Southeast Florida Coral Reef Evaluation and Monitoring Project

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2012 Year 10 Final Report

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EXECUTIVE SUMMARY

The purpose of the Southeast Coral Reef Evaluation and Monitoring Project (SECREMP) is to monitor the status and trends in the southeast Florida (Miami-Dade, Broward, Palm Beach, and Martin counties) reef system. Annual SECREMP assessments have been conducted at fixed sites since 2003 providing local, state, and federal resource managers with information on the temporal changes in benthic cover and diversity of stony corals and associated marine benthic groups.

Protocol changes were made to the program in 2012. Prior to 2012, SECREMP used an established protocol (Station Species Inventory, SSI) to record coral species richness within sampling stations. In 2012, the SSI protocol was replaced with a 1 m x 22 m belt transect survey at each station. The original SSI protocol only provided stony coral species richness data and with the addition of this belt transect, stony coral species (colonies ≥ 4 cm diameter), octocoral (first 10 m of the belt), and barrel sponge (*Xestospongia muta*) abundance, size, and condition are now being recorded. In addition to total octocoral abundance, five target species [*Eunicea calyculata, Antillogorgia americana* (formerly *Pseudopterogorgia americana*), *Eunicea flexuosa* (formerly *Plexaura flexuosa), Pseudoplexaura porosa*, and *Gorgonia ventalina*] are counted, measured, and their condition recorded. The addition of these data permits a more meaningful evaluation of the status and trends in the coral reef communities of southeast Florida and consistent with the Coral Reef Evaluation and Monitoring Project (CREMP) in Florida Keys National Marine Sanctuary and Dry Tortugas National Park. Stony coral and octocoral species densities, size class distributions, and condition can be tracked and evaluated through time. The core method of using image-transects to estimate benthic percent cover has not changed. Project year 10 (2012) signifies the first year for collecting the new demographic data and therefore, annual differences cannot yet be documented thus only species densities have been summarized in this report. Annual differences (between 2011 and 2012) in the percent cover of major benthic taxa (stony corals, octocorals, sponges, and macroalgae) are also included, as well as long-term trend analyses of the major benthic taxa dating back to 2003.

Mean (±SD) region-wide (n = 16 sites) stony coral density was 1.15 ± 0.81 colonies (≥ 4 cm)/m² and ranged from 0.34 ± 0.47 colonies/m² (PB1) to 2.88 ± 0.86 colonies /m² (DC5). In 2012, 24 stony coral species were identified with a region-wide mean (±SD) of 9.1 ± 3.4 species per site and a range of 4 (BCA) to 15 (DC5) species within a site. Six species (*Montastraea cavernosa*, *Siderastrea siderea*, *Porites astreoides*, *Stephanocoenia intersepta*, *Agaricia agaricites*, and *Meandrina meandrites*) were very common region-wide and contributed more than 80% to total colony abundance in each county except Martin (73%). Disease was not common and only recorded in six of the 16 sites in 2012. A white syndrome referred to as rapid tissue loss was identified on *Acropora cervicornis* colonies in both sites in the

project that had this species (BCA and DC1). The only other disease seen in the sites was dark spots disease which was identified on four *S. siderea* colonies (one colony in BC1, one in DC1, and two in PB5).

Region-wide (n = 16 sites) mean (±SD) octocoral density was 10.10 ± 9.30 colonies/m², and ranged from a high of 30.08 ± 6.61 colonies/m² at site PB5 to 0.00 ± 0.00 colonies/m² at sites MC1 and MC2. Octocorals generally have greater species richness than stony corals, and they are much more difficult to identify in the field. Five target species were added to the belt transect protocol in order to describe and document changes within the octocoral community. Five species were selected based on their abundance across a range of habitats and depths and ease of field identification using morphological characteristics. The five target species (*E. calyculata, A. americana, E. flexuosa, P. porosa*, and *G. ventalina*) were identified in all counties except Martin (no octocorals were recorded) and at 11 sites. *Antillogorgia americana*, *E. flexuosa,* and *E. calyculata* were present at most of the sites and were the most abundant of the target species.

Barrel sponges (*X. muta*) are large, conspicuous, important components of the Florida reef community. Barrel sponges were identified in all counties and at 12 of the 16 sites. No barrel sponges were identified at BCA, PB1, MC1, and MC2. At sites which had barrel sponges present, densities ranged from a high of 0.61 ± 0.12 sponges/m² at site PB4 to a low of 0.05 ± 0.05 sponges/m² at site BC1.

Region-wide (n = 16 sites) mean (±SD) stony cover in 2012 (3.0 ± 0.04%) was significantly greater than in 2011 (2.6 ± 0.04%) (p = 0.001). However, only one site (DC1) had significantly greater cover in 2012 than in 2011 ($p < 0.001$). The long-term analysis did not find a region-wide significant trend for stony coral cover (p = 0.078). At the site level, BCA was the only site to have experienced a significant trend (decreasing) in cover since 2003 ($p < 0.001$), but annual changes in stony coral cover at BCA were not detected between 2011 and 2012.

Even though there was no year-to-year significant difference in mean (±SD) octocoral cover region-wide (n = 16 sites) between 2012 (11.38 ± 1.62%) and 2011 (11.18 ± 1.42%), two sites (DC2 and PB3) had significantly less octocoral cover in 2012 than in 2011 ($p < 0.001$ and $p < 0.001$, respectively). For the long-term analysis (2003-2012) there was a region-wide significant decreasing trend identified for octocoral cover (p = 0.019), and at the site level, DC3, PB3, and PB1 all indicated a significant decreasing trend (p = 0.003, $p < 0.001$, and $p < 0.001$, respectively).

Mean (±SD) sponge cover significantly decreased in 2012 (6.36 ± 4.25%) from 2011 (7.03 ± 4.53%) region-wide (n = 16 sites) (p = 0.01), however, no individual sites were significantly different between years. In contrast to this most recent year-to-year comparison, sponge cover had shown a significant increasing trend region-wide since 2003 ($p < 0.001$), and several sites in 2012, including DC1, BC3, and PB2, reflected this increasing trend ($p = 0.005$, $p = 0.003$, and $p = 0.005$, respectively).

Region-wide mean (±SD) macroalgae cover in 2012 (9.06 ± 15.73%) was significantly greater than in 2011 (5.66 ± 7.73%) ($p = 0.005$). Only one site (MC2) was significantly greater in 2012 (49.89 ± 30.74%) than in 2011 (21.62 ± 8.38%) ($p < 0.001$). Annual macroalgae cover has fluctuated greatly over the last 10 years ranging from less than 5% in 2003 to nearly 20% in 2006. The highly variable nature both temporally and spatially (even at the station level) of macroalgae cover makes identifying long-term trends difficult, and a trend was not identified for macroalgae cover region-wide.

After 10 years of monitoring, the status (as defined by percent cover of stony corals, octocorals, sponges, and macroalgae) of the southeast Florida reef system has demonstrated a few changes from 2003 to 2012. For example, a region-wide decrease in octocoral cover and region-wide increase in sponge cover has occurred. However, the long-term trend analysis completed for years 2003 through 2012 did not indicate consistent trends within major functional groups among counties or sites. This result indicates that local (site level) factors may be exerting more influence than regionalized factors. Identifying and separating these spatially and temporally variable stressors is a challenge.

The chronic nature of disturbances and the significant economic value of southeast Florida reefs require comprehensive, long-term monitoring to define and quantify change and to help identify threats to the ecosystem. The information generated by SECREMP provides scientifically valid status and trends data designed to help local resource managers understand the implications of actions occurring in terrestrial and adjacent marine habitats. However, SECREMP was established to be a monitoring project independent of coastal development projects and un-permitted incidents (e.g., ship groundings), and as such, most localized impacts from these activities are not specifically targeted by SECREMP. There is a need for more comprehensive, longer-term, and site-specific project and incident monitoring. 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 permit sustainable use, and realization of the economic value, of these fragile marine ecosystems.

INTRODUCTION

The coral reef ecosystem in Florida extends approximately 577 km from the Dry Tortugas in the south, to the St. Lucie Inlet in the north. However, until 2003, the primary focus for long-term coral reef monitoring was limited to the Florida Keys and Dry Tortugas in Monroe County, with only limited attention directed towards the reefs off Miami-Dade, Broward, Palm Beach, and Martin counties. 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 Florida Reef Tract, from Key West to Carysfort (Ruzicka et al. 2010; Ruzicka et al. 2013). In 1999, the project was expanded to include sites in the Dry Tortugas.

In 2003, CREMP was further expanded to include 10 sites offshore of southeast Florida in Miami-Dade, Broward, and Palm Beach counties. The project has since been expanded twice. In 2006, three sites in Martin County offshore of the St. Lucie Inlet Preserve State Park were established, and in 2010, two new sites in Palm Beach County and two new sites in Miami-Dade County were established. This CREMP expansion, named the Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP), is filling gaps in coverage of knowledge and monitoring of coral reef ecosystems in Florida and nationwide.

Off the mainland coast of southeast Florida, the northern extension of Florida's coral reef ecosystem extends beyond the Florida Keys, approximately 170 km from Miami-Dade County into Martin County. From Cape Florida (Miami-Dade County), north to central Palm Beach County, in particular offshore of Broward County, the reef system 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 Cape Florida 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, and worm reef (*Phragmatapoma* spp.) substrata colonized by reef biota (Cooke and Mossom 1992; Herren 2004).

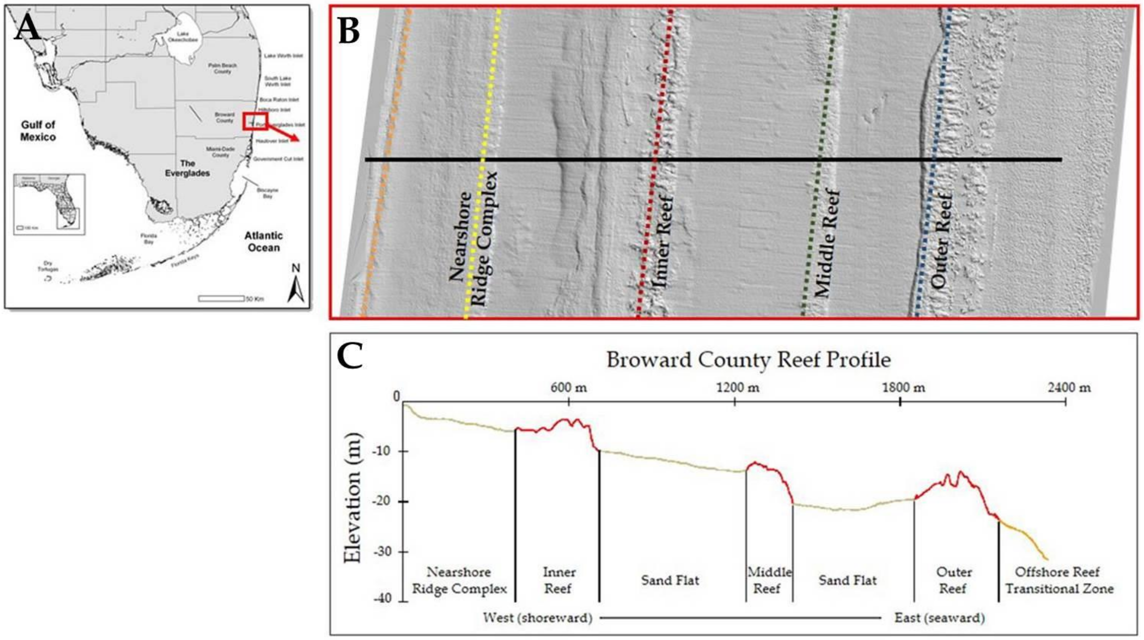

Figure 1. Panel A is a view of southern Florida showing an area off Broward County in red that corresponds to Panel B which is sea floor bathymetry from LIDAR (Light Detection and Ranging) data. The black line in Panel B shows the location of a bathymetric profile illustrated in Panel C.

Most previous and current monitoring efforts (e.g., Gilliam et al. 2012) along the mainland southeast coast originated as impact and mitigation studies from environmental impacts to specific sites (dredge impacts, ship groundings, pipeline and cable deployments, and beach renourishment). The temporal duration of monitoring efforts associated with marine construction activities are generally limited, defined by the activity permit, and focused on monitoring for project effects to the specific reference areas.

In 2003, the Florida Department of Environmental Protection (FDEP) proposed and was awarded funding for the inception of coral reef monitoring along the southeast Florida coast. To ensure that this monitoring is of the highest scientific quality, and consistent with CREMP monitoring in the Dry Tortugas and the FKNMS, the FDEP contracted this work to the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWC-FWRI) who in turn subcontracts Nova Southeastern University Oceanographic Center.

The southeast Florida reef system exists within 3 km of the mainland Atlantic coast, offshore of a highly urbanized area influenced by numerous impacts from commercial and recreational fishing and diving, major shipping ports, sewer outfalls, canal discharges, ship groundings, and marine construction activities. These reefs are important economic assets with an estimated $3.4 billion in sales and income generated from the natural reefs offshore southeast Florida (Johns et al. 2003, 2004). The goal of SECREMP is 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. These reports also provide resource managers with information on temporal changes in resource condition. SECREMP is also important for resource managers because, unlike previous southeast Florida monitoring efforts, the reef status and trend information is collected at a broad spatial scale and independently of marine construction activities, thereby providing results that are not directly tied to event response monitoring of these activities.

Project Planning and Sampling

Expansion of SECREMP has occurred twice since 2003. In 2006, three sites (MC1, MC2, and MC3) were added in Martin County, within the St. Lucie Inlet Preserve State Park (SLIPSP) (www.floridastateparks.org/stlucieinlet/default.cfm). In 2009, two new sites (PB4 and PB5) were established on the Outer Reef in Palm Beach County south of the existing Palm Beach sites (PB2 and PB3), and two new sites (DC4 and DC5) were established offshore Key Biscayne in Miami-Dade County. One new Miami-Dade site (DC4) was established on the Outer reef and one (DC5) on the Inner reef. Sites installed in 2009 were first sampled in 2010.

The current SECREMP effort includes 17 sites. Figures 2a and 2b show the location of the 17 sites along the southeast Florida coast. Project sampling is scheduled annually between May and August. Table 1 provides reef type, depths locations, and sample date of each of the SECREMP sites.

In 2011, CREMP made changes to the standard sampling methods, switching from video capturing to digital still image photography and replacing the standard Station Species Inventory (SSI) with demographic surveys of stony corals, octocorals, and the barrel sponge *Xestospongia muta*. These changes were also adopted by the SECREMP program in 2011. Changes are detailed in the methods.

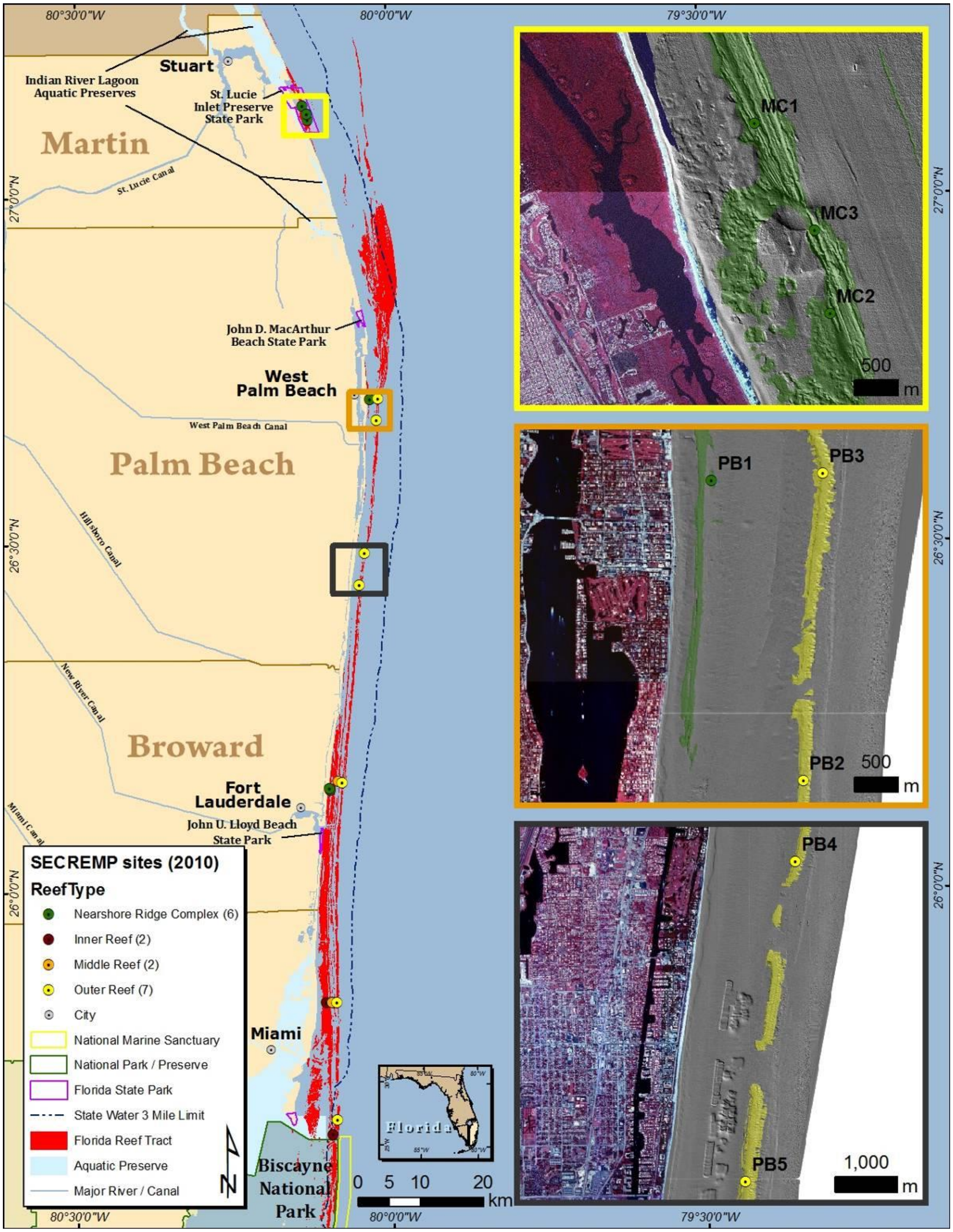

Figure 2a. Map of the 17 SECREMP sites illustrating their locations offshore southeast Florida and insert boxes showing the locations of the Palm Beach and Martin counties sites.

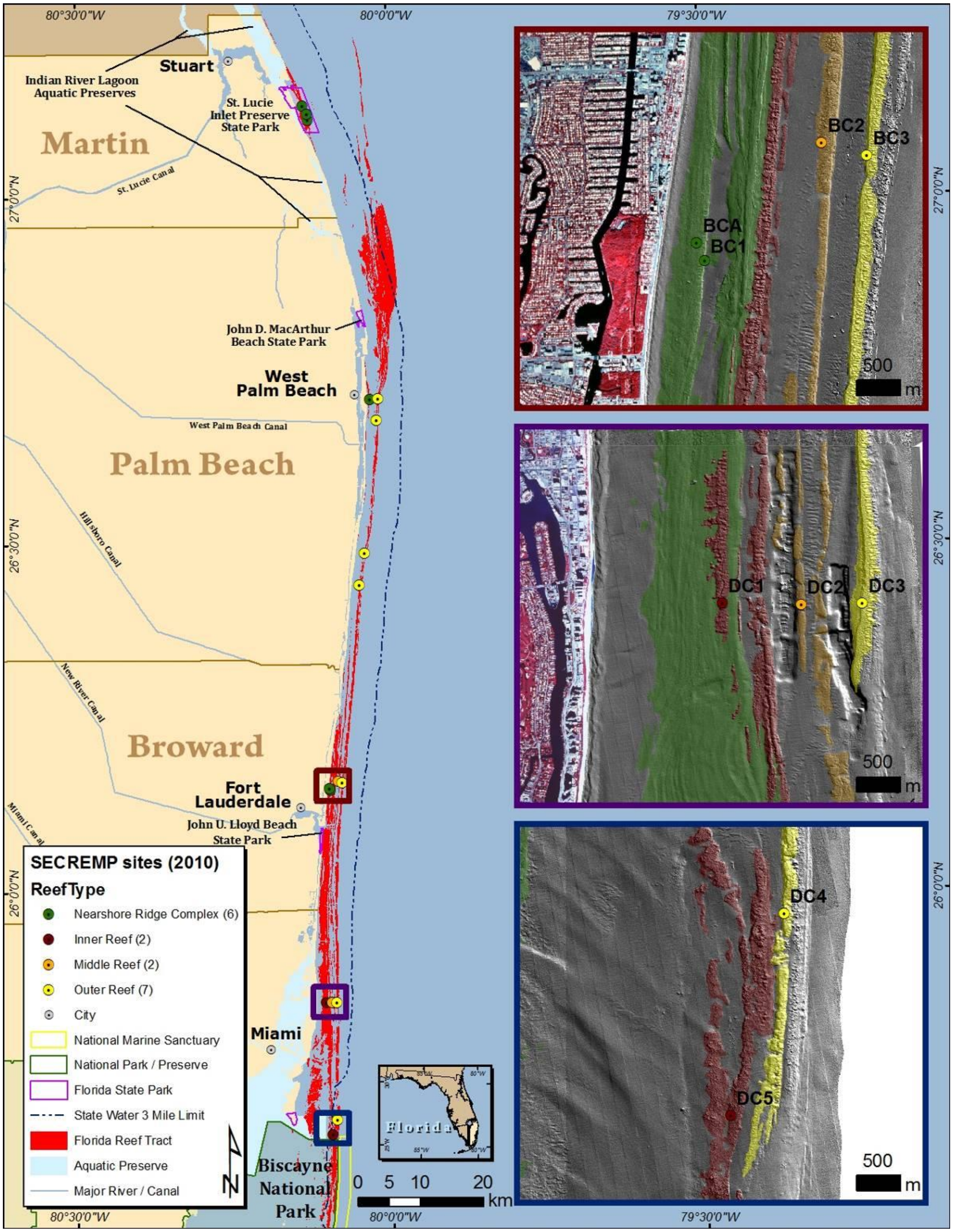

Figure 2b. Map of the 17 SECREMP sites illustrating their locations offshore southeast Florida and insert boxes showing the locations of the Miami-Dade and Broward counties sites.

Table 1. Monitoring site locations and depths (**DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County**) (* indicates sites first sampled in 2010) (NRC = Nearshore Ridge Complex) (NA = site visited multiple times but data was not able to be collected).

Site Code	Reef Type	Depth (ft)	Latitude (N)	Longitude (W)	Sample Date
DC1	Inner	25	25° 50.530′	80° 06.242′	6 Sept
DC2	Middle	45	25° 50.520′	80° 05.704′	18 Sept
DC3	Outer	55	25° 50.526′	80° 05.286′	6 Sept
*DC4	Inner	41	25° 40.357′	80° 05.301′	2 July
*DC5	Outer	24	25° 39.112′	80° 05.676′	2 July
BCA	NRC	25	26° 08.985′	80° 05.810′	15 June
BC1	NRC	25	26° 08.872′	80° 05.758′	13 & 14 June
BC2	Middle	40	26° 09.597′	80° 04.950′	13 & 15 June
BC3	Outer	55	26° 09.518′	80° 04.641′	14 June
PB1	NRC	25	26° 42.583′	80° 01.714′	7 Aug
PB2	Outer	55	26° 40.710′	80° 01.095′	9 Aug
PB3	Outer	55	26° 42.626′	80° 00.949′	7 Aug
*PB4	Outer	55	26° 29.268′	80° 02.345′	8 Aug
*PB5	Outer	55	26° 26.504′	80° 02.854′	4 Sept
MC1	NRC	15	27° 07.900′	80° 08.042′	4 June
MC2	NRC	15	27° 06.722′	80° 07.525′	4 June
MC3	NRC	15	27° 07.236′	80° 07.633′	NA

METHODS

Sixteen of the 17 SECREMP monitoring sites consist of four monitoring stations delineated by permanent stainless steel markers (the remaining site, MC3, is described separately below). Stations are 2 x 22 meters. The SECREMP stations have a north-south orientation, which is generally parallel to the reef tracts of southeast Florida. Within each station, field sampling consists of three photo-image transects (100, 300, and 500) and one 1 m x 22 m belt-transect (Figure 3).

Image Transects

In 2011 CREMP replaced images acquired through standard definition (SD) video with digital still photography. CREMP completed comparative analyses to ensure that images and data acquired through digital point and shoot cameras were consistent with images and datasets acquired through previous technologies (Morrison et al. 2012). Utilizing this CREMP analysis, SECREMP also replaced video with digital still photography in 2012.

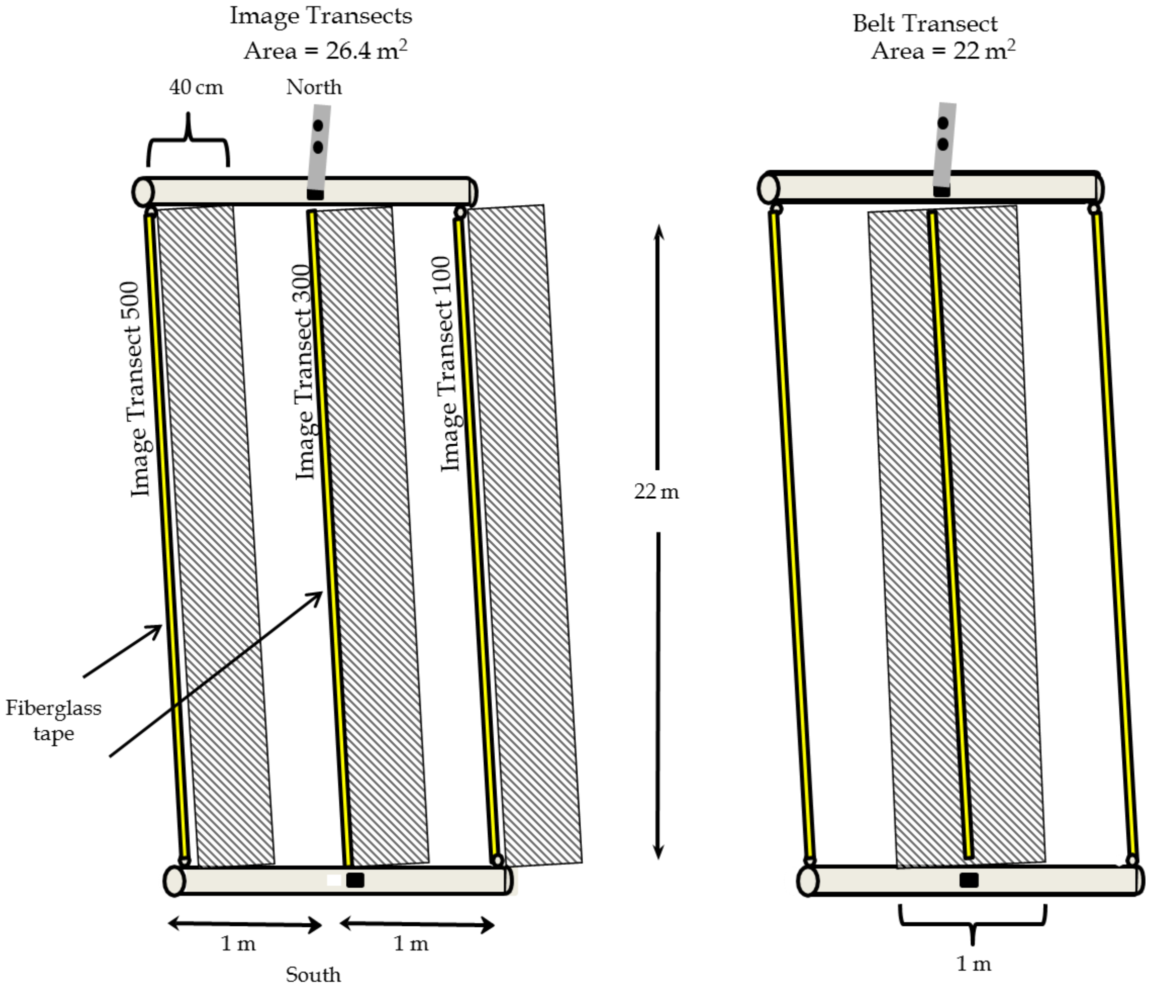

Figure 3. Typical layout of each SECREMP station showing the areas (hatch areas) within which the image and stony coral belt transect data were collected (note the gorgonian belt area is 1 m x 10 m and the barrel sponge area is the entire station between the 100 and 500 transects).

All transect images, delineated with fiberglass tapes, were taken with a Canon PowerShot S95 digital camera. All transect images were taken on the east side of the transect tapes. All images were captured at a distance of 40 cm above the reef to yield an approximately 40 cm wide image. An aluminum bar aids in maintaining a constant height above the substrate. Prior to starting each transect, the camera operator photographed a clapperboard that provides information on the date and location of each transect. To ensure minimal overlap between images, benthic features seen in the top border of the camera viewfinder and the fiberglass tape were visual reference points used to proceed along the transect.

In the lab, images were formatted for PointCount '99 image analysis software. Fifteen random points were overlaid on each image. Underneath each point, select benthic taxa were identified to species (e.g., stony corals, *Gorgonia ventalina*, *Xestospongia muta*), genus (*Dictyota* spp., *Halimeda* spp., and *Lobophora* spp), or higher taxonomic levels (e.g. encrusting or branching octocoral, crustose coralline algae, zoanthid, sponge, and macroalgae). The substrate type was identified as sand, consolidated rubble, etc. The software uses a "point and click" feature that enters the identification data into a spreadsheet. After all images were analyzed, the data were checked for quality assurance and entered into the Microsoft Access database.

Stony Coral Demographic Survey

Prior to 2012, SECREMP used an established protocol to record coral species richness within sampling stations (Gilliam 2012). These station species inventory surveys (SSI) comprised a census of all stony coral species (Milleporina and Scleractinia), counts of *Diadema antillarum*, and the incidence of disease or bleaching within a station. In 2011, CREMP modified this survey to collect density and size class information for all coral species in addition to the species richness data collected from conventional SSI surveys. Also, modification of the survey allowed for an expanded assessment of the prevalence of disease, bleaching, or malignant conditions that adversely affect corals. The revised demographic survey protocol is similar to those used along the entire Florida Reef Tract by the Florida Reef Resilience Program (FRRP) (Wagner et al. 2010) and locally, by the Broward County annual reef monitoring project (Gilliam et al. 2012). These modifications were adopted by SECREMP in 2012. At all stations, divers conducted a 1 m x 22 m belt transect from north to south along the "300" transect (Figure 3) (note: CREMP surveys a 1 m x 10 m transect). Every stony coral species present was recorded and all colonies ≥4 cm diameter were measured to the nearest cm with a ruler affixed to the 0.5 m PVC stick. The maximum diameter and height taken along growth plane, the presence of disease, clionaids and bleaching, the percentage of estimated tissue mortality, and the cause of the mortality, if known, were recorded for each colony. Mortality was considered ''recent'' if the corallite structure can be clearly distinguished, and there is minimal overgrowth by algae or other fouling organisms. Otherwise, mortality was classified as ''old''. *Millepora alcicornis* (fire coral) colony abundance was not recorded, only presence or absence.

Octocoral Demographic Survey

An octocoral demographic survey was added to the SECREMP methods in 2012. As before, these methods follow those adopted by CREMP. At all stations, divers conducted a 1 m x 10 m octocoral survey along the "300" transect (Figure 3). The survey was completed in two stages. First, all octocoral colonies within the belt transect were counted, regardless of species, to provide a measurement of overall octocoral density. Second, for five target species of octocorals, *Eunicea calyculata, Antillogorgia americana* (formerly *Pseudopterogorgia americana*), *Eunicea flexuosa* (formerly *Plexaura flexuosa*), *Pseudoplexaura porosa*, and *Gorgonia ventalina*, all colonies within the belt transect were recorded and measured. These species were selected because they can be easily distinguished in the field, and they are relatively abundant in their preferred reef habitat along the Florida Reef Tract. For each colony recorded, maximum height and maximum width were recorded for *G. ventalina* and maximum height only for the other five species. Colonies were measured to the nearest centimeter with a ruler affixed to the 0.5 m PVC stick. The presence of disease, syndromes, or bleaching was recorded for each species in addition to any condition leading to compromised health of the colony (e.g., predation, overgrowth). For each incidence of disease or compromised health the percentage of the colony affected was estimated.

Barrel Sponge Demographic Survey

A barrel sponge (*Xestospongia muta*) survey was also added to the SECREMP methods in 2012. Barrel sponge density is determined by counting all sponges within the entire station (2 m x 22 m) between the "100" and "500" transects (Figure 3). Maximum sponge diameter, base diameter, and height were recorded for each sponge only within the 1 m x 22 m belt transect. The percent of the sponge affected by injury, disease, and/or bleaching were also recorded.

Site MC3 Stony Coral Colony Condition

Limited appropriate reef area within the Martin County sampling area did not permit the establishment of three standard SECREMP sites. Stony coral cover and density is lower in this area which limits the ability of the standard SECREMP sampling protocol to track changes in the stony coral assemblage. After discussions with project colleagues from FDEP and FWC-FWRI, it was decided that a third site (MC3) would be established; but this site will be used to fate track a representative sample of stony coral colonies. Five stakes were deployed in a reef area between sites MC1 and MC2. These stakes mark the center point from which stony coral colonies were identified and recorded. The distance and bearing from these center stakes to the colonies were recorded. These measurements permit the same colony to be located and sampled each year. During the first monitoring year (2006), colonies within approximately 10 m of the stake were targeted. As colonies mapped and tagged in 2006 die or become missing, new colonies have been added to the project by mapping and tagging colonies greater than 10 m from the stake or by adding colonies within 10 m of the stake that were not included in 2006.

Total colony size (length and width) and colony condition (presence of bleaching, disease, etc.) were recorded *in situ*. In addition to the *in situ* measurements, a digital image was taken of each colony. The images were taken with a digital camera attached to a PVC framer ($0.38m^2$). Date and colony tag numbers were included within each image. The framer allows all images from each monitoring event to be a consistent planar view of the colony. These consistent planar view images allow changes in tissue area between monitoring events to be measured. Software developed by the National Coral Reef Institute (NCRI) (Coral Point Count with Excel Extensions, CPCe, http://www.nova.edu/ocean/cpce/index.html) (Kohler and Gill, 2006) is used to trace the tissue area (cm^2) in each colony planar image. The software automatically calculates the area (cm^2) encompassed by the traced portion of the image (Figure 4). If dead areas are present within the living area of a colony, these dead areas are also traced. The dead area(s) are subtracted from the previously traced living tissue area thus providing a more accurate measure of the living tissue area.

Figure 4. Example of a site MC3 mapped colony, *Diploria clivosa*, Tag # 24, with the live tissue area traced and determined (721 cm^2) using NCRI CPCe.

Monitoring Site Temperature Record

In 2007, the deployment of StowAway TidbiT™ (www.onsetcomp.com) temperature loggers was added to the SECREMP sampling protocol. Two temperature recorders were deployed at each site and were replaced during each annual sampling event. The loggers were programmed to record data at a sampling interval of two hours. Two loggers were deployed at each site in order to provide backup data in case one logger fails or is lost due to loggers remaining on site for a year. The two loggers were attached approximately 10 cm off the substrate to the 'northern' stake identifying Stations 1 and 2. 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.

Statistical Analyses

Differences in stony coral, macroalgae, octocoral, and sponge percent cover between 2011 and 2012 at each site were tested using a two-way mixed model ANOVA, with year and site (stations nested within site) as fixed effects. Station data were pooled and square-root transformed. Significant differences within sites between years were identified using a Bonferroni adjusted ($p \leq 0.003$) post-hoc Tukey-Kramer test. All analyses were completed using a generalized linear mixed model (GLIMMIX) with SAS/STAT® v 9.2 software.

Long-term trends in benthic cover variables (stony coral, macroalgae, octocoral and sponge) were examined using a generalized mixed model regression in SAS v 9.2. These trend analyses followed those completed for the CREMP analyses (Ruzicka et al. 2013). Trends were examined at the site level with stations as replicates (n = four stations per site) and region-wide with the data averaged for 12 sites. County-wide summaries were not analyzed statistically because of design constraints and limited within county replication. Benthic percent cover variables for each station at each of the 10 sites sampled from 2003-2012 (BCA, BC1, BC2, BC3, DC1, DC2, DC3, PB1, PB2, PB3) and two from 2006-2012 (Martin County Sites MC1 and MC2) were pooled and square root-transformed. Stations were nested within sites to provide long-term trend information at the site and region level. A 2-sided *t*-test was used to determine whether the slope of the regression was significantly different from zero. Model residual met all assumptions for normality and homogenous variance. For trend analysis of sites, a post hoc Bonferroni adjustment ($p < 0.004$) was used to determine significance in order to reduce the possibility of Type I error due to the repeated testing of the same response variable. Lower statistical power and the Bonferroni correction limited the number of sites for which a significant trend in cover was identified. This adjustment was not applied to the region-wide analysis. County-wide summaries were not analyzed statistically because of design constraints and limited replication

YEAR 10 (2012) RESULTS

Stony Coral Demographic Survey

Mean (±SD) stony colony density (colonies ≥ 4 cm/m²) for the project (n = 16 sites) was 1.15 ± 0.81 colonies/m². Mean (±SD) stony coral density for each site is shown in Table 2 and in Figure 5. Density ranged from a high of 2.88 ± 0.86 colonies/m² at site DC5 to a low of 0.34 ± 0.47 colonies/m² at site PB1. BCA density does not include *Acropora cervicornis* because the colony density at this site does not permit counting individual colonies.

Table 2. Mean (±SD) stony coral density (colonies ≥ 4 cm/m²) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County).

Site	Mean	SD	Site	Mean	SD
DC1	2.06	0.31	**BC3**	0.63	0.14
DC2	1.10	0.23	**PB1**	0.34	0.47
DC3	0.40	0.12	**PB2**	1.02	0.39
DC4	0.85	0.27	**PB3**	0.95	0.41
DC5	2.88	0.86	**PB4**	1.76	0.49
BCA	0.51	0.25	**PB5**	2.06	0.41
BC1	1.86	0.67	**MC1**	0.97	0.02
BC2	0.63	0.30	**MC2**	0.39	0.09

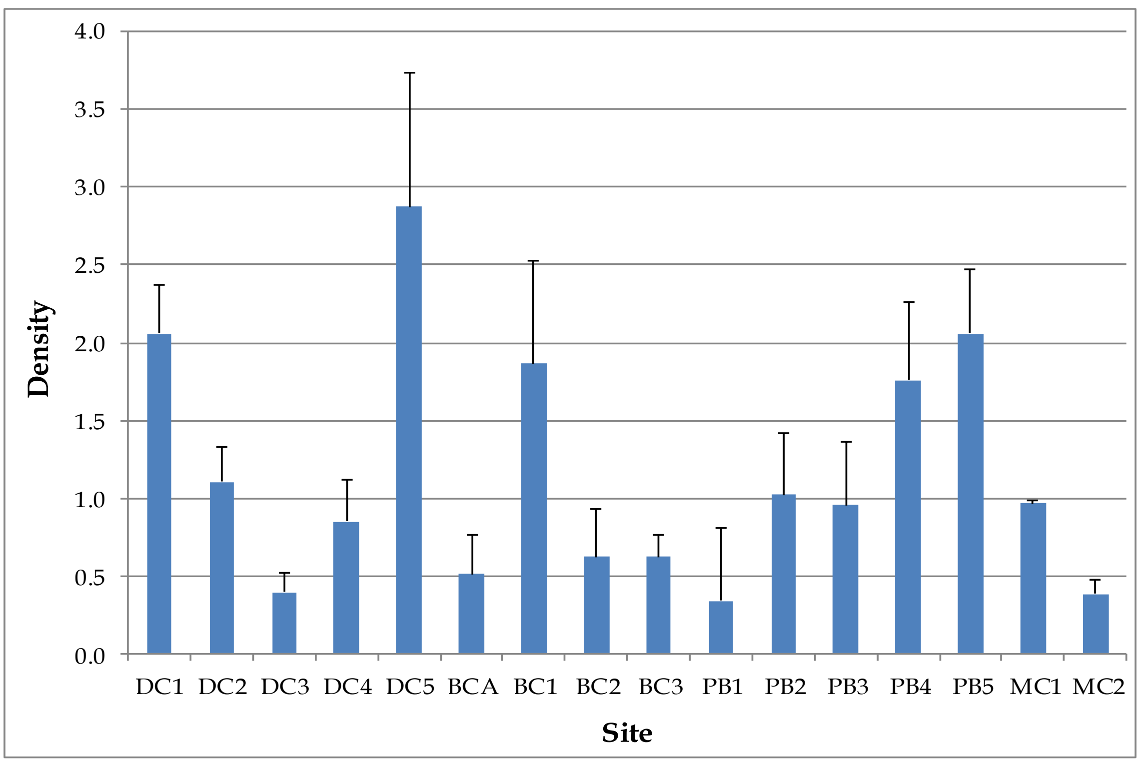

Figure 5. Mean (±SD) stony coral density (colonies ≥ 4 cm/m²) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County).

A total of 24 stony coral species (colonies ≥ 4 cm) were identified in the 16 sites. Twenty species were identified in the Miami-Dade sites, 16 in the Broward sites, 18 in the Palm Beach sites, and eight in Martin sites. Appendix 1 lists all the species identified and presence/absence for each site. The order of species in Appendix 1 represents the project (n = 16 sites) most to least abundant species (top to bottom). Table 3 lists the six species (*Montastraea cavernosa*, *Siderastrea siderea*, *Porites astreoides*, *Stephanocoenia intersepta*, *Agaricia agaricites*, and *Meandrina meandrites*) which contributed most (percent of total) to colony abundance for each county. These six species contributed more than 80% in total project abundance and in abundance for each county except Martin (73%). In Martin other common species included *Diploria clivosa* and *Oculina diffusa*.

Table 3. Percent contribution for the six most common in each county (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County).

Species	**DC**	**BC**	**PB**	**MC**
Montastraea cavernosa	7.6	39.8	34.4	0.0
Siderastrea siderea	22.3	15.4	14.1	63.9
Porites astreoides	20.6	8.5	16.7	9.2
Stephanocoenia intersepta	12.6	13.5	9.3	0.0
Agaricia agaricites complex	12.9	9.7	0.0	0.0
Meandrina meandrites	5.3	2.5	7.2	0.0

Disease was not common and was only identified in six sites. A white syndrome referred to as rapid tissue loss was identified on *Acropora cervicornis* colonies in both sites in the region where the species was present (BCA and DC1). The only other disease observed was dark spot which was identified on four *Siderastrea siderea* colonies (one colony in BC1, one in DC1, and two in PB5).

Octocoral Demographic Survey

Mean (±SD) octocoral colony density (colonies/m^2) for the project (n = 16 sites) was 10.10 ± 9.30. Mean (±1SD) octocoral density for each site is shown in Table 4 and in Figure 6. Density ranged from a high of 30.08 ± 6.61 colonies/m^2 at site PB5 to a low of 0.00 ± 0.00 colonies/m^2 at sites MC1 and MC2.

No target octocoral species were identified in site PB1 or in the Martin County sites (MC1 and MC2). The five target species (*E. calyculata, A. americana, E. flexuosa, P. porosa*, and *G. ventalina*) were identified in all counties (except Martin). *Antillogorgia americana, E. flexuosa,* and *E. calyculata* were identified in 13 sites, *P. porosa* was identified in 12 (not identified in BCA) and *G. ventalina* was identified in 11 sites (not in BCA or PB4).

Table 4. Mean (±SD) octocoral density (colonies/m²) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County).

Site	Mean	SD	Site	Mean	SD
DC1	7.25	1.89	**BC3**	18.55	3.08
DC2	12.30	2.70	**PB1**	0.35	0.34
DC3	9.60	1.76	**PB2**	20.88	11.24
DC4	12.95	6.85	**PB3**	16.58	7.03
DC5	8.43	1.86	**PB4**	19.18	3.66
BCA	0.80	0.85	**PB5**	30.08	6.61
BC1	10.33	2.34	**MC1**	0.00	0.00
BC2	6.55	2.18	**MC2**	0.00	0.00

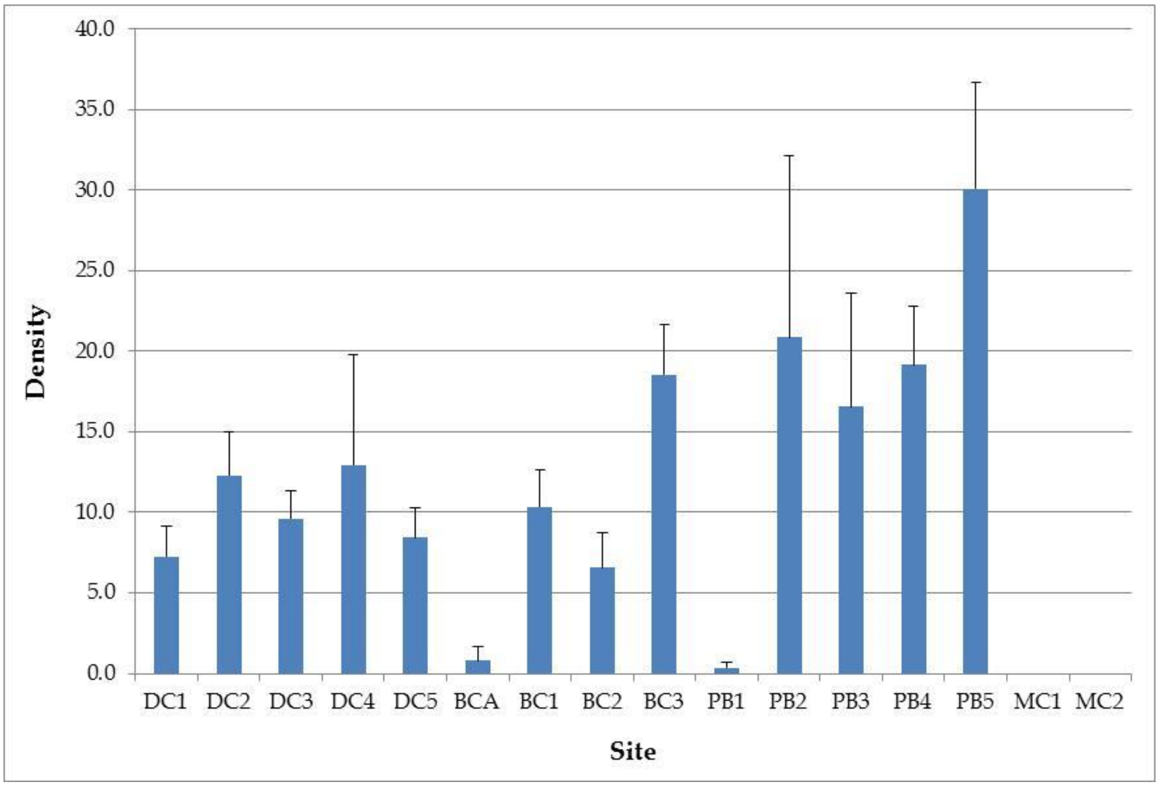

Figure 6. Mean (±SD) octocoral density (colonies/m²) for each site (BC = Broward County; DC = Miami-Dade County; PB = Palm Beach County; MC = Martin County).

Table 5 presents the mean (±SD) density (colonies/m²) for each of the target species for each site. In addition to being present in most of the sites *A. americana, E. flexuosa,* and *E. calyculata* were also the most abundant of the target species (Table 5). *Antillogorgia americana* density was the greatest of the six species at all of the Miami-Dade sites and at Broward sites BC1 and BC2 (Table 5). Interestingly, *E. flexuosa* replaced *A. americana* as having the greatest density at the Palm Beach sites (except PB1) (Table 5). Sites BCA and BC3 had relatively low densities and at both sites, *E. calyculata* had the greatest density (Table 5).

Table 5. Mean (±SD) octocoral target species density (colonies/m²) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County).

	E. calyculata		*E. flexuosa*		*G. ventalina*		*P. porosa*		*P. americana*	
Site	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
DC1	0.38	0.39	0.68	0.15	0.68	0.21	0.65	0.57	0.70	0.33
DC2	0.23	0.22	0.13	0.15	0.30	0.24	0.10	0.14	2.08	0.85
DC3	0.20	0.14	0.65	0.37	0.25	0.24	0.55	0.53	1.85	0.70
DC4	0.60	0.63	0.43	0.32	0.15	0.10	0.05	0.06	3.90	0.69
DC5	0.13	0.15	0.30	0.18	0.43	0.26	0.05	0.06	4.65	2.85
BCA	0.05	0.10	0.05	0.06	0.00	0.00	0.00	0.00	0.03	0.05
BC1	0.33	0.22	0.18	0.13	0.08	0.05	0.05	0.06	2.43	1.30
BC2	0.53	0.13	0.80	0.29	0.08	0.10	0.05	0.10	1.10	0.34
BC3	0.05	0.10	0.05	0.06	0.00	0.00	0.00	0.00	0.03	0.05
PB1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PB2	0.90	0.70	3.48	3.43	0.30	0.24	0.50	0.22	2.63	0.36
PB3	0.40	0.29	2.68	1.96	0.48	0.26	0.23	0.25	1.65	0.73
PB4	0.80	0.50	2.80	0.95	0.00	0.00	0.28	0.31	0.58	0.57
PB5	1.30	0.96	2.68	1.33	0.18	0.13	0.08	0.15	1.18	0.30
MC1	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

Barrel Sponge Demographic Survey

Table 6 and Figure 7 summarize the mean (±SD) barrel sponges (*Xestospongia muta*) densities (sponges/m²) for each site. *Xestospongia muta* were identified in all counties and in 12 of the 16 sites. No *X. muta* were identified in sites BCA, PB1, MC1, and MC2 (Table 10). In sites which had *X. muta* present, densities ranged from a high of 0.61 ± 0.12 sponges/m² at site PB4 to a low of 0.05 ± 0.05 sponges/m² at site BC1.

Table 6. Mean (±SD) barrel sponge (*Xestospongia muta*) density (sponges/m²) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County).

Site	Mean	SD	Site	Mean	SD
DC1	0.06	0.13	**BC3**	0.37	0.03
DC2	0.26	0.11	**PB1**	0.00	0.00
DC3	0.18	0.10	**PB2**	0.08	0.07
DC4	0.39	0.07	**PB3**	0.33	0.08
DC5	0.07	0.04	**PB4**	0.61	0.12
BCA	0.00	0.00	**PB5**	0.48	0.10
BC1	0.05	0.05	**MC1**	0.00	0.00
BC2	0.20	0.12	**MC2**	0.00	0.00

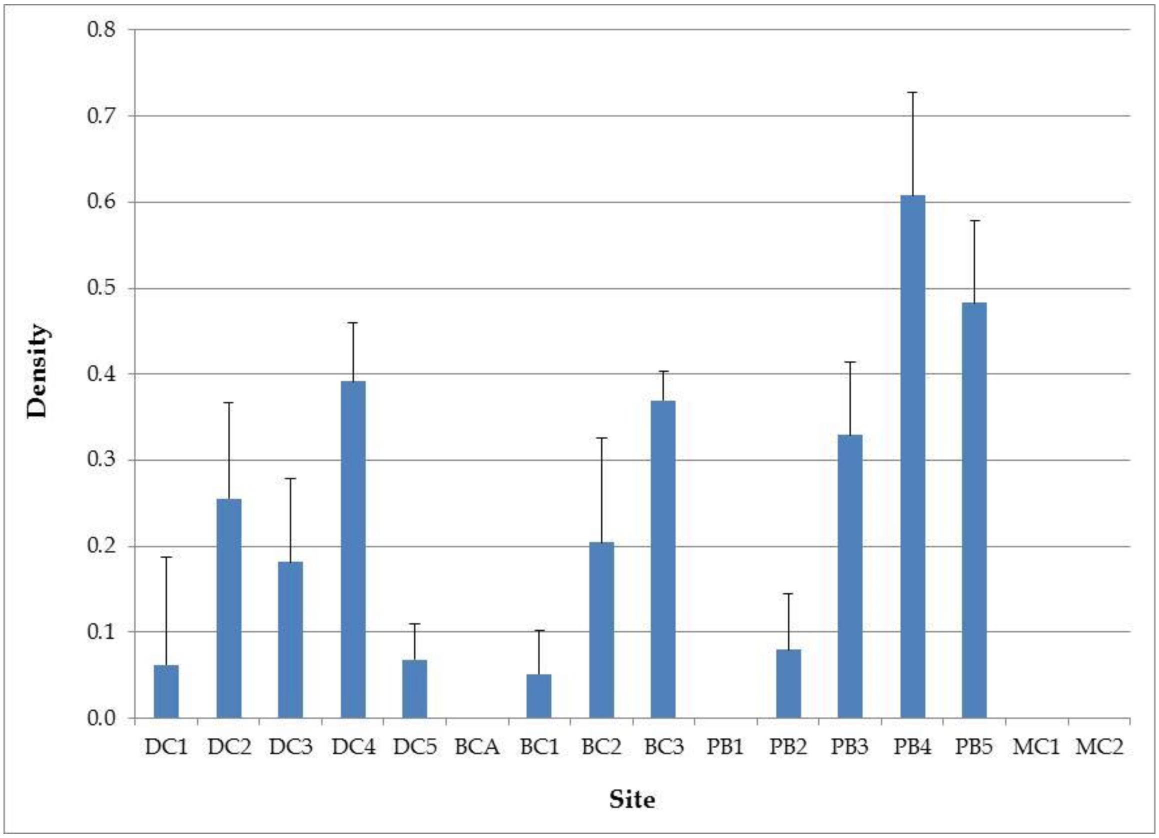

Figure 7. Mean (±SD) barrel sponge (*Xestospongia muta*) density (sponges/m²) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County).

Benthic Functional Group Percent Cover Year-to-Year Analysis: 2011 vs. 2012

Region-wide (n = 16 sites) mean (±SD) stony cover in 2012 (3.0 ± 0.04%) was significantly greater than the mean in 2011 (2.6 ± 0.04%) (Table 7). This increase was apparently due to a general increase in stony coral cover at many sites, however, only one site (DC1) was determined to be significantly greater in 2012 than in 2011 (Table 7). In 2012, stony coral cover was less than 3% at all sites except sites BCA (15.4 ± 4.12%) and BC1 (12.95 ± 2.53%). Both sites are on the nearshore ridge complex offshore of Broward County. Site BCA is dominated by an *A. cervicornis* patch, and BC1 is in an area of increased abundance of larger (1 m diameter) *M. cavernosa* stony coral colonies.

There was no significant difference determined in mean (±SD) octocoral cover region-wide (n = 16 sites) in 2012 (11.38 ± 1.62%) compared to 2011 (11.18 ± 1.42%) (Table 7). However, two sites (DC2 and PB3) were determined to have significantly less octocoral cover in 2012 than in 2011 (Table 7). DC2 cover dropped from 19.74 ± 3.01% in 2011 to 14.08 ± 1.61% in 2012, and PB3 dropped from 20.35 ± 6.92% in 2011 to 15.21 ± 3.87% in 2012 (Table 7). Of the four major functional groups examined for year-to-year comparisons, octocorals contribute most to benthic cover ranging from a low of less than 0.1% in the Martin County sites (MC1 and MC2) to a high of over 15% in six sites (DC4, DC5, PB2, PB3, PB4, and PB5) (Table 7).

Mean (±SD) sponge cover was determined to have significantly decreased in 2012 (6.36 ± 4.25%) from 2011 (7.03 ± 4.53%) region-wide (Table 7). There were no individual sites which were determined to be significantly different but there were 11 sites (DC1, DC3, DC5, BCA, BC1, BC2, PB3, PB4, PB5, MC1, and MC2) with a small decline in cover. Within the region, sponge follows octocorals in contributing to benthic cover. Sponge cover ranges from a low of 1.12 ± 1.35% in PB1 to a high of 13.84 ± 4.15% in PB4 (Table 7).

Region-wide mean (±SD) macroalgae cover in 2012 (9.06 ± 15.73%) was significantly greater than the mean in 2011 (5.66 ± 7.73%) (Table 7). Only one site (MC2) was determined to be significantly greater in 2012 (49.89 ± 30.74%) than in 2011 (21.62 ± 8.38%) (Table 7). Because macroalgae cover is both temporally and spatially (even at the station level) variable, the cover estimates within the sites ranged from a low of less than 1% estimated at three sites (DC3, PB2, and PB4) to over 30% at sites MC1 and MC2 (Table 7).

Table 7. Mean (±SD) stony coral, octocoral, sponge, and macroalgae percent cover in 2011 and 2012 (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; MC = Martin County). A 2-way mixed model ANOVA was used to detect difference between years (NS = not significant).

	Stony coral					Octocoral				
	2011		2012			2011		2012		
Site	**Mean**	**SD**	**Mean**	**SD**	**p**	**Mean**	**SD**	**Mean**	**SD**	**p**
DC1	2.64	1.30	3.82	1.37	<0.001	11.18	1.42	11.38	1.62	NS
DC2	0.64	0.22	0.72	0.14	NS	19.74	3.01	14.08	1.61	<0.001
DC3	0.42	0.30	0.53	0.28	NS	7.43	1.85	9.36	1.74	0.037
DC4	0.88	0.24	1.39	0.21	NS	16.58	3.72	15.75	2.47	NS
DC5	1.90	0.33	2.02	0.45	NS	20.06	4.09	18.49	4.63	NS
BCA	14.02	2.39	15.44	4.12	NS	2.61	0.39	2.16	0.64	NS
BC1	11.97	3.05	12.95	2.53	NS	6.42	0.60	7.45	0.84	NS
BC2	0.55	0.30	0.54	0.41	NS	7.61	2.62	6.08	0.97	NS
BC3	0.28	0.05	0.42	0.14	NS	12.90	1.07	14.97	1.58	NS
PB1	0.35	0.44	0.22	0.24	NS	0.00	0.00	0.14	0.16	NS
PB2	1.46	1.04	1.75	1.00	NS	19.95	8.54	20.89	9.68	NS
PB3	1.18	0.48	1.39	0.56	NS	20.35	6.92	15.21	3.87	<0.001
PB4	1.39	0.44	1.71	0.63	NS	20.57	2.45	19.38	3.67	NS
PB5	1.30	0.42	1.59	0.49	NS	26.70	3.37	23.91	1.75	NS
MC1	2.35	1.29	2.19	1.58	NS	0.15	0.29	0.12	0.15	NS
MC2	0.77	0.31	0.78	0.46	NS	0.00	0.00	0.06	3.31	NS
Mean	2.63	4.14	2.97	4.55	0.001	12.02	9.09	11.21	8.18	NS

	Sponge					Macroalgae				
	2011		2012			2011		2012		
Site	**Mean**	**SD**	**Mean**	**SD**	**p**	**Mean**	**SD**	**Mean**	**SD**	**p**
DC1	4.23	2.29	3.91	1.32	NS	10.54	5.90	3.70	2.05	NS
DC2	7.69	2.58	7.84	2.75	NS	4.10	3.11	2.12	1.95	NS
DC3	5.59	2.69	5.82	1.64	NS	0.53	0.89	0.37	0.22	NS
DC4	6.04	1.34	7.17	1.72	NS	1.45	2.47	2.34	1.27	NS
DC5	6.69	2.21	4.95	1.19	NS	6.59	2.76	14.17	4.58	NS
BCA	3.05	2.38	1.67	1.27	NS	2.12	3.25	3.37	4.30	NS
BC1	5.32	1.08	3.40	0.76	NS	8.57	3.16	18.54	7.84	NS
BC2	6.82	1.00	5.32	0.85	NS	3.00	2.96	9.94	5.66	NS
BC3	7.20	1.10	8.65	2.64	NS	2.06	3.23	2.07	1.36	NS
PB1	1.14	1.05	1.12	1.35	NS	0.07	0.08	0.50	0.49	NS
PB2	6.74	2.65	8.03	1.81	NS	1.48	1.02	0.33	0.37	NS
PB3	14.45	3.12	13.30	1.11	NS	4.17	1.09	1.87	0.95	NS
PB4	15.44	5.73	13.84	4.15	NS	1.75	1.08	0.77	0.66	NS
PB5	13.65	1.84	11.47	3.39	NS	0.58	0.55	1.55	2.08	NS
MC1	3.05	1.38	1.97	0.53	NS	21.93	10.81	33.41	11.23	NS
MC2	5.31	1.57	3.31	1.15	NS	21.62	8.38	49.89	30.74	<0.001
Mean	7.03	4.53	6.36	4.25	0.010	5.66	7.73	9.06	15.73	0.005

Long-Term Trends

Annual trends (2003-2012) for the region (pooled for 12 sites) in stony coral, octocoral, sponge, and macroalgae cover are presented in Figure 8. Annual trends for each county (sites within a county pooled) are presented in Figures 9-12 and are included to provide more detail for each county. The mean site data by year used to produce the trend figures is summarized in Appendix 2.

Region-wide there was no significant trend identified for stony coral cover (see Appendix 3 for the region-wide and site level statistical p-values). Mean stony coral cover appears to have dropped within the 10 sites below 5% since 2008 (Figure 8) but much of this loss in cover is attributed to site BCA which is the only site to have experienced a significant trend of decreasing cover since 2003 (Appendix 3). BCA is a site dominated by *Acropora cervicornis* and cover in this site has dropped from a high of 40% in 2005 to a low of 14% in 2011, and although not significant, cover increased to 15% in 2012 (Table 7).

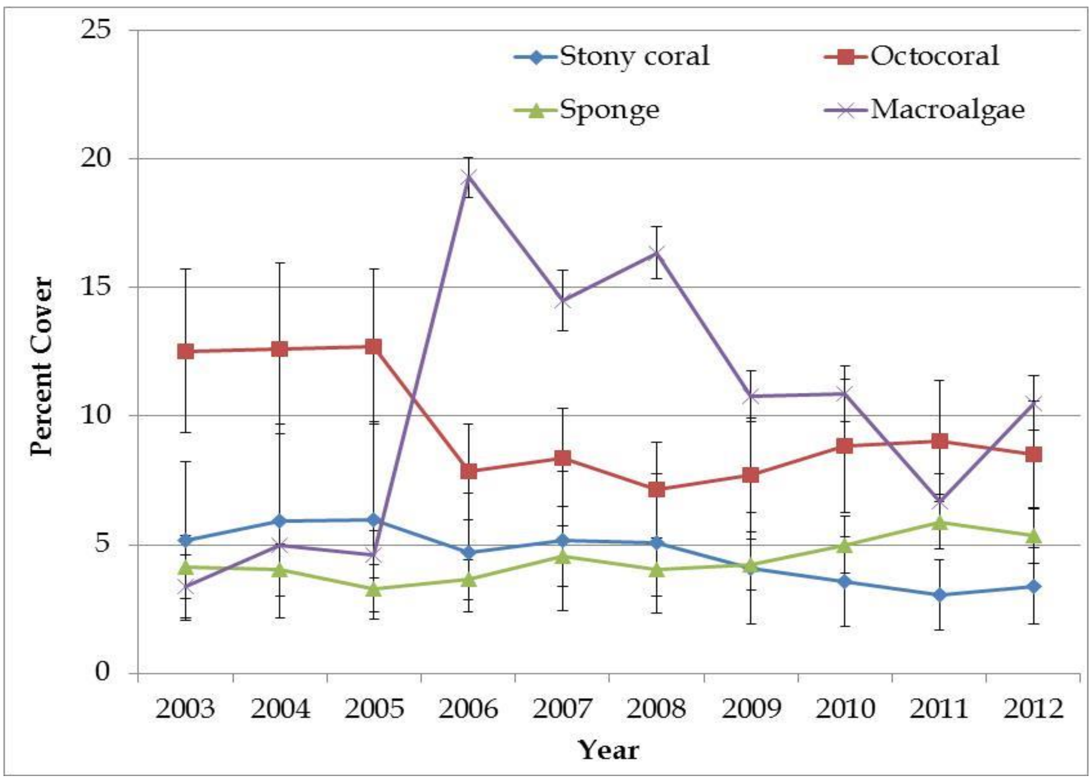

Figure 8. Mean (±SD) region-wide (n = 10 sites 2003-2006 and 12 sites 2006-2012) annual stony coral, octocoral, sponge and macroalgae percent cover. No trend (mixed model regression; see Appendix 3 for statistical values) was identified for stony coral ($p > 0.07$) or macroalgae ($p > 0.15$) cover but a decreasing trend was identified for octocoral ($p < 0.02$) and an increasing trend for sponge ($p < 0.001$) cover.

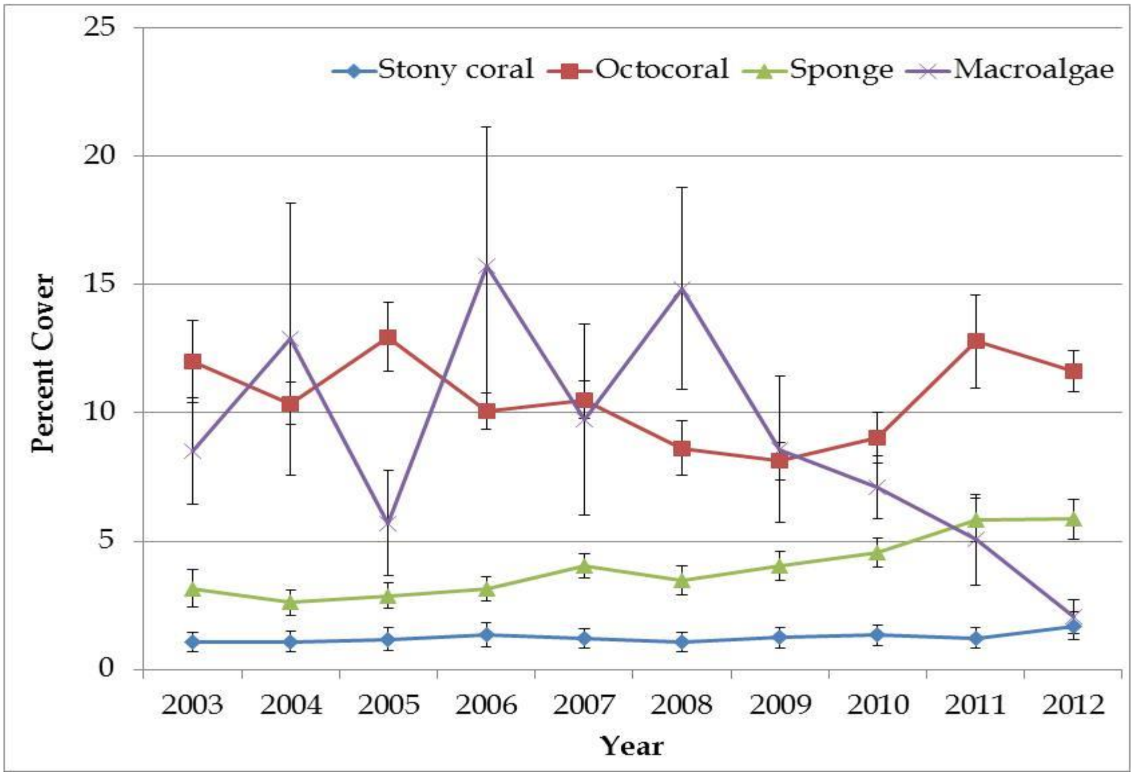

Figure 9. Mean (±1SD) Miami-Dade County (n = 3 sites) annual stony coral, octocoral, sponge, and macroalgae percent cover.

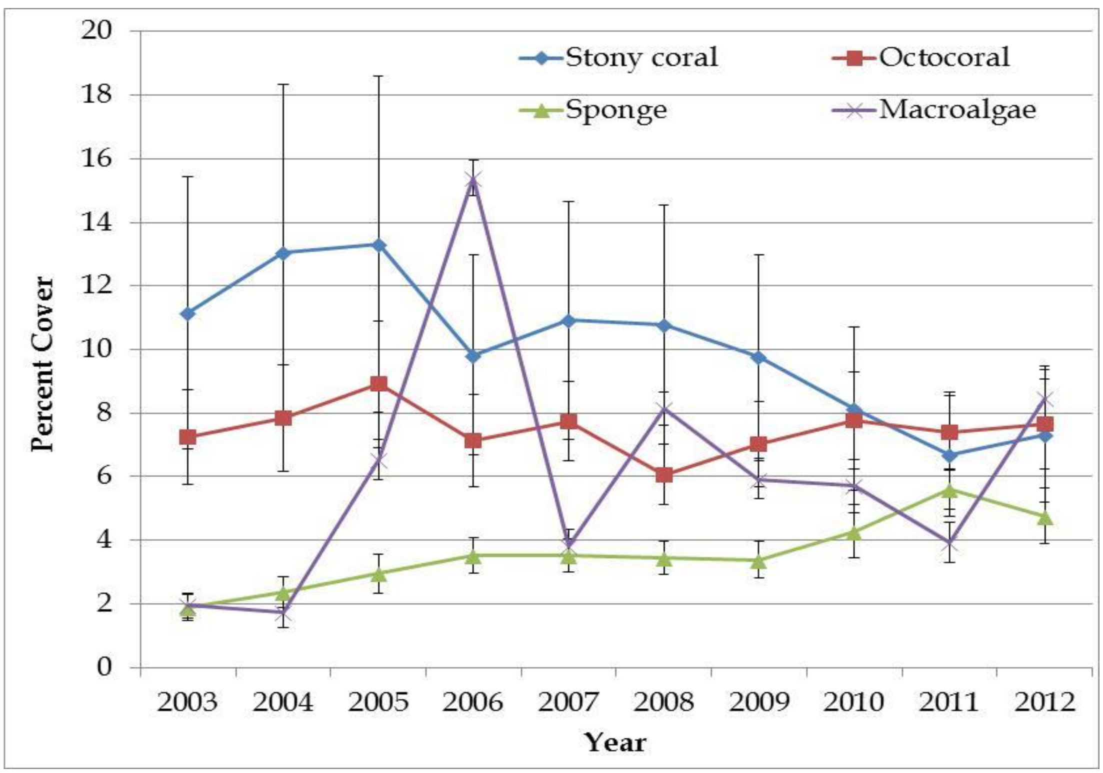

Figure 10. Mean (±1SD) Broward County (n = 4 sites) annual stony coral, octocoral, sponge, and macroalgae percent cover.

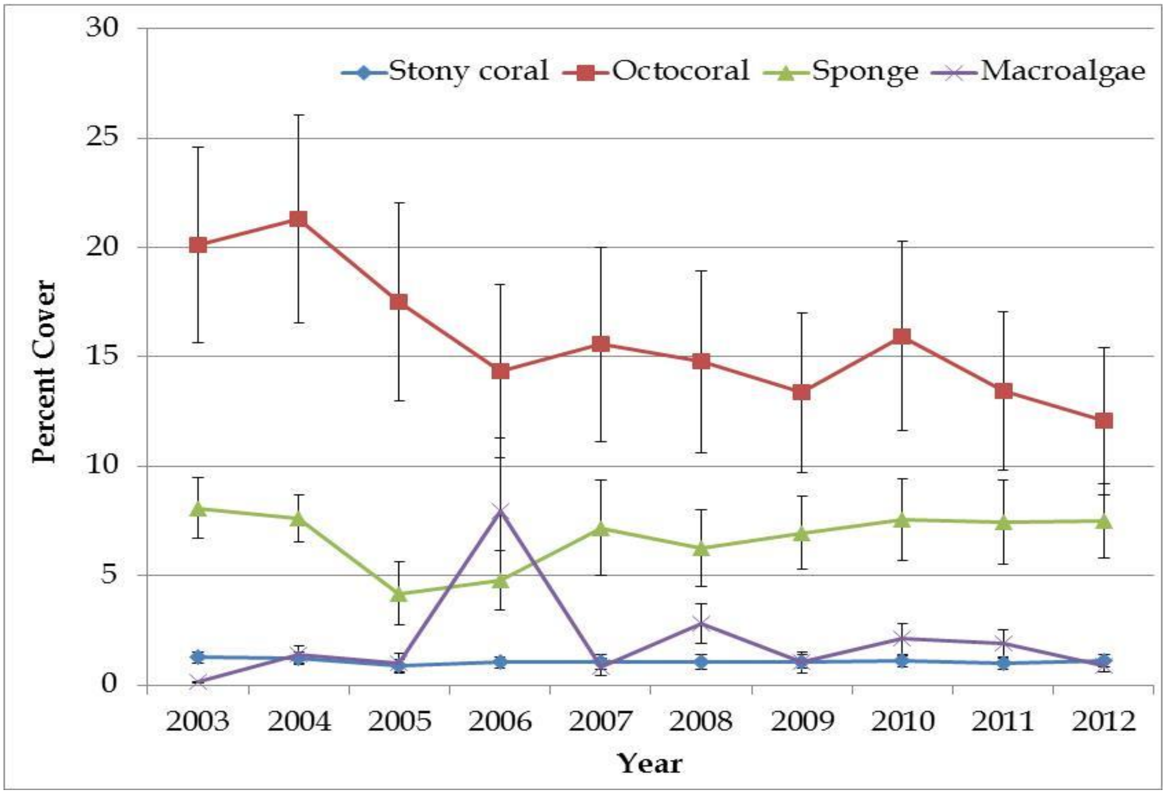

Figure 11. Mean (±1SD) Palm Beach County (n = 3 sites) annual stony coral, octocoral, sponge, and macroalgae percent cover.

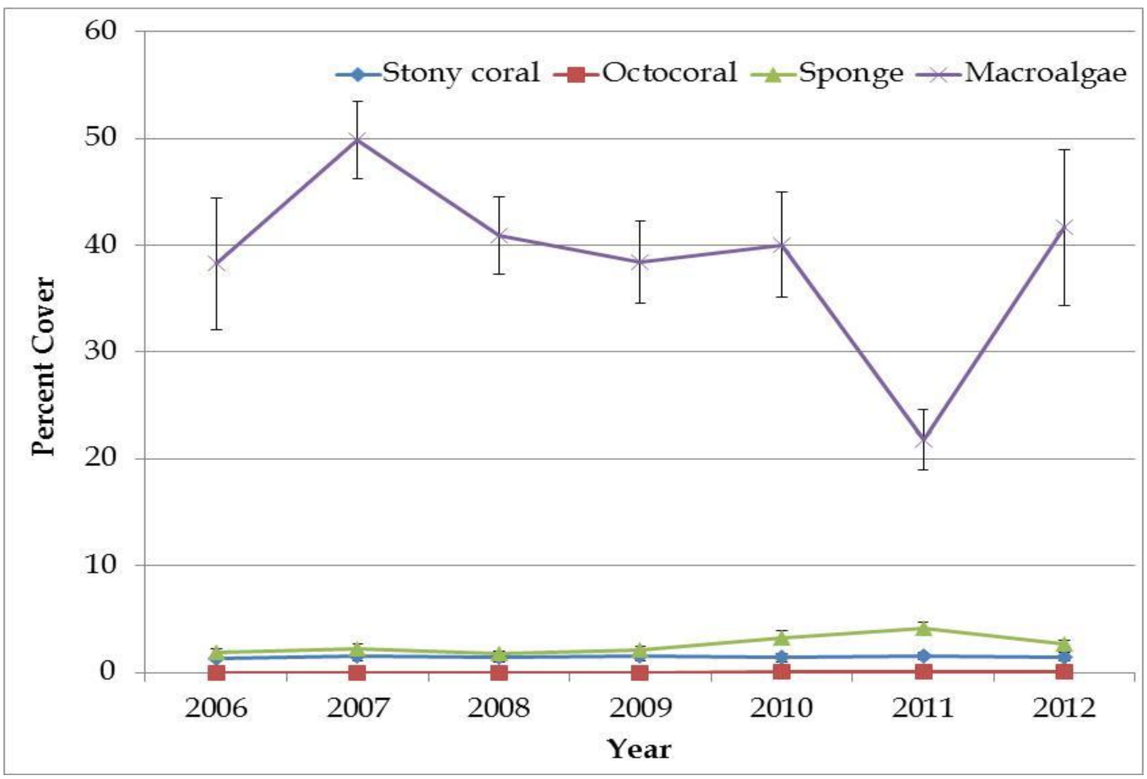

Figure 12. Mean (±1SD) Martin County (n = 2 sites) annual stony coral, octocoral, sponge, and macroalgae percent cover.

Region-wide there has been a significant decreasing trend identified for octocoral cover (Figure 8) (Appendix 3). Three sites (DC3, PB3, and PB1) were determined to have significant decreasing trends in octocoral cover since 2003. DC3 cover has decreased from 15.5% in 2003 to 9.4% in 2012 with a 10-year low of 5.7% in 2009 (Appendix 2). PB3 has decreased from 30.3% in 2003 to a low of 15.2% in 2012 (Appendix 2). Octocoral cover in PB1 has always been low but since 2006 has been less than 0.15% (Appendix 2).

Sponge cover has shown a significant increasing trend region-wide since 2003 (Figure 8) (Appendix 3). At the site level three (DC1, BC3, and PB2) sites were determined to show this increasing trend in sponge cover. DC1 has increased from less than 1% in 2003 to nearly 4% in 2012 (Appendix 2). BC3 has increased from a low of 3.6% in 2003 to a high of 8.6% in 2012, and similarly, cover in PB2 has increased from a low of 3.5% in 2003 to a high of 8.0% in 2012 (Appendix 2).

As would be expected, macroalgae cover has fluctuated greatly over the last 10 years from less than 5% in 2003 to nearly 20% in 2006 and then back near to 10% in 2012 (Figure 8) (Appendix 2). The highly variable nature of macroalgae cover makes identifying long-term trends difficult, and no trend was identified for macroalgae cover region-wide (Appendix 3).

Site MC3 Stony Coral Colony Condition

In 2012, multiple attempts were made to sample site MC3, but none were successful due to weather (thunderstorms), rough seas, or very poor visibility. No data were collected.

Site Temperature Record

Temperature loggers were deployed in 2007 at the 10 sites established in 2003. Eleven additional loggers have been deployed when new sites (n = 7) were established. Loggers are collected and replaced during each sampling event. During the 2012 sites visits, temperature data were successfully downloaded from 16 of the 17 sites (no loggers were retrieved from MC3). The 2012 sample dates shown in Table 2 are the same dates that temperature loggers were redeployed or deployed at each of the 16 SECREMP sites. Table 8 presents the dates and maximum and minimum temperatures (°C) for each site from late winter 2007 into summer 2012. Figures 13-16 show the mean annual temperatures for the 17 sites by county. These figures illustrate the general warming trend (as expected) at all sites from February to August/September. Figure 16 also shows that the three Martin County sites tend to have lower winter temperatures (as low as 14°C in winter 2010) while much of the remaining year is similar to the southern counties.

Table 8. Maximum and minimum temperatures (°C) and dates for the 17 sites with temperature loggers winter 2007 through winter 2012.

	Maximum		Minimum	
Site	**Temp**	**Date**	**Temp**	**Date**
DC1	31.4	4 Aug 11	19.7	23 Jan 09
DC2	30.7	5 Aug 11	20.1	4 Mar 10
DC3	30.6	25 Aug 11	20.4	1 Feb 11
DC4	30.5	25 Aug 11	20.3	31 Jan 11
DC5	30.9	24 Aug 11	20.3	31 Jan 11
BCA	30.9	12 Aug 09	19.0	6 Feb 09
BC1	31.1	24 Aug 11	19.6	5 Mar 10
BC2	30.6	24 Aug 11	20.4	5 Mar 10
BC3	30.7	25 Aug 11	20.0	22 Feb 11
PB1	30.9	22 Aug 11	19.5	6 Mar 10
PB2	30.6	22 Aug 11	18.5	5 Apr 11
PB3	30.5	22 Aug 11	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	12 Aug 09	13.4	11 Jan 10
MC2	30.7	11 Aug 09	13.8	11 Jan 10
MC3	30.4	12 Aug 09	13.5	11 Jan 10

For all sites during some period when temperatures have been recorded, the maximum temperature recorded was over 30°C (Table 9). These warm temperatures were generally recorded during the later summer months (August-September) of 2007, 2009, and 2010. The coolest temperatures were recorded during the winter months (January-March) of 2009, 2010, and 2011.

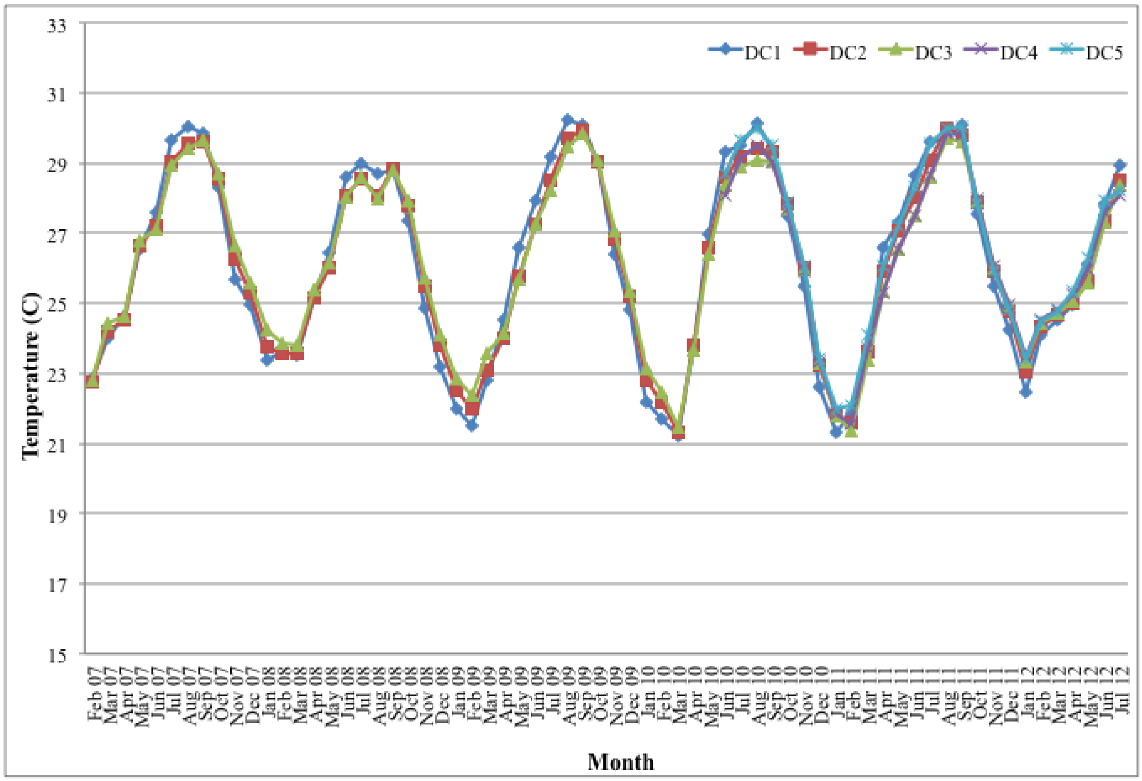

Figure 13. Mean monthly temperatures (°C) for the five Miami-Dade County sites, February 2007 – July 2012

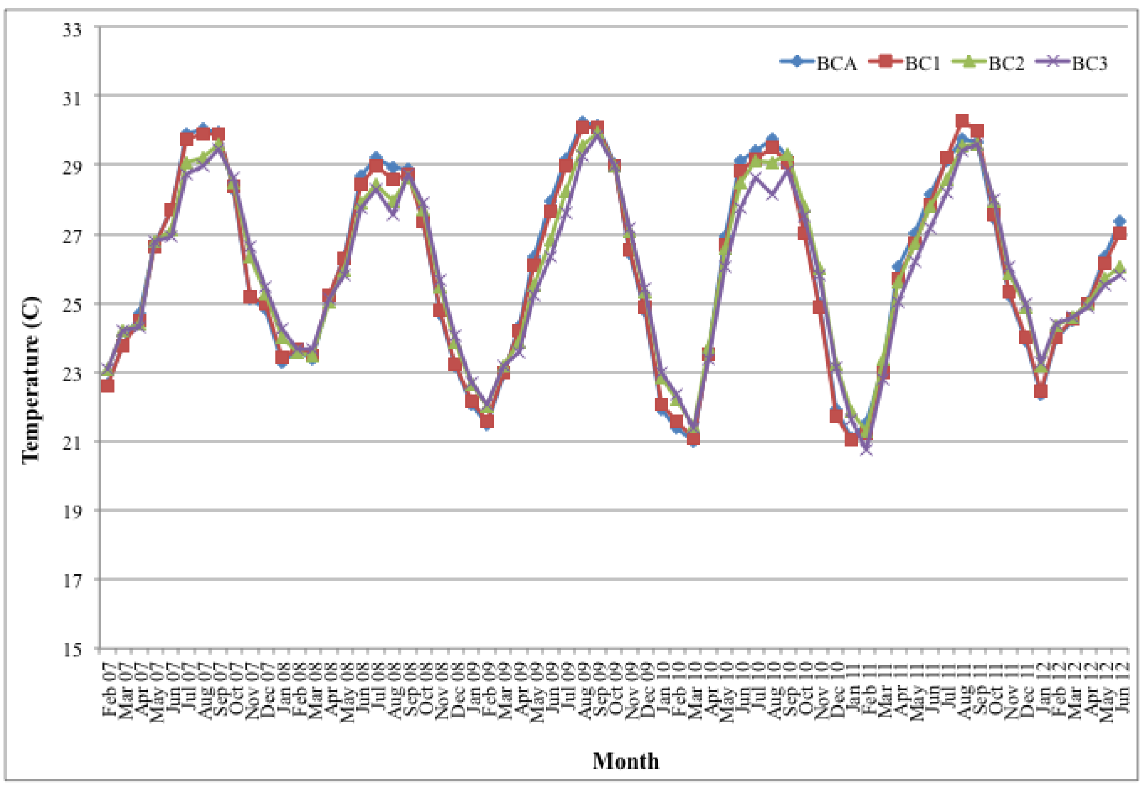

Figure 14. Mean monthly temperatures (°C) for the four Broward County sites, February 2007 – June 2012**.**

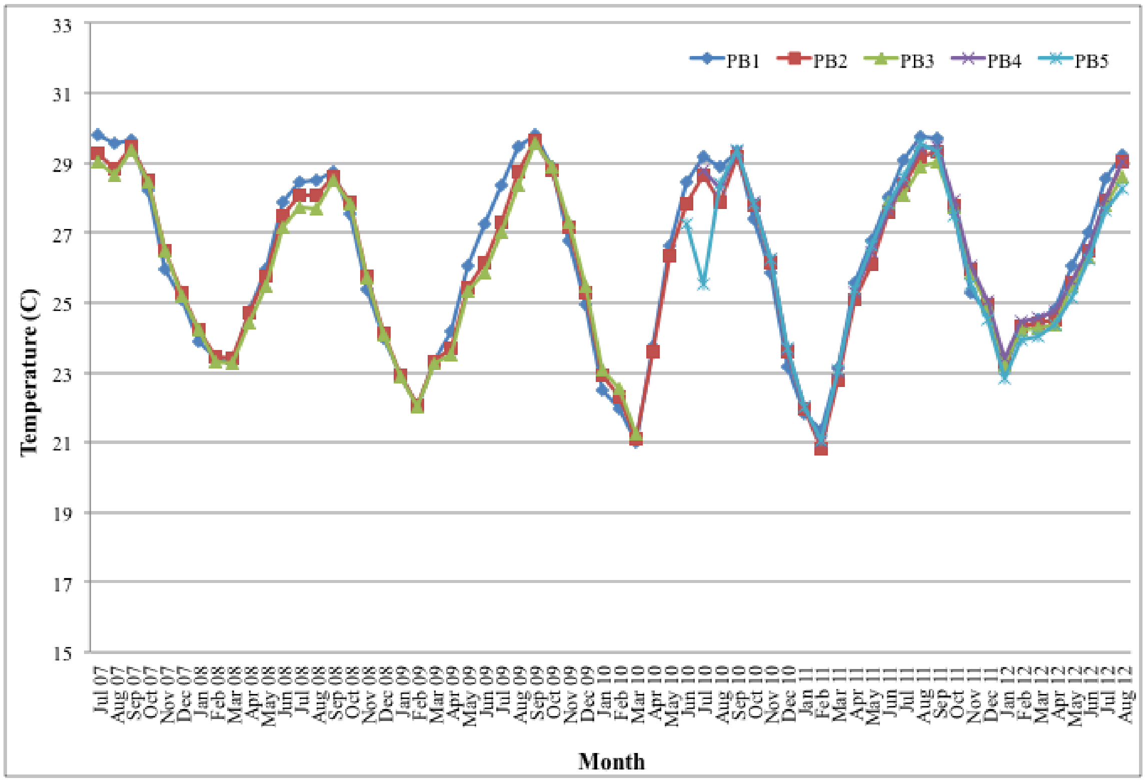

Figure 15. Mean daily temperatures (°C) for the five Palm Beach County sites, July 2007 – August 2012.

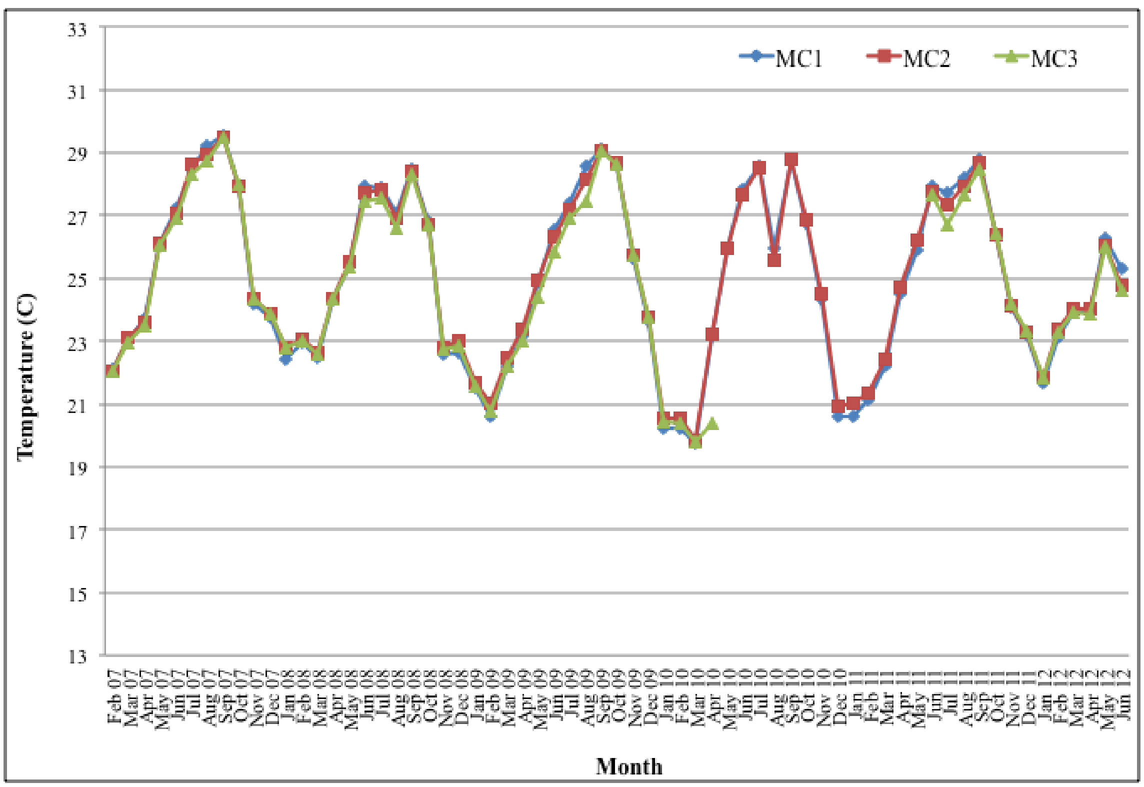

Figure 16. Mean daily temperatures (°C) for the three Martin County sites, February 2007 – June 2012.

Table 9. Number of days per year ≥ 30°C for the 17 sites with temperature loggers, winter 2007 through winter 2012 (NA = sites not established).

Site	2007	2008	2009	2010	2011	Total
DC1	51	1	51	39	21	163
DC2	20	0	26	2	9	57
DC3	20	0	12	0	0	32
DC4	NA	NA	NA	3	0	3
DC5	NA	NA	NA	31	16	47
BCA	54	3	56	20	0	133
BC1	52	0	46	3	0	101
BC2	13	0	24	4	0	41
BC3	9	0	24	0	0	33
PB1	22	0	10	7	0	60
PB2	8	0	3	3	0	29
PB3	5	0	0	0	0	14
PB4	NA	NA	NA	3	0	21
PB5	NA	NA	NA	5	0	23
MC1	10	0	14	0	0	24
MC2	9	0	14	0	0	23
MC3	8	0	8	0	0	16

DISCUSSION

The coral reef ecosystem off southeast Florida is the northern extension of the Florida Reef Tract and as such, is a high-latitude system near the environmental threshold for significant coral reef growth. Southeast Florida reefs generally have similar stony coral species richness but reduced stony coral cover, compared to the southern portions of the Florida Reef Tract in the Dry Tortugas and Florida Keys (Ruzicka et al. 2010; Ruzicka et al. 2012). Benthic cover by octocorals and macroalgae is more similar throughout the Florida Reef Tract, while sponges appear to contribute more to cover in southeast Florida than in the Florida Keys or Dry Tortugas (Ruzicka et al. 2010; Ruzicka et al. 2012; Ruzicka et al. 2013).

Protocol changes were made to the project in 2012, replacing the standard species richness survey with targeted demographic surveys for stony corals, octocorals, and barrel sponges. Mean (±SD) region-wide (n = 16 sites) stony coral density was 1.15 ± 0.81 colonies (≥ 4 cm)/m² and ranged from 0.34 ± 0.47 colonies/m² (PB1) to 2.88 ± 0.86 colonies/m² (DC5) (Table 2 and Figure 5). In 2012, 24 stony coral species were identified with a region-wide mean (±SD) of 9.1 ± 3.4 species per site and a range of 15 (DC5) to 4 (BCA) species within a site (Appendix 1). A greater total number of species (27), mean (±SD) number of species per site (13.8 ± 4.4), and number of species per site were recorded in 2011 (Gilliam 2012). The reduction of species identified in 2012 was due to the smaller area within which species were recorded (22 m² in 2012 versus 44 m² in 2011). Although slightly fewer species were recorded within each site, the belt transect now allows for a more robust comparison of changes in the stony coral community through the estimation of species density rather than just species richness. Six species (*Montastraea cavernosa*, *Siderastrea siderea*, *Porites astreoides*, *Stephanocoenia intersepta*, *Agaricia agaricites*, and *Meandrina meandrites*) were very common region-wide and contributed more than 80% in total colony abundance in each county except Martin (73%) (Table 3). Interestingly, three of these species (*M. cavernosa*, *S. siderea*, and *P. astreoides*) were also identified as being three of the most common species in the Florida Keys (Ruzicka et al. 2010) and in the Dry Tortugas (Ruzicka et al. 2012). Disease was not common and only identified at six sites in 2012. A white syndrome referred to as rapid tissue loss was identified on *A. cervicornis* colonies in both sites in the region that had this species (BCA and DC1). The only other disease was dark spots disease which was identified on four *S. siderea* colonies (one colony in BC1, one in DC1, and two in PB5).

Octocorals have previously been documented as a dominant benthic group in terms of density offshore of Broward County (Gilliam et al. 2012), but prior to 2012 there had been no program which documented octocoral density throughout the southeast Florida region. Region-wide (n = 16 sites) mean (±SD) octocoral density was 10.10 ± 9.30 colonies / m², and ranged from a high of 30.08 ± 6.61 colonies/m² at site PB5 to a low of 0.00 ± 0.00 colonies /m² at sites MC1 and MC2 (Table 4). The Miami-Dade and Broward county site mean densities estimated in this program were similar to the densities estimated in Gilliam et al. (2012) while the Palm Beach sites tended to have greater octocoral densities. The five target species were added to the protocol in order to increase our ability to describe and document changes in the octocoral community. These five species were added because they are common along the entire Florida Reef Tract (V. Brinkhuis personal communication). The choice of these five species appears to be appropriate for southeast Florida with the five target species (*E. calyculata, A. americana, E. flexuosa, P. porosa,* and *G. ventalina*) identified in all counties except Martin (no octocorals were present) (Table 5) and in 11 sites. *Antillogorgia americana*, *E. flexuosa,* and *E. calyculata* were present in most of the sites and were also the most abundant of the target species (Table 5).

Barrel sponges (*X. muta*) are large, conspicuous, and important components of the Florida reef community. Prior to 2012 there had been no southeast Florida region-wide monitoring of barrel sponge abundance or condition. Barrel sponges were identified in 12 sites. No barrel sponges were identified in the nearshore sites BCA, PB1, MC1, and MC2 (Table 6). In sites which had barrel sponges present, mean (±SD) densities ranged from a high of 0.61 ± 0.12 sponges/m² at site PB4 to a low of 0.05 ± 0.05 sponges/m² at site BC1.

Region-wide mean (±SD) stony cover in 2012 (3.0 ± 0.04%) was significantly greater than the mean in 2011 (2.6 ± 0.04%) (Table 7). This increase was apparently due to a general increase in stony coral cover at many sites (Table 7) since only one site (DC1) was determined to be significantly greater in 2012 than in 2011. Sites BCA (15.4 ± 4.12%) and BC1 (12.95 ± 2.53%) are the sites which have the greatest stony coral cover in the project. Both sites are on the nearshore ridge complex offshore of Broward County. Site BCA is dominated by an *A. cervicornis* patch, and BC1 is in an area of increased abundance of larger (1 m diameter) *Montastraea cavernosa* stony coral colonies. Year-to-year- significant loss in cover at BCA has been determined in the past (Gilliam 2012), but *A. cervicornis* cover did not decrease in 2012. The long-term analysis did not determine a region-wide significant trend for stony coral cover (Figure 8) (Appendix 3), but not surprisingly, BCA was the only site to have experienced a significant trend (decreasing) in cover since 2003 (Appendix 3).

Site BCA was included in the project to monitor one of the few, remaining large stands of *A. cervicornis* in southeast Florida. *A. cervicornis* was listed as Threatened under the U.S. Endangered Species Act in 2004 (see Federal Register 71 FR 26852, May 9, 2006) and may be uplisted to Endangered in 2014 (see Federal Register volume 77, number 99, May 22, 2012). Due to the status of acroporid corals, the results from BCA deserve additional recognition. *Acropora cervicornis* cover decreased from a high of 39% in 2004 and 2005 to a low of 14% in 2011 and remained stable at 15% in 2012 (see Appendix 4 for mean site functional group cover 2003-2012). Sampling has been conducted at the same time each year (June in 2004-2012, Table 2). The passing of Hurricane Wilma over the area in October 2005 may have contributed to some of the decline in 2006. A severe cyanobacteria bloom of *Lyngbya* spp. occurred in 2004 and may have resulted in direct mortality to *A. cervicornis.* The abundance of *Lyngbya* spp. at BCA appears to have diminished after 2004 (D. Gilliam, personal observation). Data collected by a separate monitoring effort, which includes the site BCA *A. cervicornis* patch and a second *A. cervicornis* patch to the north, has suggested that disease and predation by the fireworm, *Hermodice carunculata*, may be the primary causes of tissue loss (Gilliam, unpublished data). Stony coral cover within the *A. cervicornis* patch has also been record as declining by two additional projects (Walker et al. 2012; Gilliam et al. 2012). SECREMP is an annual monitoring project designed with the use of permanent transects. This annual permanent transect design may not provide all the data appropriate for monitoring and/or determining the changes in condition of a large *A. cervicornis* patch. Since asexual reproduction is an important mechanism structuring *A. cervicornis* populations, these larger patches may be in a dynamic state with changing boundaries and relative cover within the patch (Walker et al. 2012). A large survey effort conducted between Broward County's Port Everglades and Hillsboro Inlets (includes the area containing BCA) found numerous areas of high *A. cervicornis* abundance (D'Antonio 2013) illustrating that the changes in annual condition within BCA may not be indicative of the *A. cervicornis* population offshore southeast Florida in general.

Even though there was no year-to-year significant difference determined in mean (±SD) octocoral cover region-wide (n = 16 sites) in 2012 (11.38 ± 1.62%) compared to 2011 (11.18 ± 1.42%), two sites (DC2 and PB3) were determined to have significantly less octocoral cover in 2012 than in 2011 (Table 7). For the long-term analysis (2003-2012), a region-wide significant decreasing trend was identified for octocoral cover (Figure 8) (Appendix 3), and at the site level DC3, PB3, and PB1 followed this significant decreasing trend (Appendix 3). This is a very interesting result when compared to trends identified in octocoral cover in the Florida Keys (1999-2009). Octocoral cover was determined to have significantly increased Keys-wide and in all three habitats included in the study (Ruzicka et al 2013). Although both regions are part of the larger Florida Reef Tract, there are regional differences in sources and severity of stressors which may lead to different shifts in reef community structure.

The cyanobacteria, *Lyngbya* spp., covered much of site DC3 in 2008. Cyanobacteria were part of the "other biota" function group for the image analysis cover estimates from 2003-2010, but are now specifically noted as a group. In 2008, *Lyngbya* spp. cover was > 11%, compared to 3% or less in previous years. In 2009, cover dropped back to nearly 3% and has remained below 3% (Appendix 4). The high *Lyngbya* cover in 2008 and continuous cover since then, has likely contributed to the significant decline in octocoral cover. No physical damage has been identified at this site, and other potential causes driving the loss of octocoral cover in DC3 are difficult to identify with only annual visits. DC2 is directly inshore of DC3 and has also had continuous, although generally less, *Lyngbya* cover and also similar to DC3 no physical damage has been identified.

Octocoral cover also showed a decreasing trend at site PB3 since 2003 (Appendix 3), and cover in 2012 was determined to be significantly less than in 2011 (Table 7). As discussed with site DC3, the processes driving these changes are not clear. There has been no physical damage identified at either site and an increase in cyanobacteria cover has also not been correlated.

Mean (±SD) sponge cover was determined to have significantly decreased in 2012 (6.36 ± 4.25%) from 2011 (7.03 ± 4.53%) region-wide (Table 7), however, there were no individual sites which were determined to be significantly different. In contrast to this most recent year-to-year comparison, sponge cover has shown a significant increasing trend region-wide since 2003 (Figure 8) (Appendix 3), and at the site level DC1, BC3, and PB2 were determined to show this increasing trend (Table 7).

DC1 is a nearshore site and, in addition to an increase in sponge cover since 2003, also had a significant increase in stony coral cover in 2012 compared to 2011.

From these data there is no apparent reason for these increases. Although no significance was determined in 2012, PB2 has shown a decline in octocoral cover in previous years (Gilliam 2012). The reduction in octocoral canopy cover at this site could be partially responsible for the increase in sponge cover. A reduction in the octocoral canopy would allow a greater number of points to be identified as substrate or benthic organisms because benthic organisms like sponges would no longer be obscured in the image analysis.

Region-wide mean (±SD) macroalgae cover in 2012 (9.06 ± 15.73%) was significantly greater than the mean in 2011 (5.66 ± 7.73%) (Table 7). Macroalgae cover is both temporally and spatially (even at the station level) variable which likely lead to no significant difference determined between any of the sites (Table 7). As would be expected, macroalgae cover has fluctuated greatly over the last 10 years (Appendix 4) from less that 5% in 2003 to nearly 20% in 2006 and then back near to 10% in 2012 (Figure 8). The highly variable nature of macroalgae cover make identifying long-term trends difficult, and no trend was identified for macroalgae cover region-wide (Appendix 3).

In 2005, site PB1 was greatly affected by sand movement. Stations 2 and 4 were completely covered with sand several centimeters in depth. Stations 1 and 3 were also impacted, but to a lesser degree than Stations 2 and 4. In 2006, Stations 2 and 4 remained buried in sand. From 2007 to 2012, Stations 2 and 4 have very slowly started to become uncovered; but both stations remain dominated by sand. From 2006 to 2012, stony coral, octocoral, and sponge cover were very low (essentially zero) in these stations, but hard substrate is becoming exposed and functional group cover is increasing (Appendix 4). The cause of this sand movement is unknown, although past beach nourishment activities and the 2004 hurricanes, Jeanne and Frances, may have contributed to this significant sand movement. The variable sand cover at this site greatly influenced summary data for site PB1, and therefore, the long term trend analyses. The loss of reef habitat at these two stations reduced the number of coral species identified in Palm Beach, and is responsible for the declining trends observed for stony coral, octocoral, and sponge cover at this site (Table 7 and Appendix 3).

Temperature loggers were deployed at all existing sites in 2007 and as new sites were installed. With more than five years of temperature data recorded, some trends in water temperatures are becoming evident. All sites (Figures 13-16) show the expected pattern of cooler water temperatures in the winter months (December – March) and warmer temperature in the summer months (June – September). For all sites, August and September are the warmest months and SECREMP now has five summer period data records (2007-2011). It is also becoming clear that there is inter-annual variability in seasonal water temperatures and this variability may not be consistent among all counties. Temperatures greater than 30.5°C, which is a temperature above which bleaching has been recorded in the Florida Keys (Manzello et al. 2007), have been recorded in the region all summers (Table 9). In 2011, three sites (DC1, DC2, and DC5), had temperatures recorded above 30.5°C, and these warm waters remained at DC1, DC2, and DC5 for 21, nine, and 16 days respectively (Figure 13). The number of sites with temperatures recorded above 30.5°C in 2011 was the fewest since 2008. The SECREMP sampling period is generally conducted between late May and early August (Table 2), prior to the warmest recorded temperatures and when warm water stony coral bleaching is observed. The effect of these high temperatures on the stony coral communities at the SECREMP sites is not entirely known, but with stony coral cover not significantly changing at the sites (except for site BCA), a measurable negative effect associated with high water temperatures was not evident. In winter (December–February) 2010, much of the Florida Reef Tract experienced extreme cold water temperatures, with some areas below 10°C and many areas with prolonged periods below 16°C. This 2010 cold-water event resulted in unprecedented stony coral mortality in many areas of the Florida Reef Tract south of the Biscayne region (Colella et al. 2012, Lirman et al. 2011). Temperature data from the 13 SECREMP sites with loggers in winter 2010, indicated southeast Florida water temperatures did not fall as low as temperatures recorded in the Florida Keys region (only Martin County had temperatures lower than 16°C). Percent cover data from 2010 to 2012 supports the observation that the cold-water event did not measurably impact the southeast region of the Florida Reef Tract.

The coral reefs of southeast Florida represent a significant economic resource to the region. Between June 2000 and May 2001, visitors spent 28 million person-days enjoying artificial and natural reefs in southeast Florida. During the same period, reef-related expenditures and income amounted to over 5.7 billion dollars and supported over 61,300 jobs in Miami-Dade, Broward, Palm Beach, and Martin Counties (Johns et al. 2003, 2004). Notably, Johns et al. (2003) indicate southeast Florida reefs generate six times the sales, income, and jobs compared to reefs in the Florida Keys.

These important economic and recreational benefits are threatened because the coral reef environments of southeast Florida are under varied and chronic stressors. This area is highly urbanized along the coast. Dredging for beach nourishment, inlet and port channel deepening, and maintenance can have significant direct impacts on reef substrate, as well as impacts on water quality. Chronic turbidity and deposition of silt can smother sessile invertebrates and result in barren areas. Nearshore reef areas are at risk from the diversion of millions of gallons of fresh water and treated wastewater into the ocean, and the resultant reduction in salinity. Additional risks include the introduction of agricultural and industrial chemical contamination, and excess nutrients.

Impacts from boating and fishing activities are a significant threat to reef areas as damage from fishing gear and anchoring can be severe. Adverse impacts from SCUBA divers can also occur. Traffic from large ports (Miami, Port Everglades, and Palm Beach), including cruise and container ships, military vessels, and oil tankers, can conflict with reef resources. Fiber optic cables deployed across the reefs (Jaap 2000) and ships grounding and anchoring on reefs causing extensive and often long-lasting damage (Gilliam 2012).

The chronic nature of disturbances to, and the significant economic value of, southeast Florida reefs require 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 trends data designed to help local resource managers understand the implications of actions occurring in terrestrial and adjacent marine habitats. However, SECREMP was established to be a monitoring project independent of coastal development projects and un-permitted incidents (e.g., ship groundings), and as such most localized impacts from these activities are not captured by SECREMP. There is a need for more comprehensive, longer-term, and site-specific project/incident monitoring. 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 the CREMP to include sites in Broward, Miami-Dade, Palm Beach, and Martin Counties, through SECREMP, and the recent addition of stony coral, octocoral, and barrel sponge demographic efforts has insured that this suite of parameters is being monitored for the full extent of the Florida coral reef ecosystem. One of the goals of the NOAA Coral Ecosystem Monitoring Program is monitoring with an explicit link to assessing the efficacy of "coastal" management strategies. While a true effects study designed to assist resource managers in gauging potential effects from past or future impacts (e.g., beach nourishment, pipelines, etc.) is not possible with our limited sample size, local resource managers (county) were directly involved in choosing the sample sites and were present during the site selection field work. Site BCA (Broward County *A. cervicornis* patch) is an example of a site specifically chosen by state and county resource managers in order to monitor potential changes to this unique area.

As a monitoring project under the NOAA Coral Reef Conservation Program Cooperative Agreement for the southeast Florida coast, SECREMP will continue characterization of ecosystem condition, inventory/mapping of biotic resources, and database development, providing resource managers with the critical information required to manage this valuable, yet increasingly threatened, natural resource.

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Appendix 1. Stony coral species presence (P) and absence (A) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; and MC = Martin County).

Species	**DC1**	**DC2**	**DC3**	**DC4**	**DC5**	**BCA**	**BC1**	**BC2**	**BC3**
Montastraea cavernosa	P	P	P	P	P	A	P	P	P
Siderastrea siderea	P	P	P	P	P	A	P	P	P
Porites astreoides	P	P	P	P	P	P	P	P	P
Stephanocoenia intersepta	P	P	P	P	P	A	P	P	P
Agaricia agaricites complex	P	A	A	A	P	P	P	A	A
Meandrina meandrites	P	P	P	P	P	A	A	P	P
Solenastrea bournoni	P	P	A	P	P	A	P	P	A
Dichocoenia stokesii	P	P	P	P	P	A	P	P	A
Porites porites	P	A	A	P	P	P	A	P	A
Agaricia fragilis	A	A	A	A	P	A	P	A	A
Madracis decactis	A	P	P	A	P	A	P	A	P
Diploria clivosa	A	A	A	A	A	P	A	A	P
Madracis mirabilis	A	A	A	A	A	A	A	A	A
Orbicella (Montastraea) annularis complex	P	P	A	P	P	A	P	P	A
Acropora cervicornis	P	A	A	A	A	A	A	A	A
Diploria strigosa	A	P	A	A	A	A	A	A	A
Oculina diffusa	A	A	A	A	A	A	A	A	A
Agaricia lamarcki	A	A	A	P	A	A	A	P	P
Colpophyllia natans	P	A	A	A	P	A	P	A	A
Eusmilia fastigiata	A	P	A	P	A	A	A	A	A
Siderastrea radians	A	P	A	A	P	A	A	A	A
Isophyllia sinuosa	A	A	A	A	A	A	A	A	A
Scolymia cubensis	A	A	A	P	A	A	A	A	A
Mussa angulosa	A	A	A	A	P	A	A	A	A
Total Species Richness	**12**	**12**	**7**	**12**	**15**	**4**	**11**	**10**	**8**

Appendix 1 Continued. Stony coral species presence (P) and absence (A) for each site (DC = Miami-Dade County; BC = Broward County; PB = Palm Beach County; and MC = Martin County).

Species	PB1	PB2	PB3	PB4	PB5	MC1	MC2
Montastraea cavernosa	A	P	P	P	P	P	A
Siderastrea siderea	A	P	P	P	P	P	P
Porites astreoides	A	P	P	P	P	P	A
Stephanocoenia intersepta	A	P	P	P	P	A	A
Agaricia agaricites complex	A	A	P	P	P	A	A
Meandrina meandrites	P	P	P	P	P	A	A
Solenastrea bournoni	P	A	A	A	P	A	P
Dichocoenia stokesii	A	P	P	P	P	A	A
Porites porites	A	A	A	A	A	A	A
Agaricia fragilis	A	A	A	A	A	A	A
Madracis decactis	A	A	P	P	P	A	A
Diploria clivosa	A	A	A	A	P	P	P
Madracis mirabilis	A	P	A	A	A	A	A
Orbicella (Montastraea) annularis complex	A	A	A	A	P	A	A
Acropora cervicornis	A	A	A	A	A	A	A
Diploria strigosa	A	A	A	P	P	P	P
Oculina diffusa	P	A	A	A	A	P	P
Agaricia lamarcki	A	A	A	A	P	A	A
Colpophyllia natans	A	A	A	A	P	A	A
Eusmilia fastigiata	A	P	A	A	A	A	A
Siderastrea radians	P	A	A	A	A	A	A
Isophyllia sinuosa	A	A	A	A	A	P	A
Scolymia cubensis	A	A	A	A	A	A	A
Mussa angulosa	A	A	A	A	A	A	A
Total Species Richness	**4**	**8**	**8**	**9**	**14**	**7**	**5**

Appendix 2. Mean (±1SD) Miami-Dade county site (DC1, DC2, DC3, DC4, and DC5) data by year for stony coral, octocoral, sponge, and macroalgae percent cover.

Year	Site	Stony Coral Mean	Stony Coral SD	Octocoral Mean	Octocoral SD	Sponge Mean	Sponge SD	Macroalgae Mean	Macroalgae SD
2003	**DC1**	2.40	0.91	5.86	0.61	0.85	0.31	13.32	7.51
2004	**DC1**	2.57	1.35	7.31	0.39	1.08	0.42	31.44	18.19
2005	**DC1**	2.79	1.43	7.96	1.57	1.54	0.53	12.80	6.86
2006	**DC1**	3.04	1.27	7.67	1.51	2.09	0.87	10.25	9.95
2007	**DC1**	2.67	0.90	10.05	3.02	3.55	1.49	20.24	15.39
2008	**DC1**	2.46	1.10	7.40	1.87	2.74	0.80	23.26	9.52
2009	**DC1**	2.81	0.91	8.26	1.21	2.24	0.34	8.08	1.92
2010	**DC1**	2.94	0.82	7.97	2.35	3.11	1.55	10.23	4.62
2011	**DC1**	2.64	1.30	11.18	1.42	4.23	2.29	10.54	5.90
2012	**DC1**	3.82	1.37	11.38	1.62	3.91	1.32	3.70	2.05
2003	**DC2**	0.61	0.44	14.67	2.55	5.14	1.72	9.97	3.22
2004	**DC2**	0.47	0.21	11.54	0.98	4.02	0.99	3.26	1.28
2005	**DC2**	0.46	0.03	15.90	3.08	4.03	1.24	1.13	0.61
2006	**DC2**	0.76	0.09	12.15	0.88	4.81	0.71	20.50	6.72
2007	**DC2**	0.66	0.13	12.42	1.10	5.39	0.67	3.63	1.41
2008	**DC2**	0.62	0.17	12.66	1.32	5.60	1.17	12.11	6.59
2009	**DC2**	0.65	0.61	10.40	1.13	5.03	0.73	0.50	0.28
2010	**DC2**	0.66	0.20	12.75	0.74	5.95	1.28	4.75	1.72
2011	**DC2**	0.64	0.22	19.74	3.01	7.69	2.58	4.10	3.11
2012	**DC2**	0.72	0.14	14.08	1.61	7.84	2.75	2.12	1.95
2003	**DC3**	0.20	0.07	15.48	3.01	3.50	1.82	2.25	1.78
2004	**DC3**	0.23	0.05	12.25	2.25	2.74	1.47	3.92	3.67
2005	**DC3**	0.29	0.18	15.04	1.34	3.08	1.52	3.20	1.81
2006	**DC3**	0.24	0.26	10.38	1.21	2.57	1.00	16.41	29.33
2007	**DC3**	0.32	0.24	9.06	1.03	3.14	1.36	5.37	7.11
2008	**DC3**	0.16	0.07	5.82	0.89	2.07	0.84	9.17	16.84
2009	**DC3**	0.26	0.20	5.70	1.58	4.88	2.12	17.14	10.39
2010	**DC3**	0.42	0.15	6.38	0.90	4.67	1.55	6.30	2.81
2011	**DC3**	0.42	0.30	7.43	1.85	5.59	2.69	0.53	0.89
2012	**DC3**	0.53	0.28	9.36	1.74	5.82	1.64	0.37	0.22
2010	**DC4**	0.95	0.35	15.31	3.29	7.49	2.52	1.77	1.53
2011	**DC4**	0.88	0.24	16.58	3.72	6.04	1.34	1.45	2.47
2012	**DC4**	1.39	0.21	15.75	2.47	7.17	1.72	2.34	1.27
2010	**DC5**	1.87	0.42	19.07	3.10	4.78	1.33	19.88	7.26
2011	**DC5**	1.90	0.33	20.06	4.09	6.69	2.21	6.59	2.76
2012	**DC5**	2.02	0.45	18.49	4.63	4.95	1.19	14.17	4.58

Appendix 2 Continued. Mean (±1SD) Broward county site (BC1, BC2, and BC3) data by year for stony coral, octocoral, sponge, and macroalgae percent cover.

Year	Site	Stony Coral Mean	Stony Coral SD	Octocoral Mean	Octocoral SD	Sponge Mean	Sponge SD	Macroalgae Mean	Macroalgae SD
2003	**BC1**	12.21	3.70	6.46	3.10	1.84	0.84	0.43	0.39
2004	**BC1**	11.81	3.92	6.45	1.26	2.11	1.01	2.30	1.23
2005	**BC1**	12.57	3.80	6.76	1.74	3.10	1.29	11.89	10.43
2006	**BC1**	13.07	3.66	6.70	1.25	3.62	0.78	8.07	6.64
2007	**BC1**	12.41	3.07	7.70	0.40	3.25	0.96	6.69	5.29
2008	**BC1**	11.87	4.35	6.08	0.63	3.60	1.18	12.69	4.47
2009	**BC1**	12.48	3.56	6.41	2.18	3.89	1.07	10.27	2.70
2010	**BC1**	11.75	3.19	8.42	1.72	3.55	1.19	10.98	5.39
2011	**BC1**	11.97	3.05	6.42	0.60	5.32	1.08	8.57	3.16
2012	**BC1**	12.95	2.53	7.45	0.84	3.40	0.76	18.54	7.84
2003	**BC2**	0.40	0.21	6.63	1.39	2.67	1.00	3.70	1.48
2004	**BC2**	0.44	0.24	6.89	0.91	3.27	1.34	1.92	0.83
2005	**BC2**	0.54	0.41	9.43	0.90	4.08	1.22	5.41	5.80
2006	**BC2**	0.39	0.22	6.37	2.46	5.05	1.72	12.13	11.55
2007	**BC2**	0.35	0.18	6.93	1.68	4.48	0.46	2.42	1.92
2008	**BC2**	0.36	0.24	6.32	0.68	5.06	0.61	2.48	1.64
2009	**BC2**	0.31	0.33	5.82	1.16	5.05	1.83	7.04	3.25
2010	**BC2**	0.44	0.27	5.35	0.99	5.44	2.90	3.25	1.94
2011	**BC2**	0.55	0.30	7.61	2.62	6.82	1.00	3.00	2.96
2012	**BC2**	0.54	0.41	6.08	0.97	5.32	0.85	9.94	5.66
2003	**BC3**	0.28	0.11	13.54	3.13	2.79	0.93	3.62	1.90
2004	**BC3**	0.35	0.14	15.99	1.36	3.64	0.60	1.74	1.15
2005	**BC3**	0.27	0.09	17.90	2.70	4.19	1.99	7.02	5.10
2006	**BC3**	0.51	0.16	14.06	2.84	4.30	1.57	34.64	26.00
2007	**BC3**	0.32	0.18	13.94	0.46	5.39	0.70	3.82	1.24
2008	**BC3**	0.23	0.16	10.35	0.70	4.39	0.38	14.90	12.12
2009	**BC3**	0.28	0.13	13.86	1.80	4.03	1.15	5.50	3.73
2010	**BC3**	0.20	0.07	15.14	3.22	6.86	2.88	5.30	3.18
2011	**BC3**	0.28	0.05	12.90	1.07	7.20	1.10	2.06	3.23
2012	**BC3**	0.42	0.14	14.97	1.58	8.65	2.64	2.07	1.36

Appendix 2 Continued. Mean (±1SD) Broward county site (BCA) data by year for stony coral, octocoral, sponge, and macroalgae percent cover.

Year	Site	Stony Coral Mean	Stony Coral SD	Octocoral Mean	Octocoral SD	Sponge Mean	Sponge SD	Macroalgae Mean	Macroalgae SD
2003	**BCA**	31.72	4.90	2.34	1.03	0.27	0.06	0.03	0.06
2004	**BCA**	39.63	3.57	2.03	0.25	0.47	0.29	0.96	1.37
2005	**BCA**	39.86	2.32	1.54	0.82	0.42	0.25	1.78	1.29
2006	**BCA**	25.35	2.79	1.35	0.86	1.10	0.63	6.75	10.11
2007	**BCA**	30.64	3.19	2.37	0.67	1.01	0.15	2.39	2.35
2008	**BCA**	30.69	1.95	1.48	0.58	0.74	0.16	2.44	2.72
2009	**BCA**	25.97	1.44	1.96	0.72	0.60	0.31	0.78	0.49
2010	**BCA**	20.16	2.88	2.16	0.72	1.25	0.43	3.31	3.17
2011	**BCA**	14.02	2.39	2.61	0.39	3.05	2.38	2.12	3.25
2012	**BCA**	15.44	4.12	2.16	0.64	1.67	1.27	3.37	4.30

Appendix 2 Continued. Mean (±1SD) Palm Beach county site (PB1, PB2, PB3, PB4, and PB5) data by year for stony coral, octocoral, sponge, and macroalgae percent cover.

Year	Site	Stony Coral Mean	Stony Coral SD	Octocoral Mean	Octocoral SD	Sponge Mean	Sponge SD	Macroalgae Mean	Macroalgae SD
2003	**PB1**	0.97	0.66	2.70	0.93	10.29	2.34	0.10	0.13
2004	**PB1**	0.86	0.66	2.88	1.94	9.82	2.46	1.39	0.96
2005	**PB1**	0.14	0.28	0.03	0.06	0.17	0.35	0.84	1.48
2006	**PB1**	0.38	0.76	0.00	0.00	0.14	0.28	3.85	4.55
2007	**PB1**	0.16	0.19	0.07	0.14	0.23	0.35	0.03	0.04
2008	**PB1**	0.11	0.15	0.05	0.08	0.50	0.75	0.80	0.75
2009	**PB1**	0.22	0.28	0.09	0.13	0.72	0.95	0.97	0.97
2010	**PB1**	0.26	0.28	0.02	0.04	0.80	0.98	1.02	2.04
2011	**PB1**	0.35	0.44	0.00	0.00	1.14	1.05	0.07	0.08
2012	**PB1**	0.22	0.24	0.14	0.16	1.12	1.35	0.50	0.49
2003	**PB2**	1.79	1.07	27.32	10.11	3.53	0.94	0.00	0.00
2004	**PB2**	1.80	1.44	31.20	11.27	4.15	1.59	0.26	0.45
2005	**PB2**	1.60	1.11	27.49	8.60	2.89	0.67	0.72	1.20
2006	**PB2**	1.78	0.71	23.40	11.96	4.90	1.24	12.39	18.06
2007	**PB2**	1.85	1.34	25.30	14.38	6.57	1.86	1.76	1.78
2008	**PB2**	1.87	1.30	23.13	12.81	5.62	1.04	3.09	3.87
2009	**PB2**	1.77	1.19	22.26	10.74	7.02	0.49	0.39	0.50
2010	**PB2**	1.91	0.72	27.45	11.34	7.95	2.27	2.67	2.07
2011	**PB2**	1.46	1.04	19.95	8.54	6.74	2.65	1.48	1.02
2012	**PB2**	1.75	1.00	20.89	9.68	8.03	1.81	0.33	0.37
2003	**PB3**	1.02	0.38	30.34	4.16	10.46	4.80	0.27	0.18
2004	**PB3**	1.03	0.22	29.84	3.59	8.87	3.31	2.54	0.70
2005	**PB3**	0.95	0.27	24.98	7.69	9.51	3.88	1.45	2.04
2006	**PB3**	0.97	0.19	19.61	3.62	9.32	3.36	7.55	3.94
2007	**PB3**	1.18	0.72	21.32	4.44	14.76	5.03	0.72	0.56
2008	**PB3**	1.25	0.51	21.13	5.28	12.67	3.72	4.60	2.23
2009	**PB3**	1.23	0.38	17.72	3.51	13.13	0.83	1.74	2.31
2010	**PB3**	1.13	0.31	20.37	4.73	13.92	2.42	2.63	2.66
2011	**PB3**	1.18	0.48	20.35	6.92	14.45	3.12	4.17	1.09
2012	**PB3**	1.39	0.56	15.21	3.87	13.30	1.11	1.87	0.95
2010	**PB4**	1.20	0.33	23.35	6.58	12.88	5.25	3.04	1.17
2011	**PB4**	1.39	0.44	20.57	2.45	15.44	5.73	1.75	1.08
2012	**PB4**	1.71	0.63	19.38	3.67	13.84	4.15	0.77	0.66
2010	**PB5**	1.20	0.25	23.91	1.43	10.20	3.05	11.90	5.71
2011	**PB5**	1.30	0.42	26.70	3.37	13.65	1.84	0.58	0.55
2012	**PB5**	1.59	0.49	23.91	1.75	11.47	3.39	1.55	2.08

Appendix 2 Continued. Mean (±1SD) Martin county site (MC1 and MC2) data by year for stony coral, octocoral, sponge, and macroalgae percent cover.

Year	Site	Stony Coral Mean	Stony Coral SD	Octocoral Mean	Octocoral SD	Sponge Mean	Sponge SD	Macroalgae Mean	Macroalgae SD
2006	**MC1**	1.58	1.06	0.01	0.03	1.06	0.38	34.54	23.51
2007	**MC1**	2.11	1.51	0.01	0.02	1.39	0.75	42.66	5.14
2008	**MC1**	2.01	1.81	0.01	0.02	1.14	0.62	36.84	9.84
2009	**MC1**	2.20	1.79	0.01	0.02	1.09	0.22	33.10	12.99
2010	**MC1**	1.97	1.46	0.13	0.11	2.76	2.10	34.51	9.24
2011	**MC1**	2.35	1.29	0.15	0.29	3.05	1.38	21.93	10.81
2012	**MC1**	2.19	1.58	0.12	0.15	1.97	0.53	33.41	11.23
2006	**MC2**	1.03	0.50	0.01	0.03	2.63	1.14	41.99	17.00
2007	**MC2**	0.95	0.50	0.00	0.00	3.03	1.32	57.05	11.72
2008	**MC2**	0.90	0.34	0.02	0.02	2.35	0.54	44.96	13.08
2009	**MC2**	0.96	0.35	0.03	0.03	3.05	0.93	43.82	9.93
2010	**MC2**	0.82	0.24	0.05	0.07	3.77	1.95	45.52	19.93
2011	**MC2**	0.77	0.31	0.00	0.00	5.31	1.57	21.62	8.38

Appendix 3. Model estimation of change in stony coral, octocoral, sponge, and macroalgae percent cover per year (±1SE) by site from 2003 to 2012. Linear trends correspond to the time series presented in Figure 8. Significant trends in cover– increasing (↑), decreasing (↓), or unchanged (↔) - are bolded (R= region-wide comparison; BC = Broward County; DC = Miami-Dade County; PB = Palm Beach County; MC = Martin County).

Variable	Level	Est.	SE	DF	t	p	Trend	Max (Yr)	Min (Yr)
Stony Coral	R	-0.002	0.001	421.635	-1.770	0.078	↔	5.9 (05)	3.1 (11)
	DC1	0.003	0.003	241.205	1.031	0.303	↔	3.82 (12)	2.40 (03)
	DC2	0.001	0.003	241.205	0.416	0.678	↔	0.76 (06)	0.46 (05)
	DC3	0.003	0.003	241.205	0.864	0.389	↔	0.53 (12)	0.16 (08)
	BC1	0.001	0.003	241.205	0.237	0.813	↔	13.07 (06)	11.75 (10)
	BC2	0.001	0.003	241.205	0.180	0.857	↔	0.55 (11)	0.31 (09)
	BC3	0.000	0.003	241.205	0.070	0.944	↔	0.51 (06)	0.20 (10)
	BCA	**-0.025**	**0.003**	**241.205**	**-8.472**	**0.000**	↓	39.86 (05)	14.02 (11)
	PB1	-0.005	0.003	252.305	-1.859	0.064	↔	0.97 (03)	0.11 (03)
	PB2	0.000	0.003	241.205	-0.046	0.963	↔	1.91 (10)	1.46 (11)
	PB3	0.002	0.003	241.205	0.552	0.582	↔	1.39 (12)	0.95 (05)
	MC1	0.003	0.004	245.586	0.712	0.477	↔	2.35 (11)	1.57 (06)
	MC2	-0.002	0.004	245.586	-0.582	0.561	↔	1.03 (06)	0.77 (11)
Octocoral	R	**-0.004**	**0.002**	**396.872**	**-2.361**	**0.019**	↓	**12.6 (04)**	**7.1 (08)**
	DC1	0.009	0.004	180.894	2.074	0.040	↔	11.38 (12)	5.86 (03)
	DC2	0.002	0.004	180.894	0.516	0.607	↔	19.74 (11)	10.40 (09)
	DC3	**-0.013**	**0.004**	**180.894**	**-3.016**	**0.003**	↓	15.48 (03)	5.70 (09)
	BC1	0.002	0.004	180.894	0.486	0.628	↔	8.42 (10)	6.08 (08)
	BC2	-0.002	0.004	180.894	-0.483	0.630	↔	9.43 (05)	5.35 (10)
	BC3	-0.001	0.004	180.894	-0.239	0.811	↔	17.90 (05)	10.35 (08)
	BCA	0.001	0.004	180.894	0.262	0.794	↔	2.61 (11)	1.35 (06)
	PB1	**-0.015**	**0.004**	**188.327**	**-3.646**	**0.000**	↓	2.88 (04)	0.0 (11)
	PB2	-0.009	0.004	180.894	-2.138	0.034	↔	31.20 (04)	19.95 (11)
	PB3	**-0.016**	**0.004**	**180.894**	**-3.782**	**0.000**	↓	30.34 (03)	15.21 (12)
	MC1	0.004	0.006	196.575	0.644	0.520	↔	0.15 (11)	0.01 (09)
	MC2	0.002	0.006	196.575	0.295	0.768	↔	0.06 (12)	0.0 (11)

Appendix 3 Continued.

Variable	Level	Est.	SE	DF	t	p	Trend	Max (Yr)	Min (Yr)
Sponge	R	**0.007**	**0.002**	**95.213**	**3.873**	**0.000**	↑	**5.8 (11)**	**3.3 (05)**
	DC1	**0.012**	**0.004**	**125.943**	**2.881**	**0.005**	↑	4.23 (11)	0.85 (03)
	DC2	0.007	0.004	125.943	1.846	0.067	↔	7.84 (12)	4.02 (04)
	DC3	0.008	0.004	125.943	2.032	0.044	↔	5.82 (12)	2.07 (08)
	BC1	0.007	0.004	125.943	1.764	0.080	↔	5.32 (11)	1.84 (03)
	BC2	0.008	0.004	125.943	2.058	0.042	↔	6.82 (11)	2.67 (03)
	BC3	**0.012**	**0.004**	**125.943**	**2.999**	**0.003**	↑	8.65 (12)	2.79 (03)
	BCA	0.009	0.004	125.943	2.259	0.026	↔	3.05 (11)	0.27 (03)
	PB1	**-0.021**	**0.004**	**126.816**	**-5.349**	**0.000**	↓	10.29 (03)	0.14 (06)
	PB2	**0.011**	**0.004**	**125.943**	**2.868**	**0.005**	↑	8.03 (12)	2.89 (05)
	PB3	0.009	0.004	125.943	2.177	0.031	↔	14.76 (07)	8.87 (04)
	MC1	0.010	0.007	118.302	1.441	0.152	↔	3.05 (11)	1.06 (06)
	MC2	0.007	0.007	118.302	1.073	0.286	↔	5.31 (11)	2.35 (08)
Macroalgae	R	0.007	0.005	108.227	1.434	0.154	↔	19.3 (06)	3.4 (03)
	DC1	-0.019	0.010	85.816	-1.982	0.051	↔	31.44 (11)	3.70 (12)
	DC2	-0.012	0.010	85.816	-1.214	0.228	↔	20.50 (06)	0.50 (09)
	DC3	-0.005	0.010	85.816	-0.510	0.611	↔	17.14 (09)	0.37 (12)
	BC1	**0.028**	**0.010**	**85.816**	**2.823**	**0.006**	↑	18.54 (12)	0.43 (03)
	BC2	0.004	0.010	85.816	0.459	0.647	↔	12.13 (06)	1.92 (04)
	BC3	-0.009	0.010	85.816	-0.917	0.362	↔	34.64 (06)	1.74 (04)
	BCA	0.009	0.010	85.816	0.891	0.375	↔	6.75 (06)	0.03 (03)
	PB1	-0.004	0.010	86.714	-0.411	0.682	↔	3.85 (06)	0.03 (07)
	PB2	0.005	0.010	85.816	0.478	0.634	↔	12.39 (06)	0.0 (03)
	PB3	0.006	0.010	85.816	0.585	0.560	↔	7.55 (06)	0.27 (03)
	MC1	-0.014	0.017	86.659	-0.818	0.416	↔	42.66 (07)	21.93 (11)
	MC2	-0.016	0.017	86.659	-0.981	0.329	↔	57.05 (07)	21.62 (11)

Appendix 4. Functional group mean percent coverage 2003-2012. (BC = Broward County; DC = Miami-Dade County; PB = Palm Beach County; MC = Martin County) (Sub = substrate, SC = stony coral, Oct = octocoral, MA = macroalgae, Por = porifera, and Zoa = zoanthid).

Site	Year	Sub	SC	Oct	MA	Por	Zoa
DC1	2003	72.21	2.40	5.86	13.32	0.85	5.36
	2004	53.04	2.60	7.31	31.44	1.08	4.57
	2005	69.10	2.80	7.96	12.80	1.54	5.77
	2006	71.02	3.00	7.67	10.25	2.09	5.89
	2007	57.58	2.50	10.35	20.32	3.42	5.57
	2008	57.67	2.50	7.30	23.19	2.84	5.73
	2009	72.56	2.80	8.26	8.08	2.24	5.98
	2010	70.13	2.90	7.97	10.23	3.11	5.43
	2011	64.19	2.60	11.18	10.54	4.23	6.44
	2012	0.71	0.04	0.11	0.04	0.04	0.06
DC2	2003	69.56	0.60	14.67	9.97	5.14	0.03
	2004	79.50	0.50	11.54	3.26	4.02	0.05
	2005	78.46	0.50	15.90	1.12	4.03	0.01
	2006	61.69	0.80	12.15	20.50	4.81	0.01
	2007	77.82	0.70	12.41	3.60	5.35	0.01
	2008	67.38	0.70	12.83	12.23	5.31	0.03
	2009	83.34	0.70	10.40	0.50	5.03	0.02
	2010	75.71	0.70	12.75	4.75	5.95	0.02
	2011	63.80	0.60	19.74	4.10	7.69	0.05
	2012	0.75	0.01	0.14	0.02	0.08	0.00
DC3	2003	78.48	0.20	15.48	2.25	3.50	0.00
	2004	78.20	0.20	12.25	3.92	2.74	0.00
	2005	76.72	0.30	15.04	3.20	3.08	0.01
	2006	70.01	0.20	10.38	16.41	2.57	0.01
	2007	79.46	0.30	8.96	5.06	2.99	0.00
	2008	71.02	0.10	5.92	9.18	1.91	0.00
	2009	68.71	0.30	5.70	17.14	4.88	0.00
	2010	73.56	0.40	6.38	6.30	4.67	0.00
	2011	57.93	0.40	7.43	0.53	5.59	0.00
	2012	0.83	0.01	0.09	0.00	0.06	0.00
DC4	2010	74.39	1.00	15.31	1.77	7.49	0.03
	2011	67.35	0.90	16.58	1.45	6.04	0.08
	2012	0.73	0.01	0.16	0.02	0.07	0.00
DC5	2010	52.62	1.90	19.07	19.88	4.78	1.75
	2011	61.13	1.90	20.06	6.59	6.69	2.49
	2012	0.57	0.02	0.18	0.14	0.05	0.02

Appendix 4 Continued.

Site	Year	Sub	SC	Oct	MA	Por	Zoa
BCA	2003	64.96	31.70	2.34	0.03	0.27	0.68
	2004	55.85	39.60	2.03	0.96	0.47	0.84
	2005	55.60	39.90	1.54	1.78	0.42	0.78
	2006	64.95	25.40	1.35	6.75	1.10	0.50
	2007	62.53	31.00	2.30	2.51	0.96	0.54
	2008	63.82	30.80	1.40	2.54	0.65	0.68
	2009	70.20	26.00	2.00	0.77	0.60	0.46
	2010	71.97	20.20	2.16	3.31	1.25	0.44
	2011	76.65	14.00	2.61	2.12	3.05	0.38
	2012	0.76	0.15	0.02	0.03	0.02	0.00
BC1	2003	77.37	12.20	6.46	0.43	1.84	1.68
	2004	73.21	11.80	6.41	4.04	1.99	1.40
	2005	63.97	12.60	6.76	11.89	3.10	1.38
	2006	66.72	13.10	6.70	8.07	3.62	1.71
	2007	68.59	12.50	7.48	6.77	3.25	1.31
	2008	64.30	11.80	6.33	12.57	3.64	1.20
	2009	65.03	12.50	6.41	10.27	3.89	1.31
	2010	63.18	11.80	8.42	10.98	3.55	1.69
	2011	65.84	12.00	6.42	8.57	5.32	1.69
	2012	0.55	0.13	0.07	0.19	0.03	0.02
BC2	2003	86.58	0.40	6.63	3.70	2.67	0.00
	2004	87.09	0.40	6.89	1.92	3.27	0.14
	2005	80.39	0.50	9.43	5.41	4.08	0.08
	2006	76.03	0.40	6.37	12.13	5.05	0.03
	2007	85.96	0.30	6.92	2.56	4.12	0.05
	2008	85.42	0.30	6.14	2.66	5.12	0.02
	2009	78.74	0.30	5.82	7.04	5.05	0.08
	2010	85.23	0.40	5.35	3.25	5.44	0.07
	2011	77.43	0.60	7.61	3.00	6.82	0.15
	2012	0.77	0.01	0.06	0.10	0.05	0.00
BC3	2003	79.76	0.30	13.54	3.62	2.79	0.00
	2004	78.20	0.40	15.99	1.74	3.64	0.03
	2005	70.52	0.30	17.90	7.01	4.18	0.00
	2006	46.46	0.50	14.06	34.64	4.30	0.00
	2007	76.42	0.30	13.89	3.73	5.48	0.00
	2008	70.05	0.30	10.08	15.24	4.30	0.00
	2009	75.21	0.30	13.86	5.50	4.02	0.00
	2010	72.38	0.20	15.14	5.30	6.86	0.01
	2011	76.71	0.30	12.90	2.06	7.20	0.00
	2012	0.71	0.00	0.15	0.02	0.09	0.00

Appendix 4 Continued.

Site	Year	Sub	SC	Oct	MA	Por	Zoa
PB1	2003	83.54	1.00	2.70	0.10	10.29	0.55
	2004	82.55	0.90	2.88	1.39	9.82	0.78
	2005	98.09	0.10	0.03	0.84	0.17	0.02
	2006	95.44	0.40	0.00	3.85	0.14	0.00
	2007	97.87	0.20	0.05	0.03	0.23	0.00
	2008	95.87	0.10	0.03	0.83	0.55	0.00
	2009	96.17	0.20	0.09	0.97	0.72	0.00
	2010	96.50	0.30	0.02	1.02	0.80	0.01
	2011	97.10	0.40	0.00	0.07	1.14	0.00
	2012	0.96	0.00	0.00	0.00	0.01	0.00
PB2	2003	67.23	1.80	27.32	0.00	3.53	0.09
	2004	61.92	1.80	31.20	0.26	4.15	0.05
	2005	67.13	1.60	27.49	0.72	2.89	0.08
	2006	57.28	1.80	23.40	12.39	4.90	0.24
	2007	64.30	1.80	25.44	1.80	6.46	0.11
	2008	65.76	1.90	23.00	3.12	5.51	0.09
	2009	67.50	1.80	22.26	0.39	7.02	0.19
	2010	59.41	1.90	27.45	2.67	7.95	0.07
	2011	67.50	1.50	19.95	1.48	6.74	0.06
	2012	0.49	0.02	0.21	0.00	0.08	0.00
PB3	2003	55.37	1.00	30.34	0.27	10.46	1.36
	2004	55.69	1.00	29.84	2.54	8.87	1.20
	2005	61.12	1.00	24.98	1.45	9.51	1.02
	2006	61.18	1.00	19.61	7.55	9.32	1.20
	2007	59.23	1.30	21.30	0.75	14.41	1.46
	2008	57.23	1.20	20.97	4.69	12.42	1.25
	2009	58.96	1.20	17.72	1.73	13.14	1.50
	2010	56.18	1.10	20.37	2.63	13.92	1.13
	2011	54.49	1.20	20.35	4.17	14.45	1.31
	2012	0.49	0.01	0.15	0.02	0.13	0.02
PB4	2010	57.73	1.20	23.35	3.04	12.88	0.38
	2011	57.10	1.40	20.57	1.75	15.44	0.59
	2012	0.27	0.02	0.19	0.01	0.14	0.00
PB5	2010	52.03	1.20	23.91	11.90	10.20	0.70
	2011	53.30	1.30	26.70	0.58	13.65	0.69
	2012	0.60	0.02	0.24	0.02	0.11	0.01

Appendix 4 Continued.

Site	Year	Sub	SC	Oct	MA	Por	Zoa
MC1	2006	61.89	1.60	0.01	34.54	1.06	0.66
	2007	52.72	2.20	0.01	42.33	1.38	1.00
	2008	58.58	2.10	0.01	37.10	1.05	1.05
	2009	62.58	2.20	0.01	33.10	1.09	0.82
	2010	59.36	2.00	0.13	34.51	2.76	0.97
	2011	70.95	2.40	0.15	21.93	3.05	1.03
	2012	0.60	0.02	0.00	0.33	0.02	0.01
MC2	2006	53.20	1.00	0.01	41.99	2.63	1.08
	2007	38.20	0.90	0.00	56.86	2.89	0.95
	2008	50.58	0.80	0.02	44.85	2.47	1.05
	2009	50.82	1.00	0.03	43.82	3.05	1.06
	2010	48.74	0.80	0.05	45.52	3.77	0.80
	2011	70.95	0.80	0.00	21.62	5.31	0.98
	2012	0.44	0.01	0.00	0.50	0.03	0.01