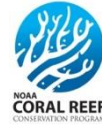


Southeast Florida Coral Reef Evaluation and Monitoring Project



Executive Summary 2021

Overview

- The Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP) documents status and trends within the Kristin Jacobs Coral Reef Ecosystem Conservation Area (Coral ECA) (Miami-Dade, Broward, Palm Beach, and Martin counties) reef system and in 2021 completed its 19th year of annual surveys.
- In 2021, all 22 SECREMP sites were surveyed through established methodologies (see Gilliam et al. 2021 for site locations and survey protocols). All surveys were performed within four permanently marked 22m x 1m stations at all sites (Figure 1).
- Survey methods include (1) photographic transects to quantify percent cover of major benthic taxa (stony corals, sponges, octocorals, macroalgae, etc.) and (2) demographic surveys to quantify abundance, size distribution, and overall condition of stony corals (Scleractinia and Milleporidae), octocorals (Octocorallia), and *Xestospongia muta* (giant barrel sponge).
- This Executive Summary focuses on 2021 stony coral demographic data post Stony Coral Tissue Loss Disease (SCTLD) event, which spanned multiple years. Octocoral and *X. muta* density data and stony coral, octocoral, sponge, and macroalgae 2021 benthic cover data are also presented to provide brief resource status information for these coral reef community functional groups.
- Statistical comparisons for stony coral density, disease prevalence, stony coral colony live tissue area, *X. muta* density, and octocoral density were selectively performed region-wide (pooling all sites) for counties (pooling all sites within a county) and sites (stations as replicates). A linear mixed model (LME) was used with year as the factor to examine changes between 2013 – 2021 within counties and sites. All statistical tests were performed using the R software package (R Core Team 2016). For counties and/or sites exhibiting statistical differences between years, a Tukey's HSD post-hoc was performed and significant differences are reported based on Tukey's multiple comparison corrected p-values.
- Percent cover changes from 2020 to 2021 for the major benthic taxa (stony corals, sponges, octocorals and macroalgae) were analyzed using generalized linear mixed models (PROC GLIMMIX) in SAS Enterprise guide® v8.3. For each taxon, points recorded as a given taxa were divided by total points evaluated and were modeled using years and sites as fixed effects. For all tests a binomial distribution and logit link function were used, and a random residual statement was included to account for the repeated measures design with variance components (VC) defined as the random residual error structure. No p-value adjustments were used for the post-hoc site vs. site comparisons.

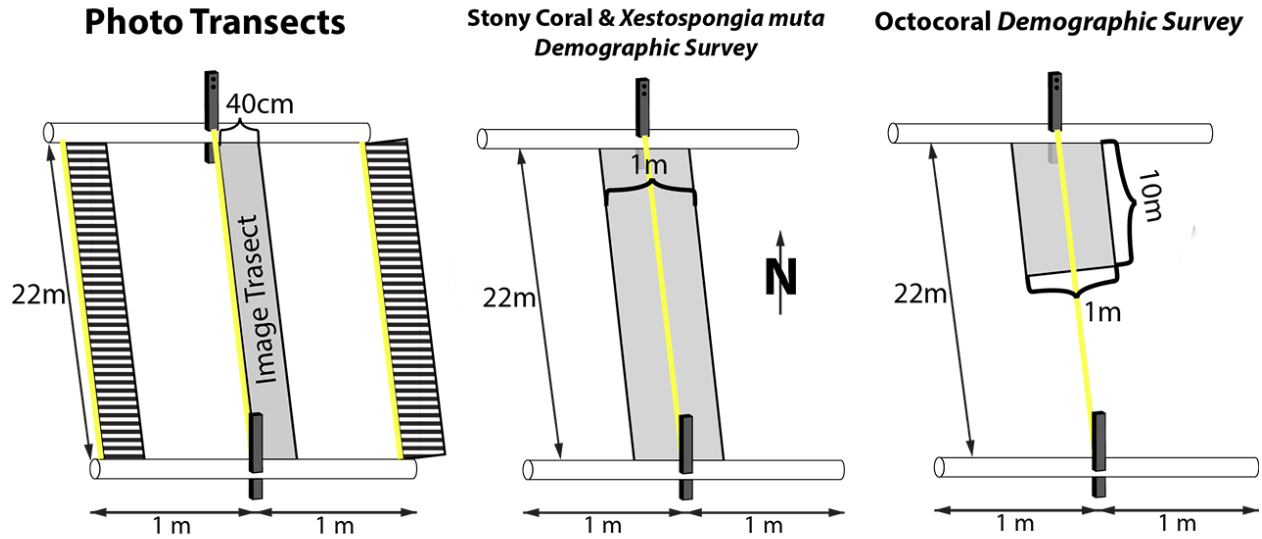


Figure 1. All SECREMP sites consist of four monitoring stations identified by permanent pins. Stations are 22m x 2m and are oriented north to south. Photo transects are taken along the center of the station surveying an 8.8m² area. The hashed photo transects represent additional area surveyed prior to 2014 modifications; this area is still surveyed at site BCA. Stony coral and *X. muta* demographic surveys are 22m x 1m along the center of the station. Octocoral demographic surveys are 10m x 1m along the station center. All demographic surveys were implemented in 2012.

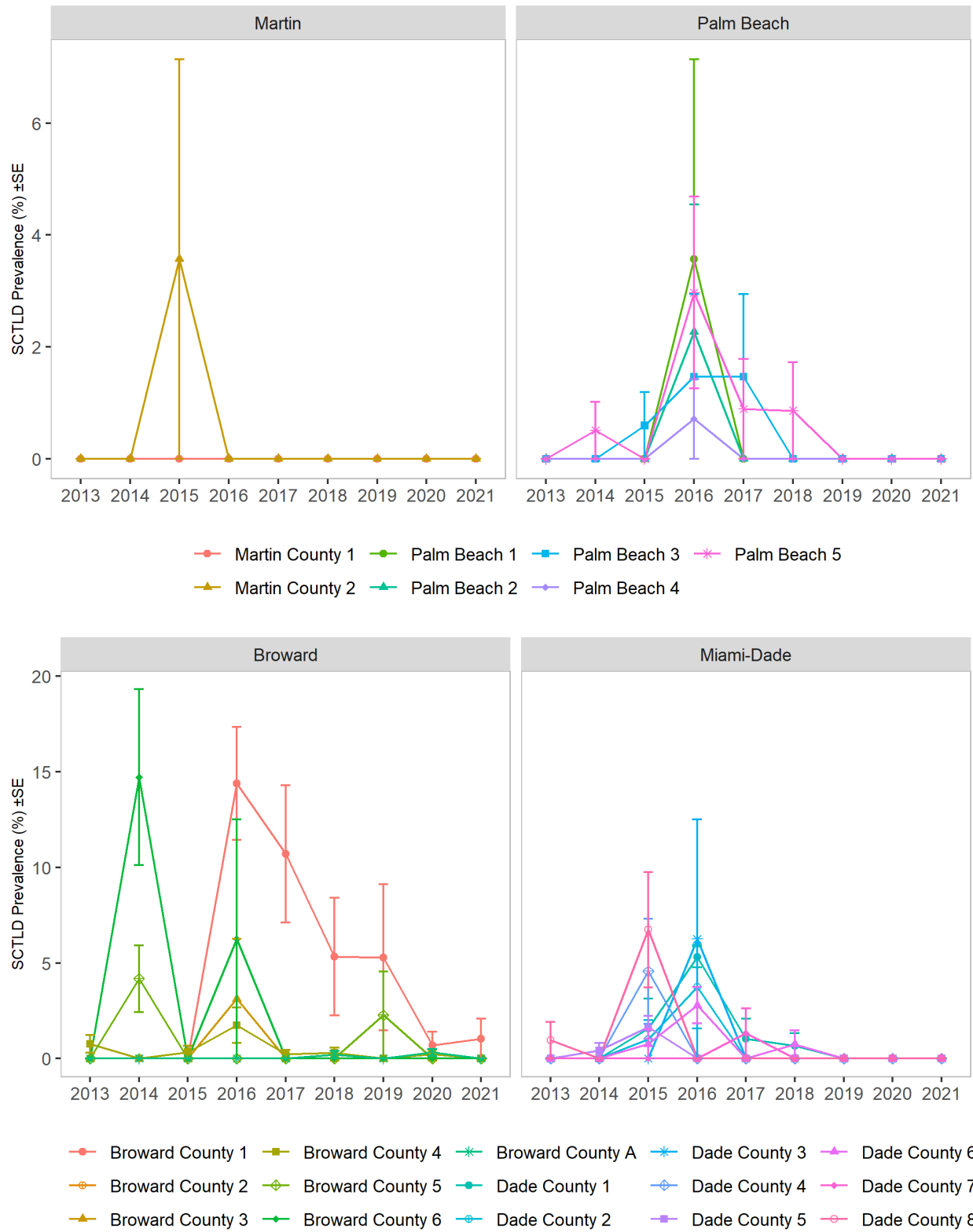
Summary

Stony Coral Demographics

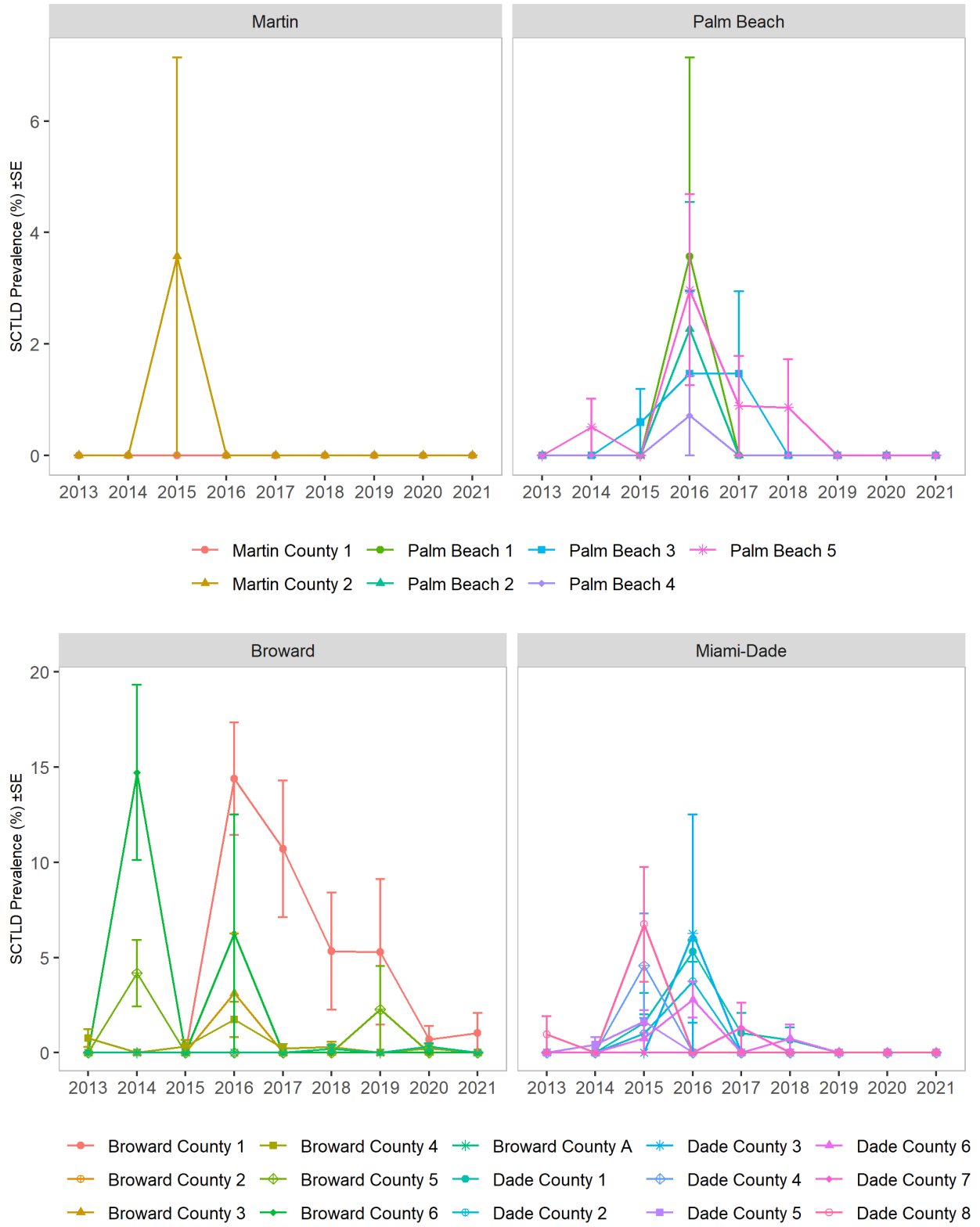
- Twenty-four stony coral species and species complexes were identified region-wide which is similar to total richness identified throughout all project years (Gilliam et al. 2021).
- Region-wide mean (\pm SE) stony coral site density (colonies \geq 4 cm) in 2021 was 1.71 ± 0.31 colonies/m² and mean (\pm SE) site density ranged from 0.34 ± 0.10 colonies/m² (site PB1) to 4.89 ± 1.09 (MC1). Sixteen sites in 2021 had mean colony density less than 2 colonies/m² while 3 sites (BC4, DC5, MC1) had mean colony density greater than 4 colonies/m² (Table 1).
- Regionally, stony coral density stayed relatively consistent from 2013 to 2015, dropping in 2016 to the lowest recorded regional density, which was the height of the Stony Coral Tissue Loss Disease (SCTLD) outbreak in Southeast Florida. Density has since increased, where regional density in 2020 and 2021 was significantly higher than in 2013 and 2016 (Table 1).
- In 2021, six sites (PB1, PB2, PB3, BC1, BCA and DC8) had significantly lower density compared to at least one previous year (Table 1). However, no sites had their minimum recorded density in 2021. Significant differences for all other years were presented in the 2020 comprehensive report (Gilliam et al. 2021).
- Colony density increases were also determined (Table 1). In 2021, eleven sites (MC1, MC2, BC2, BC3, BC4, BC6, DC1, DC2, DC4, DC5, and DC7) had significantly greater densities than at least one previous year. Nine sites (MC1, MC2, BC3, BC6, DC1, DC2, DC4, DC5, and DC7) had their maximum recorded density in 2021. However, increases in density at these sites was primarily driven by increases in only a handful of species including *Porites astreoides*, *Porites porites*, *Siderastrea siderea* and *Agaricia agaricites* complex (

- Table 2).
- *Porites astreoides*, *P. Porites*, *S. siderea* and *A. agaricites* complex accounted for 75% of all corals (≥ 4 cm) recorded in 2021. *Porites astreoides* was the most abundant coral species in 2021 (1096 colonies), followed by *S. siderea* (724 colonies) and *A. agaricites* complex (465 colonies, Table 2).
- Of the six most abundant species in 2021, *A. agaricites* complex, *P. Porites*, and *Porites astreoides* more than doubled in abundance since 2013. *Stephanocoenia intersepta* only saw an increase of 28% from 2013 to 2021, while *M. cavernosa* abundance was less than half in 2021 than in 2013 (Table 2). *Siderastrea siderea* abundance fluctuated over the years, but has increased by 38% from 2013 to 2021, with peak abundance occurring in 2021 (Table 2).

Prior to the 2021 sampling year, the Coral ECA experienced an unprecedented stony coral disease event with significant increases in SCTLD prevalence beginning summer of 2014 (

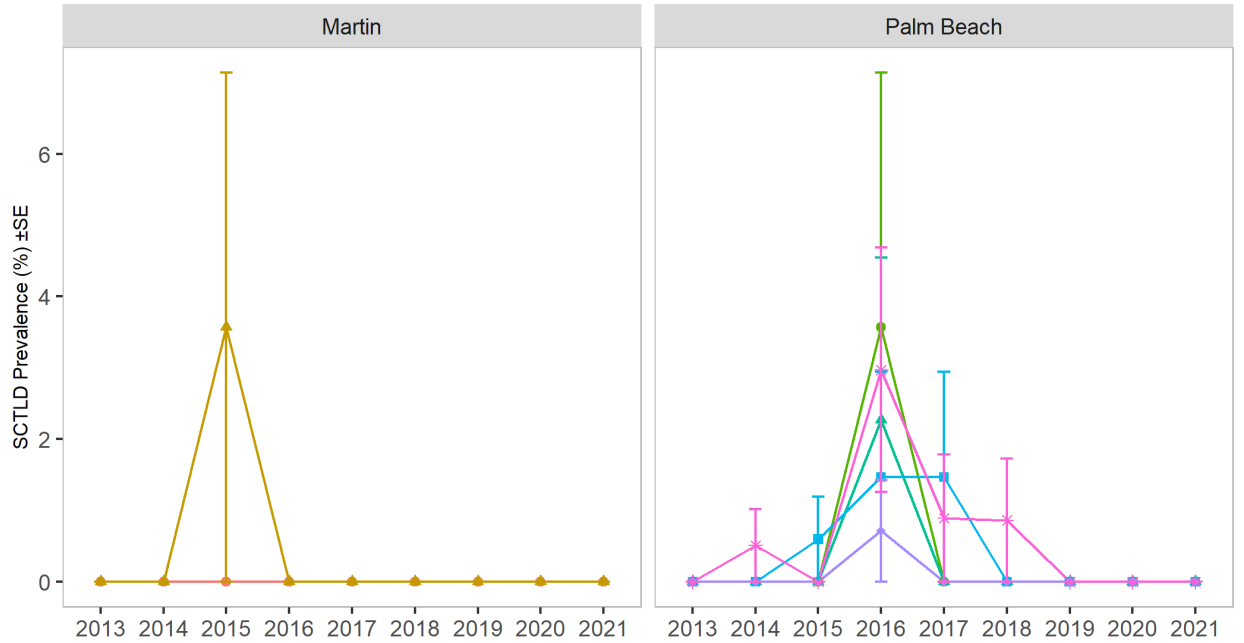


• Figure 2). Disease was first evident in Broward County in 2014, and elevated disease prevalence was observed through 2016 across all counties (

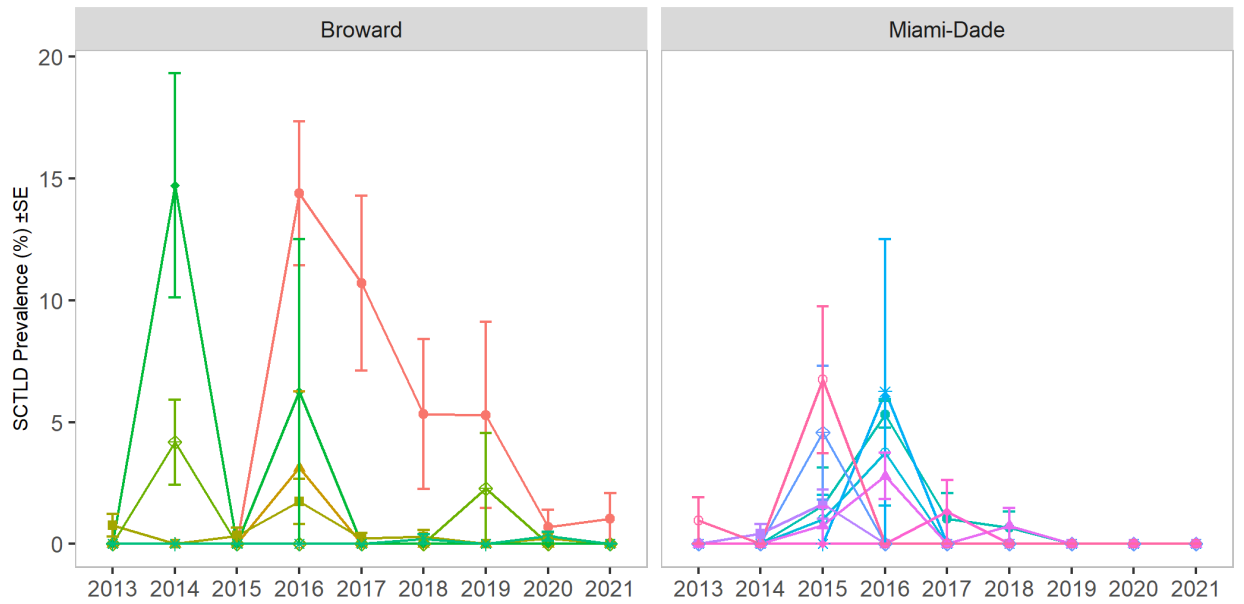


• Figure 2).

- Although SCTL D prevalence was lower in the northern counties (Martin and Palm Beach), both still experienced SCTL D outbreaks (

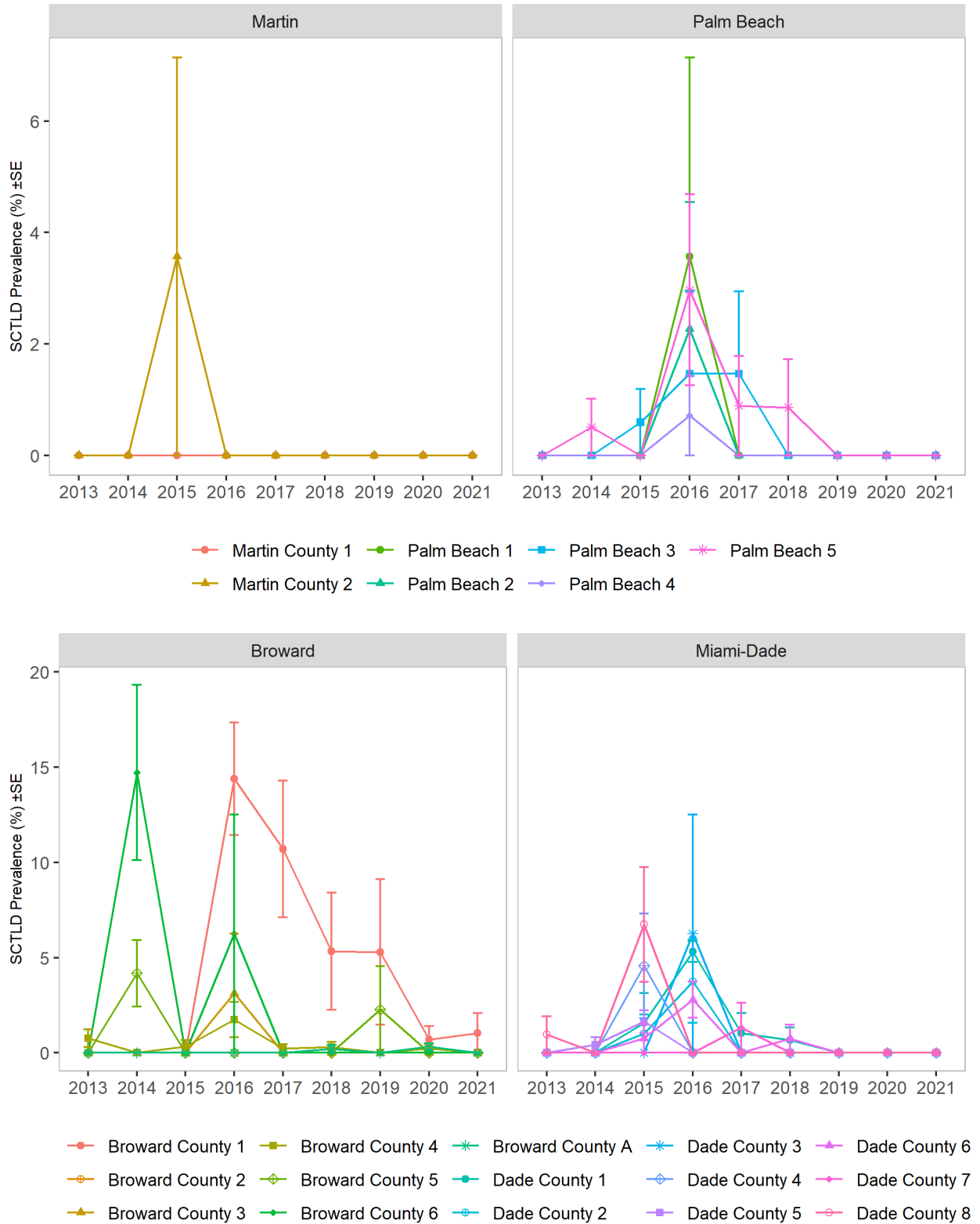


● Martin County 1 ● Palm Beach 1 ■ Palm Beach 3 ✱ Palm Beach 5
▲ Martin County 2 ▲ Palm Beach 2 ◆ Palm Beach 4

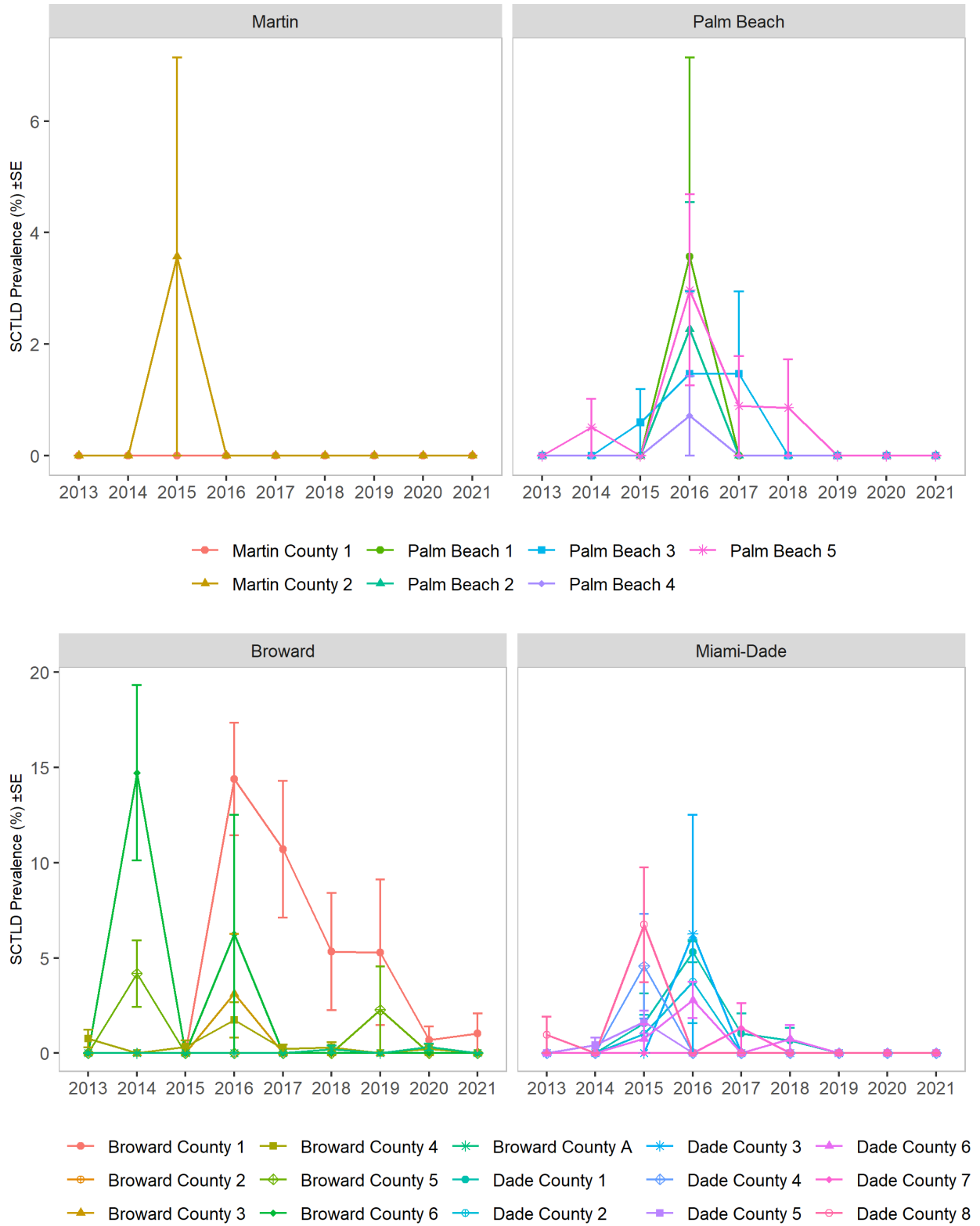


● Broward County 1 ■ Broward County 4 ✱ Broward County A ✱ Dade County 3 ▲ Dade County 6
◆ Broward County 2 ◆ Broward County 5 ● Dade County 1 ◆ Dade County 4 ✱ Dade County 7
▲ Broward County 3 ● Broward County 6 ● Dade County 2 ■ Dade County 5 ○ Dade County 8

- Figure 2). Prevalence peaked in 2015 in Martin County while Palm Beach County saw elevated SCTLN prevalence from 2014 to 2018, where prevalence peaked in 2016.
- Broward and Miami-Dade counties saw greater SCTLN prevalence than the northern counties (



• Figure 2). Broward County had sites in 2014 and 2016 with SCTL D prevalence around 15% and had five years where at least 1 site had SCTL D prevalence of $\geq 5\%$. Miami-Dade saw increased disease concentrated around 2015 and 2016 (



• Figure 2).

- In 2021 SCTL D was only observed at one of the 22 sites, with only one *M. cavernosa* recorded with active SCTL D at site BC1. This is down from 2020 where four colonies at three sites were recorded with SCTL D (Gilliam et al. 2021).

Table 1. 2013 – 2021 mean (\pm SE) SECREMP regional (R) and site stony coral colony density (colonies $\geq 4\text{cm}^2$). Bolded site values indicate the mean for 2021 is significantly higher (Linear Mixed Model followed by a Tukey’s HSD test) than the bolded years. Underlined site values indicate the mean for 2021 is significantly lower (Linear Mixed Model followed by a Tukey’s HSD test) than the underlined years. Only significant differences from 2021 sample data are presented, significant differences for all other years are presented in the 2020 comprehensive report.

Site	2013	2014	2015	2016	2017	2018	2019	2020	2021
R	1.21 \pm 0.17	1.26 \pm 0.18	1.29 \pm 0.19	1.07 \pm 0.18	1.35 \pm 0.25	1.39 \pm 0.23	1.54 \pm 0.28	1.74 \pm 0.32	1.71 \pm 0.31
MC1	0.95 \pm 0.09	1.06 \pm 0.11	0.98 \pm 0.18	0.98 \pm 0.31	2.18 \pm 0.66	2.82 \pm 0.78	3.70 \pm 1.20	4.35 \pm 1.32	4.89 \pm 1.09
MC2	0.49 \pm 0.06	0.40 \pm 0.05	0.34 \pm 0.09	0.27 \pm 0.05	0.31 \pm 0.08	0.11 \pm 0.05	0.22 \pm 0.05	0.32 \pm 0.10	0.53 \pm 0.13
PB1	0.23 \pm 0.13	0.27 \pm 0.13	0.28 \pm 0.15	0.33 \pm 0.14	0.25 \pm 0.11	0.40 \pm 0.15	0.40 \pm 0.07	<u>0.75 \pm 0.18</u>	0.34 \pm 0.10
PB2	1.07 \pm 0.15	1.24 \pm 0.09	<u>1.57 \pm 0.31</u>	1.07 \pm 0.33	1.03 \pm 0.42	0.86 \pm 0.25	0.82 \pm 0.14	0.68 \pm 0.13	0.72 \pm 0.07
PB3	1.05 \pm 0.31	<u>1.18 \pm 0.34</u>	<u>1.11 \pm 0.29</u>	0.63 \pm 0.22	0.68 \pm 0.23	0.67 \pm 0.19	0.73 \pm 0.17	0.76 \pm 0.24	0.76 \pm 0.25
PB4	1.82 \pm 0.38	1.63 \pm 0.31	1.69 \pm 0.30	1.02 \pm 0.27	1.01 \pm 0.23	1.06 \pm 0.24	1.01 \pm 0.22	1.15 \pm 0.30	1.32 \pm 0.29
PB5	2.30 \pm 0.31	2.18 \pm 0.28	2.08 \pm 0.29	1.58 \pm 0.25	1.65 \pm 0.32	1.75 \pm 0.40	1.77 \pm 0.34	1.85 \pm 0.27	2.06 \pm 0.30
BC1	1.81 \pm 0.35	<u>2.16 \pm 0.33</u>	<u>2.05 \pm 0.34</u>	1.66 \pm 0.30	1.45 \pm 0.34	1.40 \pm 0.33	1.47 \pm 0.33	1.70 \pm 0.29	1.44 \pm 0.30
BC2	0.64 \pm 0.12	0.78 \pm 0.12	0.63 \pm 0.12	0.47 \pm 0.10	0.58 \pm 0.13	0.95 \pm 0.19	0.82 \pm 0.10	1.11 \pm 0.12	0.92 \pm 0.13
BC3	0.75 \pm 0.11	0.76 \pm 0.22	0.59 \pm 0.08	0.42 \pm 0.03	0.61 \pm 0.04	0.83 \pm 0.09	0.72 \pm 0.03	0.85 \pm 0.09	0.93 \pm 0.06
BC4	3.28 \pm 0.32	3.75 \pm 0.22	4.05 \pm 0.31	3.41 \pm 0.12	4.89 \pm 0.41	3.83 \pm 0.18	4.43 \pm 0.16	5.03 \pm 0.23	4.74 \pm 0.29
BC5	1.23 \pm 0.19	1.09 \pm 0.25	1.19 \pm 0.22	0.67 \pm 0.08	0.83 \pm 0.14	0.89 \pm 0.11	1.01 \pm 0.26	1.18 \pm 0.16	1.06 \pm 0.12
BC6	0.64 \pm 0.11	0.57 \pm 0.08	0.56 \pm 0.06	0.43 \pm 0.05	0.41 \pm 0.00	0.45 \pm 0.12	0.50 \pm 0.09	0.59 \pm 0.13	0.69 \pm 0.17
BCA	0.61 \pm 0.18	0.58 \pm 0.17	1.09 \pm 0.40	1.45 \pm 0.17	3.08 \pm 1.10	3.47 \pm 1.15	3.66 \pm 1.28	<u>4.95 \pm 1.44</u>	2.58 \pm 0.72
DC1	1.80 \pm 0.15	2.10 \pm 0.16	2.14 \pm 0.03	2.36 \pm 0.06	2.28 \pm 0.13	2.70 \pm 0.27	2.81 \pm 0.10	3.36 \pm 0.24	3.51 \pm 0.33
DC2	0.88 \pm 0.09	1.08 \pm 0.14	1.07 \pm 0.11	0.83 \pm 0.09	1.03 \pm 0.04	1.10 \pm 0.10	1.16 \pm 0.06	1.07 \pm 0.11	1.34 \pm 0.11
DC3	0.31 \pm 0.09	0.33 \pm 0.03	0.31 \pm 0.06	0.27 \pm 0.07	0.28 \pm 0.01	0.44 \pm 0.03	0.42 \pm 0.01	0.48 \pm 0.06	0.41 \pm 0.05
DC4	0.73 \pm 0.11	0.75 \pm 0.12	0.75 \pm 0.20	0.57 \pm 0.14	0.90 \pm 0.18	0.90 \pm 0.10	0.91 \pm 0.11	0.95 \pm 0.08	1.18 \pm 0.10
DC5	2.56 \pm 0.24	2.53 \pm 0.14	2.33 \pm 0.26	2.40 \pm 0.26	3.28 \pm 0.35	2.94 \pm 0.41	4.01 \pm 0.57	3.64 \pm 0.48	4.73 \pm 0.59
DC6	1.38 \pm 0.26	1.42 \pm 0.25	1.51 \pm 0.25	1.44 \pm 0.33	1.55 \pm 0.35	1.51 \pm 0.25	1.58 \pm 0.27	1.45 \pm 0.18	1.45 \pm 0.25
DC7	1.13 \pm 0.05	1.02 \pm 0.12	1.10 \pm 0.14	0.67 \pm 0.09	0.85 \pm 0.08	0.98 \pm 0.14	1.14 \pm 0.10	1.30 \pm 0.10	1.39 \pm 0.13
DC8	<u>0.92 \pm 0.09</u>	<u>0.81 \pm 0.06</u>	<u>0.90 \pm 0.14</u>	0.56 \pm 0.07	0.48 \pm 0.05	0.60 \pm 0.03	0.61 \pm 0.06	0.73 \pm 0.05	0.52 \pm 0.03

Table 2. Region-wide (all sites pooled) species abundance of stony coral colonies ≥ 4 cm by species from 2013 to 2021. Region is the total stony coral abundance of colonies ≥ 4 cm across all species by year.

Species	2013	2014	2015	2016	2017	2018	2019	2020	2021
Region	2334	2438	2491	2064	2607	2701	2981	3368	3301
<i>A. agaricites</i> complex	170	177	226	249	454	431	522	631	465
<i>A. cervicornis</i>	8	22	17	19	19	8	9	9	13
<i>A. lamarcki</i>	5	4	6	6	3	5	9	6	4
<i>C. natans</i>	9	7	10	3	2	1	2	4	2
<i>D. labyrinthiformis</i>	3	2	2	1	1	2	4	2	4
<i>D. stokesii</i>	75	78	56	8	5	10	17	23	23
<i>E. fastigiata</i>	3	6	6	4	6	5	6	9	13
<i>H. cucullata</i>	0	0	0	0	0	1	2	1	0
<i>I. sinuosa</i>	1	1	3	1	8	2	0	2	3
<i>M. aliciae</i>	5	4	6	4	4	7	8	9	9
<i>M. auretenra</i>	28	43	73	67	67	42	33	16	14
<i>M. cavernosa</i>	446	473	457	248	232	265	266	290	288
<i>M. decactis</i>	39	43	41	33	41	46	43	51	46
<i>M. meandrites</i>	114	119	87	5	12	14	28	26	31
<i>M. lamarckiana</i>	0	0	0	1	0	0	0	0	0
<i>O. annularis</i> complex	21	21	24	24	21	12	16	13	14
<i>O. diffusa</i>	8	7	6	5	3	0	1	1	2
<i>O. robusta</i>	0	0	0	0	0	1	0	0	0
<i>P. americana</i>	0	0	0	0	1	1	0	1	0
<i>P. astreoides</i>	546	581	587	647	810	861	1010	1037	1096
<i>P. clivosa</i>	31	27	30	29	30	3	5	4	1
<i>P. porites</i>	51	79	116	114	151	119	160	180	189
<i>P. strigose</i>	12	12	10	4	5	5	5	8	8
<i>S. bournoni</i>	55	58	54	38	28	19	18	17	14
<i>S. cubensis</i>	3	0	0	1	3	1	2	2	1
<i>S. intersepta</i>	240	252	258	229	267	299	286	333	333
<i>S. radians</i>	10	4	10	0	8	3	1	9	1
<i>S. siderea</i>	450	418	405	324	426	538	528	683	724

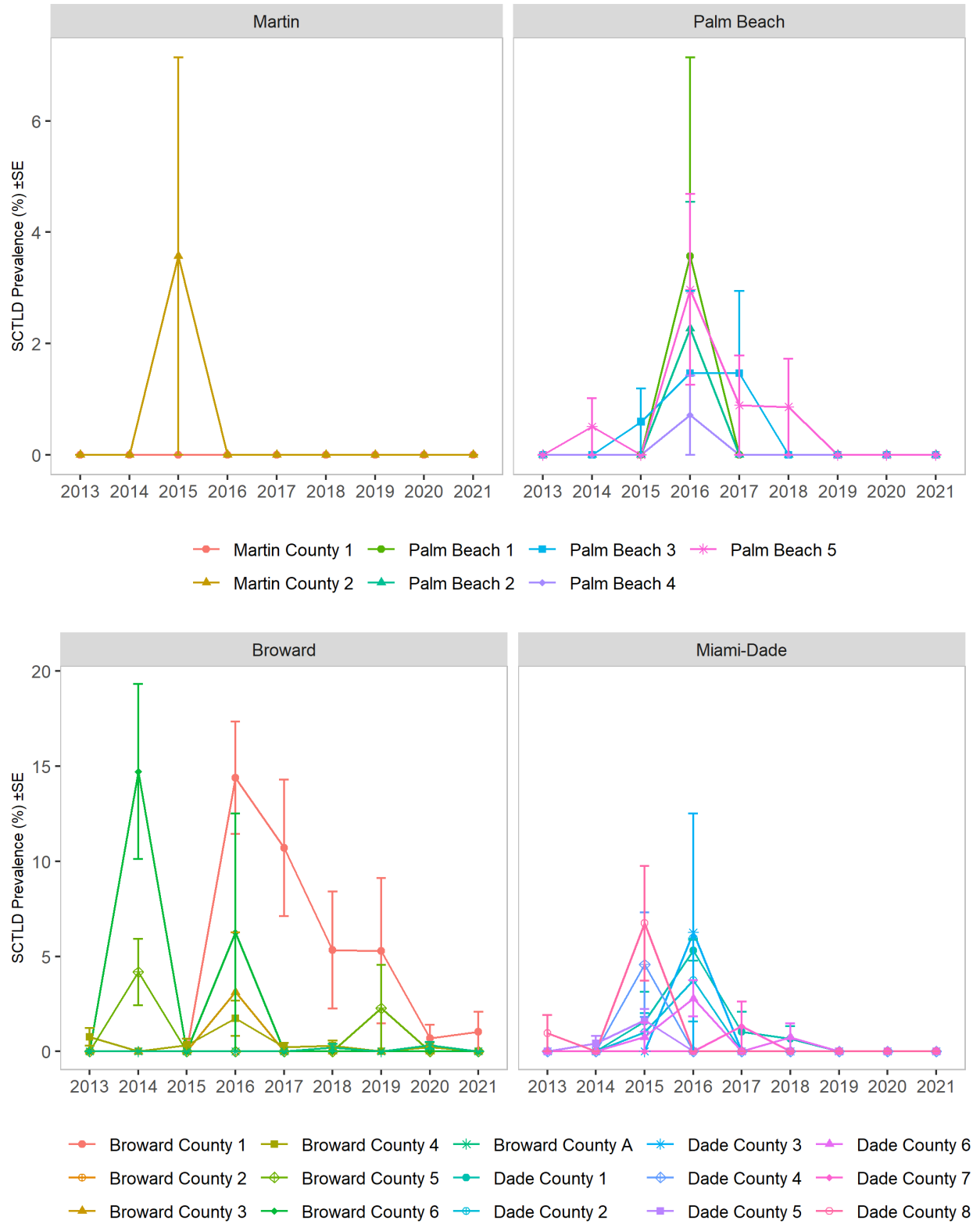


Figure 2. Stony Coral Tissue Loss Disease (SCTL D) mean (\pm SE) prevalence (%) from 2013-2021 per 22 m² transect grouped by county. Broward County A does not include *Acropora cervicornis*.

- To provide an additional metric to evaluate changes to the stony coral community, colony width, height, and percent mortality (sum of old and recent) were used to calculate total stony coral live tissue area (LTA) for each site for 2013-2021 (see Gilliam et al. 2021 for more LTA calculation details). Region-wide LTAs were also calculated for different SCTL D susceptibility groups as defined by NOAA Stony Coral Tissue Loss Disease Case Definition (2018).
- A region-wide decline in LTA was initially identified in 2016 (Gilliam et al. 2017), and regional LTA from 2017-2021 was significantly lower than the LTA in 2013, 2014 and 2015. For most sites, LTA declined after 2016 and sites with significant losses were found across all counties and all habitats (Figure 3). No significant change in regional LTA has occurred from 2017 to 2021.
- From 2013 to 2021, fourteen sites saw significant changes in LTA (MC2, PB2, PB3, PB4, PB5, BC1, BC4, BC5, BCA, DC2, DC4, DC5, DC6, and DC8). Ten sites had significantly lower LTA in 2021 than at least one previous year (MC2, PB2, PB3, PB4, PB5, BC1, BC4, BC5, DC6, and DC8, Figure 3)
- Those species defined as Highly Susceptible Species (including *Colpophyllia natans*, *Pseudodiploria strigosa*, *P. clivosa* and *Meandrina meandrites*) saw significant declines in LTA beginning in 2016 (Figure 4). LTA in 2016-2021 was significantly lower than LTA in 2013 and 2014. These significant declines were recorded across all four counties, and all sites have < 1m² of these species remaining (Figure 4).
- Species defined as Moderately Susceptible (including *Montastraea cavernosa* and *Orbicella* complex) also saw significant declines in LTA. Regional LTA in 2018-2021 was significantly lower than in 2014 and 2015 (Figure 4). *Montastraea cavernosa* is often the greatest contributor to LTA in the SECREMP region.
- Those species Presumed Susceptible to SCTL D did not have any significant changes in regional LTA over the study period. These species include *A. agaricites* complex, *Agaricia lamarcki*, and *Mycetophyllia* spp. However, many of these species do not contribute a large amount of LTA, potentially lowering the ability to capture loss.
- Although species classified as Low Susceptible Species (including *P. porites* and *P. astreoides*) did not significantly change in regional LTA, an increasing trend is noticeable, with regional LTA increasing year to year. *Porites astreoides* has almost doubled in abundance from 2013 to 2021 (Table 2).
- No species group significantly increased in LTA across the study years. However, there has been a significant increase in density in 2020 and 2021 (Table 1). This increase in density is driven by small, non-reef building colonies that have not significantly increased regional LTA.
- In addition, increases in density are driven predominantly by species not susceptible to SCTL D (Table 1). Those species susceptible to SCTL D have not seen any significant recovery post disease event (Figure 4).

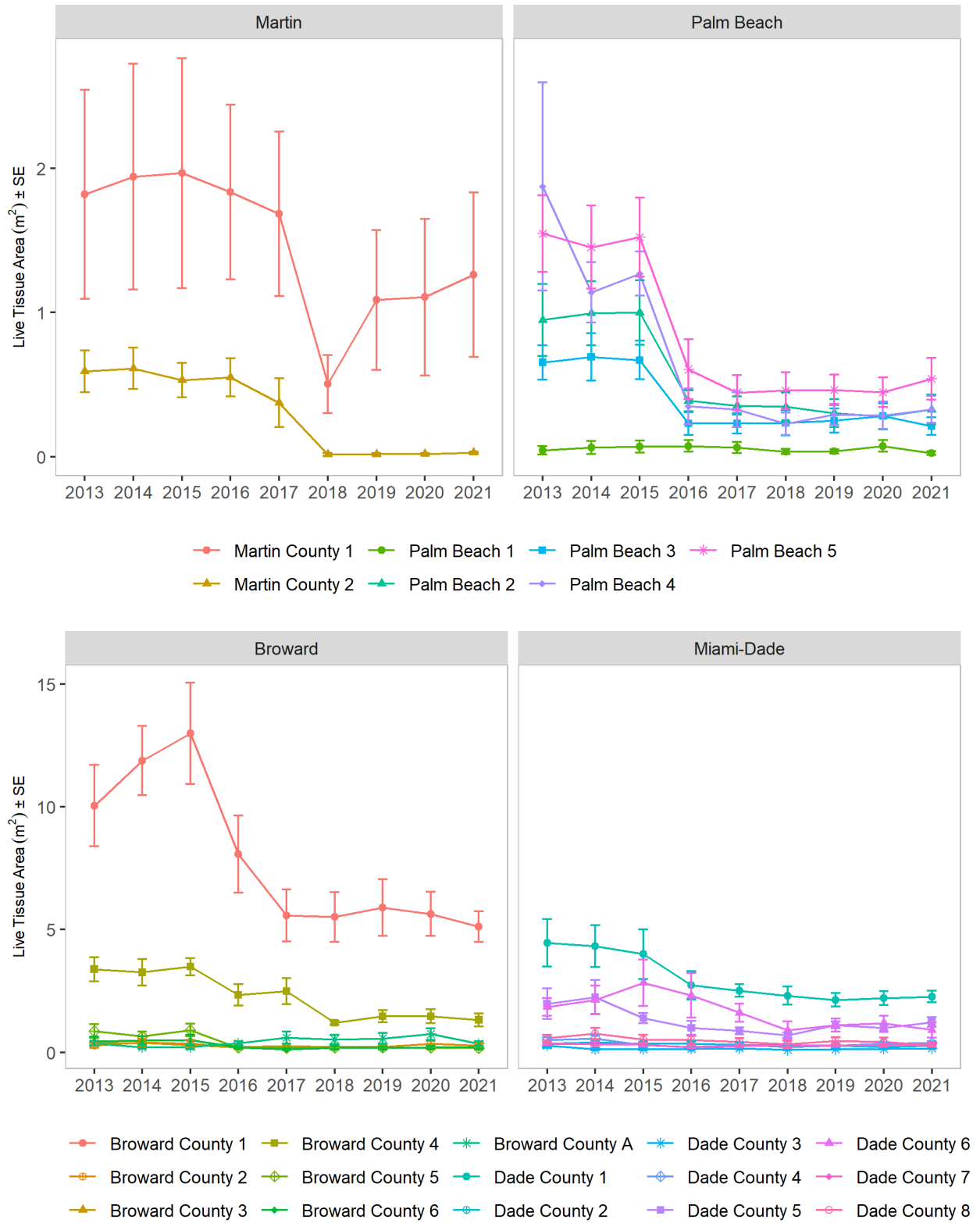


Figure 3. Mean (\pm SE) site LTA (m^2) from 2013-2021 per 22 m^2 transect grouped by county. Broward County A does not include *Acropora cervicornis*.

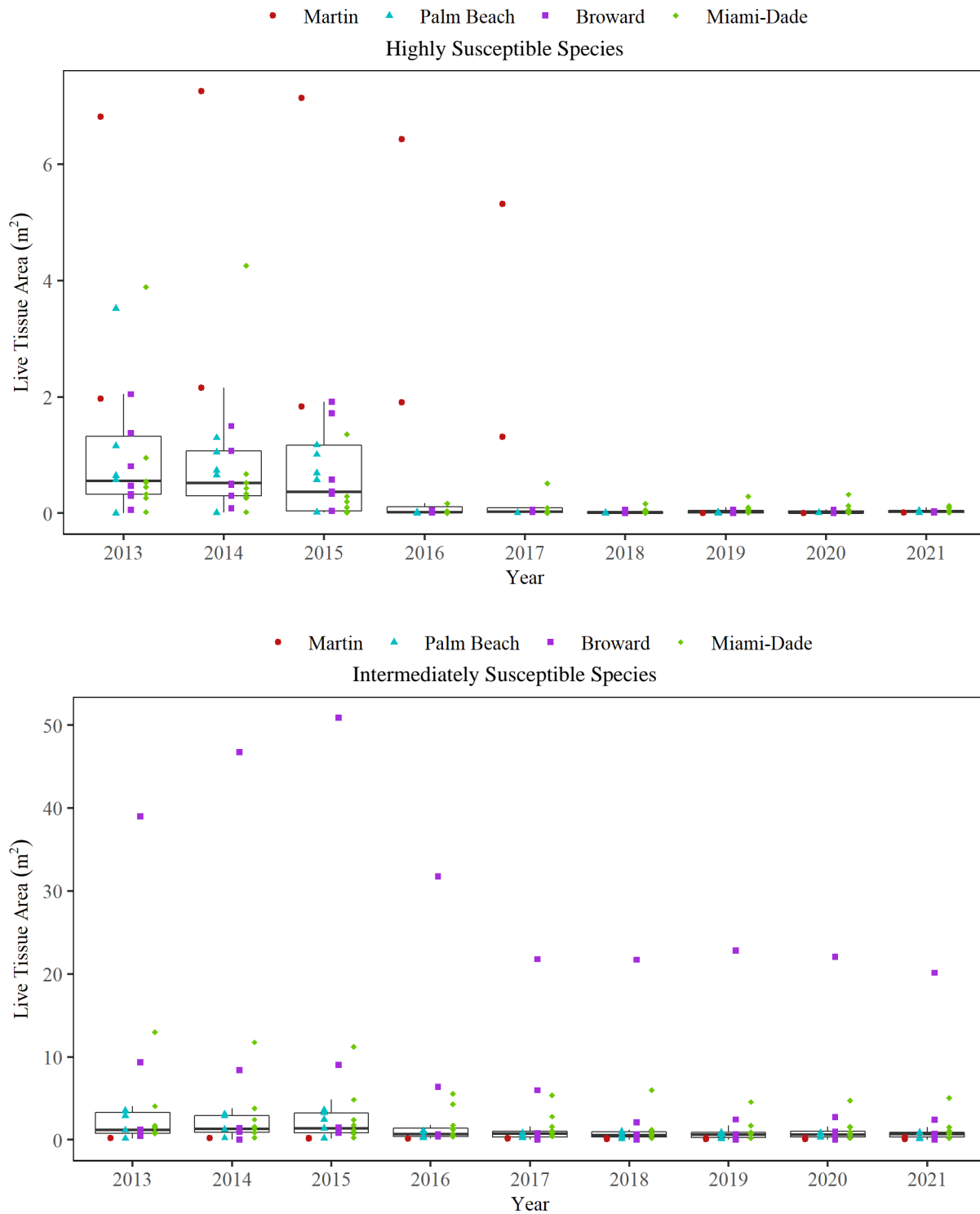


Figure 4. Mean (\pm SE) region-wide LTA (m^2) for Highly Susceptible species and Intermediately Susceptible species, respectively. Each point is the LTA at a site colored by county. The middle bar in the boxplot is the median LTA for the region, the areas above and below the median, hinges, represent the 1st and 3rd quartiles, respectively. The whiskers, upper and lower, extend from the hinge to the largest value no greater than $1.5 \cdot IQR$, where IQR is the interquartile range (distance between 1st and 3rd quartiles). Points lying beyond the whiskers are considered outliers.

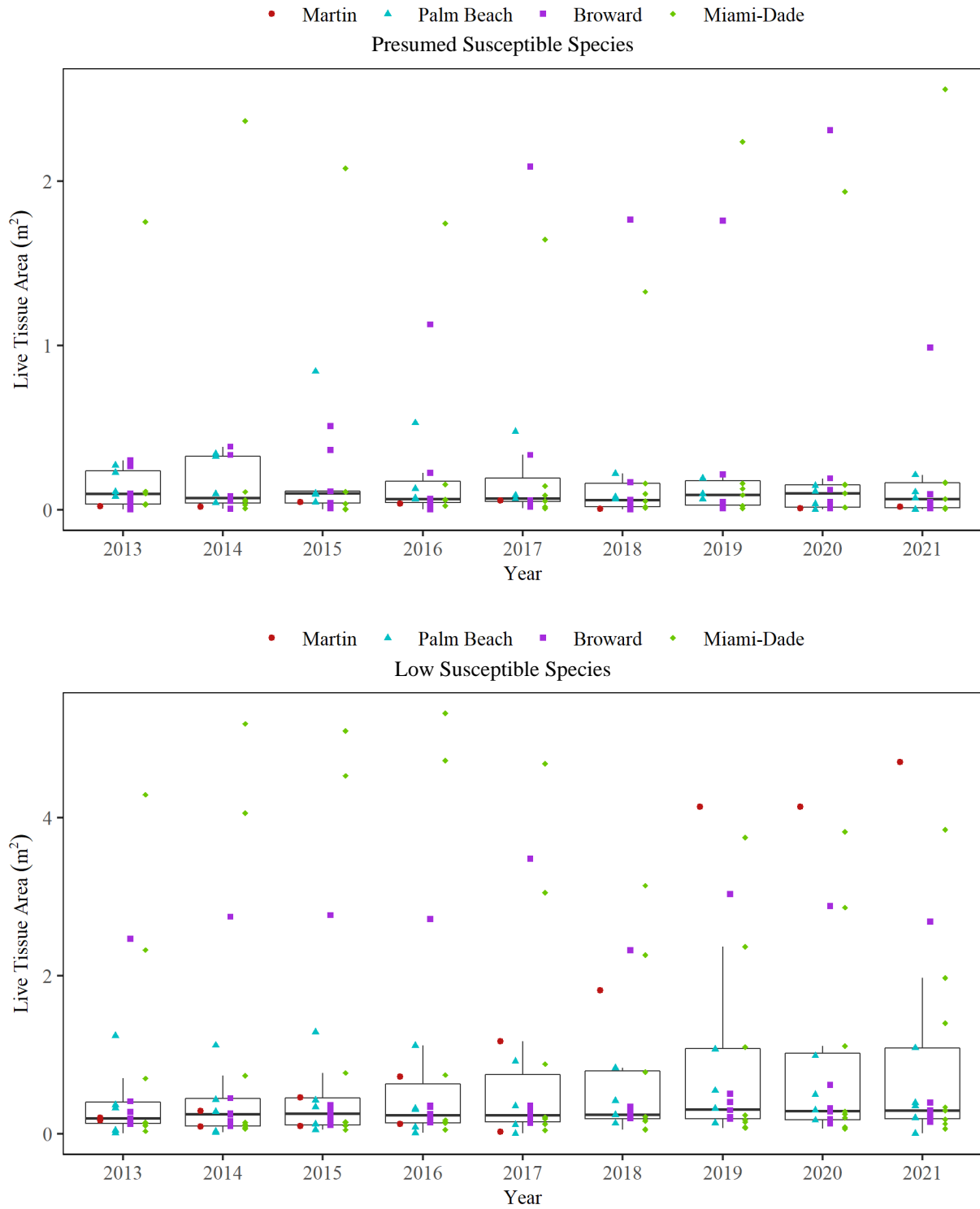


Figure 5. Mean (\pm SE) region-wide LTA (m^2) for Presumed Susceptible species and Low Susceptible species, respectively. See Figure 4 for boxplot explanation.

- Beginning in 2018, stony coral colonies <4 cm in diameter were identified to lowest taxonomic level and tallied across all SECREMP sites. In 2021, 3138 colonies <4 cm were found (Table 3).
- The three most abundance species in 2021 (colonies <4cm dia) were *S. siderea* (1873), *P. astreoides* (554), and *M. cavernosa* (210), which made up 84% of all colonies <4cm recorded. A decline from 2020 to 2021 of *A. agaricites* complex was observed, removing it from the top 3 most abundant species (Table 3).
- Of the 16 species defined as Highly or Intermediately susceptible to SCTL D seven species/genera had <10 colonies <4cm recorded across all sites (Table 3). In 2021, three species had no colonies <4cm recorded (*A. lamarcki*, *D. labyrinthiformis*, and *O. annularis* complex)

Table 3. Region-wide (all sites pooled) abundance of stony coral colonies < 4 cm from 2018-2021. Region is the total stony coral abundance of colonies < 4 cm across all species by year. Each colony was identified to lowest taxonomic level possible.

Species	2018	2019	2020	2021
Region	2072	1862	3218	3138
<i>A. agaricites</i> complex	162	325	374	190
<i>A. cervicornis</i>	0	0	0	1
<i>A. lamarcki</i>	0	0	1	0
<i>C. natans</i>	1	0	1	1
<i>D. labyrinthiformis</i>	0	1	2	0
<i>D. stokesii</i>	33	21	27	24
<i>E. fastigiata</i>	3	3	1	7
<i>H. cucullata</i>	0	0	0	2
<i>M. auretenra</i>	16	5	3	3
<i>M. cavernosa</i>	158	170	192	210
<i>M. decactis</i>	7	6	5	10
<i>M. meandrites</i>	14	12	8	9
<i>Mycetophyllia</i> spp.	3	5	7	8
<i>O. annularis</i> complex	0	0	0	0
<i>O. diffusa</i>	0	1	1	1
<i>P. americana</i>	12	2	1	3
<i>P. astreoides</i>	309	232	416	554
<i>P. porites</i>	52	87	129	113
<i>Pseudodiploria</i> spp.	7	4	6	5
<i>S. bourmoni</i>	1	1	3	3
<i>S. cubensis</i>	1	8	5	5
<i>S. intersepta</i>	122	94	110	106
<i>S. radians</i>	6	1	17	8
<i>S. siderea</i>	1164	884	1909	1873
<i>Scleractinia</i> spp.	1	0	0	1

Octocoral and Xestospongia muta Density

- Region-wide octocoral density (colonies/m²) from 2015-2017 was significantly greater than in 2013 and 2014. However, in 2018 density was significantly lower than 2017, driven by loss from Hurricane Irma. Octocoral density has since recovered, and density in 2021 was significantly greater than in 2013-2016, 2018 and 2019 (Figure 6). Octocoral target species information is available in the 2020 comprehensive report (Gilliam et al. 2021).

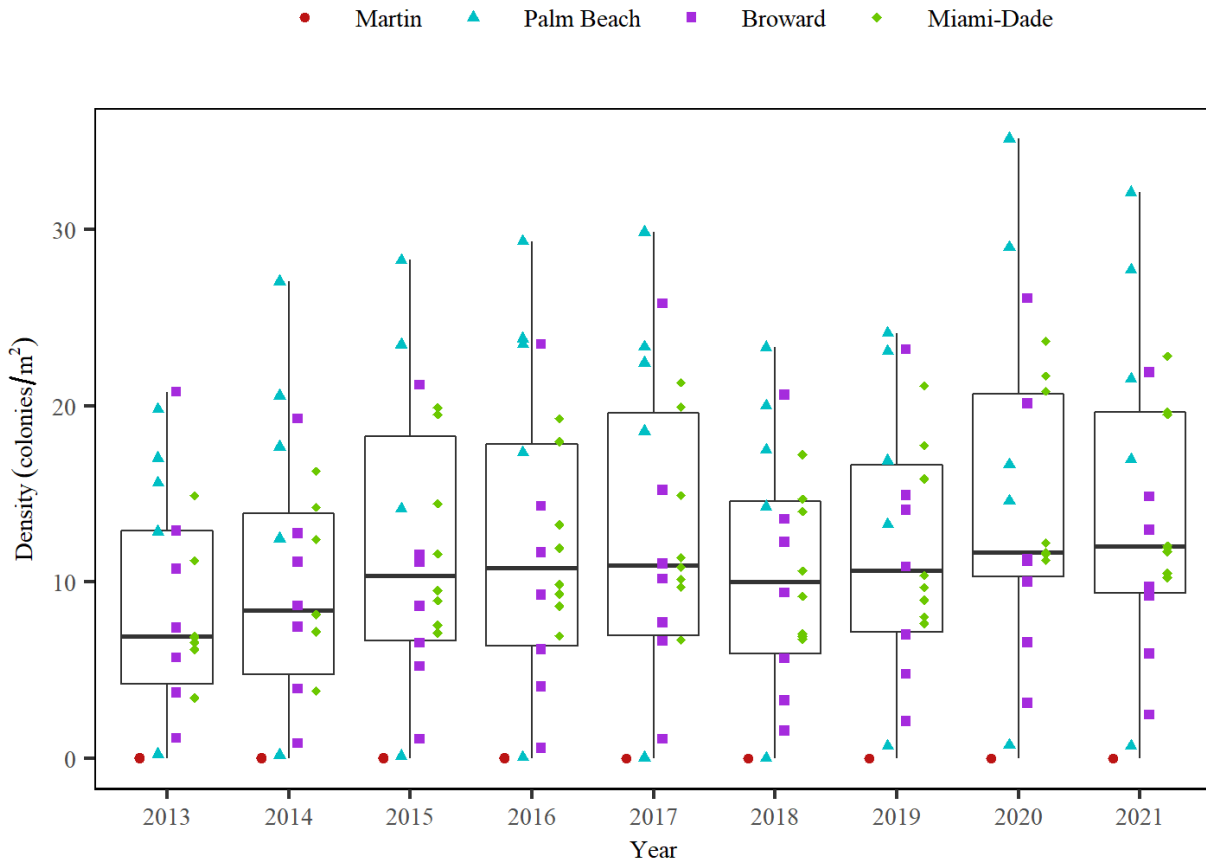


Figure 6. Octocoral density (colonies/m²) across all sites from 2013-2021. See Figure 4 for boxplot explanation.

- Region-wide (all sites pooled) *X. muta* density was significantly greater in 2015, 2016, and 2017 than it was in 2013; density in 2017 was also significantly greater than in 2014. However, as observed with octocorals, in 2018 density was significantly lower than 2017, driven by loss from Hurricane Irma. Density in 2019-2021 was significantly greater than density in 2013, showing recovery post disturbance (Figure 7).

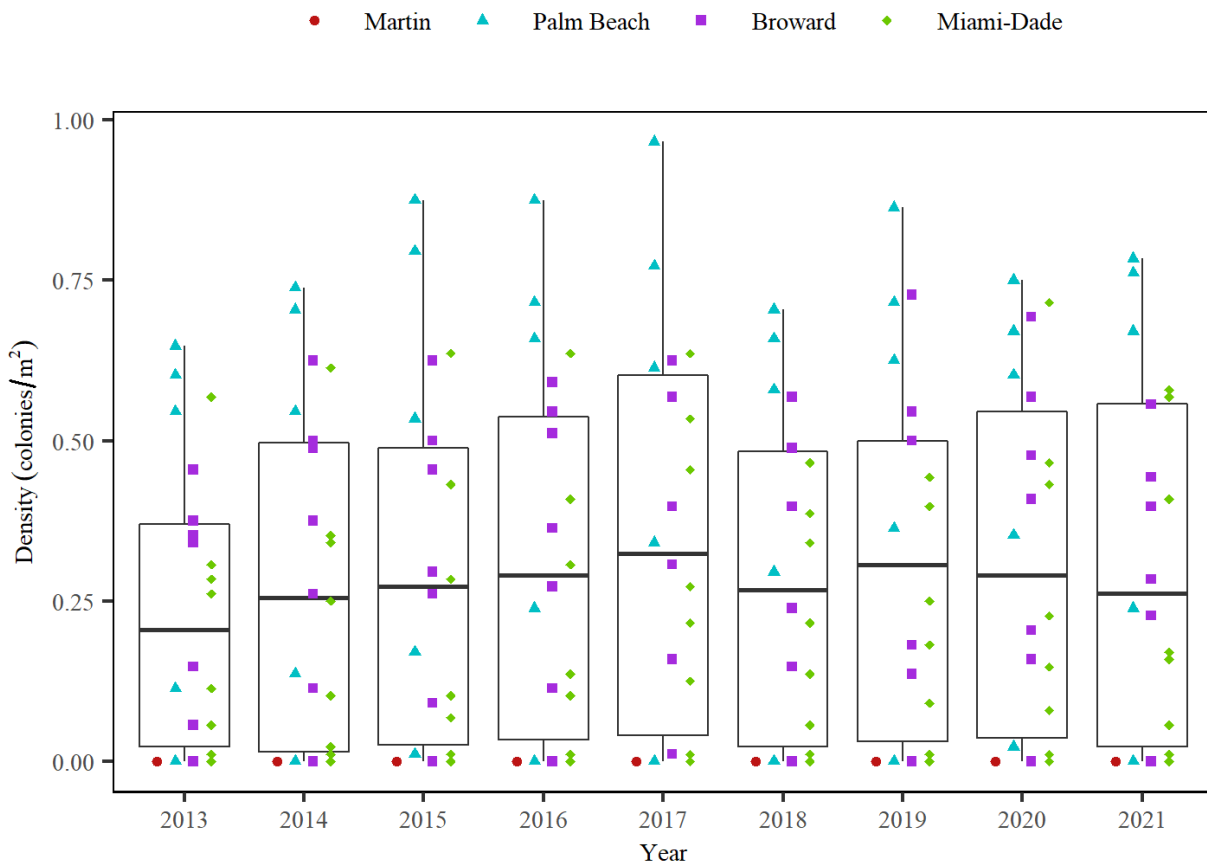


Figure 7. *Xestospongia muta* density (colonies/m²) across all sites from 2013-2021. See Figure 4 for boxplot explanation.

Functional Group Benthic Cover

- Long-term trends in benthic functional group (stony coral, octocoral, sponges, and macroalgae) cover are not presented in this Executive Summary. Long-term trend analysis (2003-2020) was presented in the 2020 comprehensive report (Gilliam et al. 2021).
- In 2021, stony coral percent cover averaged across all SECREMP sites was 0.7% (Figure 8). Region-wide stony coral cover did not significantly change from 2020 to 2021. Stony coral cover significantly increased at one site, DC7 (0.3% to 0.6%); however, given the marginal p-value and both the low percent cover values and small increase in percent cover, this increase is likely a sampling artifact. Stony coral cover significantly decreased at three sites: BCA (5.9% to 4.1%), DC8 (1.2% to 0.5%), and MC1 (2.1% to 1.5%) (Table 4).
- Region-wide octocoral cover did not significantly change from 2020 to 2021 though an increase in the mean value was observed (2.7% in 2020 to 3.9 % in 2021) (Figure 8). Significant increases were found at 6 sites whereas significant decreases were found at 4 sites. For Dade County, 5 of the 8 sites exhibited a significant increase (DC1, DC2, DC3, DC4, and DC7). The only other observed significant increase occurred at BC3. Conversely, all

significant decreases in octocoral cover occurred at Broward County sites, including BC1, BC2, BC6 and BCA (Table 4).

- The largest increase in octocoral cover occurred at DC4 where octocoral cover increased from 8.5% to 12.1% with most of the other sites that significantly increased in octocoral cover increasing by around 2-3%. Decreases in octocoral cover ranged from 0.8% at BCA to 2.2% at BC6 (Table 4).
- Changes in macroalgae cover were highly variable which is typical for this taxon and reflects the ephemeral nature of macroalgae. A region-wide significant increase in macroalgae was observed, where significant changes occurred at 21 of 22 sites (Figure 8, Table 4). Of these, 14 sites exhibited a significant increase with the largest increase occurring at DC8 where macroalgae cover increased by 39.9%, from 24.1% to 64.0%. The magnitude of other significant increases ranged from 2.2% to 13.9%. Significant decreases in macroalgae cover occurred at 7 sites with the largest decrease occurring at DC4 where macroalgae cover decreased 19.4%, from 31.6% to 12.3%. Other significant decreases ranged from 2.5% to 14.1% (Table 4).
- Region-wide sponge cover significantly decreased from 5.0% to 4.4% (Figure 8). Nine sites exhibited significant changes with eight of these decreasing (PB2, PB3, BC1, BC5, BCA, DC3, DC6, DC8). The largest decrease was observed at PB3 where sponge cover decreased from 16.5% to 12.5%. Other significant decreases were less than 2%. Only 1 site showed a significant increase, DC2 (5.7% to 7.0%) (Table 4).

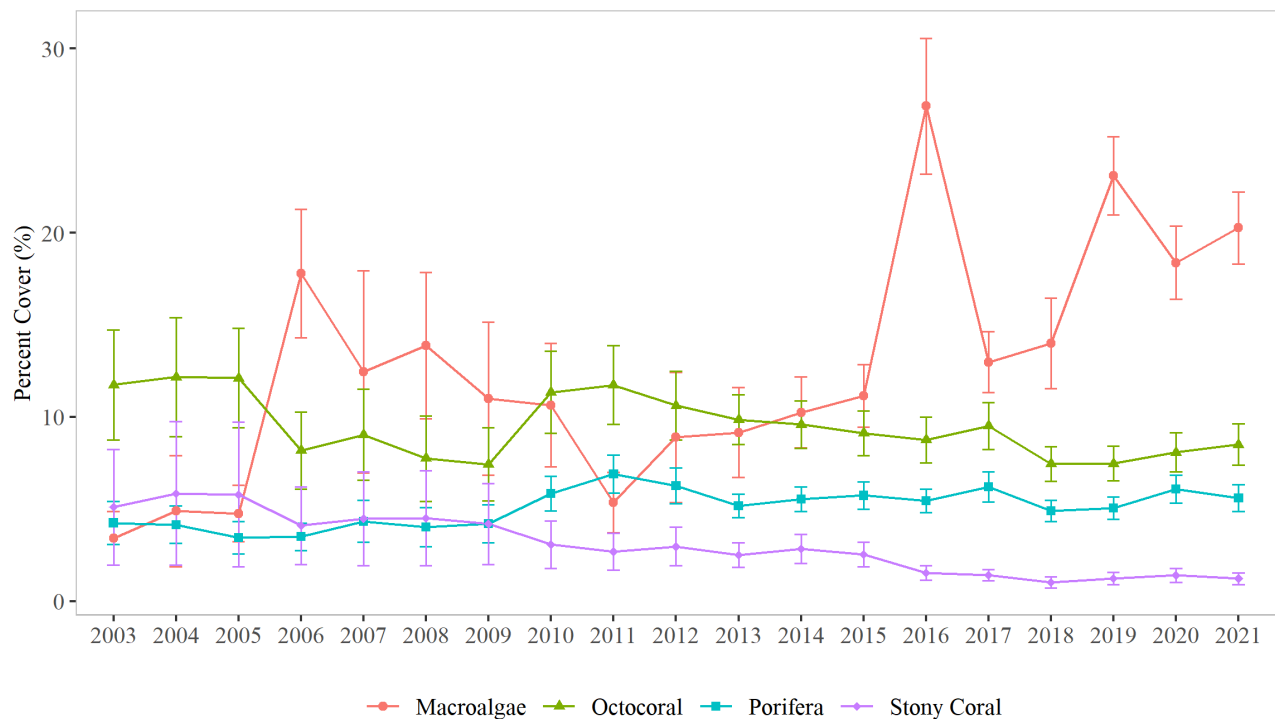


Figure 8. Mean (\pm SE) region-wide annual percent cover of stony coral, octocoral, sponge, and macroalgae (values for each year include all sites sampled that year).

Table 4. Mean (\pm SE) 2021 percent benthic cover for of stony coral, octocoral, sponge, and macroalgae. Bolded 2021 cover values with '+' are significantly greater than 2020 and cover values with '-' are significantly lower than 2020.

Site	Stony Coral	Octocoral	Sponge	Macroalgae
MC1	-1.93 \pm 0.74	0.13 \pm 0.13	1.98 \pm 0.49	+19.96 \pm 3.17
MC2	0.14 \pm 0.07	0.00 \pm 0.00	2.39 \pm 0.60	-29.19 \pm 5.74
PB1	0.06 \pm 0.03	0.17 \pm 0.07	3.36 \pm 1.38	+25.70 \pm 1.26
PB2	0.78 \pm 0.35	13.26 \pm 4.77	-6.52 \pm 1.28	+14.08 \pm 4.90
PB3	0.65 \pm 0.19	13.21 \pm 0.96	-12.54 \pm 0.70	+18.30 \pm 2.78
PB4	0.47 \pm 0.16	16.59 \pm 1.11	12.58 \pm 1.55	-10.15 \pm 1.52
PB5	1.06 \pm 0.18	15.97 \pm 0.37	10.39 \pm 2.09	+17.38 \pm 2.02
BC1	6.43 \pm 1.11	-7.24 \pm 0.24	-2.39 \pm 0.41	+26.64 \pm 3.38
BC2	0.31 \pm 0.15	-6.63 \pm 1.09	7.64 \pm 0.37	+21.64 \pm 6.63
BC3	0.33 \pm 0.04	+12.14 \pm 1.40	5.83 \pm 0.76	+19.13 \pm 11.66
BC4	2.37 \pm 0.42	2.30 \pm 0.55	3.32 \pm 0.64	+32.18 \pm 5.44
BC5	0.21 \pm 0.09	6.31 \pm 0.60	-5.76 \pm 1.23	-21.88 \pm 5.16
BC6	0.31 \pm 0.11	-14.58 \pm 1.17	6.12 \pm 1.08	10.93 \pm 1.94
BCA	-4.28 \pm 0.82	-1.44 \pm 0.37	-0.82 \pm 0.16	+18.23 \pm 4.17
DC1	2.05 \pm 0.38	+7.01 \pm 0.41	4.09 \pm 0.82	-21.60 \pm 4.02
DC2	0.48 \pm 0.09	+11.91 \pm 1.24	+7.12 \pm 1.43	+25.60 \pm 6.90
DC3	0.51 \pm 0.16	+11.19 \pm 1.94	-4.36 \pm 0.85	+23.58 \pm 6.43
DC4	1.15 \pm 0.21	+12.20 \pm 1.06	6.95 \pm 0.69	-12.02 \pm 1.86
DC5	0.98 \pm 0.18	11.44 \pm 0.99	5.05 \pm 1.24	-13.40 \pm 2.16
DC6	1.46 \pm 0.54	5.70 \pm 0.63	-1.78 \pm 0.41	+46.42 \pm 1.36
DC7	+0.62 \pm 0.24	+8.80 \pm 0.52	10.19 \pm 0.49	-17.22 \pm 1.02
DC8	-0.56 \pm 0.25	8.77 \pm 0.83	-2.18 \pm 0.23	+0.67 \pm 0.19

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