug 14	19.5	6 Mar 10
PB2	30.8	29 Aug 14	18.5	5 Apr 11
PB3	30.6	29 Aug 14	19.7	7 Mar 10
PB4	30.8	22 Aug 11	19.6	5 Apr 11
PB5	30.8	25 Aug 11	19.7	22 Feb 11
MC1	30.6	1 Sept 14	13.4	11 Jan 10
MC2	30.7	11 Aug 09	13.8	11 Jan 10

Table 9. Number of days per year with water temperature ≥ 30.5°C for the 22 sites with temperature loggers recording winter 2007 through 2021 (NA = sites not established) (2022 is not included because a full year of temperature data was not collected at the time each site was sampled).

Site	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
DC1	11	0	7	5	18	0	0	29	33	13	9	7	15	12	10
DC2	0	0	0	0	6	0	0	8	20	0	0	0	1	0	0
DC3	1	0	0	0	1	0	0	7	5	0	0	0	1	0	0
DC4	0	0	0	0	1	0	0	9	12	0	0	0	2	1	2
DC5	0	0	0	2	8	0	0	18	15	1	11	1	14	9	5
DC6	NA	NA	NA	NA	NA	NA	0	18	49	11	11	7	11	12	8
DC7	NA	NA	NA	NA	NA	NA	0	6	5	0	0	0	0	0	0
DC8	NA	NA	NA	NA	NA	NA	0	41	64	30	50	45	43	43	34
BCA	21	0	7	0	0	0	0	22	36	4	11	6	12	11	6
BC1	8	0	6	0	13	0	0	19	30	3	6	1	10	5	2
BC2	0	0	0	0	1	0	0	7	3	0	0	0	0	0	0
BC3	0	0	0	0	2	0	0	4	1	0	0	0	0	0	0
BC4	NA	NA	NA	NA	NA	NA	0	12	13	0	0	0	2	0	1
BC5	NA	NA	NA	NA	NA	NA	0	6	3	0	0	0	0	0	0
BC6	NA	NA	NA	NA	NA	NA	0	4	0	0	0	0	0	0	0
PB1	0	0	0	0	0	6	0	4	3	0	0	0	0	0	0
PB2	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0
PB3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
PB4	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0
PB5	0	0	0	0	0	7	0	4	1	0	0	0	0	0	0
MC1	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0
MC2	0	0	2	0	0	0	0	3	0	0	0	0	0	0	0

Discussion

The coral reef ecosystem within the Kristin Jacobs Coral Reef Ecosystem Conservation Area (Coral ECA) is the northern extension of Florida's Coral Reef (FCR) and is a high-latitude system near the environmental threshold for significant coral reef growth. Coral ECA reefs generally have similar stony coral species richness but reduced stony coral cover compared to the Florida Keys and Dry Tortugas (southern portions of Florida's Coral Reef) (Ruzicka et al. 2010; Ruzicka et al. 2012, Jones et al. 2020). Benthic cover by octocorals and macroalgae is similar throughout FCR, while sponges appear to contribute more to cover in the Coral ECA than in the Florida Keys or Dry Tortugas (Ruzicka et al. 2010; Ruzicka et al. 2012; Ruzicka et al. 2013).

The Coral ECA experienced significant stony coral assemblage declines across the study period, with significant losses determined for both stony coral cover and LTA. These losses were predominately driven by a significant increase in Stony Coral Tissue Loss Disease (SCTLD) that is known to affect more than 22 species of stony corals (SCTLD Case Definition 2018). Prevalence of SCTLD peaked in 2016, and subsequently has dropped every year since, reaching the lowest prevalence recorded in 2020. As regional disease prevalence has remained < 1% for six years, potential recovery can begin to be assessed.

Regionally, the year-to-year analysis found one site, DC8, with a significant increase in stony coral cover from 2021 to 2022. However, the cover at this site only increased from 0.5% to 1.1%. Previously, region-wide stony coral cover decreased every year from 2015 to 2018, where cover in 2018 was significantly lower than cover in 2017 (Gilliam et al. 2019). As of 2022, 12 sites have < 1% stony coral cover, and 19 of the 22 sites have less than 2%. Site BCA had a significant decrease in stony coral cover from 2021 to 2022; however, site BCA is a targeted *Acropora cervicornis* patch and has been experiencing long term significant declines in cover across all time periods.

Stony coral live tissue areas (LTA) were estimated to provide an additional and perhaps more sensitive metric for describing changes to the amount of live tissue in the region. Regional LTA from 2017-2022 was significantly lower than the LTA in 2013 and 2014. From 2015 to 2018 there was an estimated 58% loss in regional LTA. Although no significant recovery has been recorded, regional LTA has remained relatively stable from 2019-2022, and LTA in 2022 is the highest recorded since 2017. Regional stony coral density has been significantly increasing since 2020, where density in 2020, 2021 and 2022 was significantly higher than the density in 2016. Density in 2022 was also significantly higher than in all years from 2013-2017, and was the highest density recorded across the study period. However, this increase in density is primarily driven by small, weedy coral species that were not affected by SCTLD and that do not contribute greatly to LTA.

Differences between LTA loss across the SCTLD susceptibility groups were observed, demonstrating the effect of SCTLD on the community. Of the four groupings tested, only the High and Intermediate SCTLD susceptible species had a significant change in LTA. For High susceptibility, regional LTA in 2016-2022 was significantly lower than LTA in 2013 and 2014, and 2019-2022 was significantly lower than in 2015. These species were among the first to experience complete mortality from SCTLD. For the Intermediately susceptible group, LTA was significantly lower in 2017-2022 than in 2015. No significant increase in

LTA has occurred in either group across the study period. No significant change in LTA was observed for Low susceptible or Presumed susceptible species groups. The maximum mean regional LTA, for both Presumed and Low, was recorded in 2019 and 2022, respectively. The loss of the species in the High and Intermediate SCTLD susceptibility category demonstrates that the regional loss in LTA was driven almost entirely by the loss of SCTLD susceptible species. These species include vital reef building species such as *Montastraea cavernosa* and *Orbicella* spp. Loss of *M. cavernosa* is of particular concern because the species contributes greatly to stony coral benthic cover and LTA, and this species is present in all four Southeast Florida counties and reef habitats. *Montastraea cavernosa* is also one of the more common large (~>50 cm diameter) colony forming species and has commonly been described as a 'robust' species capable of surviving in variable habitats and conditions. This contrasts with Low susceptible species, which includes small weedier species such as *Porites astreoides* and *P. porites* which are now contributing greater to the stony coral tissue remaining within the Coral ECA. These low susceptible species are those that are contributing to the significant increase in stony coral density.

By adding the tally of colonies < 4cm in 2018, we can have a better idea of successful recruitment into the dataset, critical for assessing recovery. Previous declines in the stony coral community related to SCTLD were not confined to any one area, and this regional scale loss is of great concern. However, no species were completely lost from the project, and many of the species most susceptible to SCTLD had a consistent or increasing number of colonies < 4 cm in diameter. Although only a few recruits of certain susceptible species including *C. natans, Orbicella* spp., *Mycetophyllia* spp. were observed, each of these species had at least 1 colony < 4 cm in 2022. Although colonies < 4 cm have been decreasing from 2018-2022 for *M. meandrites,* this is due to those colonies successfully growing into the ≥ 4 cm size class. Colonies ≥ 4 cm for *Meandrina meandrites* have increased from a low of 5 colonies in 2016 to 35 colonies in 2022. Colonies < 4 cm of *M. cavernosa,* a critical reef building species in Southeast Florida, have been increasing in abundance since 2018. However, the greatest contributors to the < 4 cm size class include: *Siderastrea* spp., *P. astreoides*, and *Agaricia* spp, where both *P. astreoides* and *P. porites* have been increasing in abundance since 2018. *Porites astreoides,* which is the second most abundant species > 4 cm, is a rapidly growing, lower relief species that has not had any significant decline in any metric across the study years.

There is no clear relationship between the changes documented in the stony coral community and the octocoral or sponge communities. Octocoral cover has generally decreased through time, where 11 of the 20 octocoral sites had significantly lower cover in 2020-2022 than in 2013-2015, and only three sites had a significant increase in octocoral cover. In contrast, region-wide octocoral density in 2020, 2021, and 2022 was significantly higher than in 2013 and 2014, increasing from a low density in 2018 related to impacts from Hurricane Irma. Significant changes in density were identified for two of the three target species, *G. ventalina* and *A. americana*. Both had significant increases in density in 2020, 2021, and 2022 than in 2013, and density in 2020-2022 for *A. americana* was also significantly higher than in 2014-2018. Density for both *G. ventalina* and *A. americana* reached their maximum recorded density in 2021. There are likely several factors contributing to the contrast between the cover results and colony density. Benthic cover estimates derived from transect images in this project include octocoral canopy; therefore, larger-taller colonies will contribute greatly to percent cover estimates. All colonies with living tissue regardless of size contribute equally to colony density estimates. *Antillogorgia americana* mean colony height reached its minimum in 2020; however, height has been increasing through 2022, where height in 2022 was significantly larger than in 2020 and 2021, although these heights are still significantly lower than in 2013-2016. These results indicate that the region experienced a decline in colony size and/or an increase in partial mortality in the larger size classes, both of which would contribute to reduced cover, and likely an increase in smaller colony abundance.

Xestospongia muta, the giant barrel sponge, density region-wide has generally increased with mean density in 2022 significantly greater than in 2014, 2015 and 2018. Although there was a decrease in density in 2018 due to the passing of Hurricane Irma late in 2017, density has generally been increasing each year. The percent benthic cover of sponges was the most temporally consistent across the taxa examined, with mean cover approximately 4-6%. Although seven of the ten original sites had an increase in sponge cover from 2003-2005 to 2013-2015, 11 of the 22 sites had no significant change in cover from 2013-2015 to 2020-2022, and the remaining sites were a mix of increase (6 sites) and decrease (5 sites) in cover. The conditions driving the changes to the stony coral community and macroalgae cover do not appear to be, at the current level of examination, impacting the sponge communities.

Macroalgae cover was the most variable of all groups examined, but generally increased across most sites. From 2003-2005 compared to 2013-2015, eight of the ten sites had a significant increase in cover of macroalgae. For the time interval 2013-2015 compared to 2020-2022 18 of the 22 sites had a significant increase in cover. However, from 2021 to 2022 macroalgae cover significantly dropped at ten of the 22 sites, and cover increased at only 5 of the 22 sites, demonstrating the ephemeral nature of macroalgae. Interpreting temporal changes in macroalgae cover through annual visits is challenging as macroalgae cover can change significantly in short time periods. These data do indicate that region-wide conditions appear to be more favorable to macroalgae growth. These changing conditions may include increased nutrients, water temperatures, substrate availability and a host of other factors not specifically addressed in this project.

SECREMP is an annual monitoring program and annual programs are designed to provide current status and long-term trend information. Capturing the processes that contribute to the changes in conditions and long-term trends is a challenge for annual sampling. Diseased individuals are a normal part of all populations, but unfortunately, disease outbreaks appear to be becoming a greater and more common threat. There have been a number of environmental factors reported that are potentially increasing the risk of disease and mortality above normal levels, including elevated water temperatures, various water quality parameters, and increased sedimentation and turbidity. However, all the factors and/or conditions that may be potentially contributing to the reported disease outbreak cannot be defined or evaluated. A combination of factors is most likely driving the disease event. Additionally, not all coral mortality documented in this report was caused by disease; other stressors, environmental and biological, most certainly contributed to some mortality across the region and/or at specific sites.

As disease prevalence has dropped to < 1% regionally, and with no further significant loss of stony coral LTA and density observed over the last three years, there is hope that some natural recovery will be evident in the next few years. Stony coral density has been significantly increasing since 2020. However, the species driving this increase include weedy, low relief species that do not provide the same structure to the reef as many of the larger species impacted by SCTLD. Additionally, the composition and diversity of stony coral species at sites has been significantly impacted and will affect what species are able to successfully sexually reproduce. However, there are promising trends in SCTLD affected species including *Montastraea cavernosa*, a critical reef building species. Even with some natural recovery, mitigation and intervention may be necessary to assist those species with the greatest losses from SCTLD in order to see any significant recovery.

The reefs in the Coral ECA represent a significant economic resource to the region. The reef system has been estimated to protect over $500 million in infrastructure and $300 million in economic activity from storm-related flooding (Storlazzi et al. 2019). These reefs have also been estimated to generate more than $3 billion in sales and income and support more than 35,000 jobs (Johns et al. 2001, 2004). The entirety of Florida’s Coral Reef has an estimated asset value of $8.5 billion and generates $2 billion in local income (Brander et al. 2013).

The chronic nature of disturbances to and the significant economic value of Coral ECA reefs requires comprehensive, long-term monitoring to be conducted to define and quantify change and to help identify threats to the ecosystem. The region-wide information generated during the annual SECREMP site visits provide scientifically valid status and trend data designed to assist local resource managers in understanding the condition of the resources and possible implications of actions occurring in terrestrial and adjacent marine habitats. Both continual region-wide monitoring (SECREMP) and improved incident-specific monitoring are necessary if resource managers are to develop sound management plans for coral reefs that allow continued use and realization of the economic value of these fragile marine ecosystems.

The expansion of CREMP to include sites in Broward, Miami-Dade, Palm Beach, and Martin Counties through SECREMP, has ensured that a suite of parameters is being monitored for much of Florida’s Coral Reef. As a monitoring project under the NOAA Coral Reef Conservation Program Cooperative Agreement for the Southeast Florida coast, SECREMP will continue to provide valuable Southeast Florida coral reef status and long-term trend data. SECREMP provides resource managers with the critical information required to manage this valuable, yet increasingly threatened, natural resource.

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Appendices

Appendix 1. Mean cover (%) by site (R= region-wide comparison; BC = Broward County; DC = Miami-Dade County; PB = Palm Beach County; MC = Martin County). Region-wide values are calculated as an average of the sum of each site. Site level values are calculated as an average of the stations. For cover data for years prior to 2013 see Gilliam et al. (2013).

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Variable	Level	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Stony Coral	R (n=22)	2.51 ± 0.66	2.84 ± 0.78	2.54 ± 0.66	1.53 ± 0.39	1.42 ± 0.31	1.02 ± 0.29	1.24 ± 0.33	1.4 ± 0.37	1.23 ± 0.32	1.21 ± 0.27
	DC1	4.24 ± 0.92	5.44 ± 1.65	5.33 ± 2.54	2.7 ± 0.76	2.83 ± 0.35	2.5 ± 0.32	2.21 ± 0.7	2.18 ± 0.47	2.05 ± 0.38	2.29 ± 0.49
	DC2	0.95 ± 0.48	1.55 ± 0.4	1.22 ± 0.29	0.76 ± 0.2	0.73 ± 0.19	0.5 ± 0.05	0.51 ± 0.17	0.34 ± 0.08	0.48 ± 0.09	0.81 ± 0.21
	DC3	0.24 ± 0.07	0.4 ± 0.17	0.19 ± 0.09	0.22 ± 0.11	0.36 ± 0.13	0.24 ± 0.11	0.31 ± 0.15	0.38 ± 0.18	0.51 ± 0.16	0.32 ± 0.06
	DC4	1.52 ± 0.5	1.36 ± 0.56	1.32 ± 0.37	1.09 ± 0.12	1.01 ± 0.23	0.78 ± 0.15	1.04 ± 0.17	1.08 ± 0.27	1.14 ± 0.21	1.16 ± 0.19
	DC5	1.59 ± 0.28	2.94 ± 1.08	1.16 ± 0.29	0.7 ± 0.06	0.94 ± 0.12	0.4 ± 0.06	1.09 ± 0.3	1.2 ± 0.29	0.98 ± 0.18	1.19 ± 0.26
	DC6	2.5 ± 0.48	2.86 ± 0.8	3.24 ± 0.84	2.72 ± 0.69	2.22 ± 0.65	1.28 ± 0.42	1.6 ± 0.5	1.66 ± 0.72	1.45 ± 0.55	1.66 ± 0.6
	DC7	0.51 ± 0.09	0.5 ± 0.17	0.42 ± 0.04	0.16 ± 0.07	0.45 ± 0.07	0.34 ± 0.18	0.31 ± 0.16	0.29 ± 0.15	0.62 ± 0.24	0.82 ± 0.17
	DC8	1.51 ± 0.55	1.51 ± 0.34	1.18 ± 0.24	1.36 ± 0.51	1.04 ± 0.27	0.97 ± 0.4	1.04 ± 0.31	1.34 ± 0.56	0.55 ± 0.25	1.3 ± 0.49
	BC1	12.67 ± 1.93	12.27 ± 1.73	12.35 ± 1.17	7.28 ± 1.38	4.92 ± 0.86	6.43 ± 1.47	6.48 ± 0.89	6.56 ± 1.6	6.43 ± 1.11	5.62 ± 0.62
	BC2	0.73 ± 0.43	0.78 ± 0.21	0.89 ± 0.47	0.38 ± 0.1	0.35 ± 0.11	0.46 ± 0.17	0.38 ± 0.07	0.22 ± 0.12	0.31 ± 0.14	0.41 ± 0.11
	BC3	0.69 ± 0.32	0.61 ± 0.22	0.69 ± 0.32	0.41 ± 0.31	0.33 ± 0.12	0.24 ± 0.09	0.36 ± 0.15	0.66 ± 0.12	0.33 ± 0.04	0.41 ± 0.11
	BC4	4.04 ± 0.92	4.23 ± 0.88	4.38 ± 1.13	3.49 ± 0.67	3.82 ± 0.57	1.71 ± 0.36	2.65 ± 0.79	2.09 ± 0.46	2.37 ± 0.42	1.95 ± 0.33
	BC5	1.49 ± 0.3	1.08 ± 0.39	1.43 ± 0.2	0.16 ± 0.03	0.31 ± 0.12	0.23 ± 0.05	0.39 ± 0.17	0.43 ± 0.15	0.21 ± 0.09	0.25 ± 0.07
	BC6	0.76 ± 0.19	0.58 ± 0.23	0.6 ± 0.22	0.31 ± 0.09	0.53 ± 0.16	0.39 ± 0.1	0.36 ± 0.11	0.43 ± 0.18	0.31 ± 0.11	0.44 ± 0.08
	BCA	10.93 ± 1.67	13.85 ± 1.69	9.88 ± 2.06	4.75 ± 1.06	3.41 ± 0.9	2.44 ± 0.54	4.29 ± 0.87	6.11 ± 1.08	4.28 ± 0.82	2.97 ± 0.37
	PB1	0.11 ± 0.06	0.03 ± 0.03	0.1 ± 0.07	0.1 ± 0.07	0.06 ± 0.04	0.03 ± 0.03	0.1 ± 0.07	0.11 ± 0.06	0.06 ± 0.03	0.09 ± 0.03
	PB2	1.68 ± 0.38	2.09 ± 0.66	2.04 ± 0.42	0.87 ± 0.23	1.14 ± 0.31	1 ± 0.38	0.67 ± 0.23	1.08 ± 0.2	0.78 ± 0.35	1.08 ± 0.28
	PB3	1.49 ± 0.45	1.27 ± 0.43	1.04 ± 0.12	0.57 ± 0.1	0.59 ± 0.2	0.59 ± 0.17	0.47 ± 0.24	0.67 ± 0.28	0.65 ± 0.19	0.6 ± 0.13
	PB4	1.7 ± 0.42	1.73 ± 0.42	1.56 ± 0.54	0.4 ± 0.12	1.44 ± 1.15	0.48 ± 0.15	0.38 ± 0.11	0.36 ± 0.14	0.47 ± 0.16	0.28 ± 0.09
	PB5	1.94 ± 0.58	2.35 ± 0.37	2.04 ± 0.45	0.79 ± 0.24	0.6 ± 0.1	0.58 ± 0.31	0.7 ± 0.13	0.85 ± 0.23	1.06 ± 0.18	0.75 ± 0.15
	MC1	2.97 ± 1.47	3.6 ± 1.96	3.6 ± 1.67	2.98 ± 1.32	3.94 ± 1.14	0.89 ± 0.55	1.84 ± 1.14	2.65 ± 1.21	1.93 ± 0.74	2.09 ± 0.76
	MC2	1.52 ± 0.63	1.12 ± 0.39	1.31 ± 0.38	1.23 ± 0.56	1.13 ± 0.8	0.15 ± 0.15	0.03 ± 0.03	0.05 ± 0.05	0.14 ± 0.07	0.11 ± 0.08

Appendix 1. Continued

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Variable	**Level**	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Octocoral	R	9.86 ± 1.34	9.59 ± 1.29	9.12 ± 1.22	8.76 ± 1.24	9.52 ± 1.27	7.45 ± 0.94	7.47 ± 0.94	8.08 ± 1.07	8.5 ± 1.12	8.44 ± 1.11
	DC1	8.34 ± 0.49	12.08 ± 1.49	9.45 ± 1.95	9.67 ± 0.72	9.37 ± 1.12	9.04 ± 1.29	6.51 ± 0.82	5.73 ± 0.57	7.01 ± 0.41	6.85 ± 0.62
	DC2	11.37 ± 0.47	12.04 ± 0.86	12.44 ± 0.79	8.49 ± 0.47	11.79 ± 1.54	7.06 ± 0.76	8.83 ± 0.65	8.76 ± 0.21	11.91 ± 1.24	9.58 ± 0.96
	DC3	8.38 ± 0.94	7.97 ± 1.42	9.19 ± 2.11	9.98 ± 0.48	11.5 ± 0.94	8.95 ± 0.45	7.84 ± 1.18	8.98 ± 0.52	11.18 ± 1.94	10.52 ± 1.34
	DC4	14.58 ± 1.36	12.15 ± 1.11	12.26 ± 0.78	12.34 ± 1.48	12.32 ± 0.64	9.92 ± 0.86	10.64 ± 0.65	8.54 ± 0.64	12.2 ± 1.05	13.13 ± 1.28
	DC5	16.74 ± 2.27	12.93 ± 1.42	12.67 ± 2.41	15.26 ± 1.17	15.39 ± 1.56	11.11 ± 2.08	9.83 ± 1.29	10.18 ± 0.43	11.44 ± 0.99	17.5 ± 1.27
	DC6	9.37 ± 1.47	7.04 ± 0.93	7.55 ± 0.92	6.87 ± 0.56	8.69 ± 0.68	4.94 ± 0.52	6.65 ± 0.55	5.37 ± 0.46	5.69 ± 0.63	5.45 ± 0.58
	DC7	8.09 ± 1.64	7.73 ± 0.33	11.79 ± 1.82	5.39 ± 0.7	6.65 ± 0.84	6.18 ± 1.28	6.5 ± 0.67	6.73 ± 0.38	8.79 ± 0.52	8.47 ± 0.24
	DC8	15.82 ± 1.84	14.11 ± 2.03	13.12 ± 0.62	12.23 ± 0.85	14.43 ± 1.4	11.56 ± 1.06	15.36 ± 0.86	9.18 ± 1.28	8.77 ± 0.83	9.63 ± 0.67
	BC1	7.36 ± 0.43	7.1 ± 0.56	5.74 ± 1	5.42 ± 0.74	6.32 ± 0.66	7.82 ± 0.44	9.93 ± 0.65	8.8 ± 0.82	7.23 ± 0.24	8.67 ± 0.73
	BC2	4.69 ± 0.87	7.98 ± 0.96	5.18 ± 0.45	5.01 ± 0.63	8.48 ± 1.19	7.25 ± 1.38	5.65 ± 0.84	8.94 ± 0.89	6.64 ± 1.09	6.39 ± 0.86
	BC3	13.12 ± 0.48	8.65 ± 1.68	9.28 ± 1.29	9.95 ± 0.9	9.38 ± 1.33	10.45 ± 1.49	7.83 ± 1.12	10.34 ± 1.25	12.14 ± 1.4	10.05 ± 1.53
	BC4	4.28 ± 0.58	4.2 ± 0.68	4.61 ± 0.51	5.03 ± 0.68	4.58 ± 0.76	2.14 ± 0.42	2.43 ± 0.74	3.01 ± 0.57	2.3 ± 0.55	3.68 0.59
	BC5	6.76 ± 0.95	8.41 ± 0.76	6.51 ± 0.79	5.52 ± 0.48	7.05 ± 0.88	5.7 ± 0.41	6.81 ± 0.76	6.97 ± 0.3	6.3 ± 0.6	5.41 ± 0.51
	BC6	16.44 ± 1.4	16.79 ± 0.8	13.22 ± 0.49	13.69 ± 1.04	14.09 ± 1.16	11.64 ± 0.68	13.42 ± 0.9	16.86 ± 1.67	14.58 ± 1.17	9.02 ± 1.35
	BCA	2.96 ± 0.65	2.85 ± 0.4	2.25 ± 0.53	1.19 ± 0.23	1.13 ± 0.23	1.77 ± 0.22	2.00 ± 0.28	2.27 ± 0.49	1.44 ± 0.37	2.04 ± 0.3
	PB1	0.00 ± 0.00	0.00 ± 0.00	0.1 ± 0.07	0.00 ± 0.00	0.06 ± 0.06	0.00 ± 0.00	0.06 ± 0.06	0.03 ± 0.03	0.17 ± 0.07	0.32 ± 0.2
	PB2	17.12 ± 5.12	18.45 ± 4.22	18.61 ± 3.56	16.63 ± 3.29	18.8 ± 4.19	14.36 ± 3.14	8.93 ± 2.75	12.77 ± 3.91	13.26 ± 4.77	14.84 ± 3.27
	PB3	12.99 ± 1.89	11.91 ± 1.72	12.41 ± 1.36	17.03 ± 0.63	14.8 ± 1.71	9.8 ± 1.85	10.06 ± 0.91	12.6 ± 1.51	13.21 ± 0.96	14.48 ± 3.27
	PB4	18.93 ± 2.1	22.03 ± 2.11	20.71 ± 1.29	19.12 ± 2.36	15.4 ± 3.57	11.84 ± 2.18	12.31 ± 0.27	15.32 ± 0.92	16.59 ± 1.11	14.68 ± 1.61
	PB5	19.81 ± 1.27	16.62 ± 0.25	14.05 ± 1.95	13.88 ± 1.14	14.18 ± 1.21	12.62 ± 1.57	12.58 ± 1.03	16.41 ± 1.05	15.97 ± 0.37	14.9 ± 0.6
	MC1	0.12 ± 0.12	0.02 ± 0.02	0.05 ± 0.03	0.03 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.03 ± 0.03	0.00 ± 0.00	0.13 ± 0.13	0.12 ± 0.12
	MC2	0.00 ± 0.00	0.03 ± 0.03	0.00 ± 0.00	0.03 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.03 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

Appendix 1. Continued

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Variable	**Level**	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Sponge	R	5.17 ± 0.64	5.54 ± 0.68	5.74 ± 0.75	5.44 ± 0.63	6.2 ± 0.81	4.9 ± 0.58	5.06 ± 0.61	6.08 ± 0.76	5.61 ± 0.73	5.16 ± 0.67
	DC1	2.64 ± 0.48	2.66 ± 0.33	3.34 ± 0.38	3.17 ± 0.18	2.88 ± 0.35	3.37 ± 0.51	3.07 ± 0.4	3.93 ± 1.11	4.09 ± 0.82	3.18 ± 0.34
	DC2	4.93 ± 0.35	4.97 ± 0.52	5.69 ± 0.33	5.88 ± 0.7	6.38 ± 1.21	4.59 ± 1.04	3.57 ± 0.23	5.74 ± 0.28	7.12 ± 1.43	5.3 ± 0.58
	DC3	5.47 ± 0.91	3.59 ± 0.9	3.19 ± 0.84	4.86 ± 1.45	4.55 ± 1.14	4 ± 0.67	3.85 ± 0.54	6.44 ± 1.65	4.36 ± 0.85	4.17 ± 0.94
	DC4	7.5 ± 1.54	7.34 ± 1.44	8.64 ± 1.39	7.74 ± 1.57	8.14 ± 0.26	6.64 ± 0.46	5.93 ± 0.83	7.78 ± 0.59	6.95 ± 0.69	8.26 ± 0.33
	DC5	3.5 ± 0.57	4.22 ± 0.95	5.72 ± 1.08	5.02 ± 1.38	5.72 ± 1.23	3.36 ± 0.52	4.72 ± 0.68	4.96 ± 1.07	5.05 ± 1.24	4.09 ± 1.00
	DC6	2.28 ± 0.38	2.14 ± 0.37	1.75 ± 0.24	2.42 ± 0.19	3.02 ± 0.29	1.84 ± 0.52	2.93 ± 0.68	2.67 ± 0.36	1.78 ± 0.41	1.78 ± 0.26
	DC7	7.52 ± 1.1	7.47 ± 1.48	8.6 ± 0.6	7.82 ± 0.66	7.73 ± 1.01	6.18 ± 1.4	7.99 ± 1.77	9.75 ± 1.54	10.19 ± 0.49	9.53 ± 1.57
	DC8	2.58 ± 0.28	3.19 ± 0.43	3.6 ± 0.27	3.78 ± 0.7	3.48 ± 0.3	3.07 ± 0.6	3.87 ± 0.34	4.01 ± 0.88	2.17 ± 0.24	3.51 ± 0.33
	BC1	3.25 ± 0.3	3.72 ± 0.57	3.7 ± 0.82	3.17 ± 0.73	3.29 ± 0.11	3.63 ± 0.57	3.22 ± 0.48	3.21 ± 0.61	2.39 ± 0.41	2.36 ± 0.42
	BC2	5.22 ± 0.5	5.67 ± 0.63	6.55 ± 0.9	4.45 ± 0.58	6.79 ± 0.71	5.74 ± 0.96	5.29 ± 0.6	6.49 ± 0.37	7.64 ± 0.37	6.62 ± 1.11
	BC3	6.42 ± 0.5	5.09 ± 0.55	5.84 ± 0.39	4.48 ± 0.51	6 ± 0.82	6.37 ± 0.44	5.01 ± 0.21	5.62 ± 0.46	5.83 ± 0.76	6.16 ± 0.48
	BC4	3.01 ± 0.35	3.93 ± 0.48	3.9 ± 0.93	3.52 ± 0.53	4.59 ± 0.07	2.47 ± 0.54	3.5 ± 0.82	3.49 ± 0.73	3.32 ± 0.64	3.2 ± 0.67
	BC5	6.92 ± 0.51	7.11 ± 1.14	7.3 ± 1.05	7.00 ± 0.86	8.08 ± 1.07	6.29 ± 0.91	8.63 ± 0.73	7.74 ± 0.96	5.76 ± 1.23	7.34 ± 1.2
	BC6	3.8 ± 0.7	5.92 ± 1.34	4.96 ± 0.89	5.53 ± 0.42	5.89 ± 0.59	4.46 ± 1.4	5.8 ± 0.23	6.65 ± 0.83	6.12 ± 1.08	6.02 ± 0.83
	BCA	3.58 ± 1.59	0.72 ± 0.35	0.87 ± 0.17	0.75 ± 0.29	0.82 ± 0.33	2.05 ± 0.77	1.43 ± 0.08	1.58 ± 0.29	0.82 ± 0.16	0.89 ± 0.21
	PB1	1.82 ± 1.02	3.47 ± 1.87	3.01 ± 1.29	3.98 ± 2.1	5.65 ± 3.11	2.4 ± 1.36	2.41 ± 1.43	2.75 ± 1.43	3.36 ± 1.38	3.24 ± 1.57
	PB2	7.44 ± 0.45	8.47 ± 0.71	7.92 ± 0.87	7.24 ± 0.48	8.13 ± 1.15	6.31 ± 0.92	4.81 ± 0.16	8.06 ± 1.02	6.52 ± 1.28	4.6 ± 0.76
	PB3	10.65 ± 0.88	12.26 ± 1.59	12.39 ± 1.22	11.8 ± 0.93	14.78 ± 1.37	11.24 ± 1.6	12.63 ± 1.11	16.55 ± 1.33	12.54 ± 0.7	11.18 ± 1.23
	PB4	12.69 ± 2.79	13.34 ± 2.17	14.76 ± 2.44	13.24 ± 1.88	13.23 ± 4.1	10.48 ± 0.71	9.98 ± 0.99	11.73 ± 1.56	12.58 ± 1.55	10.52 ± 1.06
	PB5	8.6 ± 1.28	9.79 ± 0.75	9.78 ± 1.4	7.49 ± 0.86	10.73 ± 1.04	8.94 ± 1.59	8.28 ± 1.25	9.08 ± 1.01	10.39 ± 2.09	9.29 ± 1.56
	MC1	1.54 ± 0.33	2.72 ± 0.43	1.88 ± 0.47	2.72 ± 0.17	2.14 ± 0.21	2.59 ± 0.59	2.65 ± 0.89	2.66 ± 0.34	1.97 ± 0.5	1.45 ± 0.56
	MC2	2.56 ± 0.64	3.72 ± 0.75	3.01 ± 0.48	3.36 ± 0.87	1.9 ± 0.55	1.75 ± 0.48	1.64 ± 0.48	2.93 ± 0.88	2.39 ± 0.6	0.82 ± 0.23

Appendix 1. Continued

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Variable	**Level**	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Macroalgae	R	9.16 ± 2.45	10.25 ± 1.93	11.15 ± 1.7	26.88 ± 3.69	12.98 ± 1.65	14 ± 2.45	23.09 ± 2.13	18.37 ± 1.99	20.27 ± 1.96	17.66 ± 1.86
	DC1	15.26 ± 3.42	3.6 ± 0.62	2.88 ± 1.09	17.85 ± 2.7	2.3 ± 0.34	20.91 ± 3.72	25.21 ± 8.8	31.22 ± 0.78	21.6 ± 4.03	20.38 ± 1.57
	DC2	5.73 ± 2.7	5.59 ± 1.84	4.28 ± 1.6	67.44 ± 3.03	9.46 ± 2.74	23.7 ± 4.23	38.27 ± 2.81	24.55 ± 2.1	25.6 ± 6.9	19.33 ± 0.92
	DC3	1.13 ± 0.37	6.49 ± 0.94	3.57 ± 0.61	67.34 ± 3.52	15.03 ± 5.94	2.23 ± 1.77	30.11 ± 11.62	9.96 ± 4.9	23.58 ± 6.43	6.23 ± 3.46
	DC4	2.22 ± 0.68	8.38 ± 2.02	5.21 ± 1.76	21.26 ± 7.35	7.75 ± 1.7	11.52 ± 2.54	21.67 ± 2.81	28.5 ± 5.14	12.02 ± 1.86	20.35 ± 6.16
	DC5	7.06 ± 2.81	25.18 ± 2.48	25.72 ± 2.95	27.62 ± 4.12	22.37 ± 4.3	36.29 ± 2.57	24.02 ± 3.96	28.32 ± 3.42	13.4 ± 2.16	15.76 ± 3.48
	DC6	10.02 ± 0.8	9.8 ± 0.74	12.66 ± 2.7	31.97 ± 1.76	6.35 ± 2.07	40.39 ± 3.18	27.26 ± 3.54	32.65 ± 4.29	46.42 ± 1.36	46.88 ± 8.02
	DC7	2.53 ± 0.85	6.44 ± 1.41	8.91 ± 2.96	42.23 ± 3.74	12.39 ± 2.87	30.15 ± 6.36	32.28 ± 2.3	24.3 ± 2.74	17.22 ± 1.01	24.54 ± 4.33
	DC8	6.28 ± 0.91	7.79 ± 2.43	15.44 ± 4.11	26.53 ± 6.43	16.04 ± 4.62	14.23 ± 0.91	23.25 ± 2	24.22 ± 3.74	0.67 ± 0.19	13.67 ± 4.45
	BC1	7.04 ± 1.37	7.81 ± 1.07	15.21 ± 3.76	32.24 ± 6.36	27 ± 2.79	14.34 ± 3.4	23.12 ± 1.88	13.2 ± 1.32	26.64 ± 3.38	16.67 ± 2.25
	BC2	3.21 ± 0.8	6.13 ± 1.61	7.42 ± 2.8	25.62 ± 4.39	9.71 ± 1.68	0.9 ± 0.25	23.45 ± 2.74	9.43 ± 4.13	21.63 ± 6.63	19.85 ± 2.62
	BC3	1.88 ± 0.45	12.2 ± 2.59	11.55 ± 9.45	37.08 ± 8.75	21.96 ± 3.41	1.38 ± 0.74	24.22 ± 4.56	12.93 ± 4.84	19.13 ± 11.66	15.13 ± 4.56
	BC4	26.08 ± 3.2	18.87 ± 2.12	22.91 ± 1.84	40.16 ± 3.74	28.11 ± 1.89	21.4 ± 3.12	23.69 ± 2.7	22.94 ± 4.53	32.18 ± 5.44	22.74 ± 2.64
	BC5	10.92 ± 3.37	7.31 ± 0.58	18.71 ± 5.42	27.21 ± 4.9	10.1 ± 0.7	11.43 ± 3.99	9.71 ± 0.96	21.96 ± 3.96	21.88 ± 5.16	13.29 ± 1.84
	BC6	4.36 ± 1.21	4.39 ± 0.55	4.63 ± 0.7	9.67 ± 2.53	19.75 ± 4.45	17.5 ± 6.1	13.06 ± 2.55	10.57 ± 4.87	10.92 ± 1.94	12.16 ± 2.52
	BCA	2.69 ± 1.7	6.66 ± 4.37	2.54 ± 0.51	8.01 ± 3.32	6.05 ± 1.88	2.21 ± 0.79	6.03 ± 2.05	7.4 ± 0.85	18.23 ± 4.17	10.94 ± 2.38
	PB1	0.28 ± 0.16	1.75 ± 1.45	3.66 ± 0.94	1.43 ± 0.89	2.98 ± 1.13	2.4 ± 0.56	10.9 ± 3.16	16.85 ± 4.72	25.69 ± 1.26	4.6 ± 1.43
	PB2	0.6 ± 0.31	1.19 ± 0.38	3.38 ± 1.38	9.87 ± 3.19	3.49 ± 1.75	2.38 ± 0.98	19.47 ± 5.48	5.62 ± 2.69	14.08 ± 4.9	16.30 ± 4.47
	PB3	5.12 ± 0.89	7.21 ± 1.3	9.46 ± 2.56	16.1 ± 3.32	13.93 ± 3.33	8.24 ± 1.76	16.09 ± 2.31	4.9 ± 1.54	18.3 ± 2.78	10.11 ± 2.7
	PB4	3.22 ± 0.65	2.22 ± 0.47	6.07 ± 3.16	8.39 ± 0.83	7.75 ± 2.17	4.04 ± 1.25	6.82 ± 2.45	12.06 ± 2.9	10.15 ± 1.51	15.6 ± 4.86
	PB5	11.91 ± 1.8	15.19 ± 1.38	10.72 ± 1.41	30.3 ± 4.52	21.73 ± 2.79	9.89 ± 1.2	27.2 ± 3.07	11.26 ± 2.18	17.37 ± 0.02	12.43 ± 2.56
	MC1	23.38 ± 6.52	23.05 ± 2.77	26.35 ± 8.89	12.21 ± 7.54	10.09 ± 3.72	9.81 ± 3.31	39.04 ± 5.97	15.77 ± 2.44	19.96 ± 3.17	23.39 ± 5.9
	MC2	50.38 ± 3.07	38.72 ± 4.63	24.18 ± 7.2	31.35 ± 10.52	14.02 ± 4.83	22.21 ± 2.71	43.02 ± 7.55	35.48 ± 6.54	29.19 ± 5.74	28.18 ± 12.52

Appendix 2. Year to year model estimation of change in stony coral, octocoral, sponge, and macroalgae percent cover per year by region and by site from 2021 to 2022. Significant trends in cover are bolded and indicated as increasing (↑), decreasing (↓), or no significant change (-). Significance is based on Bonferroni adjusted α values; α = 0.002273.

Variable	Level	DF	Ratio	T ratio	p	Significant Change
Stony Coral	DC1	6738	0.89	-0.6614	0.5084	-
	DC2	6171	0.60	-1.5826	0.1136	-
	DC3	6770	1.59	1.1939	0.2326	-
	DC4	7312	0.98	-0.0924	0.9264	-
	DC5	7516	0.83	-0.8484	0.3963	-
	DC6	7124	0.87	-0.7124	0.4763	-
	DC7	7366	0.75	-1.0392	0.2988	-
	DC8	**8133**	**0.42**	**-3.4653**	**0.0005**	↑
	BC1	7353	1.15	1.4460	0.1482	-
	BC2	7021	0.75	-0.7268	0.4674	-
	BC3	7809	0.83	-0.5000	0.6171	-
	BC4	7667	1.21	1.2218	0.2218	-
	BC5	7043	0.81	-0.4274	0.6691	-
	BC6	7137	0.69	-0.9350	0.3498	-
	BCA	**24002**	**1.46**	**5.3899**	**<0.0001**	↓
	PB1	6974	0.62	-0.5232	0.6008	-
	PB2	7670	0.72	-1.3283	0.1841	-
	PB3	7344	1.09	0.3032	0.7617	-
	PB4	6830	1.68	1.2666	0.2053	-
	PB5	6812	1.42	1.3421	0.1796	-
	MC1	7415	0.92	-0.5110	0.6094	-
	MC2	7173	1.34	0.4384	0.6611	-
Octocoral	DC1	6738	1.03	0.2718	0.7858	-
	DC2	6171	1.28	2.9617	0.0031	-
	DC3	6770	1.07	0.8955	0.3705	-
	DC4	7312	0.92	-1.2436	0.2137	-
	DC5	**7516**	**0.61**	**-7.4029**	**0.0000**	↑
	DC6	7124	1.05	0.4442	0.6569	-
	DC7	7366	1.04	0.5039	0.6143	-
	DC8	8133	0.90	-1.3541	0.1758	-
	BC1	7353	0.82	-2.3379	0.0194	-
	BC2	7021	1.04	0.3810	0.7032	-
	BC3	7809	1.24	2.9500	0.0032	-
	BC4	**7667**	**0.62**	**-3.4818**	**0.0005**	↑
	BC5	7043	1.18	1.6253	0.1041	-
	BC6	**7137**	**1.72**	**7.2574**	**<0.0001**	↓
	BCA	**24002**	**0.70**	**-3.5428**	**0.0004**	↑
	PB1	6974	0.52	-1.2972	0.1946	-
	PB2	7670	0.87	-2.0897	0.0367	-
	PB3	7344	0.90	-1.5558	0.1198	-
	PB4	6830	1.16	2.2207	0.0264	-
	PB5	6812	1.08	1.2104	0.2262	-
	MC1				n/a	-
	MC2				n/a	-

Appendix 2. Continued

Variable	Level	DF	Ratio	T ratio	p	Significant Change
Sponge	DC1	6738	1.30	1.9914	0.0465	-
	DC2	6171	1.38	2.9897	0.0028	-
	DC3	6770	1.05	0.4053	0.6852	-
	DC4	7312	0.83	-2.0989	0.0359	-
	DC5	7516	1.25	1.9601	0.0500	-
	DC6	7124	1.01	0.0413	0.9671	-
	DC7	7366	1.08	0.9501	0.3421	-
	DC8	**8133**	**0.61**	**-3.6434**	**0.0003**	↑
	BC1	7353	1.01	0.0854	0.9319	-
	BC2	7021	1.16	1.6033	0.1089	-
	BC3	7809	0.94	-0.5999	0.5486	-
	BC4	7667	1.04	0.3298	0.7416	-
	BC5	7043	0.77	-2.6683	0.0076	-
	BC6	7137	1.02	0.1771	0.8594	-
	BCA	24002	0.92	-0.6046	0.5455	-
	PB1	6974	1.04	0.3006	0.7637	-
	PB2	**7670**	**1.45**	**3.6498**	**0.0003**	↓
	PB3	7344	1.14	1.7948	0.0727	-
	PB4	6830	1.22	2.6626	0.0078	-
	PB5	6812	1.13	1.4973	0.1344	-
	MC1	7415	1.37	1.7161	0.0862	-
	MC2	**7173**	**2.94**	**5.0881**	**0.0000**	↓
Macroalgae	DC1	6738	1.07	1.1746	0.2402	–
	DC2	**6171**	**1.44**	**5.7864**	**<0.0001**	↓
	DC3	**6770**	**4.94**	**19.2626**	**<0.0001**	↓
	DC4	**7312**	**0.54**	**-9.3714**	**<0.0001**	↑
	DC5	7516	0.84	-2.6982	0.0070	–
	DC6	7124	0.98	-0.4137	0.6791	–
	DC7	**7366**	**0.64**	**-7.6139**	**<0.0001**	↑
	DC8	**8133**	**0.04**	**-16.2596**	**<0.0001**	↑
	BC1	**7353**	**1.83**	**10.3411**	**<0.0001**	↓
	BC2	7021	1.12	1.9410	0.0523	–
	BC3	**7809**	**1.41**	**5.2830**	**<0.0001**	↓
	BC4	**7667**	**1.67**	**9.8596**	**<0.0001**	↓
	BC5	**7043**	**1.84**	**9.4303**	**<0.0001**	↓
	BC6	7137	0.88	-1.6283	0.1035	–
	BCA	**24002**	**1.85**	**16.1671**	**<0.0001**	↓
	PB1	**6974**	**7.22**	**21.7466**	**<0.0001**	↓
	PB2	7670	0.83	-2.8130	0.0049	–
	PB3	**7344**	**2.01**	**9.9825**	**<0.0001**	↓
	PB4	**6830**	**0.60**	**-6.7059**	**<0.0001**	↑
	PB5	**6812**	**1.48**	**5.6427**	**<0.0001**	↓
	MC1	**7415**	**0.81**	**-3.7442**	**0.0002**	↑
	MC2	7173	1.04	0.8064	0.4200	–

Appendix 3. Long term model estimation of change in stony coral, octocoral, sponge, and macroalgae percent cover across time intervals (±SEM). Each site was analyzed separately, where the 10 original SECREMP sites were analyzed between 3-time intervals (2003-2005, 2013-2015, 2020-2022). The full 22 sites were analyzed between 2 time points (2013-2015, 2020-2022). Mean values per site across each time interval were calculated. Significant trends in cover are bolded and indicated as increasing (↑), decreasing (↓), or no significant change (-). Significance is based on Bonferroni adjusted α values; α = 0.002273.

Stony Coral							
Site Code	**2003-2005 (A)**	**2013-2015 (B)**	**Ratio**	**df**	**T-ratio**	**P-value A vs B**	**Significant change**
BC1	10.89% ± 1.64%	12.12% ± 1.78%	0.89	31055	-2.6376	0.0084	−
BC2	0.53% ± 0.18%	0.70% ± 0.23%	0.75	31154	-1.6395	0.1011	−
BC3	**0.35% ± 0.09%**	**0.63% ± 0.14%**	**0.56**	**33140**	**-2.8210**	**0.0048**	↑
BCA	**36.86% ± 1.70%**	**11.33% ± 0.74%**	**4.57**	**96354**	**70.9308**	**<0.0001**	↓
DC1	**2.35% ± 0.53%**	**4.72% ± 1.00%**	**0.49**	**30907**	**-8.6051**	**<0.0001**	↑
DC2	**0.56% ± 0.15%**	**1.15% ± 0.28%**	**0.48**	**30230**	**-4.4122**	**<0.0001**	↑
DC3	0.20% ± 0.06%	0.27% ± 0.06%	0.74	30534	-0.9957	0.3194	−
PB1	**0.50% ± 0.08%**	**0.08% ± 0.03%**	**6.21**	**29175**	**4.9111**	**<0.0001**	↓
PB2	1.70% ± 0.43%	1.78% ± 0.44%	0.95	30332	-0.4668	0.6406	−
PB3	0.89% ± 0.23%	1.19% ± 0.29%	0.75	30443	-2.0773	0.0378	−

Appendix 3. Continued

Stony Coral							
Site Code	**2013-2015 (B)**	**2020-2022 (C)**	**Ratio**	**df**	**T-ratio**	**P-value B vs C**	**Significant change**
BC1	**12.12% ± 1.78%**	**5.99% ± 0.96%**	**2.16**	**31055**	**16.0491**	**<0.0001**	↓
BC2	**0.70% ± 0.23%**	**0.27% ± 0.09%**	**2.62**	**31154**	**4.7957**	**<0.0001**	↓
BC3	0.63% ± 0.14%	0.45% ± 0.10%	1.41	33140	1.9800	0.0477	–
BC4	**4.14% ± 0.60%**	**2.06% ± 0.32%**	**2.05**	**23572**	**9.0825**	**<0.0001**	↓
BC5	**1.36% ± 0.11%**	**0.29% ± 0.05%**	**4.72**	**22381**	**7.8853**	**<0.0001**	↓
BC6	0.60% ± 0.16%	0.36% ± 0.11%	1.65	23029	2.6127	0.0090	–
BCA	**11.33% ± 0.74%**	**4.43% ± 0.32%**	**2.75**	**96354**	**33.7106**	**<0.0001**	↓
DC1	**4.72% ± 1.00%**	**2.04% ± 0.46%**	**2.38**	**30907**	**11.1024**	**<0.0001**	↓
DC2	**1.15% ± 0.28%**	**0.49% ± 0.13%**	**2.37**	**30230**	**5.3575**	**<0.0001**	↓
DC3	0.27% ± 0.06%	0.39% ± 0.08%	0.68	30534	-1.6314	0.1028	–
DC4	1.31% ± 0.31%	1.06% ± 0.25%	1.24	22441	1.8105	0.0702	–
DC5	**1.85% ± 0.27%**	**1.10% ± 0.18%**	**1.70**	**21686**	**4.5870**	**<0.0001**	↓
DC6	**2.68% ± 0.60%**	**1.49% ± 0.35%**	**1.82**	**22842**	**6.3707**	**<0.0001**	↓
DC7	0.47% ± 0.08%	0.57% ± 0.10%	0.84	23471	-0.9932	0.3206	–
DC8	1.28% ± 0.34%	0.94% ± 0.26%	1.37	22892	2.5597	0.0105	–
MC1	**2.66% ± 1.29%**	**1.70% ± 0.84%**	**1.58**	**22047**	**5.4519**	**<0.0001**	↓
MC2	**1.07% ± 0.52%**	**0.08% ± 0.05%**	**13.13**	**22520**	**8.2479**	**<0.0001**	↓
PB1	0.08% ± 0.03%	0.08% ± 0.03%	0.96	29175	-0.0787	0.9373	–
PB2	**1.78% ± 0.44%**	**0.90% ± 0.23%**	**1.99**	**30332**	**5.8322**	**<0.0001**	↓
PB3	**1.19% ± 0.29%**	**0.59% ± 0.15%**	**2.02**	**30443**	**4.8305**	**<0.0001**	↓
PB4	**1.64% ± 0.25%**	**0.35% ± 0.07%**	**4.67**	**22330**	**8.8191**	**<0.0001**	↓
PB5	**2.07% ± 0.29%**	**0.86% ± 0.14%**	**2.43**	**22077**	**7.2423**	**<0.0001**	↓

Octocoral							
Site Code	**2003-2005 (A)**	**2013-2015 (B)**	**Ratio**	**df**	**T-ratio**	**P-value A vs B**	**Significant change**
BC1	6.44% ± 0.28%	6.75% ± 0.22%	0.95	31055	-0.8703	0.3842	–
BC2	**7.81% ± 0.46%**	**5.93% ± 0.34%**	**1.34**	**31154**	**5.2192**	**<0.0001**	↓
BC3	**13.11% ± 1.18%**	**10.22% ± 0.95%**	**1.33**	**33140**	**6.5345**	**<0.0001**	↓
BCA	**1.94% ± 0.19%**	**2.30% ± 0.21%**	**0.84**	**96354**	**-2.8358**	**0.0046**	↑
DC1	**6.26% ± 0.46%**	**9.95% ± 0.63%**	**0.60**	**30907**	**-9.0759**	**<0.0001**	↑
DC2	**13.31% ± 0.40%**	**11.97% ± 0.33%**	**1.13**	**30230**	**2.8192**	**0.0048**	↓
DC3	**13.76% ± 1.49%**	**8.37% ± 0.96%**	**1.75**	**30534**	**12.1476**	**<0.0001**	↓
PB1	**1.93% ± 0.54%**	**0.03% ± 0.02%**	**6.21**	**29175**	**4.9111**	**<0.0001**	↓
PB2	**26.08% ± 5.26%**	**17.15% ± 3.88%**	**0.95**	**30332**	**-0.4668**	**<0.0001**	↓
PB3	**28.27% ± 1.44%**	**12.32% ± 0.78%**	**0.75**	**30443**	**-2.0773**	**<0.0001**	↓

Appendix 3. Continued

Octocoral							
Site Code	**2013-2015 (B)**	**2020-2022 (C)**	**Ratio**	**df**	**T-ratio**	**P-value B vs C**	**Significant change**
BC1	**6.75% ± 0.22%**	**8.24% ± 0.26%**	**0.81**	**31055**	**-4.3115**	**<0.0001**	↑
BC2	**5.93% ± 0.34%**	**7.34% ± 0.41%**	**0.80**	**31154**	**-4.3250**	**<0.0001**	↑
BC3	10.22% ± 0.95%	10.67% ± 0.98%	0.95	33140	-1.1549	0.2481	–
BC4	**4.30% ± 0.54%**	**2.92% ± 0.38%**	**1.49**	**23572**	**5.6451**	**<0.0001**	↓
BC5	7.18% ± 0.40%	6.21% ± 0.36%	1.17	22381	2.8789	0.0040	–
BC6	**15.40% ± 0.72%**	**13.31% ± 0.66%**	**1.19**	**23029**	**4.5051**	**<0.0001**	↓
BCA	**2.30% ± 0.21%**	**1.90% ± 0.17%**	**1.21**	**96354**	**3.7862**	**0.0002**	↓
DC1	**9.95% ± 0.63%**	**6.45% ± 0.45%**	**1.60**	**30907**	**9.5287**	**<0.0001**	↓
DC2	**11.97% ± 0.33%**	**10.04% ± 0.32%**	**1.22**	**30230**	**4.5495**	**<0.0001**	↓
DC3	**8.37% ± 0.96%**	**10.03% ± 1.13%**	**0.82**	**30534**	**-4.3373**	**<0.0001**	↑
DC4	**12.92% ± 0.69%**	**11.38% ± 0.64%**	**1.16**	**22441**	**3.5131**	**0.0004**	↓
DC5	13.95% ± 1.34%	13.22% ± 1.29%	1.06	21686	1.5702	0.1164	–
DC6	**7.84% ± 0.80%**	**5.42% ± 0.58%**	**1.48**	**22842**	**7.2894**	**<0.0001**	↓
DC7	**9.07% ± 0.70%**	**7.93% ± 0.63%**	**1.16**	**23471**	**3.1287**	**0.0018**	↓
DC8	**14.21% ± 1.10%**	**9.11% ± 0.77%**	**1.65**	**22892**	**11.9596**	**<0.0001**	↓
MC1						n/a	–
MC2						n/a	–
PB1	0.03% ± 0.02%	0.15% ± 0.05%	0.21	29175	-2.8043	0.0050	–
PB2	**17.15% ± 3.88%**	**12.73% ± 3.03%**	**1.42**	**30332**	**9.3711**	**<0.0001**	↓
PB3	**12.32% ± 0.78%**	**13.46% ± 0.84%**	**0.90**	**30443**	**-2.5335**	**0.0113**	–
PB4	20.46% ± 1.36%	15.39% ± 1.10%	1.41	22330	9.8389	<0.0001	↓
PB5	**16.75% ± 0.56%**	**15.78% ± 0.55%**	**1.07**	**22077**	**1.9584**	**0.0502**	–

Sponge							
Site Code	**2003-2005 (A)**	**2013-2015 (B)**	**Ratio**	**df**	**T-ratio**	**P-value A vs B**	**Significant change**
BC1	**2.45% ± 0.39%**	**3.48% ± 0.51%**	**0.70**	**31055**	**-4.1248**	**<0.0001**	↑
BC2	**3.13% ± 0.28%**	**5.79% ± 0.41%**	**0.53**	**31154**	**-8.5281**	**<0.0001**	↑
BC3	**3.30% ± 0.24%**	**5.77% ± 0.31%**	**0.56**	**33140**	**-8.2157**	**<0.0001**	↑
BCA	**0.34% ± 0.10%**	**1.60% ± 0.41%**	**0.21**	**96354**	**-13.041**	**<0.0001**	↑
DC1	**1.08% ± 0.17%**	**2.81% ± 0.34%**	**0.38**	**30907**	**-8.0119**	**<0.0001**	↑
DC2	4.47% ± 0.27%	5.23% ± 0.26%	0.85	30230	-2.4294	0.0151	–
DC3	3.35% ± 0.69%	3.93% ± 0.79%	0.85	30534	-2.1804	0.0292	–
PB1	**7.15% ± 1.77%**	**2.55% ± 0.67%**	**2.94**	**29175**	**14.9447**	**<0.0001**	↓
PB2	**3.92% ± 0.42%**	**7.90% ± 0.74%**	**0.48**	**30332**	**-11.023**	**<0.0001**	↑
PB3	**9.92% ± 0.83%**	**11.62% ± 0.93%**	**0.84**	**30443**	**-3.7583**	**0.0002**	↑

Appendix 3. Continued

Sponge							
Site Code	**2013-2015 (B)**	**2020-2022 (C)**	**Ratio**	**df**	**T-ratio**	**P-value B vs C**	**Significant change**
BC1	**3.48% ± 0.51%**	**2.59% ± 0.40%**	**1.36**	**31055**	**3.9808**	**<0.0001**	↓
BC2	**5.79% ± 0.41%**	**6.87% ± 0.49%**	**0.83**	**31154**	**-3.3919**	**0.0007**	↑
BC3	5.77% ± 0.31%	5.87% ± 0.32%	0.98	33140	-0.3471	0.7285	–
BC4	3.54% ± 0.45%	3.27% ± 0.43%	1.09	23572	1.1661	0.2436	–
BC5	6.98% ± 0.86%	6.82% ± 0.85%	1.02	22381	0.4665	0.6409	–
BC6	**4.76% ± 0.69%**	**6.10% ± 0.87%**	**0.77**	**23029**	**-4.5051**	**<0.0001**	↑
BCA	**1.60% ± 0.41%**	**1.00% ± 0.26%**	**1.61**	**96354**	**7.5249**	**<0.0001**	↓
DC1	**2.81% ± 0.34%**	**3.67% ± 0.43%**	**0.76**	**30907**	**-3.7259**	**0.0002**	↑
DC2	5.23% ± 0.26%	6.07% ± 0.30%	0.85	30230	-2.6934	0.0071	–
DC3	**3.93% ± 0.79%**	**4.77% ± 0.95%**	**0.82**	**30534**	**-3.1713**	**0.0015**	↑
DC4	7.83% ± 0.72%	7.65% ± 0.71%	1.03	22441	0.5157	0.6061	–
DC5	4.29% ± 0.83%	4.42% ± 0.85%	0.97	21686	-0.5141	0.6072	–
DC6	2.03% ± 0.25%	2.06% ± 0.25%	0.99	22842	-0.1608	0.8722	–
DC7	**7.69% ± 0.88%**	**9.67% ± 1.08%**	**0.78**	**23471**	**-5.4043**	**<0.0001**	↑
DC8	3.15% ± 0.16%	3.16% ± 0.16%	1.00	22892	-0.0326	0.9740	–
MC1	1.96% ± 0.38%	1.92% ± 0.37%	1.02	22047	0.2370	0.8127	–
MC2	**2.95% ± 0.53%**	**1.93% ± 0.36%**	**1.55**	**22520**	**5.0022**	**<0.0001**	↓
PB1	2.55% ± 0.67%	2.83% ± 0.74%	0.90	29175	-1.3281	0.1842	–
PB2	**7.90% ± 0.74%**	**6.25% ± 0.60%**	**1.29**	**30332**	**4.8179**	**<0.0001**	↓
PB3	**11.62% ± 0.93%**	**13.32% ± 1.04%**	**0.86**	**30443**	**-3.8490**	**0.0001**	↑
PB4	**13.35% ± 1.71%**	**11.36% ± 1.49%**	**1.20**	**22330**	**4.5439**	**<0.0001**	↓
PB5	9.16% ± 1.27%	9.32% ± 1.29%	0.98	22077	-0.4195	0.6748	–

Macroalgae							
Site Code	**2003-2005 (A)**	**2013-2015 (B)**	**Ratio**	**df**	**T-ratio**	**P-value A vs B**	**Significant change**
BC1	**4.73% ± 0.76%**	**9.77% ± 1.44%**	**0.46**	**31055**	**-12.802**	**<0.0001**	↑
BC2	**3.49% ± 0.61%**	**5.40% ± 0.89%**	**0.63**	**31154**	**-6.3306**	**<0.0001**	↑
BC3	**4.35% ± 0.73%**	**8.21% ± 1.29%**	**0.51**	**33140**	**-11.150**	**<0.0001**	↑
BCA	**0.92% ± 0.11%**	**3.85% ± 0.38%**	**0.23**	**96354**	**-18.998**	**<0.0001**	↑
DC1	**19.34% ± 1.92%**	**7.22% ± 0.84%**	**3.08**	**30907**	**25.0721**	**<0.0001**	↓
DC2	4.34% ± 0.43%	5.06% ± 0.47%	0.85	30230	-2.3416	0.0192	–
DC3	**2.44% ± 0.59%**	**3.45% ± 0.81%**	**0.70**	**30534**	**-4.2168**	**<0.0001**	↑
PB1	**0.80% ± 0.14%**	**1.97% ± 0.26%**	**0.40**	**29175**	**-6.2805**	**<0.0001**	↑
PB2	**0.28% ± 0.09%**	**1.58% ± 0.44%**	**0.17**	**30332**	**-8.2315**	**<0.0001**	↑
PB3	**1.53% ± 0.34%**	**6.89% ± 1.35%**	**0.21**	**30443**	**-16.338**	**<0.0001**	↑

Appendix 3. Continued

Macroalgae							
Site Code	**2013-2015 (B)**	**2020-2022 (C)**	**Ratio**	**df**	**T-ratio**	**P-value B vs C**	**Significant change**
BC1	**9.77% ± 1.44%**	**18.50% ± 2.46%**	**0.48**	**31055**	**-19.112**	**<0.0001**	↑
BC2	**5.40% ± 0.89%**	**16.39% ± 2.36%**	**0.29**	**31154**	**-26.467**	**<0.0001**	↑
BC3	**8.21% ± 1.29%**	**15.18% ± 2.18%**	**0.50**	**33140**	**-16.932**	**<0.0001**	↑
BC4	**22.41% ± 1.69%**	**25.94% ± 1.87%**	**0.82**	**23572**	**-6.3236**	**<0.0001**	↑
BC5	**12.01% ± 2.23%**	**18.44% ± 3.17%**	**0.60**	**22381**	**-13.457**	**<0.0001**	↑
BC6	**4.41% ± 0.56%**	**11.03% ± 1.26%**	**0.37**	**23029**	**-18.566**	**<0.0001**	↑
BCA	**3.85% ± 0.38%**	**12.02% ± 1.06%**	**0.29**	**96354**	**-40.154**	**<0.0001**	↑
DC1	**7.22% ± 0.84%**	**24.69% ± 2.27%**	**0.24**	**30907**	**-34.898**	**<0.0001**	↑
DC2	**5.06% ± 0.47%**	**23.26% ± 1.62%**	**0.18**	**30230**	**-36.122**	**<0.0001**	↑
DC3	**3.45% ± 0.81%**	**12.37% ± 2.59%**	**0.25**	**30534**	**-24.364**	**<0.0001**	↑
DC4	**5.09% ± 0.75%**	**20.00% ± 2.44%**	**0.21**	**22441**	**-32.149**	**<0.0001**	↑
DC5	19.21% ± 1.82%	18.45% ± 1.77%	1.05	21686	1.4211	0.1553	–
DC6	**10.79% ± 0.55%**	**41.82% ± 1.29%**	**0.17**	**22842**	**-50.485**	**<0.0001**	↑
DC7	**5.77% ± 0.45%**	**22.04% ± 1.32%**	**0.22**	**23471**	**-34.123**	**<0.0001**	↑
DC8	**9.61% ± 1.65%**	**11.49% ± 1.92%**	**0.82**	**22892**	**-4.6622**	**<0.0001**	↑
MC1	**24.62% ± 1.42%**	**19.85% ± 1.23%**	**1.32**	**22047**	**8.4919**	**<0.0001**	↓
MC2	**37.69% ± 2.79%**	**31.23% ± 2.55%**	**1.33**	**22520**	**10.1321**	**<0.0001**	↓
PB1	**1.97% ± 0.26%**	**15.84% ± 1.60%**	**0.11**	**29175**	**-30.821**	**<0.0001**	↑
PB2	**1.58% ± 0.44%**	**11.32% ± 2.76%**	**0.13**	**30332**	**-26.945**	**<0.0001**	↑
PB3	**6.89% ± 1.35%**	**10.70% ± 2.01%**	**0.62**	**30443**	**-10.187**	**<0.0001**	↑
PB4	**3.59% ± 0.92%**	**11.86% ± 2.74%**	**0.28**	**22330**	**-22.606**	**<0.0001**	↑
PB5	12.49% ± 1.06%	13.44% ± 1.13%	0.92	22077	-2.1000	0.0357	–

Appendix 4. Stony coral live tissue area (m^2) by region and site. For region-wide values the live tissue area of all colonies within a site were summed and the average of all sites taken. Site values are the sum of the live tissue area of all colonies within a station and the average of the stations.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Level	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
R	6.11 ± 1.87	6.38 ± 2.16	6.48 ± 2.38	4.2 ± 1.5	3.53 ± 1.09	2.72 ± 1.01	3.08 ± 1.08	3.11 ± 1.03	2.95 ± 0.96	3.16 ± 0.98
DC1	4.46 ± 0.97	4.32 ± 0.85	4 ± 1.01	2.73 ± 0.58	2.52 ± 0.26	2.31 ± 0.37	2.13 ± 0.27	2.21 ± 0.28	2.27 ± 0.23	2.62 ± 0.36
DC2	0.35 ± 0.09	0.42 ± 0.03	0.36 ± 0.07	0.36 ± 0.09	0.32 ± 0.08	0.22 ± 0.05	0.28 ± 0.07	0.22 ± 0.04	0.29 ± 0.06	0.27 ± 0.03
DC3	0.28 ± 0.1	0.13 ± 0.03	0.13 ± 0.05	0.15 ± 0.05	0.17 ± 0.05	0.11 ± 0.01	0.12 ± 0.02	0.15 ± 0.02	0.16 ± 0.02	0.17 ± 0.02
DC4	0.5 ± 0.11	0.57 ± 0.14	0.3 ± 0.08	0.23 ± 0.07	0.29 ± 0.08	0.3 ± 0.06	0.28 ± 0.04	0.35 ± 0.05	0.39 ± 0.05	0.39 ± 0.07
DC5	1.98 ± 0.63	2.25 ± 0.71	1.4 ± 0.21	1 ± 0.28	0.88 ± 0.14	0.7 ± 0.11	1.12 ± 0.14	0.99 ± 0.17	1.23 ± 0.2	1.3 ± 0.25
DC6	1.85 ± 0.36	2.14 ± 0.58	2.83 ± 0.95	2.32 ± 0.91	1.61 ± 0.36	0.9 ± 0.36	1.1 ± 0.26	1.18 ± 0.31	0.91 ± 0.31	1.18 ± 0.36
DC7	0.36 ± 0.07	0.34 ± 0.08	0.32 ± 0.05	0.21 ± 0.05	0.25 ± 0.05	0.25 ± 0.08	0.28 ± 0.07	0.28 ± 0.06	0.31 ± 0.05	0.4 ± 0.12
DC8	0.57 ± 0.15	0.76 ± 0.23	0.53 ± 0.18	0.5 ± 0.17	0.43 ± 0.15	0.33 ± 0.14	0.47 ± 0.15	0.43 ± 0.18	0.3 ± 0.09	0.45 ± 0.2
BC1	10.04 ± 1.65	11.88 ± 1.41	12.98 ± 2.06	8.06 ± 1.57	5.56 ± 1.06	5.51 ± 0.9	5.9 ± 1.15	5.64 ± 0.9	5.12 ± 0.63	5.13 ± 0.89
BC2	0.28 ± 0.1	0.4 ± 0.17	0.35 ± 0.15	0.22 ± 0.05	0.26 ± 0.08	0.23 ± 0.07	0.22 ± 0.07	0.35 ± 0.13	0.28 ± 0.09	0.28 ± 0.07
BC3	0.37 ± 0.07	0.38 ± 0.12	0.29 ± 0.05	0.21 ± 0.05	0.26 ± 0.09	0.18 ± 0.01	0.19 ± 0.01	0.18 ± 0.03	0.19 ± 0.02	0.2 ± 0.05
BC4	3.39 ± 0.49	3.26 ± 0.55	3.49 ± 0.35	2.35 ± 0.44	2.49 ± 0.53	1.2 ± 0.07	1.46 ± 0.24	1.47 ± 0.28	1.32 ± 0.26	1.6 ± 0.31
BC5	0.86 ± 0.29	0.65 ± 0.19	0.91 ± 0.26	0.19 ± 0.02	0.18 ± 0.04	0.18 ± 0.05	0.19 ± 0.06	0.2 ± 0.03	0.18 ± 0.04	0.23 ± 0.05
BC6	0.45 ± 0.18	0.49 ± 0.17	0.5 ± 0.22	0.2 ± 0.03	0.13 ± 0.03	0.19 ± 0.06	0.18 ± 0.04	0.2 ± 0.06	0.21 ± 0.07	0.18 ± 0.06
BCA	0.37 ± 0.09	0.21 ± 0.07	0.22 ± 0.09	0.37 ± 0.07	0.6 ± 0.25	0.53 ± 0.19	0.59 ± 0.21	0.74 ± 0.23	0.35 ± 0.09	0.35 ± 0.09
PB1	0.05 ± 0.03	0.06 ± 0.04	0.07 ± 0.04	0.08 ± 0.04	0.06 ± 0.04	0.04 ± 0.02	0.04 ± 0.01	0.07 ± 0.04	0.03 ± 0.01	0.04 ± 0.09
PB2	0.95 ± 0.25	1 ± 0.22	1 ± 0.22	0.39 ± 0.07	0.35 ± 0.06	0.35 ± 0.1	0.3 ± 0.1	0.28 ± 0.09	0.33 ± 0.1	0.3 ± 0.09
PB3	0.65 ± 0.12	0.69 ± 0.16	0.67 ± 0.13	0.23 ± 0.08	0.23 ± 0.07	0.23 ± 0.09	0.25 ± 0.08	0.28 ± 0.09	0.21 ± 0.06	0.27 ± 0.09
PB4	1.87 ± 0.72	1.14 ± 0.21	1.27 ± 0.15	0.35 ± 0.12	0.33 ± 0.12	0.23 ± 0.08	0.29 ± 0.07	0.29 ± 0.1	0.32 ± 0.09	0.32 ± 0.1
PB5	1.55 ± 0.27	1.45 ± 0.29	1.52 ± 0.27	0.61 ± 0.21	0.45 ± 0.12	0.46 ± 0.13	0.46 ± 0.11	0.45 ± 0.1	0.54 ± 0.14	0.52 ± 0.09
MC1	1.82 ± 0.72	1.94 ± 0.78	1.97 ± 0.8	1.83 ± 0.6	1.68 ± 0.57	0.5 ± 0.2	1.09 ± 0.49	1.11 ± 0.54	1.26 ± 0.57	1.16 ± 0.39
MC2	0.6 ± 0.14	0.61 ± 0.14	0.53 ± 0.12	0.55 ± 0.13	0.37 ± 0.17	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.03 ± 0.01	0.03 ± 0.00

Appendix 5. Regional stony coral live tissue area of select species. Live tissue area was summed at each site and the regional live tissue area is the average of all sites.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Susceptibility Group	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)	Mean ± SE (m2)
Low	0.64 ± 0.23	0.77 ± 0.3	0.82 ± 0.3	0.84 ± 0.31	0.78 ± 0.27	0.71 ± 0.2	0.95 ± 0.29	0.97 ± 0.29	0.91 ± 0.29	1.00 ± 0.31
Intermediate	4.03 ± 1.79	4.28 ± 2.11	4.73 ± 2.39	2.86 ± 1.5	2.13 ± 0.99	1.83 ± 0.98	1.9 ± 1.02	1.9 ± 0.99	1.79 ± 0.90	1.89 ± 0.9
High	1.23 ± 0.35	1.14 ± 0.37	0.93 ± 0.34	0.59 ± 0.44	0.57 ± 0.41	0.03 ± 0.01	0.04 ± 0.02	0.04 ± 0.02	0.04 ± 0.01	0.06 ± 0.01
Presumed	0.22 ± 0.1	0.26 ± 0.14	0.28 ± 0.13	0.27 ± 0.12	0.33 ± 0.15	0.24 ± 0.12	0.33 ± 0.18	0.31 ± 0.17	0.27 ± 0.15	0.3 ± 0.17

Appendix 6. Stony coral live tissue area (LTA) statistics
Linear Mixed Effects Model ANOVA results

Variable	**Level**	**Intercept**	**Year**
Region	DF	1	9
	F	8.959599	7.327599
	P	0.0031	<.0001
High Susp. Spp.	DF	1	9
	F	4.944086	9.961697
	P	0.0277	<.0001
Intermediate Susp. Spp.	DF	1	9
	F	4.092624	4.299426
	P	0.0445	<.0001
Presumed Susp. Spp.	DF	1	9
	F	4.316101	0.0397
	P	0.440437	0.9109
Low Susp. Spp.	DF	1	9
	F	10.087638	0.937946
	P	0.0018	0.4935

Appendix 6. Continued

Tukey post hoc Test

Variable	Years	Est.	SE	z	P > |z|
Region	2014-2013	0.27246	0.80357	0.339	1
	2015-2013	0.37273	0.80357	0.464	1
	2016-2013	-1.90547	0.80357	-2.371	0.3425
	2017-2013	-2.57196	0.80357	-3.201	0.044
	2018-2013	-3.38656	0.80357	-4.214	<0.01
	2019-2013	-3.02817	0.80357	-3.768	<0.01
	2020-2013	-3.0003	0.80357	-3.734	<0.01
	2021-2013	-3.15492	0.80357	-3.926	<0.01
	2022-2013	-2.94395	0.80357	-3.664	<0.01
	2015-2014	0.10027	0.80357	0.125	1
	2016-2014	-2.17793	0.80357	-2.71	0.1693
	2017-2014	-2.84443	0.80357	-3.54	0.0148
	2018-2014	-3.65902	0.80357	-4.553	<0.01
	2019-2014	-3.30063	0.80357	-4.107	<0.01
	2020-2014	-3.27276	0.80357	-4.073	<0.01
	2021-2014	-3.42738	0.80357	-4.265	<0.01
	2022-2014	-3.21641	0.80357	-4.003	<0.01
	2016-2015	-2.2782	0.80357	-2.835	0.125
	2017-2015	-2.9447	0.80357	-3.665	<0.01
	2018-2015	-3.7593	0.80357	-4.678	<0.01
	2019-2015	-3.4009	0.80357	-4.232	<0.01
	2020-2015	-3.37303	0.80357	-4.198	<0.01
	2021-2015	-3.52765	0.80357	-4.39	<0.01
	2022-2015	-3.31668	0.80357	-4.127	<0.01
	2017-2016	-0.66649	0.80357	-0.829	0.9981
	2018-2016	-1.48109	0.80357	-1.843	0.7073
	2019-2016	-1.1227	0.80357	-1.397	0.9286
	2020-2016	-1.09483	0.80357	-1.362	0.9385
	2021-2016	-1.24945	0.80357	-1.555	0.8698
	2022-2016	-1.03848	0.80357	-1.292	0.9557
	2018-2017	-0.8146	0.80357	-1.014	0.9915
	2019-2017	-0.45621	0.80357	-0.568	0.9999
	2020-2017	-0.42833	0.80357	-0.533	1
	2021-2017	-0.58296	0.80357	-0.725	0.9994
	2022-2017	-0.37198	0.80357	-0.463	1
	2019-2018	0.35839	0.80357	0.446	1
	2020-2018	0.38626	0.80357	0.481	1
	2021-2018	0.23164	0.80357	0.288	1
	2022-2018	0.44261	0.80357	0.551	0.9999
	2020-2019	0.02787	0.80357	0.035	1
	2021-2019	-0.12675	0.80357	-0.158	1
	2022-2019	0.08422	0.80357	0.105	1
	2021-2020	-0.15462	0.80357	-0.192	1
	2022-2020	0.05635	0.80357	0.07	1
	2022-2021	0.21097	0.80357	0.263	1

Appendix 6. Continued

Tukey post hoc Test

Variable	Years	Est.	SE	z	P > |z|
High	2014-2013	-0.128915	0.158445	-0.814	0.9984
	2015-2013	-0.341945	0.158445	-2.158	0.4842
	2016-2013	-0.807157	0.175518	-4.599	<0.01
	2017-2013	-0.875065	0.184128	-4.752	<0.01
	2018-2013	-0.900127	0.175777	-5.121	<0.01
	2019-2013	-0.923842	0.166088	-5.562	<0.01
	2020-2013	-0.916686	0.163299	-5.614	<0.01
	2021-2013	-0.975689	0.166014	-5.877	<0.01
	2022-2013	-0.91307	0.168926	-5.405	<0.01
	2015-2014	-0.213029	0.158685	-1.342	0.9432
	2016-2014	-0.678242	0.175736	-3.859	<0.01
	2017-2014	-0.74615	0.184335	-4.048	<0.01
	2018-2014	-0.771212	0.175994	-4.382	<0.01
	2019-2014	-0.794927	0.166317	-4.78	<0.01
	2020-2014	-0.787771	0.163532	-4.817	<0.01
	2021-2014	-0.846773	0.166244	-5.094	<0.01
	2022-2014	-0.784155	0.169152	-4.636	<0.01
	2016-2015	-0.465213	0.175736	-2.647	0.1947
	2017-2015	-0.53312	0.184335	-2.892	0.1076
	2018-2015	-0.558183	0.175994	-3.172	0.0484
	2019-2015	-0.581898	0.166317	-3.499	0.017
	2020-2015	-0.574742	0.163532	-3.515	0.0158
	2021-2015	-0.633744	0.166244	-3.812	<0.01
	2022-2015	-0.571126	0.169152	-3.376	0.0253
	2017-2016	-0.067908	0.196836	-0.345	1
	2018-2016	-0.09297	0.191559	-0.485	1
	2019-2016	-0.116685	0.183611	-0.636	0.9998
	2020-2016	-0.109529	0.180726	-0.606	0.9999
	2021-2016	-0.168532	0.183501	-0.918	0.9959
	2022-2016	-0.105913	0.186414	-0.568	0.9999
	2018-2017	-0.025062	0.197781	-0.127	1
	2019-2017	-0.048778	0.190203	-0.256	1
	2020-2017	-0.041621	0.188469	-0.221	1
	2021-2017	-0.100624	0.191068	-0.527	1
	2022-2017	-0.038005	0.193964	-0.196	1
	2019-2018	-0.023715	0.180845	-0.131	1
	2020-2018	-0.016559	0.179105	-0.092	1
	2021-2018	-0.075561	0.181631	-0.416	1
	2022-2018	-0.012943	0.183778	-0.07	1
	2020-2019	0.007156	0.169574	0.042	1
	2021-2019	-0.051846	0.172095	-0.301	1
	2022-2019	0.010772	0.174943	0.062	1
	2021-2020	-0.059002	0.170243	-0.347	1
	2022-2020	0.003616	0.173123	0.021	1
	2022-2021	0.062619	0.17421	0.359	1

Appendix 6. Continued

Tukey post hoc Test

Variable	**Years**	**Est.**	**SE**	**z**	**P > |z|**
Intermediate	2014-2013	0.25003	0.7736	0.323	1
	2015-2013	0.5845	0.78387	0.746	0.9992
	2016-2013	-1.27954	0.78387	-1.632	0.8324
	2017-2013	-1.89602	0.7736	-2.451	0.2954
	2018-2013	-2.19676	0.7736	-2.84	0.1231
	2019-2013	-2.13326	0.7736	-2.758	0.151
	2020-2013	-2.12873	0.7736	-2.752	0.1533
	2021-2013	-2.23761	0.7736	-2.892	0.1074
	2022-2013	-2.13852	0.7736	-2.764	0.1486
	2015-2014	0.33447	0.78387	0.427	1
	2016-2014	-1.52957	0.78387	-1.951	0.6334
	2017-2014	-2.14605	0.7736	-2.774	0.1454
	2018-2014	-2.44679	0.7736	-3.163	0.0505
	2019-2014	-2.38329	0.7736	-3.081	0.064
	2020-2014	-2.37876	0.7736	-3.075	0.0651
	2021-2014	-2.48764	0.7736	-3.216	0.043
	2022-2014	-2.38855	0.7736	-3.088	0.0623
	2016-2015	-1.86404	0.7918	-2.354	0.3539
	2017-2015	-2.48052	0.78387	-3.164	0.0494
	2018-2015	-2.78126	0.78387	-3.548	0.0144
	2019-2015	-2.71776	0.78387	-3.467	0.0187
	2020-2015	-2.71323	0.78387	-3.461	0.0195
	2021-2015	-2.82212	0.78387	-3.6	0.0115
	2022-2015	-2.72302	0.78387	-3.474	0.0186
	2017-2016	-0.61647	0.78387	-0.786	0.9988
	2018-2016	-0.91722	0.78387	-1.17	0.9768
	2019-2016	-0.85372	0.78387	-1.089	0.9859
	2020-2016	-0.84919	0.78387	-1.083	0.9864
	2021-2016	-0.95807	0.78387	-1.222	0.969
	2022-2016	-0.85898	0.78387	-1.096	0.9852
	2018-2017	-0.30074	0.7736	-0.389	1
	2019-2017	-0.23724	0.7736	-0.307	1
	2020-2017	-0.23271	0.7736	-0.301	1
	2021-2017	-0.3416	0.7736	-0.442	1
	2022-2017	-0.2425	0.7736	-0.313	1
	2019-2018	0.0635	0.7736	0.082	1
	2020-2018	0.06803	0.7736	0.088	1
	2021-2018	-0.04085	0.7736	-0.053	1
	2022-2018	0.05824	0.7736	0.075	1
	2020-2019	0.00453	0.7736	0.006	1
	2021-2019	-0.10436	0.7736	-0.135	1
	2022-2019	-0.00526	0.7736	-0.007	1
	2021-2020	-0.10888	0.7736	-0.141	1
	2022-2020	-0.00979	0.7736	-0.013	1
	2022-2021	0.0991	0.7736	0.128	1

Appendix 7. Stony coral, octocoral and *Xestospongia muta* density (colonies/m^2) data region and by site. Regional density was calculated as an average of all sites, where site is the sum of all four stations. Site level values were calculated as an average of the four stations.

		2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Variable	**Level**	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Stony	R	1.21 ± 0.16	1.26 ± 0.18	1.29 ± 0.19	1.07 ± 0.17	1.35 ± 0.25	1.4 ± 0.23	1.54 ± 1.54	1.74 ± 0.32	1.71 ± 0.31	1.92 ± 0.36
Coral	DC1	1.8 ± 0.15	2.1 ± 0.16	2.15 ± 0.03	2.36 ± 0.06	2.28 ± 0.13	2.7 ± 0.27	2.8 ± 0.11	3.36 ± 0.24	3.51 ± 0.33	4.38 ± 0.55
	DC2	0.88 ± 0.09	1.08 ± 0.14	1.07 ± 0.11	0.83 ± 0.09	1.03 ± 0.04	1.1 ± 0.1	1.16 ± 0.06	1.07 ± 0.11	1.34 ± 0.11	1.14 ± 0.12
	DC3	0.31 ± 0.09	0.33 ± 0.03	0.31 ± 0.06	0.27 ± 0.07	0.28 ± 0.01	0.44 ± 0.03	0.42 ± 0.01	0.48 ± 0.06	0.41 ± 0.05	0.45 ± 0.04
	DC4	0.73 ± 0.11	0.75 ± 0.12	0.75 ± 0.2	0.57 ± 0.14	0.9 ± 0.18	0.9 ± 0.1	0.91 ± 0.11	0.95 ± 0.08	1.18 ± 0.1	1.34 ± 0.09
	DC5	2.56 ± 0.24	2.55 ± 0.14	2.33 ± 0.26	2.4 ± 0.26	3.3 ± 0.35	2.94 ± 0.41	4.01 ± 0.57	3.64 ± 0.48	4.73 ± 0.59	5.55 ± 0.63
	DC6	1.38 ± 0.26	1.42 ± 0.25	1.51 ± 0.25	1.44 ± 0.33	1.55 ± 0.35	1.51 ± 0.25	1.58 ± 0.27	1.45 ± 0.18	1.45 ± 0.24	1.75 ± 0.21
	DC7	1.13 ± 0.05	1.02 ± 0.12	1.1 ± 0.14	0.67 ± 0.09	0.85 ± 0.08	0.98 ± 0.14	1.14 ± 0.1	1.3 ± 0.1	1.39 ± 0.13	1.34 ± 0.11
	DC8	0.92 ± 0.09	0.82 ± 0.06	0.91 ± 0.15	0.56 ± 0.07	0.48 ± 0.05	0.6 ± 0.03	0.61 ± 0.06	0.73 ± 0.05	0.52 ± 0.03	1 ± 0.03
	BC1	1.81 ± 0.35	2.16 ± 0.33	2.05 ± 0.34	1.66 ± 0.3	1.45 ± 0.34	1.41 ± 0.34	1.47 ± 0.33	1.7 ± 0.29	1.44 ± 0.3	1.47 ± 0.35
	BC2	0.64 ± 0.12	0.78 ± 0.12	0.78 ± 0.12	0.47 ± 0.1	0.05 ± 0.13	0.95 ± 0.19	0.82 ± 0.1	1.11 ± 0.12	0.92 ± 0.13	0.95 ± 0.11
	BC3	0.75 ± 0.11	0.76 ± 0.22	0.59 ± 0.08	0.09 ± 0.03	0.61 ± 0.04	0.83 ± 0.09	0.72 ± 0.03	0.85 ± 0.09	0.93 ± 0.06	0.92 ± 0.08
	BC4	3.28 ± 0.32	3.75 ± 0.22	4.05 ± 0.31	3.41 ± 0.12	4.9 ± 0.4	3.83 ± 0.18	4.43 ± 0.16	5.03 ± 0.23	4.74 ± 0.29	5.69 ± 0.38
	BC5	1.23 ± 0.19	1.09 ± 0.25	1.19 ± 0.22	0.67 ± 0.08	0.83 ± 0.14	0.9 ± 0.12	1.01 ± 0.26	1.18 ± 0.16	1.06 ± 0.12	1.35 ± 0.08
	BC6	0.64 ± 0.11	0.59 ± 0.07	0.56 ± 0.06	0.43 ± 0.05	0.41 ± 0	0.45 ± 0.12	0.5 ± 0.09	0.59 ± 0.13	0.69 ± 0.17	0.68 ± 0.17
	BCA	0.61 ± 0.18	0.58 ± 0.17	1.09 ± 0.4	1.45 ± 0.17	3.08 ± 1.1	3.47 ± 1.15	3.66 ± 1.28	4.95 ± 1.44	2.58 ± 0.72	2.52 ± 0.58
	PB1	0.23 ± 0.15	0.27 ± 0.17	0.28 ± 0.15	0.33 ± 0.14	0.25 ± 0.11	0.4 ± 0.15	0.4 ± 0.07	0.75 ± 0.18	0.34 ± 0.1	0.49 ± 0.12
	PB2	1.07 ± 0.15	1.24 ± 0.09	1.57 ± 0.31	1.07 ± 0.33	1.03 ± 0.42	0.86 ± 0.25	0.82 ± 0.14	0.68 ± 0.13	0.72 ± 0.07	0.84 ± 0.05
	PB3	1.05 ± 0.31	1.18 ± 0.34	1.11 ± 0.29	0.63 ± 0.22	0.68 ± 0.23	0.67 ± 0.19	0.73 ± 0.17	0.76 ± 0.24	0.76 ± 0.25	0.93 ± 0.28
	PB4	1.82 ± 0.38	1.63 ± 0.31	1.7 ± 0.29	1.02 ± 0.27	1.01 ± 0.23	1.06 ± 0.24	1.01 ± 0.22	1.15 ± 0.3	1.32 ± 0.29	1.28 ± 0.22
	PB5	2.3 ± 0.31	2.2 ± 0.29	2.08 ± 0.29	1.58 ± 0.25	1.65 ± 0.32	1.75 ± 0.4	1.77 ± 0.34	1.85 ± 0.27	2.06 ± 0.3	2.28 ± 0.21
	MC1	0.95 ± 0.09	1.06 ± 0.11	0.98 ± 0.18	0.98 ± 0.31	2.18 ± 0.66	2.82 ± 0.78	3.7 ± 1.2	4.35 ± 1.32	4.89 ± 1.09	5.44 ± 1.01
	MC2	0.49 ± 0.06	0.4 ± 0.05	0.34 ± 0.05	0.27 ± 0.05	0.31 ± 0.08	0.11 ± 0.05	0.22 ± 0.05	0.32 ± 0.1	0.53 ± 0.13	0.49 ± 0.08

Appendix 7. Continued

		2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Variable	**Level**	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Octocoral	R	8.68 ± 1.34	9.97 ± 1.55	11.52 ± 1.76	11.85 ± 1.83	12.58 ± 1.85	10.36 ± 1.5	11.57 ± 1.61	14.05 ± 2.01	13.38 ± 1.87	12.14 ± 1.6
	DC1	6.93 ± 1.42	8.18 ± 0.74	11.6 ± 1.52	13.25 ± 1.28	11.38 ± 1.19	10.63 ± 1.09	8.98 ± 0.91	11.7 ± 0.54	12.05 ± 1.41	10.48 ± 0.5
	DC2	6.88 ± 2.3	14.25 ± 1.8	19.5 ± 2.09	17.98 ± 1.44	19.93 ± 1.91	14.7 ± 1.77	17.75 ± 1.14	20.83 ± 1.42	22.8 ± 0.52	19 ± 2.18
	DC3	6.18 ± 1.43	7.23 ± 1.23	7.55 ± 1.36	9.33 ± 0.44	10.15 ± 1.19	9.2 ± 0.97	9.7 ± 1.12	12.23 ± 1.75	10.5 ± 1.72	12.35 ± 1.36
	DC4	11.23 ± 2.52	12.43 ± 3.18	14.45 ± 2.6	11.93 ± 1	14.9 ± 2.36	14 ± 2.03	15.85 ± 2.95	21.68 ± 2.93	19.5 ± 3.92	21.1 ± 3.34
	DC5	6.58 ± 1.19	7.15 ± 0.8	8.95 ± 0.91	8.63 ± 0.96	9.7 ± 0.58	7.08 ± 0.73	10.38 ± 1.1	11.23 ± 1.16	10.25 ± 1.08	10.3 ± 1.06
	DC6	6.9 ± 0.75	8.13 ± 0.97	9.53 ± 1.83	9.88 ± 1.65	10.85 ± 1.38	6.93 ± 0.99	7.65 ± 0.9	11.65 ± 0.82	11.95 ± 1.13	12.8 ± 1.55
	DC7	3.43 ± 0.26	3.83 ± 0.14	7.13 ± 0.47	6.95 ± 0.41	6.7 ± 0.54	6.75 ± 0.78	8.03 ± 0.91	11.6 ± 1.84	11.73 ± 2.09	9.38 ± 1.29
	DC8	14.9 ± 1.45	16.28 ± 1.7	19.9 ± 1.91	19.28 ± 1.41	21.33 ± 1.48	17.23 ± 2.84	21.13 ± 1.13	23.65 ± 2.98	19.7 ± 3.42	21.68 ± 2.8
	BC1	10.75 ± 0.79	11.15 ± 0.99	11.15 ± 0.96	11.68 ± 0.88	11.05 ± 1.3	13.58 ± 0.81	14.93 ± 1.86	20.13 ± 1.49	14.85 ± 2.58	14.45 ± 2.4
	BC2	7.4 ± 1.11	8.65 ± 1.3	8.63 ± 1.65	9.28 ± 1.99	10.18 ± 1.56	9.4 ± 1.7	10.88 ± 2.23	10 ± 1.79	9.23 ± 2.22	8.3 ± 1.45
	BC3	12.9 ± 1.06	12.75 ± 1.3	11.53 ± 1.4	14.3 ± 1.89	15.23 ± 1.3	12.28 ± 1.6	14.08 ± 1.11	11.2 ± 2.85	12.95 ± 0.93	15.18 ± 1.89
	BC4	3.73 ± 0.61	3.95 ± 0.97	5.23 ± 0.58	4.08 ± 0.68	6.65 ± 1.21	3.28 ± 0.85	4.78 ± 1.63	6.58 ± 2.04	5.93 ± 1.49	5.85 ± 1.62
	BC5	5.73 ± 0.53	7.45 ± 0.56	6.55 ± 0.63	6.18 ± 0.71	7.7 ± 1.37	5.68 ± 0.66	7.03 ± 0.96	11.3 ± 1.01	9.73 ± 1.15	7.78 ± 0.73
	BC6	20.78 ± 3.78	19.28 ± 1.91	21.18 ± 2.13	23.48 ± 0.88	25.8 ± 1.02	20.63 ± 2.76	23.2 ± 3.16	26.1 ± 1.78	21.9 ± 0.62	16.13 ± 0.63
	BCA	1.15 ± 0.51	0.85 ± 0.39	1.1 ± 0.54	0.58 ± 0.28	1.1 ± 0.46	1.58 ± 0.5	2.1 ± 0.41	3.15 ± 0.76	2.48 ± 0.6	1.88 ± 0.59
	PB1	0.23 ± 0.14	0.18 ± 0.09	0.13 ± 0.05	0.05 ± 0.03	0.03 ± 0.03	0.00 ± 0.00	0.7 ± 0.33	0.75 ± 0.4	0.7 ± 0.25	0.65 ± 0.21
	PB2	17.03 ± 3.85	20.55 ± 5.32	23.45 ± 5.59	23.48 ± 4.99	23.33 ± 4.55	17.48 ± 3.77	16.88 ± 5.68	16.65 ± 6.69	21.53 ± 5.92	16.25 ± 3.53
	PB3	12.85 ± 3.18	12.45 ± 2.56	14.15 ± 2.39	17.33 ± 3.14	18.55 ± 3.2	14.28 ± 2.32	13.25 ± 2	14.6 ± 1.65	16.95 ± 2.91	17.25 ± 2.51
	PB4	15.63 ± 2.31	17.65 ± 1.09	23.48 ± 2.48	23.8 ± 4.01	22.43 ± 2.93	20 ± 0.81	23.08 ± 0.87	28.98 ± 1.59	27.7 ± 2.93	19.25 ± 1.89
	PB5	19.8 ± 2.36	27.03 ± 4.61	28.25 ± 4.98	29.33 ± 3.83	29.83 ± 3.38	23.3 ± 2.11	24.13 ± 1.73	35.13 ± 3.57	32.1 ± 5.98	27.05 ± 1.21
	MC1	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	MC2	0.03 ± 0.03	0.03 ± 0.03	0.03 ± 0.03	0.03 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

Appendix 7. Continued

		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Variable	**Level**	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
X. muta	R	0.24 ± 0.05	0.28 ± 0.06	0.3 ± 0.06	0.31 ± 0.06	0.35 ± 0.06	0.28 ± 0.05	0.32 ± 0.06	0.32 ± 0.06	0.31 ± 0.6	0.36 ± 0.06
	DC1	0.06 ± 0.04	0.02 ± 0.02	0.07 ± 0.04	0.1 ± 0.04	0.13 ± 0.04	0.06 ± 0.01	0.09 ± 0.03	0.08 ± 0.02	0.06 ± 0.03	0.16 ± 0.03
	DC2	0.31 ± 0.02	0.35 ± 0.04	0.43 ± 0.04	0.41 ± 0.06	0.45 ± 0.06	0.34 ± 0.05	0.4 ± 0.04	0.47 ± 0.03	0.57 ± 0.06	0.51 ± 0.05
	DC3	0.26 ± 0.07	0.25 ± 0.07	0.28 ± 0.07	0.31 ± 0.11	0.27 ± 0.08	0.22 ± 0.08	0.25 ± 0.09	0.23 ± 0.1	0.17 ± 0.05	0.26 ± 0.11
	DC4	0.57 ± 0.04	0.61 ± 0.05	0.64 ± 0.03	0.64 ± 0.03	0.64 ± 0.03	0.47 ± 0.04	0.44 ± 0.05	0.43 ± 0.04	0.41 ± 0.06	0.49 ± 0.07
	DC5	0.15 ± 0.02	0.1 ± 0.03	0.1 ± 0.03	0.14 ± 0.06	0.22 ± 0.02	0.14 ± 0.04	0.18 ± 0.06	0.15 ± 0.06	0.16 ± 0.05	0.14 ± 0.04
	DC6	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.00 ± 0.00
	DC7	0.28 ± 0.05	0.34 ± 0.03	0.43 ± 0.04	0.41 ± 0.06	0.53 ± 0.02	0.39 ± 0.08	0.44 ± 0.08	0.72 ± 0.14	0.58 ± 0.09	0.65 ± 0.1
	DC8	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	BC1	0.06 ± 0.04	0.11 ± 0.06	0.09 ± 0.04	0.11 ± 0.05	0.16 ± 0.07	0.15 ± 0.11	0.14 ± 0.09	0.16 ± 0.1	0.23 ± 0.1	0.26 ± 0.1
	BC2	0.35 ± 0.05	0.5 ± 0.05	0.05 ± 0.07	0.51 ± 0.08	0.57 ± 0.09	0.57 ± 0.08	0.52 ± 0.06	0.57 ± 0.06	0.56 ± 0.05	0.61 ± 0.03
	BC3	0.34 ± 0.04	0.63 ± 0.08	0.63 ± 0.11	0.55 ± 0.12	0.63 ± 0.14	0.49 ± 0.1	0.35 ± 0.11	0.41 ± 0.1	0.44 ± 0.11	0.56 ± 0.04
	BC4	0.15 ± 0.02	0.26 ± 0.04	0.26 ± 0.04	0.27 ± 0.06	0.31 ± 0.05	0.24 ± 0.06	0.18 ± 0.03	0.2 ± 0.04	0.28 ± 0.03	0.35 ± 0.07
	BC5	0.45 ± 0.11	0.49 ± 0.14	0.44 ± 0.11	0.59 ± 0.09	0.63 ± 0.08	0.57 ± 0.12	0.73 ± 0.16	0.69 ± 0.14	0.56 ± 0.2	0.67 ± 0.26
	BC6	0.38 ± 0.1	0.38 ± 0.11	0.25 ± 0.09	0.36 ± 0.11	0.4 ± 0.08	0.4 ± 0.07	0.5 ± 0.11	0.48 ± 0.12	0.4 ± 0.08	0.48 ± 0.11
	BCA	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01
	PB1	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.02	0.00 ± 0.00	0.00 ± 0.00
	PB2	0.11 ± 0.05	0.14 ± 0.04	0.17 ± 0.02	0.24 ± 0.05	0.34 ± 0.05	0.3 ± 0.07	0.36 ± 0.1	0.35 ± 0.12	0.24 ± 0.06	0.43 ± 0.18
	PB3	0.55 ± 0.1	0.55 ± 0.1	0.71 ± 0.13	0.66 ± 0.13	0.61 ± 0.11	0.58 ± 0.16	0.63 ± 0.13	0.6 ± 0.12	0.67 ± 0.12	0.78 ± 0.09
	PB4	0.6 ± 0.1	0.7 ± 0.07	0.64 ± 0.1	0.72 ± 0.09	0.77 ± 0.06	0.7 ± 0.06	0.72 ± 0.06	0.67 ± 0.08	0.76 ± 0.1	0.72 ± 0.07
	PB5	0.65 ± 0.05	0.74 ± 0.09	0.88 ± 0.07	0.88 ± 0.07	0.97 ± 0.11	0.66 ± 0.08	0.86 ± 0.12	0.75 ± 0.1	0.78 ± 0.08	0.78 ± 0.11
	MC1	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
	MC2	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

Appendix 8. Stony coral, octocoral and *Xestospongia muta* density statistics.

Linear Mixed Effects Model ANOVA results.

Variable	**Level**	**Intercept**	**Year**
Stony Coral	DF	1	9
	F	40.90802	5.09178
	P	<.0001	<.0001
Octocoral	DF	1	9
	F	49.29005	13.90394
	P	<.0001	<.0001
Xestospongia Muta	DF	1	9
	F	30.206329	6.820849
	P	<.0001	<.0001

Appendix 8. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
Stony Coral	2014-2013	0.05372	0.17024	0.316	1
	2015-2013	0.0811	0.17024	0.476	1
	2016-2013	-0.13946	0.17024	-0.819	0.9983
	2017-2013	0.14101	0.17024	0.828	0.9982
	2018-2013	0.18957	0.17024	1.114	0.9835
	2019-2013	0.33419	0.17024	1.963	0.6253
	2020-2013	0.53409	0.17024	3.137	0.0538
	2021-2013	0.49948	0.17024	2.934	0.096
	2022-2013	0.71694	0.17024	4.211	<0.01
	2015-2014	0.02738	0.17024	0.161	1
	2016-2014	-0.19318	0.17024	-1.135	0.9812
	2017-2014	0.08729	0.17024	0.513	1
	2018-2014	0.13585	0.17024	0.798	0.9986
	2019-2014	0.28048	0.17024	1.648	0.8246
	2020-2014	0.48037	0.17024	2.822	0.1289
	2021-2014	0.44576	0.17024	2.618	0.2081
	2022-2014	0.66322	0.17024	3.896	<0.01
	2016-2015	-0.22056	0.17024	-1.296	0.9549
	2017-2015	0.05992	0.17024	0.352	1
	2018-2015	0.10847	0.17024	0.637	0.9998
	2019-2015	0.2531	0.17024	1.487	0.8978
	2020-2015	0.453	0.17024	2.661	0.1897
	2021-2015	0.41839	0.17024	2.458	0.2917
	2022-2015	0.63585	0.17024	3.735	<0.01
	2017-2016	0.28048	0.17024	1.648	0.8245
	2018-2016	0.32903	0.17024	1.933	0.647
	2019-2016	0.47366	0.17024	2.782	0.1421
	2020-2016	0.67355	0.17024	3.957	<0.01
	2021-2016	0.63895	0.17024	3.753	<0.01
	2022-2016	0.8564	0.17024	5.031	<0.01
	2018-2017	0.04855	0.17024	0.285	1
	2019-2017	0.19318	0.17024	1.135	0.9812
	2020-2017	0.39308	0.17024	2.309	0.3828
	2021-2017	0.35847	0.17024	2.106	0.5232
	2022-2017	0.57593	0.17024	3.383	0.0252
	2019-2018	0.14463	0.17024	0.85	0.9978
	2020-2018	0.34452	0.17024	2.024	0.5818
	2021-2018	0.30992	0.17024	1.82	0.7222
	2022-2018	0.52738	0.17024	3.098	0.0603
	2020-2019	0.1999	0.17024	1.174	0.9763
	2021-2019	0.16529	0.17024	0.971	0.9938
	2022-2019	0.38275	0.17024	2.248	0.4231
	2021-2020	-0.03461	0.17024	-0.203	1
	2022-2020	0.18285	0.17024	1.074	0.9872
	2022-2021	0.21746	0.17024	1.277	0.9588

Appendix 8. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
Octocoral	2014-2013	1.29205	0.60911	2.121	0.51231
	2015-2013	2.83864	0.60911	4.66	< 0.001
	2016-2013	3.17159	0.60911	5.207	< 0.001
	2017-2013	3.9	0.60911	6.403	< 0.001
	2018-2013	1.68068	0.60911	2.759	0.15062
	2019-2013	2.88523	0.60911	4.737	< 0.001
	2020-2013	5.36932	0.60911	8.815	< 0.001
	2021-2013	4.70341	0.60911	7.722	< 0.001
	2022-2013	3.45909	0.60911	5.679	< 0.001
	2015-2014	1.54659	0.60911	2.539	0.24769
	2016-2014	1.87955	0.60911	3.086	0.06294
	2017-2014	2.60795	0.60911	4.282	< 0.001
	2018-2014	0.38864	0.60911	0.638	0.99978
	2019-2014	1.59318	0.60911	2.616	0.21039
	2020-2014	4.07727	0.60911	6.694	< 0.001
	2021-2014	3.41136	0.60911	5.601	< 0.001
	2022-2014	2.16705	0.60911	3.558	0.0139
	2016-2015	0.33295	0.60911	0.547	0.99994
	2017-2015	1.06136	0.60911	1.742	0.77103
	2018-2015	-1.15795	0.60911	-1.901	0.66863
	2019-2015	0.04659	0.60911	0.076	1
	2020-2015	2.53068	0.60911	4.155	0.00146
	2021-2015	1.86477	0.60911	3.061	0.06814
	2022-2015	0.62045	0.60911	1.019	0.99123
	2017-2016	0.72841	0.60911	1.196	0.97315
	2018-2016	-1.49091	0.60911	-2.448	0.29723
	2019-2016	-0.28636	0.60911	-0.47	0.99998
	2020-2016	2.19773	0.60911	3.608	0.01174
	2021-2016	1.53182	0.60911	2.515	0.2598
	2022-2016	0.2875	0.60911	0.472	0.99998
	2018-2017	-2.21932	0.60911	-3.644	0.00977
	2019-2017	-1.01477	0.60911	-1.666	0.81467
	2020-2017	1.46932	0.60911	2.412	0.31822
	2021-2017	0.80341	0.60911	1.319	0.9496
	2022-2017	-0.44091	0.60911	-0.724	0.99937
	2019-2018	1.20455	0.60911	1.978	0.6147
	2020-2018	3.68864	0.60911	6.056	< 0.001
	2021-2018	3.02273	0.60911	4.963	< 0.001
	2022-2018	1.77841	0.60911	2.92	0.09984
	2020-2019	2.48409	0.60911	4.078	0.00179
	2021-2019	1.81818	0.60911	2.985	0.08412
	2022-2019	0.57386	0.60911	0.942	0.99508
	2021-2020	-0.66591	0.60911	-1.093	0.9855
	2022-2020	-1.91023	0.60911	-3.136	0.0543
	2022-2021	-1.24432	0.60911	-2.043	0.56845

Appendix 8. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
Xestospongia muta	2014-2013	0.0428719	0.0184777	2.32	0.376
	2015-2013	0.0609504	0.0184777	3.299	0.033
	2016-2013	0.0754132	0.0184777	4.081	<0.01
	2017-2013	0.1089876	0.0184777	5.898	<0.01
	2018-2013	0.0464876	0.0184777	2.516	0.2593
	2019-2013	0.0790289	0.0184777	4.277	<0.01
	2020-2013	0.0795455	0.0184777	4.305	<0.01
	2021-2013	0.0743802	0.0184777	4.025	<0.01
	2022-2013	0.1198347	0.0184777	6.485	<0.01
	2015-2014	0.0180785	0.0184777	0.978	0.9935
	2016-2014	0.0325413	0.0184777	1.761	0.7596
	2017-2014	0.0661157	0.0184777	3.578	0.0129
	2018-2014	0.0036157	0.0184777	0.196	1
	2019-2014	0.036157	0.0184777	1.957	0.6295
	2020-2014	0.0366736	0.0184777	1.985	0.6097
	2021-2014	0.0315083	0.0184777	1.705	0.7931
	2022-2014	0.0769628	0.0184777	4.165	<0.01
	2016-2015	0.0144628	0.0184777	0.783	0.9988
	2017-2015	0.0480372	0.0184777	2.6	0.2182
	2018-2015	-0.0144628	0.0184777	-0.783	0.9988
	2019-2015	0.0180785	0.0184777	0.978	0.9935
	2020-2015	0.018595	0.0184777	1.006	0.992
	2021-2015	0.0134298	0.0184777	0.727	0.9993
	2022-2015	0.0588843	0.0184777	3.187	0.0459
	2017-2016	0.0335744	0.0184777	1.817	0.7249
	2018-2016	-0.0289256	0.0184777	-1.565	0.8649
	2019-2016	0.0036157	0.0184777	0.196	1
	2020-2016	0.0041322	0.0184777	0.224	1
	2021-2016	-0.0010331	0.0184777	-0.056	1
	2022-2016	0.0444215	0.0184777	2.404	0.3229
	2018-2017	-0.0625	0.0184777	-3.382	0.0252
	2019-2017	-0.0299587	0.0184777	-1.621	0.838
	2020-2017	-0.0294421	0.0184777	-1.593	0.8518
	2021-2017	-0.0346074	0.0184777	-1.873	0.6877
	2022-2017	0.0108471	0.0184777	0.587	0.9999
	2019-2018	0.0325413	0.0184777	1.761	0.7599
	2020-2018	0.0330579	0.0184777	1.789	0.7426
	2021-2018	0.0278926	0.0184777	1.51	0.8888
	2022-2018	0.0733471	0.0184777	3.969	<0.01
	2020-2019	0.0005165	0.0184777	0.028	1
	2021-2019	-0.0046488	0.0184777	-0.252	1
	2022-2019	0.0408058	0.0184777	2.208	0.4506
	2021-2020	-0.0051653	0.0184777	-0.28	1
	2022-2020	0.0402893	0.0184777	2.18	0.4709
	2022-2021	0.0454545	0.0184777	2.46	0.2912

Appendix 9. Octocoral target species mean density (colonies/m^2).

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Species	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
G. ventalina	0.21 ± 0.05	0.24 ± 0.05	0.3 ± 0.08	0.29 ± 0.07	0.33 ± 0.07	0.28 ± 0.07	0.29 ± 0.07	0.35 ± 0.09	0.41 ± 0.09	0.36 ± 0.08
A. americana	1.36 ± 0.24	1.39 ± 0.26	1.71 ± 0.28	1.79 ± 0.31	1.8 ± 0.31	1.7 ± 0.3	1.98 ± 0.37	2.54 ± 0.45	2.64 ± 0.45	2.61 ± 0.45
E. flexuosa	0.58 ± 0.14	0.73 ± 0.2	0.83 ± 0.27	0.78 ± 0.24	0.77 ± 0.24	0.6 ± 0.19	0.68 ± 0.23	0.81 ± 0.25	0.81 ± 0.25	0.78 ± 0.26

Appendix 10. Octocoral density statistics.

Linear Mixed Effects Model ANOVA results.

Variable	**Level**	**Intercept**	**Year**
G. ventalina	DF	1	9
	F	20.770598	3.811899
	P	<.0001	2e-04
A. americana	DF	1	9
	F	35.13432	14.58651
	P	<.0001	<.0001
E. flexuosa	DF	1	9
	F	10.970798	2.087178
	P	0.0011	0.0325

Appendix 10. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
G. ventalina	2014-2013	0.029545	0.041755	0.708	0.9995
	2015-2013	0.089773	0.041755	2.15	0.4916
	2016-2013	0.079545	0.041755	1.905	0.6655
	2017-2013	0.111364	0.041755	2.667	0.1872
	2018-2013	0.064773	0.041755	1.551	0.8713
	2019-2013	0.073864	0.041755	1.769	0.7546
	2020-2013	0.134091	0.041755	3.211	0.0434
	2021-2013	0.196591	0.041755	4.708	<0.01
	2022-2013	0.148864	0.041755	3.565	0.0135
	2015-2014	0.060227	0.041755	1.442	0.9138
	2016-2014	0.05	0.041755	1.197	0.973
	2017-2014	0.081818	0.041755	1.959	0.6277
	2018-2014	0.035227	0.041755	0.844	0.9979
	2019-2014	0.044318	0.041755	1.061	0.9882
	2020-2014	0.104545	0.041755	2.504	0.2656
	2021-2014	0.167045	0.041755	4.001	<0.01
	2022-2014	0.119318	0.041755	2.858	0.118
	2016-2015	-0.010227	0.041755	-0.245	1
	2017-2015	0.021591	0.041755	0.517	1
	2018-2015	-0.025	0.041755	-0.599	0.9999
	2019-2015	-0.015909	0.041755	-0.381	1
	2020-2015	0.044318	0.041755	1.061	0.9882
	2021-2015	0.106818	0.041755	2.558	0.2374
	2022-2015	0.059091	0.041755	1.415	0.9229
	2017-2016	0.031818	0.041755	0.762	0.9991
	2018-2016	-0.014773	0.041755	-0.354	1
	2019-2016	-0.005682	0.041755	-0.136	1
	2020-2016	0.054545	0.041755	1.306	0.9525
	2021-2016	0.117045	0.041755	2.803	0.1351
	2022-2016	0.069318	0.041755	1.66	0.818
	2018-2017	-0.046591	0.041755	-1.116	0.9832
	2019-2017	-0.0375	0.041755	-0.898	0.9966
	2020-2017	0.022727	0.041755	0.544	0.9999
	2021-2017	0.085227	0.041755	2.041	0.5696
	2022-2017	0.0375	0.041755	0.898	0.9966
	2019-2018	0.009091	0.041755	0.218	1
	2020-2018	0.069318	0.041755	1.66	0.8182
	2021-2018	0.131818	0.041755	3.157	0.0506
	2022-2018	0.084091	0.041755	2.014	0.5887
	2020-2019	0.060227	0.041755	1.442	0.9139
	2021-2019	0.122727	0.041755	2.939	0.0946
	2022-2019	0.075	0.041755	1.796	0.7377
	2021-2020	0.0625	0.041755	1.497	0.8938
	2022-2020	0.014773	0.041755	0.354	1
	2022-2021	-0.047727	0.041755	-1.143	0.9802

Appendix 10. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
A. americana	2014-2013	0.035227	0.179268	0.197	1
	2015-2013	0.354545	0.179268	1.978	0.61502
	2016-2013	0.434091	0.179268	2.421	0.31309
	2017-2013	0.439773	0.179268	2.453	0.29443
	2018-2013	0.344318	0.179268	1.921	0.65537
	2019-2013	0.628409	0.179268	3.505	0.01674
	2020-2013	1.186364	0.179268	6.618	< 0.001
	2021-2013	1.288636	0.179268	7.188	< 0.001
	2022-2013	1.257955	0.179268	7.017	< 0.001
	2015-2014	0.319318	0.179268	1.781	0.7472
	2016-2014	0.398864	0.179268	2.225	0.4392
	2017-2014	0.404545	0.179268	2.257	0.41722
	2018-2014	0.309091	0.179268	1.724	0.78213
	2019-2014	0.593182	0.179268	3.309	0.03228
	2020-2014	1.151136	0.179268	6.421	< 0.001
	2021-2014	1.253409	0.179268	6.992	< 0.001
	2022-2014	1.222727	0.179268	6.821	< 0.001
	2016-2015	0.079545	0.179268	0.444	0.99999
	2017-2015	0.085227	0.179268	0.475	0.99998
	2018-2015	-0.010227	0.179268	-0.057	1
	2019-2015	0.273864	0.179268	1.528	0.88152
	2020-2015	0.831818	0.179268	4.64	< 0.001
	2021-2015	0.934091	0.179268	5.211	< 0.001
	2022-2015	0.903409	0.179268	5.039	< 0.001
	2017-2016	0.005682	0.179268	0.032	1
	2018-2016	-0.089773	0.179268	-0.501	0.99997
	2019-2016	0.194318	0.179268	1.084	0.98632
	2020-2016	0.752273	0.179268	4.196	0.00114
	2021-2016	0.854545	0.179268	4.767	< 0.001
	2022-2016	0.823864	0.179268	4.596	< 0.001
	2018-2017	-0.095455	0.179268	-0.532	0.99995
	2019-2017	0.188636	0.179268	1.052	0.98892
	2020-2017	0.746591	0.179268	4.165	0.00115
	2021-2017	0.848864	0.179268	4.735	< 0.001
	2022-2017	0.818182	0.179268	4.564	< 0.001
	2019-2018	0.284091	0.179268	1.585	0.85587
	2020-2018	0.842045	0.179268	4.697	< 0.001
	2021-2018	0.944318	0.179268	5.268	< 0.001
	2022-2018	0.913636	0.179268	5.096	< 0.001
	2020-2019	0.557955	0.179268	3.112	0.05846
	2021-2019	0.660227	0.179268	3.683	0.00881
	2022-2019	0.629545	0.179268	3.512	0.01596
	2021-2020	0.102273	0.179268	0.571	0.99991
	2022-2020	0.071591	0.179268	0.399	1
	2022-2021	-0.030682	0.179268	-0.171	1

Appendix 10. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
E. flexuosa	2014-2013	0.140909	0.086182	1.635	0.831
	2015-2013	0.25	0.086182	2.901	0.105
	2016-2013	0.198864	0.086182	2.307	0.383
	2017-2013	0.1875	0.086182	2.176	0.474
	2018-2013	0.017045	0.086182	0.198	1
	2019-2013	0.098864	0.086182	1.147	0.98
	2020-2013	0.221591	0.086182	2.571	0.232
	2021-2013	0.225	0.086182	2.611	0.212
	2022-2013	0.2	0.086182	2.321	0.376
	2015-2014	0.109091	0.086182	1.266	0.961
	2016-2014	0.057955	0.086182	0.672	1
	2017-2014	0.046591	0.086182	0.541	1
	2018-2014	-0.123864	0.086182	-1.437	0.916
	2019-2014	-0.042045	0.086182	-0.488	1
	2020-2014	0.080682	0.086182	0.936	0.995
	2021-2014	0.084091	0.086182	0.976	0.994
	2022-2014	0.059091	0.086182	0.686	1
	2016-2015	-0.051136	0.086182	-0.593	1
	2017-2015	-0.0625	0.086182	-0.725	0.999
	2018-2015	-0.232955	0.086182	-2.703	0.172
	2019-2015	-0.151136	0.086182	-1.754	0.764
	2020-2015	-0.028409	0.086182	-0.33	1
	2021-2015	-0.025	0.086182	-0.29	1
	2022-2015	-0.05	0.086182	-0.58	1
	2017-2016	-0.011364	0.086182	-0.132	1
	2018-2016	-0.181818	0.086182	-2.11	0.521
	2019-2016	-0.1	0.086182	-1.16	0.978
	2020-2016	0.022727	0.086182	0.264	1
	2021-2016	0.026136	0.086182	0.303	1
	2022-2016	0.001136	0.086182	0.013	1
	2018-2017	-0.170455	0.086182	-1.978	0.615
	2019-2017	-0.088636	0.086182	-1.028	0.991
	2020-2017	0.034091	0.086182	0.396	1
	2021-2017	0.0375	0.086182	0.435	1
	2022-2017	0.0125	0.086182	0.145	1
	2019-2018	0.081818	0.086182	0.949	0.995
	2020-2018	0.204545	0.086182	2.373	0.342
	2021-2018	0.207955	0.086182	2.413	0.319
	2022-2018	0.182955	0.086182	2.123	0.511
	2020-2019	0.122727	0.086182	1.424	0.92
	2021-2019	0.126136	0.086182	1.464	0.906
	2022-2019	0.101136	0.086182	1.174	0.976
	2021-2020	0.003409	0.086182	0.04	1
	2022-2020	-0.021591	0.086182	-0.251	1
	2022-2021	-0.025	0.086182	-0.29	1

Appendix 11. Octocoral target species mean height (cm).

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Species	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
G. ventalina	18.26 ± 1.12	16.52 ± 1.02	14.82 ± 0.78	15.17 ± 0.83	16.43 ± 0.82	17.64 ± 0.88	16.7 ± 0.88	14.83 ± 0.79	13 ± 0.6	13.9 ± 0.69
A. americana	27.15 ± 0.52	25.09 ± 0.52	23.24 ± 0.46	23.76 ± 0.42	23.34 ± 0.44	21.8 ± 0.46	19.06 ± 0.36	17.89 ± 0.3	19.3 ± 0.3	20.87 ± 0.31
E. flexuosa	24.87 ± 0.59	24.43 ± 0.67	21.53 ± 0.55	22.34 ± 0.55	22.89 ± 0.54	23.07 ± 0.61	22.61 ± 0.55	20.28 ± 0.54	20.9 ± 0.5	20.64 ± 0.52

Appendix 12.Octocoral height statistics

Linear Mixed Effects Model ANOVA results.

Variable	**Level**	**Intercept**	**Year**
G. ventalina	DF	1	9
	F	73.39137	3.49065
	P	<.0001	3e-04
A. americana	DF	1	9
	F	651.4497	53.0123
	P	<.0001	<.0001
E. flexuosa	DF	1	9
	F	615.4277	7.1509
	P	<.0001	<.0001

Appendix 12. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
E. flexuosa	2014-2013	-0.5969	0.8356	-0.714	0.9994
	2015-2013	-3.3439	0.814	-4.108	<0.01
	2016-2013	-2.3166	0.8222	-2.818	0.1293
	2017-2013	-1.8568	0.8261	-2.248	0.4227
	2018-2013	-1.588	0.8747	-1.815	0.7246
	2019-2013	-2.1513	0.8486	-2.535	0.2484
	2020-2013	-4.5086	0.8212	-5.49	<0.01
	2021-2013	-3.8915	0.8177	-4.759	<0.01
	2022-2013	-4.1459	0.8253	-5.023	<0.01
	2015-2014	-2.747	0.7627	-3.602	0.0116
	2016-2014	-1.7197	0.7734	-2.223	0.4392
	2017-2014	-1.2599	0.7767	-1.622	0.8372
	2018-2014	-0.9911	0.8277	-1.197	0.9728
	2019-2014	-1.5544	0.8005	-1.942	0.6389
	2020-2014	-3.9117	0.7704	-5.078	<0.01
	2021-2014	-3.2946	0.7678	-4.291	<0.01
	2022-2014	-3.549	0.7744	-4.583	<0.01
	2016-2015	1.0273	0.7455	1.378	0.9337
	2017-2015	1.4871	0.748	1.988	0.6062
	2018-2015	1.756	0.802	2.189	0.4629
	2019-2015	1.1926	0.774	1.541	0.8752
	2020-2015	-1.1646	0.743	-1.567	0.8635
	2021-2015	-0.5476	0.74	-0.74	0.9992
	2022-2015	-0.8019	0.746	-1.075	0.987
	2017-2016	0.4598	0.7596	0.605	0.9999
	2018-2016	0.7287	0.8124	0.897	0.9966
	2019-2016	0.1653	0.7848	0.211	1
	2020-2016	-2.192	0.7543	-2.906	0.1035
	2021-2016	-1.5749	0.7513	-2.096	0.5297
	2022-2016	-1.8292	0.7584	-2.412	0.3185
	2018-2017	0.2689	0.8144	0.33	1
	2019-2017	-0.2944	0.7878	-0.374	1
	2020-2017	-2.6517	0.7569	-3.503	0.0171
	2021-2017	-2.0346	0.7542	-2.698	0.1735
	2022-2017	-2.289	0.7605	-3.01	0.0781
	2019-2018	-0.5633	0.838	-0.672	0.9997
	2020-2018	-2.9206	0.8084	-3.613	0.0114
	2021-2018	-2.3035	0.8067	-2.856	0.1189
	2022-2018	-2.5579	0.8126	-3.148	0.0522
	2020-2019	-2.3573	0.7802	-3.021	0.0751
	2021-2019	-1.7402	0.7778	-2.237	0.4305
	2022-2019	-1.9946	0.7839	-2.544	0.2445
	2021-2020	0.6171	0.7459	0.827	0.9982
	2022-2020	0.3627	0.7525	0.482	1
	2022-2021	-0.2544	0.7502	-0.339	1

Appendix 12. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
G. ventalina	2014-2013	-1.204473	1.17466	-1.025	0.99068
	2015-2013	-2.421342	1.120219	-2.161	0.48165
	2016-2013	-2.076632	1.130247	-1.837	0.70924
	2017-2013	-0.542903	1.110351	-0.489	0.99998
	2018-2013	0.510369	1.143838	0.446	0.99999
	2019-2013	-0.545641	1.137114	-0.48	0.99998
	2020-2013	-2.030604	1.093629	-1.857	0.69673
	2021-2013	-3.470218	1.063089	-3.264	0.03617
	2022-2013	-2.99327	1.083919	-2.762	0.14838
	2015-2014	-1.21687	1.077306	-1.13	0.98153
	2016-2014	-0.872159	1.084769	-0.804	0.99852
	2017-2014	0.661569	1.06346	0.622	0.99982
	2018-2014	1.714842	1.099483	1.56	0.86641
	2019-2014	0.658832	1.094013	0.602	0.99986
	2020-2014	-0.826131	1.052669	-0.785	0.99878
	2021-2014	-2.265745	1.018874	-2.224	0.43866
	2022-2014	-1.788798	1.043256	-1.715	0.78587
	2016-2015	0.34471	1.024328	0.337	1
	2017-2015	1.878439	1.001268	1.876	0.68369
	2018-2015	2.931711	1.038627	2.823	0.12773
	2019-2015	1.875701	1.032061	1.817	0.72252
	2020-2015	0.390738	0.987933	0.396	1
	2021-2015	-1.048876	0.953648	-1.1	0.98469
	2022-2015	-0.571928	0.979027	-0.584	0.99989
	2017-2016	1.533729	1.00693	1.523	0.8823
	2018-2016	2.587001	1.045567	2.474	0.28049
	2019-2016	1.530991	1.039743	1.472	0.90237
	2020-2016	0.046028	0.997191	0.046	1
	2021-2016	-1.393586	0.961916	-1.449	0.91065
	2022-2016	-0.916639	0.988493	-0.927	0.99555
	2018-2017	1.053272	1.020574	1.032	0.99025
	2019-2017	-0.002738	1.013861	-0.003	1
	2020-2017	-1.4877	0.970385	-1.533	0.87797
	2021-2017	-2.927315	0.932501	-3.139	0.05329 .
	2022-2017	-2.450367	0.960683	-2.551	0.23925
	2019-2018	-1.05601	1.051554	-1.004	0.99201
	2020-2018	-2.540973	1.010045	-2.516	0.25791
	2021-2018	-3.980587	0.974632	-4.084	0.00179
	2022-2018	-3.50364	1.001472	-3.498	0.0166
	2020-2019	-1.484963	0.999693	-1.485	0.89743
	2021-2019	-2.924577	0.964741	-3.031	0.07314
	2022-2019	-2.44763	0.989746	-2.473	0.28118
	2021-2020	-1.439614	0.911364	-1.58	0.857
	2022-2020	-0.962667	0.938293	-1.026	0.99068
	2022-2021	0.476948	0.90152	0.529	0.99995

Appendix 12. Continued.

Tukey post hoc Test.

Variable	Years	Est.	SE	z	P > |z|
A. americana	2014-2013	-2.163	0.6461	-3.348	0.0269
	2015-2013	-3.8765	0.616	-6.293	<0.01
	2016-2013	-3.2274	0.6103	-5.289	<0.01
	2017-2013	-3.6547	0.6101	-5.99	<0.01
	2018-2013	-5.0991	0.618	-8.25	<0.01
	2019-2013	-8.0196	0.5988	-13.393	<0.01
	2020-2013	-9.209	0.5714	-16.116	<0.01
	2021-2013	-7.7816	0.5674	-13.715	<0.01
	2022-2013	-6.1467	0.5691	-10.801	<0.01
	2015-2014	-1.7135	0.6117	-2.801	0.1337
	2016-2014	-1.0644	0.6058	-1.757	0.7599
	2017-2014	-1.4917	0.6056	-2.463	0.285
	2018-2014	-2.9361	0.6139	-4.783	<0.01
	2019-2014	-5.8566	0.594	-9.859	<0.01
	2020-2014	-7.046	0.5664	-12.439	<0.01
	2021-2014	-5.6186	0.5625	-9.989	<0.01
	2022-2014	-3.9836	0.5643	-7.06	<0.01
	2016-2015	0.6492	0.5722	1.134	0.9808
	2017-2015	0.2218	0.572	0.388	1
	2018-2015	-1.2225	0.5802	-2.107	0.5184
	2019-2015	-4.1431	0.5595	-7.405	<0.01
	2020-2015	-5.3324	0.5302	-10.058	<0.01
	2021-2015	-3.9051	0.5256	-7.429	<0.01
	2022-2015	-2.2701	0.527	-4.308	<0.01
	2017-2016	-0.4274	0.5653	-0.756	0.9991
	2018-2016	-1.8717	0.5735	-3.264	0.0364
	2019-2016	-4.7923	0.5526	-8.672	<0.01
	2020-2016	-5.9816	0.523	-11.436	<0.01
	2021-2016	-4.5542	0.5184	-8.785	<0.01
	2022-2016	-2.9193	0.5197	-5.617	<0.01
	2018-2017	-1.4443	0.5732	-2.52	0.2548
	2019-2017	-4.3649	0.5523	-7.903	<0.01
	2020-2017	-5.5542	0.523	-10.621	<0.01
	2021-2017	-4.1269	0.5183	-7.963	<0.01
	2022-2017	-2.4919	0.5196	-4.796	<0.01
	2019-2018	-2.9206	0.56	-5.215	<0.01
	2020-2018	-4.1099	0.5311	-7.738	<0.01
	2021-2018	-2.6825	0.5267	-5.093	<0.01
	2022-2018	-1.0476	0.5279	-1.985	0.6067
	2020-2019	-1.1893	0.507	-2.346	0.3558
	2021-2019	0.238	0.503	0.473	1
	2022-2019	1.873	0.5046	3.712	<0.01
	2021-2020	1.4274	0.4702	3.036	0.0718
	2022-2020	3.0623	0.472	6.488	<0.01
	2022-2021	1.6349	0.4668	3.502	0.0165