Southeast Florida Coral Reef Evaluation and Monitoring Project

Executive Summary 2015

Overview

- The Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP) documents the status and trends in the southeast Florida (Miami-Dade, Broward, Palm Beach, and Martin counties) reef system and in 2015 completed its 13th year of annual surveys.

- In 2015, all 22 SECREMP sites were surveyed through established methodologies for evaluating status and trends of the Southeast Florida reef communities. See Gilliam et al. (2015) for site locations and survey protocols. All surveys were performed within four permanently marked 22m x 2m stations at all sites (Figure 1).

- Survey methods consisted of (1) photographic transects to quantify percent cover of major benthic taxa (stony corals, sponges, octocorals, macroalgae, etc.) and (2) demographic surveys to quantify abundance/density, size distribution, and overall condition of stony corals (Scleractinia and Milleporidae), octocorals (Octocorallia), and *Xestospongia muta* (giant barrel sponge).

- Statistical comparisons for stony coral density, bleaching prevalence, disease prevalence, and stony coral colony live tissue area were performed for counties (pooling all sites within a county) and sites (stations as replicates). A repeated measures ANOVA was used with year as the factor to examine changes between 2012 – 2015 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.

- While all cover data and demographic data were collected in 2015, this summary focuses on changes (if any) in stony coral demographic data, especially with respect to bleaching and disease, from 2012 through 2015. Special attention to stony coral condition was made in response to the widespread bleaching and disease events during the summers of 2014 and 2015. Numerous reports of extreme bleaching and high prevalence of disease throughout 2014 and 2015 impacting many stony coral species are cause for concern. As a result, this Executive Summary aims to gain an understanding and quantify the impacts of the event on the SECREMP sites.

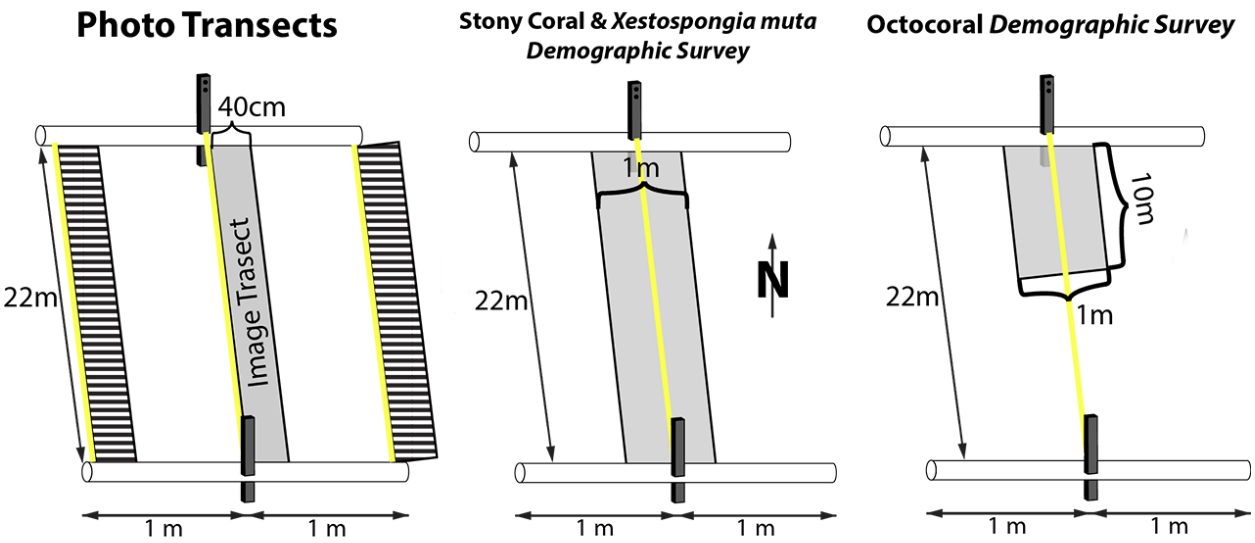

Figure 1. All SECREMP sites consist of four monitoring stations identified by permanent markers. Stations are 22m x 2m and are oriented north to south. Photo transects are taken along the center of the station surveying an 8.8m^2 area. The hashed photo transects represent additional area surveyed prior to the 2014 modifications; this area is still surveyed at site BCA. Stony coral and *Xestospongia 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.

Results and Discussion

Stony Coral Demographics

- 25 stony coral species were identified project wide. This has remained stable throughout all project years (Gilliam et al. 2015).

- Mean (±SE) stony coral species richness (number of species) ranged from 2.25 ± 0.05 and 2.25 ± 0.44 (BCA & PB1, respectively) to 12.00 ± 0.10 (BC4) (Table 1). It is not surprising that BCA and PB1 had the fewest species, because they are both unique sites. BCA is dominated by staghorn coral, *Acropora cervicornis*, and PB1 is a site that has historically experienced several sand burial events.

- Similar to previous years, six species were dominant in terms of abundance, contributing to more than 80% of the total stony coral abundance. The six most common species were (in order of greatest abundance): *Porites astreoides, Montastraea cavernosa, Siderastrea siderea, Stephanocoenia intersepta, Undaria/Agaricia agaricites*, and *Porites porites*. Prior to 2015 *Meandrina meandrites* was consistently one the six most common species. In 2015, *M. meadrites* was replaced by *P. porites*, likely as a result of colony mortality due to the ongoing bleaching and disease event (Table 3).

- Combined for all coral species, mean (±SE) stony coral size (diameter) ranged from 7.28 ± 0.46 cm (PB1) to 41.09 ± 2.22 cm (BC1). Mean coral size project wide was 15.99 ± 0.18 cm (Table 1). The largest colony in terms of max diameter was a *Pseudodiploria/Diploria clivosa*

at MC1 with a diameter of 200 cm. From 2012 – 2015 the largest colonies, in terms of mean diameter, have been *Montastraea annularis complex* (*M. annularis, M. faveolata,* and *M. franksi*), *P./D. clivosa, M. cavernosa, M. meandrites,* and *Pseudodiploria/Diploria strigosa* (Table 2).

- The overall mean (±SE) stony coral density was 1.55 ± 0.99 colonies/m^2. Stony coral density in the SECREMP region is substantially lower compared to the Florida Keys, where the mean density is 6.68 ± 0.35 colonies/m^2 (CREMP unpublished data).

- Mean (±SE) stony coral density (colonies/m^2) ranged from 0.31 ± 0.02 (site DC3) to 4.05 ± 0.03 (BC4). The density at BC4 is nearly twice that of the next densest site (DC5, 2.33 ± 0.04) (Table 1).

Table 1. 2015 mean (±SE) SECREMP site stony coral density (colonies/m^2), richness and diameter (cm). DC = Miami-Dade; BC = Broward; PB = Palm Beach; MC = Martin) (Density = colonies ≥ 4 cm diameter/m^2, Richness = number of species). Note: BCA density does not include colonies of *A. cervicornis.*

Site	Mean Density (±SE)	Mean Richness (±SE)	Mean Diameter (±SE)
BC1	2.05 ± 0.05	8.50 ± 0.04	41.09 ± 2.22
BC2	0.56 ± 0.03	4.60 ± 0.26	12.34 ± 1.32
BC3	0.59 ± 0.02	5.25 ± 0.35	11.79 ± 1.04
BC4	4.05 ± 0.03	12.00 ± 0.10	13.28 ± 0.62
BC5	1.19 ± 0.04	7.00 ± 0.14	12.58 ± 1.18
BC6	0.56 ± 0.02	4.25 ± 0.14	15.43 ± 1.93
BCA	1.09 ± 0.08	2.25 ± 0.05	8.18 ± 0.42
DC1	2.15 ± 0.01	8.50 ± 0.13	18.74 ± 1.38
DC2	1.07 ± 0.02	6.00 ± 0.08	9.09 ± 0.78
DC3	0.31 ± 0.02	4.50 ± 0.25	9.67 ± 1.35
DC4	0.75 ± 0.05	5.50 ± 0.07	12.36 ± 1.60
DC5	2.33 ± 0.04	8.75 ± 0.12	11.18 ± 0.65
DC6	1.51 ± 0.04	7.50 ± 0.21	21.17 ± 1.61
DC7	1.10 ± 0.03	7.75 ± 0.05	9.42 ± 0.66
DC8	0.91 ± 0.03	6.25 ± 0.14	13.26 ± 1.22
MC1	0.98 ± 0.04	4.25 ± 0.18	19.43 ± 2.89
MC2	0.35 ± 0.04	3.00 ± 0.18	19.39 ± 4.64
PB1	0.38 ± 0.06	2.25 ± 0.44	7.28 ± 0.46
PB2	1.57 ± 0.05	6.00 ± 0.07	14.95 ± 1.01
PB3	1.11 ± 0.06	6.75 ± 0.10	13.92 ± 0.84
PB4	1.70 ± 0.05	6.75 ± 0.12	15.37 ± 1.03
PB5	2.08 ± 0.04	8.00 ± 0.10	13.93 ± 0.72

Table 2. Mean (±SE) diameter (cm) for select species per year. DCLI = *P./D. clivosa*, DSTR = *P./D. strigosa*, MANN = *Orbicella annularis* complex (includes *O. Annularis, O. franksi* and *O. faveolata*, MCAV = *M. cavernosa*, MMEA = *M. meandrites.*

YEAR	DCLI	DSTR	MANN	MCAV	MMEA
2012	51.59 ± 6.57	40.00 ± 6.76	63.71 ± 11.60	26.18 ± 1.17	24.14 ± 2.28
2013	50.26 ± 6.22	38.83 ± 10.16	59.57 ± 6.94	23.35 ± 1.05	23.37 ± 2.04
2014	55.04 ± 7.64	26.42 ± 7.07	50.00 ± 7.29	28.25 ± 1.04	23.71 ± 1.89
2015	52.50 ± 6.36	38.50 ± 6.37	61.79 ± 8.99	29.35 ± 1.08	22.70 ± 2.06

Table 3. Species specific density 2012 through 2015. Density equals the total number of colonies recorded divided by the area surveyed. All sites have an area of 88m^2 and the n for each year represents the number of sites surveyed. Coral abbreviations are PAST = *Porites astreoides*, MCAV = *Montastraea cavernosa*, SSID = *Siderastrea siderea*, SINT = *Stephanocoenia intersepta*, UAGA = *Undaria/Agaricia agaricites*, MMEA = *Meandrina meandrites*, PPOR = *Porites porites.*

YEAR	PAST	MCAV	SSID	SINT	UAGA	MMEA	PPOR
2012 n=16	0.18	0.23	0.24	0.11	0.09	0.06	0.02
2013 n=22	0.28	0.25	0.24	0.12	0.09	0.06	0.03
2014 n=22	0.30	0.24	0.22	0.13	0.09	0.06	0.04
2015 n=22	0.30	0.24	0.21	0.13	0.11	0.05	0.06

- Stony coral densities have not changed significantly at the county or site level (repeated measures ANOVA, F = varies, $p > 0.05$). While the bleaching and disease event is impacting many corals in the southeast region, whole colony mortality from the event in 2014-2015 was not enough to result in significant changes in density. This disease event was ongoing during the 2015 sampling, and the full extent of effects may not be seen until the 2016 data is collected.

- Colony partial mortality, which is comprised of old and recent mortality, was recorded at all 22 sites. Old mortality is estimated as a percent of a colony where tissue has died and the area is overgrown by turf algae, macroalgae, sponges, etc. Whereas, recent mortality is estimated as a percent of a colony that has bright white carbonate skeleton visible with no overgrowth. Recent mortality is often the result of disease and/or predation.

- Mean (±SE) percent old mortality ranged from 3.40 ± 1.86% (PB1) to 30.34 ± 2.31% (PB2) (Table 4).

- Recent colony mortality was recorded at 20 of the 22 sites. Recent mortality was not observed at PB1 and MC2. For the 20 sites having recent mortality, the mean (±SE) percent range was 0.03 ± 0.01% (PB4) to 3.99 ± 1.00% (DC1) (Table 4). In terms of ecological contributions, higher values of partial mortality indicate lower colony contribution to the ecological services.

- The majority of recent mortality was due to disease, although some recent mortality was observed at sites where disease was not observed. In these cases, recent mortality was primarily due to predation or interactions with macroalgae (abrasion). BC6 had the second highest mean (±SE) percent recent mortality (1.78 ± 0.54%) and this was a result of macroalgae interactions.

Table 4. 2015 mean (±SE) SECREMP stony coral demographic data. Percent disease prevalence includes all diseases that cause recent mortality, as well as dark spot syndrome (DSS) and skeletal anomalies. DC = Miami-Dade; BC = Broward; PB = Palm Beach; MC = Martin. Density = colonies ≥ 4cm/m^2, Richness = number of species, % Disease prevalence = (# of diseased colonies / total # of colonies) * 100. **Note: BCA density and prevalence do not include colonies of *A. cervicornis.***

Site	Mean % Old Mortality (±SE)	Mean % Recent Mortality (±SE)	Disease Occurrence	Mean % Disease Prevalence (±SE)
BC1	23.33 ± 1.78	0.03 ± 0.03	1	0.45 ± 0.45
BC2	18.00 ± 3.23	0.92 ± 0.22	1	0.00 ± 0.00
BC3	16.12 ± 2.84	0.29 ± 0.21	0	0.00 ± 0.00
BC4	15.37 ± 1.09	0.44 ± 0.24	2	0.65 ± 0.37
BC5	14.20 ± 2.01	0.71 ± 0.47	0	0.00 ± 0.00
BC6	16.82 ± 2.91	1.78 ± 0.54	0	0.00 ± 0.00
BCA	6.49 ± 1.11	0.09 ± 0.06	0	0.00 ± 0.00
DC1	16.80 ± 1.41	3.99 ± 1.00	9	4.75 ± 1.83
DC2	15.56 ± 1.74	0.18 ± 0.12	1	0.96 ± 0.96
DC3	13.33 ± 2.56	0.19 ± 0.19	0	0.00 ± 0.00
DC4	28.70 ± 3.30	0.39 ± 0.22	3	6.35 ± 2.31
DC5	13.90 ± 1.46	0.22 ± 0.10	5	2.45 ± 0.37
DC6	21.83 ± 1.89	1.43 ± 0.57	1	0.76 ± 0.76
DC7	12.73 ± 1.81	0.29 ± 0.15	0	0.00 ± 0.00
DC8	22.91 ± 3.34	0.88 ± 0.30	7	8.40 ± 2.85
MC1	12.51 ± 1.85	0.08 ± 0.03	4	3.93 ± 2.55
MC2	19.13 ± 2.79	0.00 ± 1.00	0	3.57 ± 3.57
PB1	3.40 ± 1.86	0.00 ± 0.00	0	0.00 ± 0.00
PB2	30.34 ± 2.31	0.73 ± 0.02	5	0.00 ± 0.00
PB3	24.19 ± 2.76	0.28 ± 0.10	1	0.60 ± 0.60
PB4	20.29 ± 1.95	0.03 ± 0.01	1	0.96 ± 0.96
PB5	15.49 ± 1.60	0.23 ± 0.08	0	0.00 ± 0.00

Stony Bleaching Event

- 2014 had the highest number of days recorded over 30°C for the lifetime of the project, 476 days across all 22 sites. Additionally, 2014 had the highest number of days over 30.5°C, 229 days. Previously the highest for a year was 50 days. Days over 30°C and 30.5°C are of interest because these temperature values are critical thresholds for coral bleaching. Due to the timing of SECREMP sampling, temperature data for the summer of 2015 will not be available until the 2016 sampling.

- Bleaching, partial bleaching, and paling are indicators of coral stress and can eventually result in disease. For the purposes of this report, bleaching, partial bleaching, and paling are grouped together for prevalence calculations.

- Bleaching prevalence changed significantly in Palm Beach County, with prevalence in 2015 being significantly higher than prevalence in 2013 (repeated measures ANOVA, $F = 2.919$, $p = 0.0401$). Bleaching was also higher in 2015 in Miami-Dade County, but was not significant (one-way repeated measures ANOVA, $F = 2.522$, $p = 0.0615$) (Table 5).

- Between 2012 and 2015 at the site level, 3 sites had bleaching prevalence that was significantly higher than other years (one-way repeated measures ANOVA, F = varies, $p < 0.5$) (Table 6).

Table 5. Mean (±SE) bleaching prevalence for each county by year. Bleaching prevalence is calculated based the total number of colonies that had bleaching, partial bleaching, or paling divided by the total number of colonies in the county.

Year	Martin	Palm Beach	Broward	Miami-Dade
2012	7.63 ± 5.51	4.15 ± 1.80	5.13 ± 1.71	4.48 ± 1.43
2013	0.00 ± 0.00	1.99 ± 0.75	13.10 ± 4.06	6.70 ± 1.09
2014	0.96 ± 0.64	6.07 ± 1.54	13.96 ± 3.10	10.29 ± 2.22
2015	3.66 ± 2.40	7.92 ± 1.65	17.43 ± 3.19	12.72 ± 3.00

Table 6. Mean (±SE) bleaching prevalence for sites with significant differences. **Bolded** values are years that are significantly higher compared to at least one other year. Bleaching prevalence includes, bleaching, partial bleaching, and paling.

Site	2012	2013	2014	2015
Broward County A	1.56 ± 1.56	**50.82 ± 17.58**	8.95 ± 5.24	4.65 ± 4.65
Broward County 5	NA	0.65 ± 0.65	21.37 ± 9.88	**41.06 ± 4.68**
Dade County 2	3.10 ± 1.83	4.86 ± 2.06	**14.04 ± 5.20**	0.00 ± 0.00

Stony Disease Event

- Disease occurrence was noted at 13 of the 22 sites, with a maximum of nine diseased colonies recorded at DC1. Of the 13 sites with disease, the prevalence ranged from 0.45 ± 0.45 % (BC1) to 8.40 ± 2.85% (DC8) (Table 4).

- Mean disease prevalence per county has shown some increases, but not significant (repeated measures ANOVA, F = varies, $p > 0.05$). Figure 2 shows the disease prevalence for each county by year, both with (black) and without (red) Dark Spot Syndrome (DSS) and skeletal

anomalies (SKA) included in the prevalence. It is interesting to note there was a large spike in prevalence for Broward County in 2014, which is driven by BC6. Mean (± SE) prevalence at BC6 in 2014 was 16.64 ± 3.98%, compared to 2015 when it was 0.00 ± 0.00%. As sampling time was similar for all Broward sites in both 2014 and 2015, it is possible the 2014 sampling captured the height of the event while in 2015 disease had run its course. Skeletal anomalies were not observed in 2015, but were noted in previous years and are therefore included in the disease prevalence for all years.

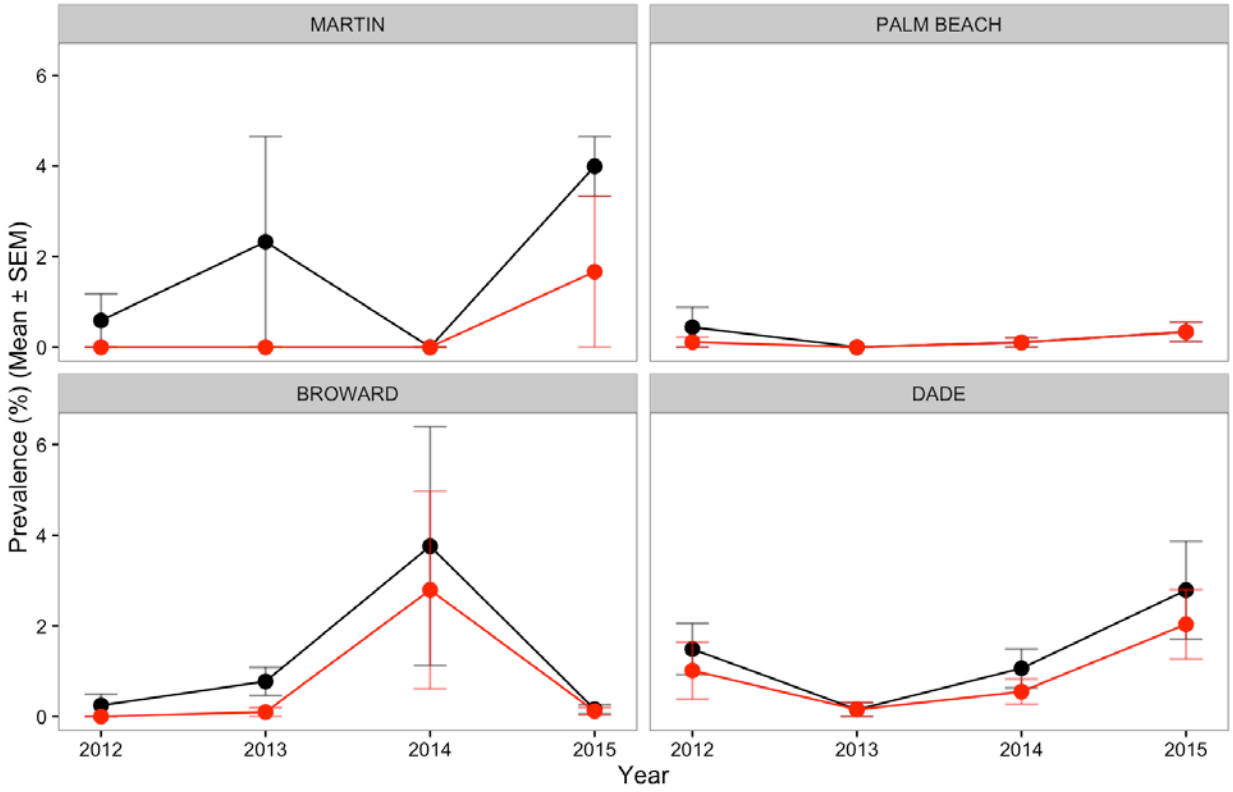

Figure 2. 2015 mean (±SE) percent disease prevalence by county. Each point is the mean of disease prevalence of all sites in each county per year. 2012 is the mean of 16 sites and 2013 – 2015 is the mean of 22 sites. The black lines and points are the prevalence including Dark Spot Syndrome and Skeletal Anomalies. The red lines and points are prevalence without DSS and SKA; only includes diseases known to cause recent mortality.

- While changes of prevalence of disease, both with and without the inclusion of DSS and SKA, can be seen in each county, the changes are not statistically significant.

- When looking at prevalence of only diseases causing recent mortality, there again has not been a significant change at the county level, but two sites show significant changes. BC5 had significantly higher disease prevalence in 2014, compared to 2013 and 2015 (repeated measures ANOVA, $F = 5.824$, $p < 0.05$) (Table 7).

- Miami-Dade County has exhibited the highest prevalence of disease in 2015. All Miami-Dade County sites had disease present in 2015, except DC7, which is the northernmost DC site and

is also at a depth of 55 feet. DC8 and DC4 had the first and second highest disease prevalence, respectively. These two sites are 2 of the 3 southernmost sites, DC5 is the third and it also had high prevalence, ranking fourth of the Dade sites (Figure 3).

Table 7. 2012 – 2015 mean (±SE) percent disease prevalence for only SECREMP sites that had significant changes in prevalence. Bolded numbers for a site indicate the mean for that year is significantly different from the others (Comparisons are for within the site only). Significance for a site was determined by a one-way repeated measures ANOVA followed by a Tukey's HSD test to determine years that differed. **** NOTE: DSS and SKA not include in prevalence calculation.****

Site	2013	2014	2015
BC5	0.00 ± 0.00	**4.11 ± 1.70**	0.00 ± 0.00
BC6	0.00 ± 0.00	**16.64 ± 3.98**	0.00 ± 0.00

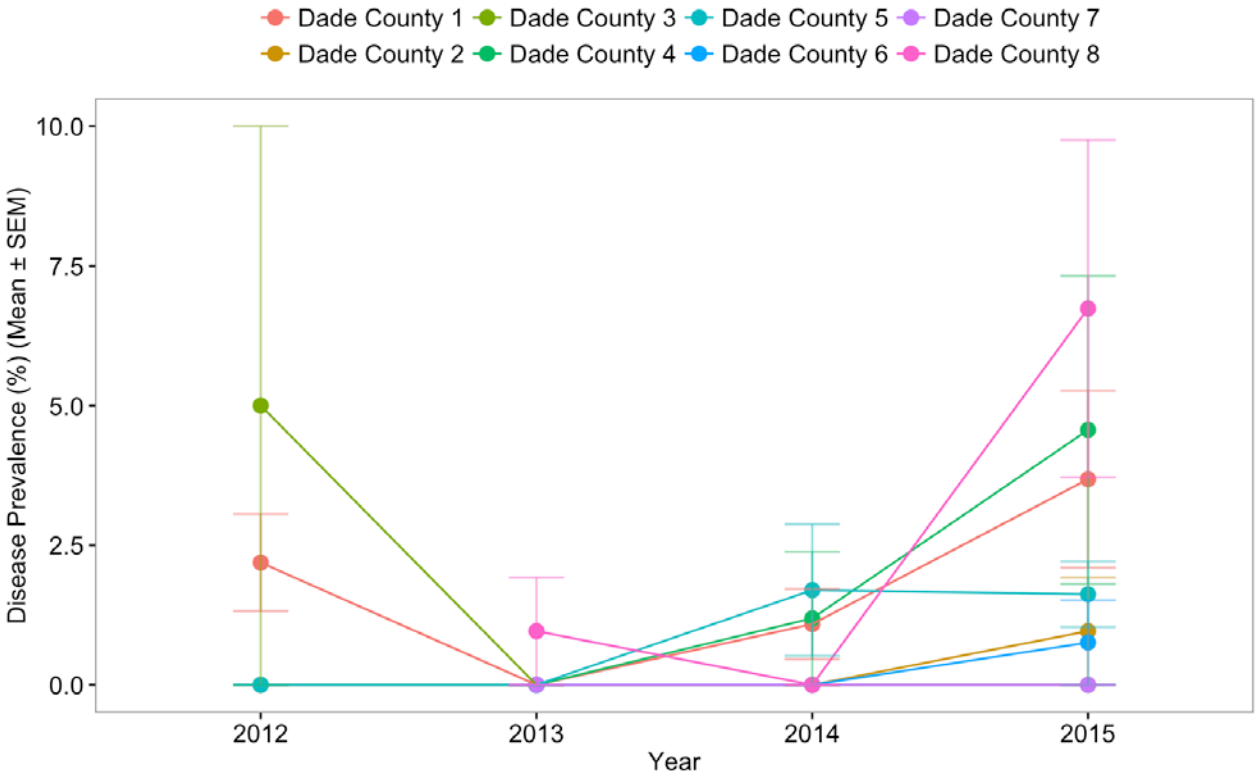

Figure 3. Mean (±SE) percent disease prevalence for all Miami-Dade County sites. Prevalence only includes diseases causing recent mortality. Sites DC6, DC7, and DC8 were added in 2013, so there are not points for them in 2012. Only DC1 and DC3 had disease in 2012, all others were 0%.

- The diseases recorded and species impacted are shown in Table 8. Black Band Disease (BBD), White Plague (WPL) and Rapid Tissue Loss (RTL) result in tissue mortality, whereas DSS and SKA do not. DSS is most common on *S. siderea* colonies in the region and contributes to the

disease occurrence and prevalence. However, DSS does not necessarily result in mortality, meaning colonies affected by DSS can persist for long periods.

- White plague, which for SECREMP includes all white syndromes except RTL, White Band Disease (WBD) and White Pox (WPX), was the most common disease observed and affected *Dichocoenia stokesii*, *Montastraea cavernosa*, *Orbicella/Montastraea. faveolata* and *Meadrina meandrites*.

- Black Band disease affected *Pseudodiploria/Diploria strigosa* (1 colony) and *M. cavernosa* (2 colonies). The three instances of BBD were not localized to a single county; there was one colony affected in each of the following counties, Miami-Dade, Broward, and Palm Beach (Table 9).

- Rapid tissue loss, only known to impact Acroporids was observed at two sites, BCA and DC1, affecting only *A. cervicornis* as no *A. palmata* was observed within the SECREMP sites. It should be noted that, although BCA exhibited RTL, it is not included in occurrence data and prevalence calculations because the high density of *A. cervicornis* leads to difficulty identifying individual colonies necessary for determining prevalence (Table 9).

- Dark Spot syndrome, known to affect several species, was only observed on *S. siderea.* It is important to note that Dark Spot Syndrome was not the cause of any recent mortality.

Table 8. 2015 disease occurrences and affected species. BBD = Black Band Disease, WPL = White Plague, RTL = Rapid Tissue Loss, DSS = Dark Spot Syndrome.

Stony Species	BBD	WPL	RTL	DSS
Acropora cervicornis	0	0	3	0
Dichocoenia stokesii	0	6	0	0
Pseudodiploria strigosa	1	0	0	0
Montastraea cavernosa	2	3	0	0
Orbicella faveolata	0	2	0	0
Meandrina meandrites	0	2	0	0
Porites astreoides	0	1	0	0
Porites porites	0	1	0	0
Solenastrea bournoni	0	1	0	0
Stephanocoenia intersepta	0	1	0	0
Siderastrea siderea	0	1	0	8

Table 9. 2015 Disease occurrence by site. Numbers are a count of the colonies per sites recorded with each particular disease/condition. BBD = Black Band Disease, WPL = White Plague, RTL = Rapid Tissue Loss, DSS = Dark Spot Syndrome. Note: BCA had RTL present, but is not included here because only non-Acropora demographic data is collected due to the *A. cervicornis* patch structure at this site.

Site	BBD	WPL	RTL	DSS	Total Colonies
MC1	0	0	0	0	86
MC2	0	0	0	0	30
PB1	0	0	0	0	25
PB2	0	0	0	0	138
PB3	0	**1**	0	0	98
PB4	**1**	0	0	0	150
PB5	0	0	0	0	183
BC1	**1**	0	0	0	180
BC2	0	**1**	0	0	55
BC3	0	0	0	0	52
BC4	0	**1**	0	**1**	356
BC5	0	0	0	0	105
BC6	0	0	0	0	49
BCA	0	0	0	0	96
DC1	**1**	**3**	**3**	**2**	189
DC2	0	**1**	0	0	94
DC3	0	0	0	0	27
DC4	0	**2**	0	**1**	66
DC5	0	**3**	0	**2**	205
DC6	0	**1**	0	0	133
DC7	0	0	0	0	97
DC8	0	**5**	0	**2**	80

- While Table 9 shows the total number of colonies disease relative to the number of colonies at each site, it is important to look at the species level of colonies affected. At DC8, 5 of 80 total colonies were diseased, but more importantly 4 of the 5 were *D. stokesii* and 1 was *M. meandrites*. Furthering the impact of disease at DC8 is the fact that 4 of 19 (21%) of the *D. stokesii* colonies and 1 of 2 (50%) *M. meandrites* colonies were affected (Table 10).

Table 10. 2015 disease occurrence for species sites. Numbers are the count of colonies of particular species at sites where disease was recorded. Total Colonies is the number of colonies of that particular species at that site. BBD = Black Band Disease, WPL = White Plague, RTL = Rapid Tissue Loss, DSS = Dark Spot Syndrome. MCAV = *Montastraea cavernosa*, PAST = *Porites astreoides*, ACER = *Acropora cervicornis*, DSTO = *Dichocoenia stokesii*, PPOR = *Porites porites*, SMIC = *Stephanocoenia intersepta*, MFAV = *Orbicella/Montastraea faveolata*, SBOU = *Solenastrea bournoni*, MMEA = *Meandrina meandrites*, SSID = *Siderastrea siderea*.

Site	Stony Species	BBD	WPL	RTL	DSS	Total Colonies
BC1	MCAV	1	0	0	0	112
BC4	PAST	0	0	1	0	163
DC1	ACER	0	0	0	3	12
DC1	DSTO	0	0	1	0	2
DC1	MCAV	1	0	1	0	22
DC1	PPOR	0	0	1	0	28
DC2	SMIC	0	0	1	0	45
DC4	MCAV	0	0	2	0	11
DC5	MFAV	0	0	2	0	5
DC5	SBOU	0	0	1	0	1
DC6	MMEA	0	0	1	0	2
DC8	DSTO	0	0	4	0	19
DC8	MMEA	0	0	1	0	2
MC2	SSID	0	0	1	0	20
PB3	DSTO	0	0	1	0	5
PB4	DSTR	1	0	0	0	2

- In an effort to capture the full effects of the 2014 – 2015 bleaching and disease event, live stony coral colony tissue area was calculated to look for changes. While anecdotal observations throughout the SECREMP region have presented high disease incidence, whole colony mortality may be too low during SECREMP sampling to detect changes in density as a result of whole colony mortality. Additionally, colonies may be sampled before total mortality has resulted, therefore live tissue area can be used to capture changes during the ongoing event. It should be noted that it cannot be said that all loss of live tissue is a result of disease and/or bleaching. Instead, this loss of live tissue is a mechanism that can be used with the available SECREMP data to provide an idea of the extent of mortality during the event. Live tissue area was calculated with the assumption that all colonies were circles. The following formula was used to calculate live tissue area, where r is ½ the measured colony maximum diameter and OM and RM are the percent old and recent mortalities, respectively, as proportions of the colony.

$$A = (\pi r^2) * \big(1 - (OM + RM)\big)$$

Equation 1. Live Tissue Area

- Live tissue area for all species combined was not significantly different at the county level or the site level (repeated measures ANOVA, F = varies, $p > 0.05$).

- Species level examination of live tissue for the entire region showed two species experiencing notable declines, *D. stokesii* and *M. meandrites* (Figure 4). The major loss of tissue on these species is consistent with reports of the disease impacts in the area (anecdotal accounts and personal observations).

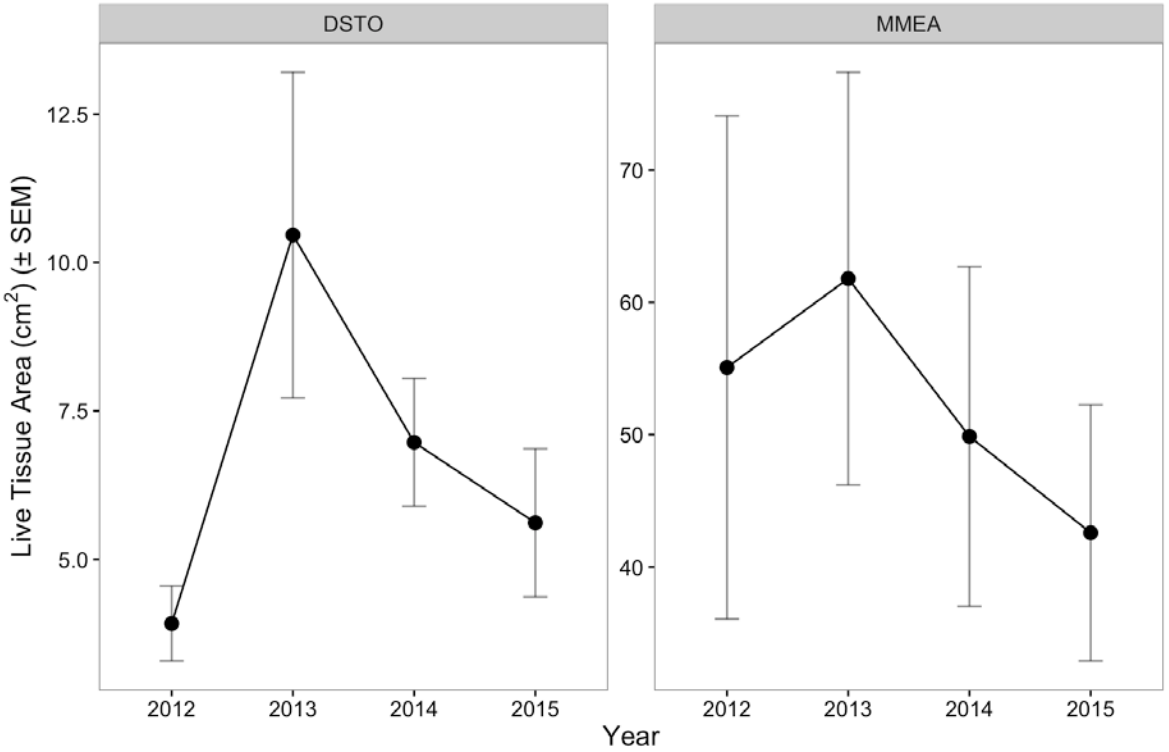

Figure 4. Mean (±SE) live tissue area for *D. stokesii* and *M. meandrites* for the all SECREMP sites. Live tissue area was calculated for each colony using Equation 1. 2012 = 16 sites; 2013 – 2015 = 22 sites.

- Examining the live tissue area at individual sites reveals on-going changes, especially when looking at those species most affected by the recent bleaching and disease event. Although the changes are not significant there are marked declines in *D. stokesii*, *M. meandrites*, *P. astreoides*, and *M. cavernosa* at sites across three of the four SECREMP counties, Palm Beach, Broward, and Miami-Dade (Figures 5 & 6).

- *Dichocoenia stokesii* was severely impacted at nearly half the Miami-Dade sites. The mean (±SE) live tissue area at DC1 and DC2 was reduced to < 1.00cm^2. DC5 experienced total loss of *D. stokesii* from 2014 – 2015 (Figure 5 (A)). The most striking loss of live tissue in *D. stokesii* occurred at BC4 where mean (±SE) live tissue was 31.77 ± 14.06cm^2 in 2013 and 13.38 ± 3.68cm^2 in 2015.

- *Meandina meandrites* has declined to < 1cm^2 mean (±SE) live tissue area at DC8 as a result of disease on one of two colonies. Live tissue area at PB4 has declined from a mean (±SE) live tissue area of 117.90 ± 42.82cm^2 in 2013 to 53.48 ± 40.47cm^2 in 2015 (Figure 5 (B)).

- *Porites astreoides*, one of the top six species in terms of density for 2015, surprisingly shows declines in mean live tissue area at several sites throughout the region (Figure 6 (A)).

- *M*ontastraea *cavernosa*, a species that often contributes greatly to live tissue area in the SECREMP region and thought of as a particularly robust species, has also shown live tissue area declines at a few sites, especially in Miami-Dade County (Figure 6 (B)).

- While not all changes have been statistically significant, there are changes occurring during the ongoing bleaching and disease event, particularly at the species level. As the event was ongoing during the 2014 and 2015 sampling periods, these changes may be more pronounced following the collection of the 2016 data. Additionally, the signals through 2015 do not represent all the species that have been reported to be impacted, so collection of the 2016 data will be important to assess how widespread this event has become, especially in terms of tissue loss.

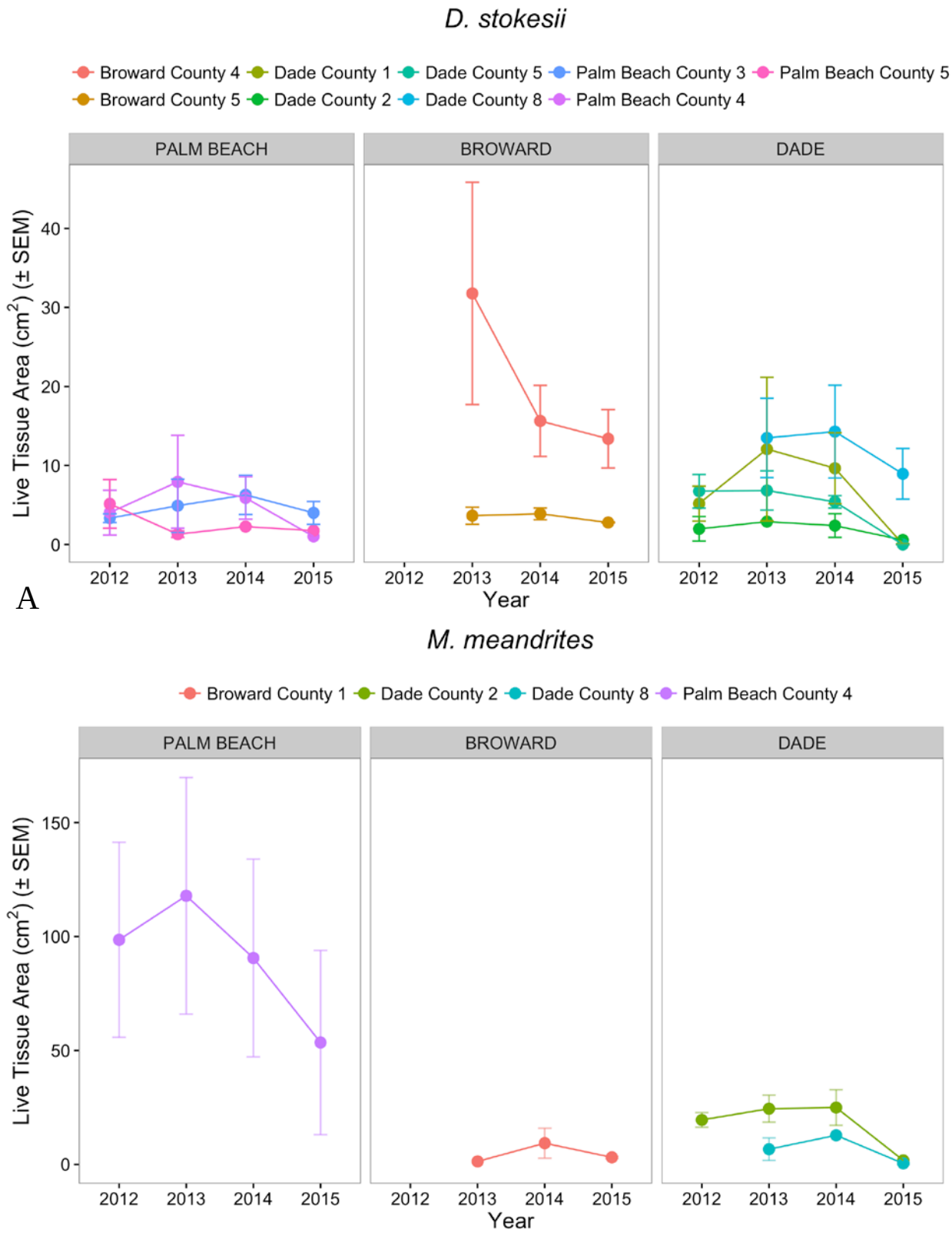

Figure 5. Mean live tissue area (±SE) for (A) *D. stokesii* and (B) *M. meandrites* for select SECREMP sites from 2012 – 2015. 2012 = 16 sites; 2013 – 2015 = 22 sites.

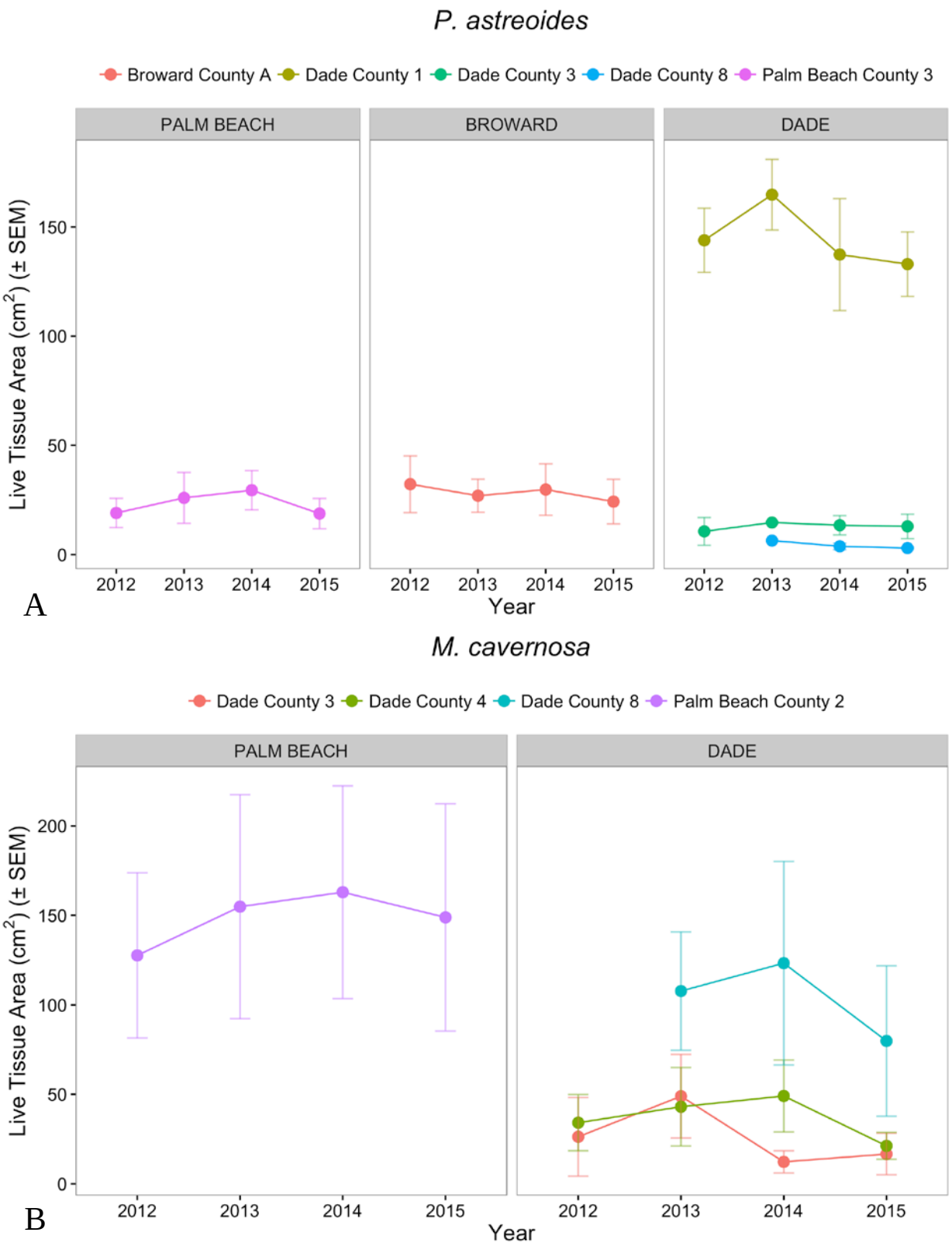

Figure 6. Mean (±SE) live tissue area for (A) *P. astreoides* and (B) *M. cavernosa* for select SECREMP sites from 2012 – 2015. 2012 = 16 sites; 2013 – 2015 = 22 sites.

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