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Southeast Florida Coral Reef Evaluation and Monitoring Project 2011 Year 9 Final Report

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Southeast Florida Coral Reef Evaluation and Monitoring Project

Land-Based Sources of Pollution
Southeast Florida Coral Reef Initiative
Local Action Strategy Project 12

DEPARTMENT OF ENVIRONMENTAL PROTECTION
FLORIDA

Southeast Florida Coral Reef Evaluation and Monitoring Project

2011 Year 9 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 of the southeast Florida (Miami-Dade, Broward, Palm Beach, and Martin counties) reef system. SECREMP assessments have been conducted annually at fixed sites since 2003 and data collected provides local, state, and federal resource managers information on the temporal changes in benthic cover and diversity of stony corals and associated marine benthic groups. Findings presented in this report include data from 17 SECREMP monitoring sites. The core field methods include underwater videography and timed coral species inventories conducted at 16 of the 17 sites. The report describes the annual differences (between 2010 and 2011) in the percent cover of major benthic taxa (stony corals, octocorals, sponges, and macroalgae), mean coral species richness and the incidence of stony coral conditions. Additionally, it examines the long-term trends of the major benthic taxa from data collected through 2010.

Stony coral species richness and cover are very similar across years. In 2011, a total of 28 stony coral species were identified within the 16 standard SECREMP sites. No new species were identified. The incidence of disease in 2011 (13 colonies) was not high and was much less than the high of 46 colonies identified in 2007. Coral diseases do not appear to be a major factor affecting stony coral condition or cover in the SECREMP sites, especially since the presence of 'disease' within the sites is primarily in *S. siderea* colonies (23 of the 31 colonies in 2009, eight of 10 in 2010, and 10 of 13 in 2011).

The comparison of 2010 and 2011 data did show annual differences in the percent cover of stony corals, octocorals, sponges and macroalgae at some sites. In 2011, two sites had significantly reduced stony coral cover in 2011 compared to 2010, BCA (20.2% in 2010 and 14.0% in 2011) and PB2 (1.9% in 2010 and 1.5% in 2011). As seen in previous monitoring years, octocorals, and sponges were the biota functional groups which contributed most to benthic cover. Octocoral cover was determined to be significantly greater in 2011 compared to 2010 at sites BC2 (5.4% in 2010 and 7.6% in 2011), DC1 (8.0% in 2010 and 11.2% in 2011), and DC2 (12.8% in 2010 and 19.7% in 2011). BCA was the only site with significant difference in sponge cover between 2010 and 2011, exhibiting a significant increase in cover from 2010 to 2011 (1.3% and 3.1%, respectively). Three sites had a significant decrease in macroalgae from 2010 to 2011, DC3 (6.3% and 0.5%, respectively), DC5 (19.9% and 6.6%, respectively), and PB5 (11.9% and 0.6%, respectively). Also of note in 2011, 10 sites had increased other biota (cyanobacteria) cover compared to 2010.

With nine years of data, in general, the status (as defined by percent cover of stony corals, octocorals, sponges, and macroalgae) of the southeast Florida reef system has changed little from 2003 to 2011. The long term trend analysis

completed for years 2003 through 2010 did not indicate change in cover at most sites. A few sites, however, have shown significant changes in functional group cover, including BCA and PB1, which have significantly decreased in stony coral cover since 2003. Three sites PB1, PB2, and PB3, have decreased in octocoral cover since project inception, while three sites DC1, PB2, and PB3 have increased in sponge cover. Similar to the trends for stony corals and octocorals at PB1, sponge cover has also significantly declined at this site. The long-term analysis indicated that macroalgal cover had not changed at any site between 2003 and 2010 except BC1 which exhibited a significant increasing trend.

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 site-specific monitoring are necessary if resource managers are to develop sound management plans for coral reefs that permit continued use, and realization of the economic value, of these fragile marine ecosystems.

As a monitoring project under the Coral Reef Conservation Grant Program for the Florida southeast coast, the SECREMP will continue characterization of baseline ecosystem condition, inventory/mapping of biotic resources, and data base development, providing resource managers with the critical information required to manage this valuable natural resource.

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 coral reef research and long-term 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). In 1999, the project was expanded to include sites in the Dry Tortugas.

In 2003, CREMP was further expanded to include 10 sites offshore 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 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. SECREMP also complements the goals of the National Monitoring Network to monitor a minimum suite of parameters at sites in the network. These efforts will assist the National Monitoring Network in building its capacity to archive biotic attributes of coral reef ecosystems nationwide. To date, nine years (2003-2011) of SECREMP sampling have been completed.

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 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 6 to 8 m. 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).

Most previous and current monitoring efforts (e.g., Gilliam et al. 2011) 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.

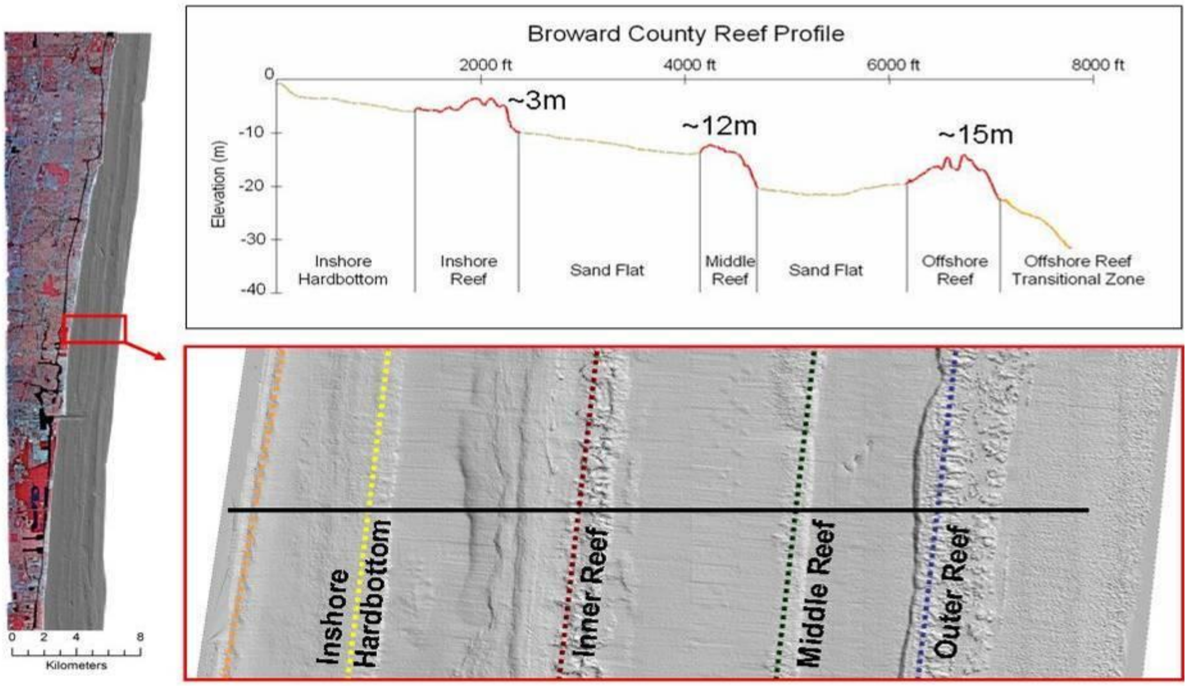

Figure 1. Panel A (at left): View of the southeast Florida coastline of Broward County, showing the land area in red and offshore reefs in gray. Panel B (bottom right): The sea floor shown is bathymetry from LIDAR data. The red square is enlarged in Panel B, showing the LIDAR bathymetry in greater detail. The black line shows the location of a bathymetric profile illustrated in Panel C (top right).

Beginning in 1997, in response to beach renourishment efforts in Broward County, annual collection of environmental data (sedimentation quantities and rates and limited temperature measurements), and coral species cover, sponge cover, and fish abundance data has been conducted at 18 sites. In 2000, Nova Southeastern University (NSU) assumed this monitoring responsibility from the County and added five new sites. In 2003, two additional sites were added. Monitoring of these 25 sites has been conducted annually from 1997 to 2011 (Gilliam et al. 2011).

Previous reef habitat monitoring off Miami-Dade and Palm Beach counties has been short term, localized, and of little use in evaluating the overall health and condition of the northern extension of the Florida Reef Tract. Estimates of functional group (stony coral, octocoral, sponge, macroalgae, etc.) cover are available from some local areas such as those in Broward County, but to a large extent, cover throughout the southeast Florida reefs has been poorly defined. Because the area has few long-term data sets on abundance and/or cover for benthic components, it has been difficult to provide scientifically valid information on status and trends for this reef system.

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, and National Monitoring Network protocols, the FDEP contracted this work to the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWC-FWRI).

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 annual input for southeast Florida at over 5.7 billion dollars (Johns et al. 2003, 2004). The uniqueness, proximity and value of southeast Florida's reefs to the community demand sustained monitoring and increased investigations into limiting environmental/ecological processes. The goal of SECREMP is to provide local, state, and federal resource managers an annual report on the status/condition of the southeast Florida (Miami-Dade, Broward, Palm Beach, and Martin counties) reef system. These annual reports also provide these same 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 independent of marine construction activities and is not tied to the geographic or temporal constraints of those activities.

Project Planning and Monitoring Site Selection and Sampling

During Year 1 (2003) of the project, National Coral Reef Institute (NCRI) worked closely with FWC-FWRI and representatives from Miami-Dade, Broward, and Palm Beach Counties on site selection. In addition, NCRI worked with FWRI on methods training and site sampling. NCRI was responsible for managing and completing the sampling efforts for Years 2 (2004) through 9 (2011) in consultation with FWC-FWRI and FDEP.

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). Expanding upon the overall SECREMP goal of providing reef monitoring data for the southeast Florida reef system, sites offshore SLIPSP are providing coral community monitoring data from this area as St. Lucie River water discharge changes occur, associated with Everglades restoration efforts. Researchers and managers from NCRI, FWC-FWRI, FWC, FDEP, and the State Park were involved in all Martin County planning discussions.

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. These four new sites were first sampled in 2010 and serve the SECREMP goal of providing resource managers with reef monitoring data by increasing spatial coverage and providing much needed information on large, important reef features throughout the southeast Florida reef system. Researchers and managers from NCRI, FWC-FWRI, FWC, and FDEP's Office of Coastal and Aquatic Managed Areas (CAMA) worked together in choosing the location of these four new sites.

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 depths and locations of each of the SECREMP sites, and Table 2 provides the date sampling was completed at each site for each year.

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 a station species inventory (SSI), three video transects (100, 300, and 500), and stony coral colony fate tracking (Figure 3).

All transects, delineated with fiberglass tapes, are filmed with a SONY TRV 900 digital video camcorder. Two lasers converge 40 cm from the camera lens and guide the researcher in maintaining the camera at a uniform distance above the reef surface. Filming is conducted perpendicular to the substrate at a constant swim speed of about 4 meters per minute.

Table 1. Monitoring site locations and depths (BC = Broward County; DC = Miami-Dade County; PB = Palm Beach County; MC = Martin County) (* indicates new sites sampled in 2010).

Site Code	Depth (ft)	Latitude (N)	Longitude (W)
BCA	25	26° 08.985′	80° 05.810′
BC1	25	26° 08.872′	80° 05.758′
BC2	40	26° 09.597′	80° 04.950′
BC3	55	26° 09.518′	80° 04.641′
DC1	25	25° 50.530′	80° 06.242′
DC2	45	25° 50.520′	80° 05.704′
DC3	55	25° 50.526′	80° 05.286′
*DC4	41	25° 40.357′	80° 05.301′
*DC5	24	25° 39.112′	80° 05.676′
PB1	25	26° 42.583′	80° 01.714′
PB2	55	26° 40.710′	80° 01.095′
PB3	55	26° 42.626′	80° 00.949′
*PB4	55	26° 29.268′	80° 02.345′
*PB5	55	26° 26.504′	80° 02.854′
MC1	15	27° 07.900′	80° 08.042′
MC2	15	27° 06.722′	80° 07.525′
MC3	15	27° 07.236′	80° 07.633′

All transect videos are taken on the east side of the transect tapes. The minimum number of digital images necessary to represent each station are framegrabbed and then written to, and archived on, CD-ROM.

Analysis of benthic cover images is predicated on selecting video frames that abut, with minimal overlap between images. At a filming distance of 40 cm above the reef surface, the field of view is approximately 40 cm wide. A set of abutting images that best covers the station is grabbed directly from the video tape.

The image analyses are conducted using a custom software application, PointCount ‘99, for coral reefs. The software places 15 random points on each image. Under each point, selected benthic taxa (stony coral species, octocoral, zoanthid, sponge, seagrass, and macroalgae) and substrate are identified. The software has a “point and click” feature that feeds the identification data into a backend spreadsheet. After all images are analyzed, the data are converted to an ASCII file for Quality Assurance and entry into a master ACCESS data set.

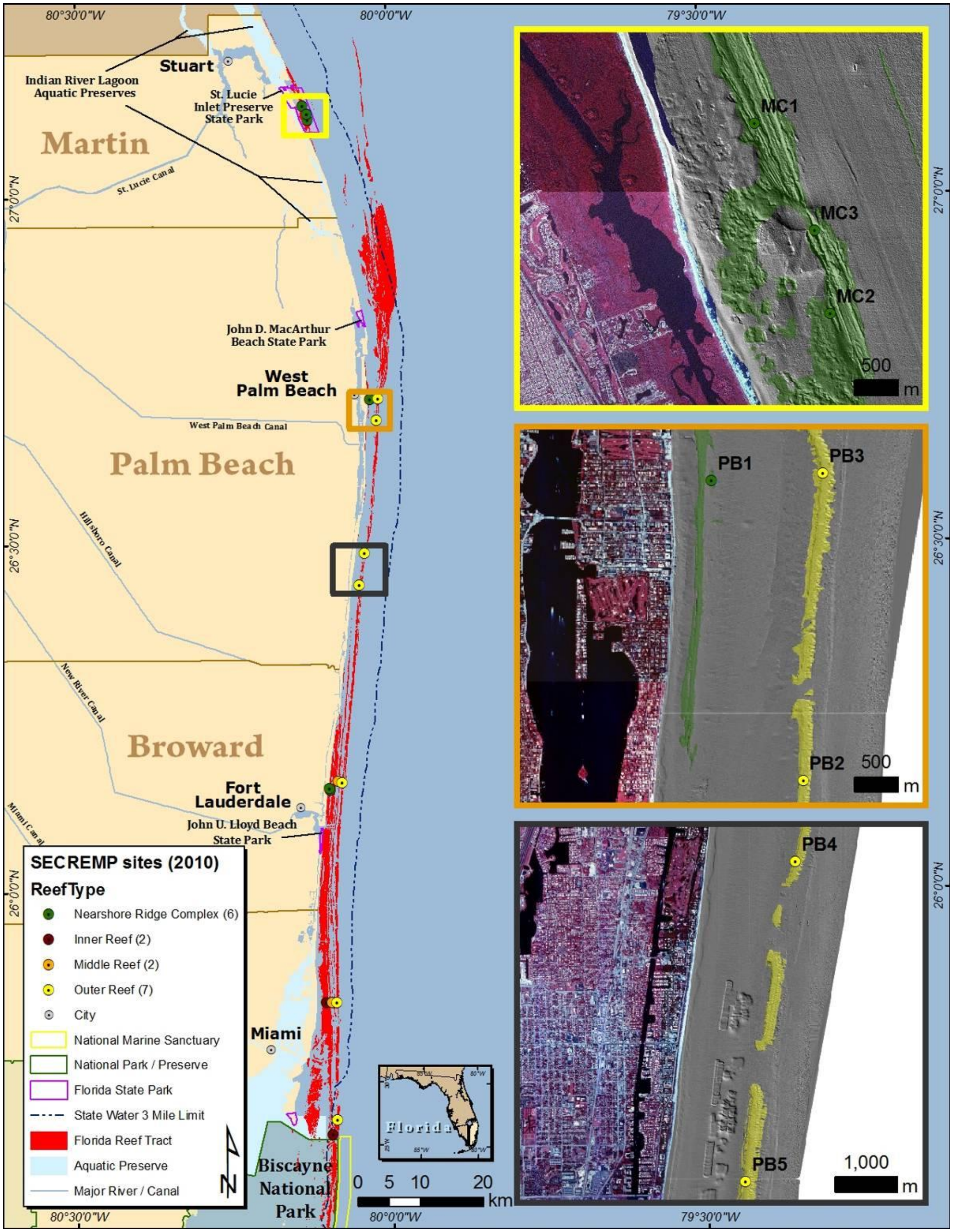

Figure 2a. Map of the 17 SECREMP sites illustrating their locations offshore southeast Florida and insert boxes showing the locations of the Palm Beach and Martin Counties sites.

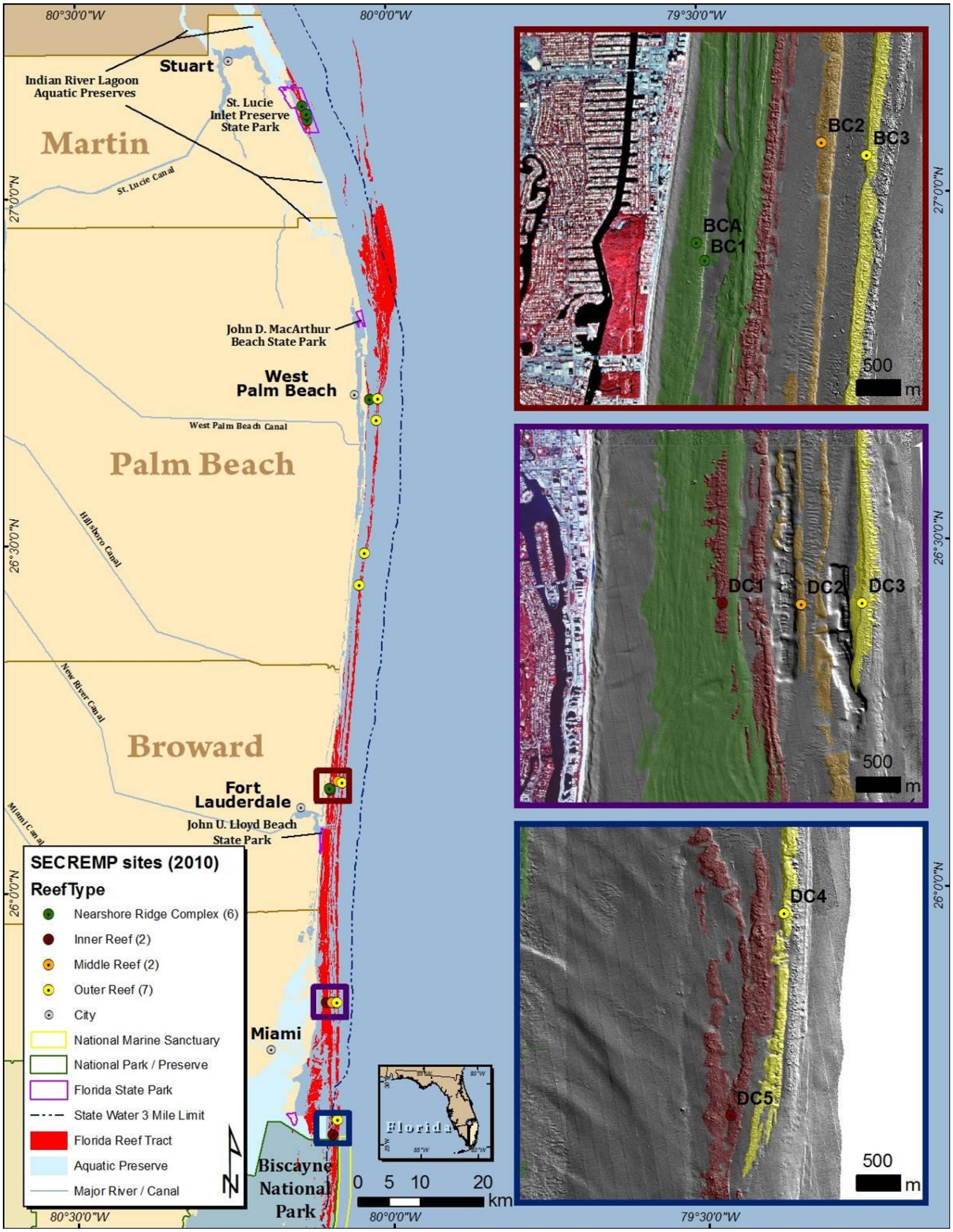

Figure 2b. Map of the 17 SECREMP sites illustrating their locations offshore southeast Florida and insert boxes showing the locations of the Miami-Dade and Broward sites.

Table 2. Site sample dates (see Table 1 for county abbreviations, NA = no data collection because sites were not yet established).

Site Code	2003 Yr 1	2004 Yr 2	2005 Yr 3	2006 Yr 4	2007 Yr 5	2008 Yr 6	2009 Yr 7	2010 Yr 8	2011 Yr 9
BCA	5-19-03	5-06-04	6-08-05 6-30-05	6-16-06	6-14-07	6-10-08	6-19-09	6-03-10	6-17-11
BC1	5-17-03	6-14-04	5-27-05	6-16-06	6-04-07 6-13-07	5-23-08 6-20-08	7-6-09	5-27-10	7-12-11
BC2	6-18-03	6-03-04	6-30-05	6-18-06	6-04-07	5-23-08	7-6-09	6-03-10	9-21-11
BC3	6-18-03	6-09-04	6-08-05	6-27-06	6-13-07	6-20-08	7-14-09	5-27-10	7-12-11
DC1	6-24-03	6-15-04	7-15-05 8-10-05	7-07-06 8-04-06	6-05-07 8-14-07	7-25-08	6-08-09 6-09-09	6-02-10	8-09-11 8-15-11
DC2	6-24-03	6-15-04	7-15-05	8-04-06	6-05-07	7-25-08	6-09-09	7-27-10	8-15-11
DC3	6-23-03	6-04-04	8-10-05	7-07-06	8-14-07	7-15-08	6-08-09	6-02-10	8-09-11
DC4	NA	NA	NA	NA	NA	NA	NA	6-07-10	8-08-11
DC5	NA	NA	NA	NA	NA	NA	NA	6-07-10	8-08-11
PB1	8-20-03	7-21-04	7-29-05	6-21-06	7-19-07	8-07-08	8-05-09	7-01-10	6-21-11 6-22-11
PB2	8-18-03	7-21-04	7-28-05	6-21-06	7-18-07	8-05-08	8-04-09	6-30-10	6-22-11
PB3	8-19-03	7-22-04	7-27-05	6-22-06	7-17-07	8-06-08	9-22-09	6-29-10	6-21-11
PB4	NA	NA	NA	NA	NA	NA	NA	6-28-10	6-20-11 6-23-11
PB5	NA	NA	NA	NA	NA	NA	NA	7-30-10	9-14-11
MC1	NA	NA	NA	5-31-06	7-30-07	5-20-08	6-03-09	6-15-10	5-24-11
MC2	NA	NA	NA	5-31-06	7-30-07	5-21-08	6-03-09	6-03-10	5-24-11
MC3	NA	NA	NA	9-28-06	7-31-07	5-21-08	6-04-09	6-16-10	5-20-11

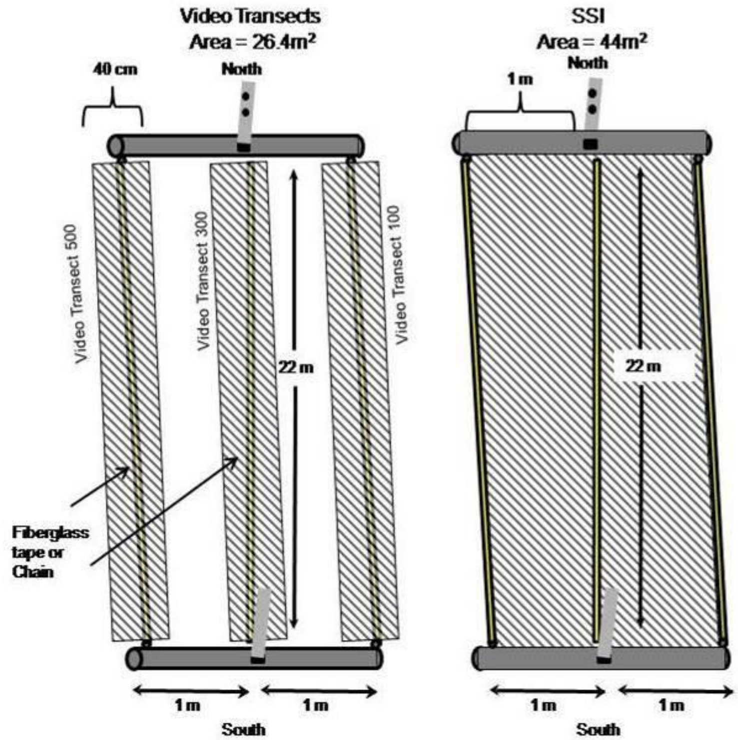

Figure 3. Typical layout of each SECREMP station showing the areas (hatch areas) within which the video and station species inventory (SSI) data are collected. The colony fate tracking area is the same as the SSI area.

Statistical Analyses

Differences in stony coral, macroalgae, octocoral, and sponge percent cover between 2010 and 2011 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 Tukey-Kramer post-hoc test. All analyses were completed using a generalized linear mixed model (GLIMMIX) with SAS/STAT® v9.2 software.

Long-term trends in benthic cover variables (stony coral, macroalgae, octocoral, and sponge) were examined using a generalized mixed model regression in SAS v9.2 with data collected through 2010. Percent cover data for the benthic variables for each station at each of the 10 sites sampled from 2003-2010 (BCA, BC1, BC2, BC3, DC1, DC2, DC3, PB1, PB2, and PB3) and from 2006-2010 (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 level. Regression lines were calculated from 2003-2010 or 2006-2010 to understand how each benthic variable cover has changed at each site. For all datasets, a regression for each site was calculated from annual percent cover values, and the trend was identified as increasing or decreasing by t-tests demonstrating that the slope of the regression was significantly different from zero. To reduce the possibility of Type I errors due to repeating the same test on multiple sites, a Bonferroni correction was used to adjust the p-value for identifying a trend as significantly increasing or decreasing. At the site level the p-value was adjusted to $p \leq 0.004$.

Station Stony Coral Species Inventory (SSI) and Colony Fate Tracking

Stony coral species (Milleporina and Scleractinia) presence is recorded at each station. Two observers conduct simultaneous inventories within the SSI area and enter the data on underwater data sheets. Each observer records all stony coral taxa and records the number of long-spined urchins (*Diadema antillarum*) within the station boundaries. After conducting the survey, the observers compare data (5 minutes) underwater and confirm the species present in each station. Data sheets are verified aboard the vessel and entered into the database. All data and data sheets are then forwarded to the FWC-FWRI for quality assurance checks.

During the species inventory, the location of any stony coral colony within a station that exhibits specific signs of either disease or presence of the three clionid sponge species (*Cliona delitrix, C. lampa*, and *C. caribbaea*) is documented on the data sheet. Diseases are sorted into three categories: black band, white complex (including white plague, white band, white pox), and other (dark spot, yellow band). All colonies exhibiting any of these conditions are mapped and imaged. These colonies will be fate tracked during subsequent sampling years.

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 low 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 was recorded. These measurements permit the same colony to be located and sampled each year. During the first monitoring year (2006), colonies approximately within 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 (0.38m²). 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 permit changes in tissue area between monitoring events to be measured. NCRI developed software (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 (cm²) in each colony planar image. The software automatically calculates the area (cm²) 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 cm²) 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 are deployed at each site and are replaced during each annual sampling event. The loggers are programmed to record data at a sampling interval of two hours. Because the loggers remain on site for a year, two loggers are deployed at each site in order to provide backup data in case one logger fails or is lost. The two loggers are attached approximately 10 cm off the substrate to the 'northern' stake identifying stations 1 and 2. Data from both loggers are downloaded. If data from both loggers are successfully downloaded, the data from the logger attached to station 1 is reported.

YEAR 9 (2011) RESULTS

Stony Coral Species Richness

Stony coral species richness was summarized from SSI data. In 2011, a total of 28 stony coral species were identified within the 16 standard SECREMP sites (Table 3). No new species were identified in 2011. The mean number of species identified per site in 2010 for all 16 standard sites was 14 ± 5 (Mean ± SD), and for the 12 sites prior to 2010, the mean number of species was 12 ± 4 (Mean ± SD). Seven species were identified in all four counties (*Diploria clivosa*, *Millepora alcicornis*, *Montastraea cavernosa*, *Porites astreoides*, *Siderastrea siderea*, *Solenastrea bournoni,* and *Phyllangia americana*). Fourteen species were identified in Miami-Dade, Broward, and Palm Beach counties but were not identified in Martin County. Common species in all 16 standard sites (64 total stations) included: *Millepora alcicornis, Siderastrea siderea*, *Montastraea cavernosa*, and *Porites astreoides*. Broward County contained the most species identified (26) followed by Palm Beach County (25), Miami-Dade County (23), and then Martin County (9). Figure 5 shows the number of species identified for each site 2003-2011.

Miami-Dade County had a mean of 12 stony coral species per station (n= 5 sites and 20 stations), Broward County had 8 species per station (n= 4 sites and 16 stations), Palm Beach had 9 species per station (n= 5 sites and 20 stations), and Martin County had 6 species per station (n= 2 sites and 8 stations). Counts at Broward County sites were slightly skewed by site BCA, which is dominated by *A. cervicornis*. Without site BCA, Broward County had a greater mean number (10) of species per station. Counts at Palm Beach sites were slightly skewed by site PB1, which was partially buried by sand between the 2004 and 2005 samples. Without site PB1, Palm Beach County had a greater mean number (10) of species per station.

Table 3. Stony coral species presence/absence for the 16 standard SECREMP sites in Miami-Dade, Broward, Palm Beach, and Martin Counties for 2011. (A, 1, 2, 3, 4, 5 = sites with species present; 0 = species absent.)

	Miami-Dade	**Broward**	**Palm Beach**	**Martin**
Acropora cervicornis	1	A	0	0
Agaricia agaricites	1,2,4,5	A,1	3,4,5	0
Agaricia fragilis	2, 5	A,1,2	5	0
Agaricia lamarcki	2,4,5	2,3	5	0
Cladocora arbuscula	0	0	0	0
Colpophyllia natans	5	1,2	5	0
Dichocoenia stokesii	1,2,3,4,5	1,2,3	1,2,3,4,5	0
Diploria clivosa	1,5	A	1,2,3,4,5	1,2
Diploria labyrinthiformis	1,5	1	4,5	0
Diploria strigosa	2,4,5	3	1,4,5	0
Eusmilia fastigiata	2	1,3	2,4,5	0
Isophyllia sinuosa	0	0	0	1
Madracis decactis	2,3,4,5	1,2,3	2,3,4,5	0
Madracis mirabilis	2	0	2	0
Meandrina meandrites	1,2,3,4,5	1,2,3	1,2,3,4,5	0
Millepora alcicornis	1,2,3,4,5	A,1,2,3	1,2,3,4,5	1,2
Montastraea annularis complex	1,2,4,5	1,2	4,5	0
Montastraea cavernosa	1,2,3,4,5	A,1,2,3	1,2,3,4,5	1
Mussa angulosa	5	0	4	
Mycetophyllia aliciae	3	0	0	0
Oculina diffusa	0	1	1	1,2
Phyllangia americana	1,3	1	1	1,2
Porites astreoides	1,2,3,4,5	A,1,2,3	2,3,4,5	1
Porites porites	1,2,4,5	A, 1,2,3	2,3,4,5	0
Scolymia cubensis	2,3,4,5	2,3	4,5	0
Siderastrea radians	1,4,5	0	1	0
Siderastrea siderea	1,2,3,4	A,1,2,3	1,2,3,5	1,2
Solenastrea bournoni	1,2,3,4,5	1,2,3	1,5	2
Stephanocoenia intersepta	1,2,3,4,5	1,2,3	2,3,4,5	0

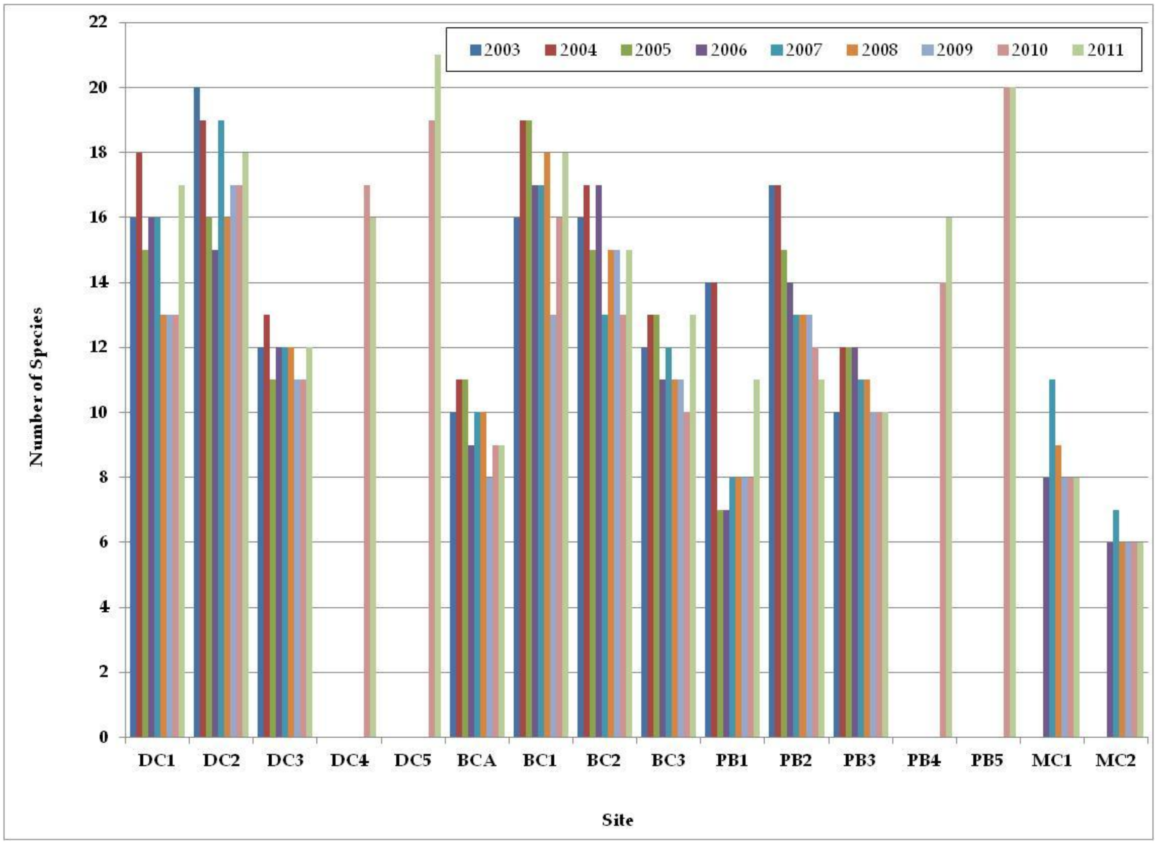

Figure 5. Stony coral species richness for Broward (BC), Miami-Dade (DC), Palm Beach (PB), and Martin (MC) county sites 2003-2011 (n= 3 sites, 12 stations, for Miami-Dade and Palm Beach counties; n= 4 sites, 16 stations, for Broward County; n = 2 sites, 8 stations for Martin County).

Stony Coral Condition

The SSI protocol has included recording stony coral species with the presence of bleaching or disease. Table 4 lists the stony coral species which have shown the presence of partial bleaching at each of the sites, 2003-2011. In 2011, partially bleached colonies were identified in 14 sites (BC2, BC3, DC1, DC2, DC3, DC4, DC5, PB1, PB2, PB3, PB4, PB5, MC1, and MC2) and included seven species (*M. cavernosa, S. siderea, S. bournoni*, *D. stokesii*, *M. annularis*, *S. intersepta*, and *P. astreoides*). No completely bleached colonies were observed.

Beginning in 2004, a count of diseased colonies was recorded at each station. Table 5 lists the number of colonies of each species that displayed symptoms of disease at each site and station 2004-2011. In 2010, nine diseased colonies, within the 16 standard SECREMP sites, were identified and their locations mapped. Each of these nine colonies was assessed in 2011. Of the nine diseased colonies identified in 2010, four were no longer diseased, and five were still identified with disease. Of the five which remained diseased, three were *S. siderea* colonies with 'dark spot', one was *S. intersepta* with white disease, and one was a *M. cavernosa* with white disease.

Beginning in 2010, long–term fate tracking of stony coral colonies with the presence of boring sponges (*Cliona delitrix*) and disease was initiated. Disease categories included black band, white complex (white plague, white band, white pox), and "other" (dark spot). All colonies, in all 16 standard sites, exhibiting any of these conditions were mapped and photographed. All colonies recorded in 2009 (disease only) were included in this effort as well as all diseased colonies and colonies with *Cliona* identified in 2010.

Table 6 summarizes the condition of the colonies recorded during the fate tracking effort. In 2011, 13 diseased colonies were identified in nine sites (DC1, DC2, DC5, BCA, BC1, BC2, BC3, PB2, and PB5). Eight of these colonies were not categorized as diseased in 2010. "Other" diseases were seen at five sites (BC1, BC2, BC3, DC2, and DC5), and most cases were 'dark spots' on *S. siderea* colonies. White complex diseases were identified at three sites (BC3, PB2, and PB5) (Table 5). Similar to 2010, most of the diseased colonies were *S. siderea* (10 of the 13 colonies). Eight of these *S. siderea* diseased colonies were categorized with "other" disease (dark spot). Diseased *A. cervicornis* colonies were seen at site BCA and site DC1. Site BCA is within an *A. cervicornis* "thicket" and the number of affected colonies within a station was not quantified.

In addition to fate tracking diseased colonies, stony coral colonies with the presence of boring sponges were also recorded and mapped, starting in 2010. Within the 16 standard sites sampled in 2010, 77 stony coral colonies were identified with boring sponges. All cases were *Cliona delitrix*. Table 6 summarizes the sites and species with boring sponges. In 2010, 10 species were identified with *Cliona* and over 60% (46 of 77) of the colonies were *M. cavernosa* colonies. In 2011, 77 colonies were also identified with *Cliona*. Of these 77 colonies, 17 were new colonies, and 60 were from 2010. As seen in 2010, the majority of the colonies with *Cliona* were *M. cavernosa* (45 of 77 colonies). Of the 77 colonies identified in 2010, 60 still had *Cliona*, two were dead, and 14 no longer had visual evidence of *Cliona*. Eight stony coral species were identified with *Cliona* (*M. cavernosa*, *S. siderea*, *S. intersepta*, *M. decactis*, *A. agaricites*, *M. meandrites*, *M. annularis*, and *D. clivosa*). Twelve of the 16 sites had colonies with *Cliona*, however two sites contributed nearly 40% of the total number of colonies and included PB2 with 12 colonies, BC1 with 18.

Table 4. Sites and stony coral species with partial bleaching presence from 2003-2011 (A = absence of bleaching; H = bleaching).

Site	Species Affected	03	04	05	06	07	08	09	10	11
DC1	*A. agaricites*	A	A	A	H	A	H	A	A	A
DC1	*M. meandrites*	A	A	H	H	A	A	A	A	A
DC1	*M. cavernosa*	A	A	A	A	A	A	H	A	A
DC1	*P. astreoides*	H	H	H	H	A	H	A	H	H
DC1	*P. porites*	A	A	H	H	A	A	A	A	A
DC1	*S. siderea*	A	H	H	H	A	H	H	H	H
DC1	*S. bournoni*	A	A	A	W	A	A	A	A	A
DC2	*A. agaricites*	A	A	A	H	A	A	A	A	A
DC2	*E. fastigiata*	A	A	A	H	A	A	A	A	A
DC2	*M. cavernosa*	A	A	H	A	A	H	H	A	A
DC2	*P. astreoides*	A	A	A	H	A	A	A	A	H
DC2	*S. bournoni*	A	H	H	A	A	H	A	A	A
DC2	*S. intersepta*	A	A	H	H	A	H	A	A	A
DC2	*S. siderea*	A	A	H	H	W	H	A	A	H
DC3	*M. annularis*	A	H	A	A	A	A	A	A	A
DC3	*M. cavernosa*	A	A	A	A	A	A	A	A	H
DC3	*S. bournoni*	A	A	H	H	A	A	A	A	A
DC3	*D. stokesii*	A	A	A	A	A	A	A	H	H
DC3	*S. siderea*	A	A	A	A	A	H	A	A	A
DC3	*St. intersepta*	A	H	H	A	A	A	A	A	A
DC4	*S. siderea*	NA	NA	NA	NA	NA	NA	NA	H	H
DC4	*M. cavernosa*	NA	NA	NA	NA	NA	NA	NA	A	H
DC4	*D. stokesii*	NA	NA	NA	NA	NA	NA	NA	H	A
DC5	*S. siderea*	NA	NA	NA	NA	NA	NA	NA	H	H
BC1	*D. stokesii*	A	A	H	H	A	H	A	A	A
BC1	*M. annularis*	A	A	A	H	A	H	A	A	A
BC1	*M. cavernosa*	A	H	A	H	H	H	A	H	A
BC1	*P. astreoides*	H	A	A	A	A	A	A	A	A
BC1	*O. diffusa*	A	A	A	A	A	H	A	A	A
BC1	*S. siderea*	H	H	A	H	A	H	A	A	A
BC1	*S. intersepta*	A	A	A	H	A	A	A	A	A
BC2	*D. stokesii*	A	H	A	H	A	A	A	A	A
BC2	*M. meandrites*	A	H	A	A	A	A	A	H	A
BC2	*M. cavernosa*	A	H	A	A	A	A	A	A	A
BC2	*M. annularis*	A	A	A	A	A	A	A	A	H
BC2	*P. astreoides*	A	H	H	A	H	A	A	A	H
BC2	*S. radians*	A	A	A	H	A	A	A	A	A
BC2	*S. siderea*	H	H	H	H	A	A	A	A	H
BC2	*S. bournoni*	A	A	A	A	A	A	H	A	H
BC2	*S. intersepta*	A	H	A	A	H	A	A	A	H

Table 4. Continued.

Site	Species Affected	03	04	05	06	07	08	09	10	11
BC3	*A. fragilis*	A	A	H	A	A	H	A	A	A
BC3	*D. stokesii*	H	A	A	A	A	A	A	A	A
BC3	*M. meandrites*	A	H	A	H	A	H	A	A	A
BC3	*M. cavernosa*	A	A	H	A	H	H	A	H	A
BC3	*S. siderea*	H	H	H	H	A	H	A	H	H
BC3	*P. astreoides*	A	A	A	A	A	A	A	H	A
BC3	*S. intersepta*	A	A	A	H	A	A	A	A	A
PB1	*D. clivosa*	A	H	A	A	A	A	A	A	A
PB1	*M. meandrites*	H	A	A	A	A	A	A	A	A
PB1	*O. diffusa*	H	A	A	A	A	A	A	A	A
PB1	*S. bournoni*	H	H	A	A	A	A	A	H	A
PB1	*S. radians*	H	H	H	A	A	A	A	A	A
PB1	*S. siderea*	A	A	A	A	A	H	A	A	H
PB2	*M. meandrites*	A	H	A	H	A	A	A	A	A
PB2	*M. cavernosa*	A	H	H	H	H	A	H	H	H
PB2	*P. astreoides*	A	H	H	A	A	A	A	A	A
PB2	*S. intersepta*	A	H	A	A	A	H	A	A	A
PB2	*S. radians*	A	H	A	A	A	A	A	A	A
PB2	*S. siderea*	A	H	H	A	H	H	H	H	H
PB3	*D. stokesii*	A	H	A	A	A	A	A	H	A
PB3	*M. cavernosa*	A	A	H	A	H	H	H	A	H
PB3	*S. siderea*	A	A	A	A	A	H	A	H	A
PB4	*M. cavernosa*	NA	NA	NA	NA	NA	NA	NA	H	A
PB4	*S. siderea*	NA	NA	NA	NA	NA	NA	NA	H	H
PB4	*P. astreoides*	NA	NA	NA	NA	NA	NA	NA	H	A
PB5	*S. siderea*	NA	NA	NA	NA	NA	NA	NA	H	H
PB5	*M. cavernosa*	NA	NA	NA	NA	NA	NA	NA	A	H
PB5	*A. lamarcki*	NA	NA	NA	NA	NA	NA	NA	A	H
PB5	*M. meandrites*	NA	NA	NA	NA	NA	NA	NA	A	H
PB5	*S. intersepta*	NA	NA	NA	NA	NA	NA	NA	A	H
PB5	*P. astreoides*	NA	NA	NA	NA	NA	NA	NA	A	H
MC1	*D. clivosa*	NA	NA	NA	H	H	H	A	A	A
MC1	*M. cavernosa*	NA	NA	NA	H	A	A	A	A	A
MC1	*P. astreoides*	NA	NA	NA	A	H	A	A	A	A
MC1	*S. siderea*	NA	NA	NA	H	H	H	A	A	H
MC2	*D. clivosa*	NA	NA	NA	H	H	H	A	A	A
MC2	*O. diffusa*	NA	NA	NA	H	A	A	A	A	A
MC2	*S. siderea*	NA	NA	NA	H	H	H	H	A	H

Table 5. Sites and stations with diseased stony corals. Species codes include the first initial of the genus and first three letters of the species (# = number of colonies; C = condition [W = white complex disease, B = black band, O = other disease; only presence, P, is noted for sites BCA and DC1]). (Note: No diseased colonies have been identified in sites PB3, MC1, or MC2.)

			04		**05**		**06**		**07**		**08**		**09**		**10**		**11**	
Site	**Station**	**Species**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**
DC1	1	*S. sid*	3	O	0	---	1	O	5	O	1	O	2	O	0	---	1	O
DC1	1	*S. sid*	0	---	0	---	0	---	0	---	0	---	1	W	0	---	1	W
DC1	1	*M. cav*	0	---	1	O	0	---	0	---	0	---	0	---	0	---	0	---
DC1	2	*M. cav*	0	---	0	---	0	---	0	---	1	B	0	---	0	---	0	---
DC1	2	*S. sid*	1	O	2	O	0	---	1	O	2	O	1	O	0	---	1	O
DC1	2	*S. sid*	0	---	0	---	0	---	0	---	0	---	1	W	0	---	0	---
DC1	3	*S. sid*	1	O	0	---	0	---	1	W	1	O	1	W	1	O	1	O
DC1	3	*M. ann*	1	O	0	---	0	---	0	---	0	---	0	---	0	---	0	---
DC1	3	*A. cer*	0	---	0	---	P	W	P	W/O	P	W/O	0	---	0	---	P	W/O
DC1	3	*D. sto*	0	---	0	---	0	---	1	W	0	---	0	---	0	---	0	---
DC1	4	*A. cer*	0	---	P	O	0	---	0	---	0	---	0	---	0	---	0	---
DC1	4	*S. sid*	2	O	1	O	0	---	2	O	1	O	3	W	0	---	0	---
DC1	4	*S. sid*	0	---	0	---	0	---	0	---	0	---	1	O	1	O	0	---
DC1	4	*S. bou*	0	---	0	---	1	W	1	W	0	---	0	---	0	---	0	---
DC1	4	*D. sto*	1	W	0	---	0	---	1	W	0	---	0	---	0	---	0	---
DC2	1	S. sid	0	---	0	---	0	---	0	---	0	---	---	0	0	---	1	O
DC2	2	*S. int*	0	---	0	---	1	W	0	---	0	---	---	0	0	---	0	---
DC2	3	*S. sid*	0	---	0	---	1	W	1	W	0	---	---	0	0	---	0	---
DC2	3	*S. bou*	0	---	0	---	1	W	0	---	0	---	---	0	0	---	0	---
DC2	4	None	0	---	0	---	0	---	0	---	0	---	---	0	0	---	0	---
DC3	1	*S. sid*	0	---	0	---	1	O	0	---	0	---	0	---	0	---	0	---
DC3	2	None	0	---	0	---	0	---	0	---	0	---	0	---	0	---	0	---
DC3	3	*S. sid*	0	---	0	---	0	---	0	---	0	---	1	O	1	O	0	---
DC3	4	*S. sid*	0	---	0	---	1	O	0	---	0	---	0	---	0	---	0	---
DC5	1	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	---	0	---
DC5	2	*S. sid*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	O	0	---
DC5	3	*S. sid*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	O	1	O
DC5	4	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	---	0	---
BCA	1-4	*A. cer*	NA	NA	P	W/O	P	W/O	P	W/O	P	W/O	P	W/O	P	W/O	P	W/O
BC1	1	*S. sid*	1	O	2	O	0	---	2	O	1	O	1	W	0	---	0	---
BC1	1	*M.ann*	0	---	0	---	0	---	0	---	0	---	1	O	0	---	0	---
BC1	1	*S. bou*	0	---	0	---	0	---	0	---	0	---	1	W	0	---	0	---
BC1	2	*S. sid*	1	O	2	O	0	---	5	O	1	O	1	W	0	---	1	O
BC1	2	*M. cav*	0	---	0	---	0	---	1	O	0	---	0	---	0	---	0	---
BC1	2	*M.ann*	0	---	0	---	0	---	0	---	0	---	1	O	0	---	0	---
BC1	2	*D. sto*	0	---	0	---	0	---	0	---	0	---	1	W	0	---	0	---
BC1	3	*S. sid*	1	O	1	O	0	---	1	O	0	O	1	W	0	---	1	O
BC1	3	*S. sid*	0	---	0	---	0	---	2	W	0	---	1	O	1	O	0	---

Table 5. Continued

			04		**05**		**06**		**07**		**08**		**09**		**10**		**11**	
Site	**Station**	**Species**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**
BC1	3	*S. int*	0	---	0	---	0	---	0	---	1	0	0	---	0	---	0	---
BC1	4	*S. sid*	0	---	0	---	0	---	0	---	2	O	0	---	0	---	0	---
BC2	1	*S. sid*	0	---	1	W	1	O	3	O	2	O	1	O	0	---	0	---
BC2	1	*S. sid*	0	---	0	---	0	---	0	---	0	---	1	W	0	---	0	---
BC2	2	*S. sid*	0	---	0	---	1	W	1	O	1	O	1	O	0	---	0	---
BC2	2	*S. sid*	0	---	0	---	0	---	2	W	1	W	1	W	1	O	0	
BC2	3	*S. int*	0	---	0	---	0	---	0	---	0	---	0	---	1	O	1	O
BC2	3	*S. sid*	1	O	2	W	2	O	3	O	2	O	1	W	0	---	0	---
BC2	3	*S. sid*	0	---	0	---	1	W	1	W	0	---	1	0	0	---	0	---
BC2	4	*S. sid*	0	---	0	---	2	O	1	O	0	---	0	---	0	---	0	---
BC2	4	*S. sid*	0	---	2	W	2	W	3	W	0		0	---	0	---	0	---
BC3	1	*S. sid*	0	---	0	---	1	O	1	O	1	O	0	---	0	---	0	---
BC3	1	*M. cav*	0	---	0	---	0	---	0	---	0	---	0	---	0	---	1	W
BC3	2	*S. sid*	0	---	1	O	0	---	1	O	1	W	2	W	0	---	0	---
BC3	3	*M. cav*	0	---	0	---	0	---	1	O	0	---	0	---	0	---	0	---
BC3	3	*S. int*	0	---	0	---	0	---	0	---	0	---	1	W	0	---	0	---
BC3	4	*S. sid*	0	---	0	---	2	O	2	W	0	---	1	O	1	O	1	O
PB1	1	*S. sid*	1	O	0	---	0	---	0	---	0	---	0	---	0	---	0	---
PB1	1	*S. bou*	1	W	0	---	0	---	0	---	0	---	0	---	0	---	0	---
PB1	2	None	0	---	0	---	0	---	0	---	0	---	0	---	0	---	0	---
PB1	3	*S. sid*	1	O	0	---	0	---	0	---	0	---	0	---	0	---	0	---
PB1	4	*D. cli*	1	O	0	---	0	---	0	---	0	---	0	---	0	---	0	---
PB2	1	*S. sid*	0	---	1	W	0	---	0	---	1	W	0	---	0	---	0	---
PB2	1	*P. ast*	0	---	0	---	0	---	1	W	0	---	0	---	0	---	0	---
PB2	1	*M. cav*	0	---	0	---	0	---	0	---	1	O	2	O	0	---	0	---
PB2	1	*M. dec*	0	---	0	---	0	---	1	W	0	---	0	---	0	---	0	---
PB2	1	*D. str*	0	---	1	O	0	---	0	---	0	---	0	---	0	---	0	---
PB2	2	None	0	---	0	---	0	---	0	---	0	---	0	---	0	---	0	---
PB2	3	None	0	---	0	---	0	---	0	---	0	---	0	---	0	---	0	---
PB2	4	*M. cav*	0	---	0	---	0	---	0	---	0	---	0	---	0	---	1	W
PB2	4	*S. int*	0	---	0	---	0	---	1	W	0	---	0	---	0	---	0	---
PB5	1	*S. bou*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	W	1	W
PB5	2	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	---	0	---
PB5	3	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	---	0	---
PB5	4	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	---	0	---

Table 6. List of all mapped diseased and stony corals with *Cliona* present in 2009, 2010 and 2011. Species codes include the first initial of the genus and first three letters of the species (ND = not diseased, O = other disease, W = white complex disease, DSD = dark spot, D = dead, NF = not found, Cdel = *Cliona delitrix,* CG = *Cliona delitrix* Gone).

Site	Station	Species	2009	2010	2011
BC1	1	*M. cav*	ND	Cdel	Cdel
BC1	1	*M. cav*	ND	Cdel	Cdel
BC1	1	*M. cav*	ND	Cdel	Cdel
BC1	1	*M. cav*	ND	Cdel	Cdel
BC1	1	*M. cav*	ND	Cdel	Cdel
BC1	1	*M. cav*	ND	ND	Cdel
BC1	1	*M. cav*	ND	ND	Cdel
BC1	1	*M. cav*	ND	ND	Cdel
BC1	1	*M. cav*	ND	ND	Cdel
BC1	1	*M. cav*	ND	ND	Cdel
BC1	1	*S. bou*	W	ND	ND
BC1	1	*M. ann*	W	ND	ND
BC1	1	*S. sid*	DSD	ND	ND
BC1	2	*S. sid*	W	ND	ND
BC1	2	*M. ann*	W	ND	ND
BC1	2	*D. sto*	W	ND	ND
BC1	2	*S. sid*	ND		DSD
BC1	3	*S. sid*	ND	Cdel	Cdel
BC1	3	*M. cav*	ND	Cdel	Cdel
BC1	3	*M. cav*	ND	Cdel	Cdel
BC1	3	*M. cav*	ND	Cdel	Cdel
BC1	3	*M. cav*	ND	Cdel	Cdel
BC1	3	*M. cav*	ND	Cdel	Cdel
BC1	3	*S. sid*	DSD	DSD	DSD
BC1	3	*S. sid*	W	ND	ND
BC1	4	*S. int*	ND	Cdel	Cdel
BC1	4	*M. cav*	ND	Cdel	Cdel
BC2	1	*S. sid*	W	Cdel	Cdel
BC2	1	*S. sid*	W	Cdel	Cdel
BC2	1	*M. cav*	ND	Cdel	Cdel
BC2	1	*S. int*	ND	Cdel	Cdel
BC2	2	*S. sid*	W	DSD	ND
BC2	2	*S. sid*	DSD	ND	ND
BC2	3	*S. sid*	W	ND	ND
BC2	3	*S. int*	W	O	O
BC3	2	*S. sid*	ND	Cdel	CG
BC3	2	*P. ast*	ND	Cdel	D

Table 6. Continued

Site	Station	Species	2009	2010	2011
BC3	2	*S. sid*	W	Cdel	Cdel
BC3	2	*S. sid*	W	D	D
BC3	3	*M. cav*	ND	Cdel	Cdel
BC3	4	*M. cav*	ND	Cdel	D
BC3	4	*S. int*	W	ND	ND
BC3	4	*S. sid*	DSD	W	DSD
DC1	1	*S. sid*	ND	Cdel	Cdel
DC1	1	*S. sid*	ND	DSD	DSD
DC1	1	*S. sid*	DSD	ND	ND
DC1	1	*S. sid*	DSD	ND	ND
DC1	1	*S. sid*	W	ND	ND
DC1	2	*M. cav*	ND	Cdel	Cdel
DC1	2	*S. sid*	ND	DSD	DSD
DC1	2	*S. sid*	DSD	ND	ND
DC1	2	*S. sid*	W	ND	ND
DC1	3	*S. sid*	W	ND	ND
DC1	3	*M. cav*	ND	Cdel	Cdel
DC1	3	*A. cer*	ND	ND	RTL
DC1	3	*A. cer*	ND	ND	RTL
DC1	3	*S. sid*	ND	ND	DSD
DC1	4	*M. cav*	ND	Cdel	Cdel
DC1	4	*S. sid*	DSD	ND	ND
DC1	4	*S. sid*	W	ND	ND
DC1	4	*S. sid*	W	ND	ND
DC1	4	*S. sid*	W	ND	ND
DC2	1	*S. sid*	ND	ND	DSD
DC3	1	*M. cav*	ND	ND	Cdel
DC3	2	*M. dec*	ND	Cdel	Cdel
DC3	2	*M. dec*	ND	ND	Cdel
DC3	3	*S. sid*	DSD	DSD	ND
DC3	4	*M. cav*	ND	Cdel	Cdel
DC4	1	*A. aga*	ND	Cdel	Cdel
DC4	1	*M. mea*	ND	Cdel	Cdel
DC4	2	*M. cav*	ND	Cdel	Cdel
DC4	2	*S. sid*	ND	ND	Cdel
DC4	3	*M. cav*	ND	Cdel	Cdel
DC5	1	*S. sid*	ND	Cdel	Cdel
DC5	1	*M. ann*	ND	Cdel	Cdel
DC5	1	*S. sid*	ND	DSD	ND
DC5	2	*S. sid*	ND	Cdel	Cdel
DC5	2	*A. aga*	ND	Cdel	Cdel
DC5	2	*S. sid*	ND	DSD	ND
DC5	3	*S. sid*	ND	DSD	DSD

Table 6. Continued

Site	Station	Species	2009	2010	2011
MC1	3	*D. cli*	ND	Cdel	Cdel
MC1	4	*D. cli*	ND	Cdel	Cdel
MC1	4	*D. cli*	ND	Cdel	Cdel
MC1	4	*D. cli*	ND	ND	Cdel
PB2	1	*M. cav*	ND	Cdel	CG
PB2	1	*M. cav*	ND	Cdel	CG
PB2	1	*M. cav*	ND	Cdel	CG
PB2	1	*M. cav*	ND	Cdel	Cdel
PB2	1	*M. cav*	ND	Cdel	Cdel
PB2	1	*M. cav*	ND	Cdel	CG
PB2	1	*M. cav*	ND	Cdel	Cdel
PB2	1	*M. cav*	ND	Cdel	CG
PB2	1	*M. cav*	ND	Cdel	CG
PB2	1	*M. cav*	O	ND	ND
PB2	1	*M. cav*	W	ND	ND
PB2	2	*M. cav*	ND	Cdel	CG
PB2	2	*M. cav*	ND	Cdel	D
PB2	2	*M. mea*	ND	Cdel	CG
PB2	4	*M. cav*	ND	ND	W
PB2	4	*M. mea*	ND	Cdel	CG
PB2	4	*M. cav*	ND	Cdel	Cdel
PB3	1	*M. cav*	ND	Cdel	Cdel
PB3	1	*M. mea*	ND	Cdel	CG
PB3	2	*M. cav*	ND	Cdel	Cdel
PB3	2	*M. mea*	ND	Cdel	CG
PB3	2	*M. cav*	ND	Cdel	CG
PB4	1	*M. cav*	ND	Cdel	Cdel
PB4	1	*M. cav*	ND	Cdel	Cdel
PB4	1	*M. cav*	ND	Cdel	CG
PB4	1	*M. cav*	ND	Cdel	Cdel
PB4	1	*M. cav*	ND	Cdel	Cdel
PB4	2	*M. cav*	ND	Cdel	Cdel
PB4	2	*M. cav*	ND	ND	Cdel
PB4	3	*D. str*	ND	Cdel	Cdel
PB4	3	*M. cav*	ND	Cdel	Cdel
PB4	3	*M. cav*	ND	Cdel	Cdel
PB4	3	*M. cav*	ND	Cdel	Cdel
PB4	4	*S. sid*	ND	ND	Cdel
PB4	4	*M. cav*	ND	ND	Cdel
PB5	1	*P. ast*	ND	Cdel	Cdel
PB5	1	*S. int*	ND	Cdel	Cdel
PB5	1	*P. ast*	ND	Cdel	Cdel
PB5	1	*P. ast*	ND	Cdel	Cdel
PB5	1	*S. bou*	ND	W	W
PB5	1	*M. cav*	ND	ND	Cdel

Table 6. Continued

Site	Station	Species	2009	2010	2011
PB5	2	*M. cav*	ND	Cdel	Cdel
PB5	2	*S. int*	ND	ND	Cdel
PB5	3	*P. ast*	ND	Cdel	Cdel
PB5	3	*D. str*	ND	ND	Cdel
PB5	4	*M. cav*	ND	Cdel	Cdel
PB5	4	*M. cav*	ND	Cdel	Cdel
PB5	4	*S. int*	ND	Cdel	Cdel
PB5	4	*S. sid*	ND	ND	Cdel
PB5	4	*S. int*	ND	ND	Cdel

Sea Urchin (*Diadema antillarum)* Abundance

Diadema antillarum sea urchin abundance was recorded for each station during the SSI sampling. In 2011, a total of 28 *Diadema* were identified within the 16 standard sites (Table 7). Total numbers decreased from 2010 (41 urchins), and the 28 identified in 2011 was the fewest since 2007. *Diadema* continue to be more abundant in the Martin County sites (15 of the 28 total urchins in 2010) than the sites in the other three counties.

Table 7. *Diadema antillarum* sea urchin abundance at each of the 16 standard SECREMP sites. The total abundance numbers are for the 10 original sites established in 2003 for comparison among years.

Site	2003	2004	2005	2006	2007	2008	2009	2010	2011
BCA	0	0	0	4	0	0	1	1	0
BC1	0	2	6	0	4	3	1	1	3
BC2	0	1	2	3	0	0	1	0	0
BC3	0	2	0	0	1	1	1	4	1
DC1	0	0	3	4	3	10	13	7	8
DC2	0	1	2	1	0	0	0	0	0
DC3	0	0	1	2	1	0	1	0	0
DC4	NA	NA	NA	NA	NA	NA	NA	0	0
DC5	NA	NA	NA	NA	NA	NA	NA	0	0
PB1	0	0	1	0	0	0	4	4	1
PB2	0	0	0	1	0	0	0	0	0
PB3	0	0	0	0	0	0	0	0	0
PB4	NA	NA	NA	NA	NA	NA	NA	3	0
PB5	NA	NA	NA	NA	NA	NA	NA	0	0
MC1	NA	NA	NA	7	13	17	18	19	12
MC2	NA	NA	NA	2	5	11	6	5	3
Total (n= 10, 2003 sites)	0	6	15	15	9	14	22	17	13
Total (n= 12, 2006 sites)	NA	NA	NA	24	27	42	46	41	28

Stony Coral Cover

Table 8 lists, and Figures 6 and 7 illustrate, the mean (±SD) percent stony coral coverage for each of the standard SECREMP sites, 2003-2011. Two sites, PB1 (Figure 6) and BCA (Figure 7), are the only sites which showed a significant decreasing trend in stony coral cover from 2003 to 2010 (Table 9). No sites have shown a significant increase in cover 2003 to 2010 (Table 9).

The loss of stony coral cover within site PB1 is attributable to the movement of sand between the 2004 and 2005 sampling events which covered stations 2 and 4. These two stations remained covered in sand in 2006, but in 2007 both stations had started to become uncovered, re-exposing substrate. In 2011, stations 2 and 4 continued the process of becoming uncovered.

In 2011, two sites, BCA (ANOVA, $p<0.0001$) and PB2 (ANOVA, $p=0.02$), had significantly reduced stony coral cover in 2011 compared to 2010. Site BCA stony coral cover dropped from 20% to 14% (Table 8, Figure 7). BCA cover is dominated by *A. cervicornis*, contributing over 95% of stony coral cover at this site. Cover at site PB2 dropped from 1.9% in 2010 to 1.5% in 2011. The reasons for the tissue mortality and/or loss of colonies are not known, but eight of the 11 stony coral species identified in 2010 had reduced cover in 2011.

Table 10 lists the five species for each site which contributed most to stony coral cover 2003-2011. The mean cover for each species over this eight year span was used to determine this list. The two most prevalent species in the SECREMP sites were *S. siderea* and *M. cavernosa*. Both species were in the top five in cover in 10 of the 16 sites, and were identified in all sites (Table 3).

Table 8. Mean (+SD) percent stony coral cover for each site from 2003-2011 (n = 4 stations).

		BC1	BC2	BC3	BCA	DC1	DC2	DC3	DC4	DC5
2003	**Mean**	12.2	0.4	0.3	31.7	2.4	0.6	0.2	NA	NA
	SD	3.7	0.2	0.1	4.9	0.9	0.4	0.1	NA	NA
2004	**Mean**	11.8	0.4	0.4	39.6	2.6	0.5	0.2	NA	NA
	SD	3.9	0.2	0.1	3.6	1.3	0.2	0	NA	NA
2005	**Mean**	12.6	0.5	0.3	39.9	2.8	0.5	0.3	NA	NA
	SD	3.8	0.4	0.1	2.3	1.4	0	0.2	NA	NA
2006	**Mean**	13.1	0.4	0.5	25.4	3	0.8	0.2	NA	NA
	SD	3.7	0.2	0.2	2.8	1.3	0.1	0.3	NA	NA
2007	**Mean**	12.5	0.3	0.3	31.0	2.5	0.7	0.3	NA	NA
	SD	3.2	0.3	0.2	3.0	0.9	0.2	0.3	NA	NA
2008	**Mean**	11.8	0.3	0.3	30.8	2.5	0.7	0.1	NA	NA
	SD	4.2	0.2	0.2	2.3	1.8	0.2	0.1	NA	NA
2009	**Mean**	12.5	0.3	0.3	26.0	2.8	0.7	0.3	NA	NA
	SD	3.6	0.3	0.1	1.4	0.9	0.6	0.2	NA	NA
2010	**Mean**	11.7	0.4	0.2	20.2	2.9	0.7	0.4	1.0	1.9
	SD	3.2	0.3	0.1	2.9	0.8	0.2	0.2	0.3	0.4
2011	**Mean**	12.0	0.5	0.3	14.0	2.6	0.6	0.4	0.9	1.9
	SD	3.0	0.3	0.1	2.4	1.3	0.2	0.3	0.2	0.3
		PB1	**PB2**	**PB3**	**PB4**	**PB5**	**MC1**	**MC2**		
2003	**Mean**	1	1.8	1	NA	NA	NA	NA		
	SD	0.7	1.1	0.4	NA	NA	NA	NA		
2004	**Mean**	0.9	1.8	1	NA	NA	NA	NA		
	SD	0.7	1.4	0.2	NA	NA	NA	NA		
2005	**Mean**	0.1	1.6	1	NA	NA	NA	NA		
	SD	0.3	1.1	0.3	NA	NA	NA	NA		
2006	**Mean**	0.4	1.8	1	NA	NA	1.6	1		
	SD	0.8	0.7	0.2	NA	NA	1.1	0.5		
2007	**Mean**	0.2	1.8	1.3	NA	NA	2.2	0.9		
	SD	0.2	1.2	0.8	NA	NA	1.5	0.3		
2008	**Mean**	0.1	1.9	1.2	NA	NA	2.1	0.8		
	SD	0.2	1.3	0.6	NA	NA	1.2	0.3		
2009	**Mean**	0.2	1.8	1.2	NA	NA	2.2	1		
	SD	0.3	1.2	0.4	NA	NA	1.8	0.4		
2010	**Mean**	0.3	1.9	1.1	1.2	1.2	2.0	0.8		
	SD	0.3	0.7	0.3	0.3	0.2	1.5	0.2		
2011	**Mean**	0.4	1.5	1.2	1.4	1.3	2.3	0.8		
	SD	0.4	1.0	0.5	0.4	0.4	1.3	0.3		

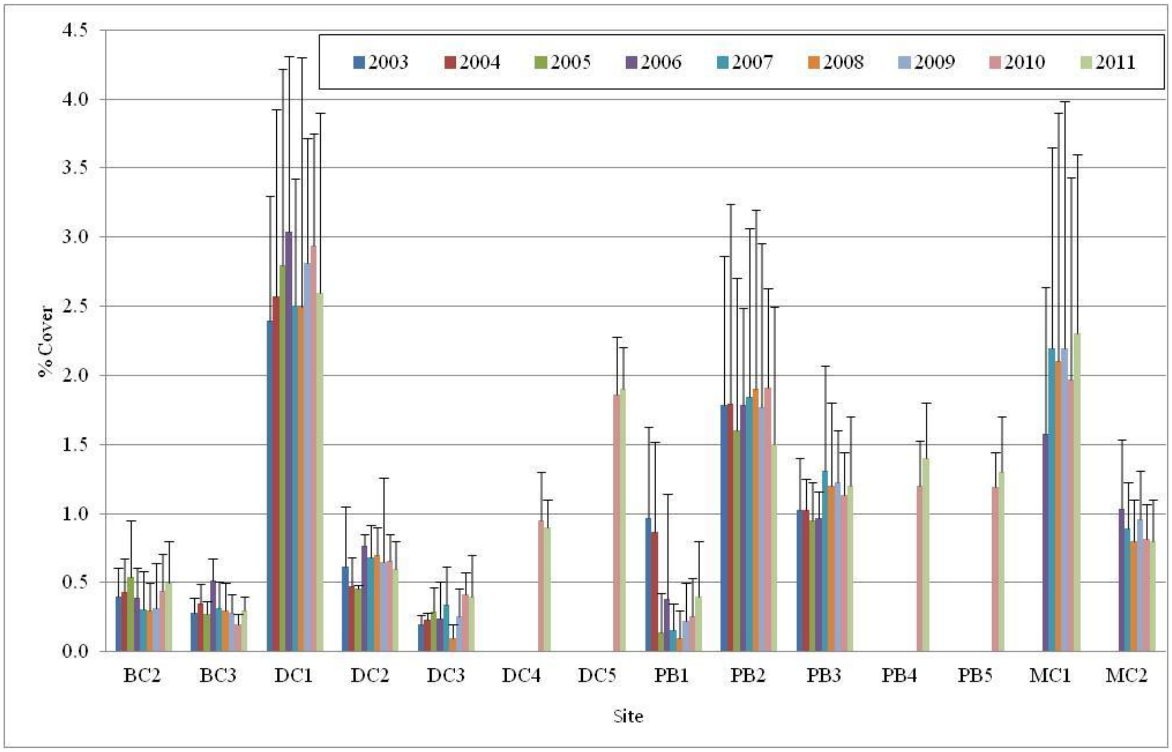

Figure 6. Mean (+SD) percent stony coral cover from 2003-2011. Martin County sites were not sampled prior to 2006. Sites DC4, DC5, PB4 and PB5 were not sampled prior to 2010.

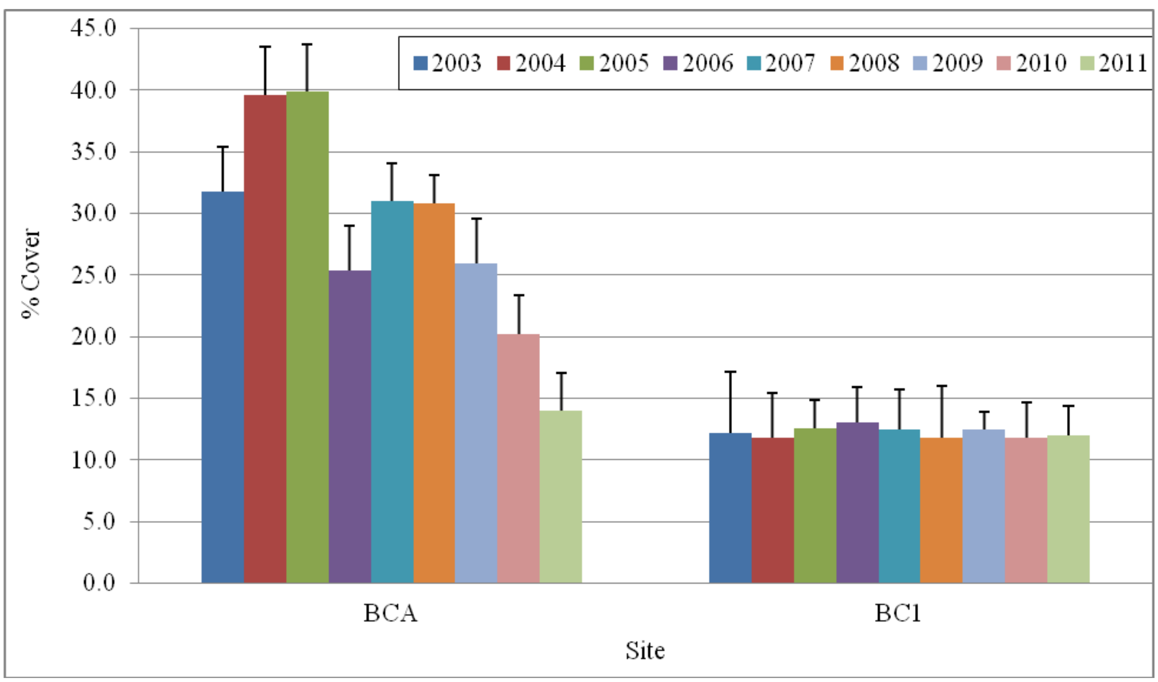

Figure 7. Mean (+SD) percent stony coral cover at BCA and BC1 sites from 2003-2011.

Table 9. Long term trend analysis (2003-2010) for stony coral, octocoral, sponge, and macroalgae percent cover. (D = significant decrease, I = significant increase, and NC = no significant change)

	Stony Coral		Octocoral		Sponge		Macroalgae	
Site	Trend	p-value	Trend	p-value	Trend	p-value	Trend	p-value
BCA	D	< 0.001	NC	0.956	NC	0.047	NC	0.197
BC1	NC	0.825	NC	0.262	NC	0.011	I	0.001
BC2	NC	0.474	NC	0.047	NC	0.005	NC	0.836
BC3	NC	0.334	NC	0.190	NC	0.006	NC	0.366
DC1	NC	0.306	NC	0.110	I	< 0.001	NC	0.193
DC2	NC	0.464	NC	0.087	NC	0.163	NC	0.331
DC3	NC	0.430	D	< 0.001	NC	0.109	NC	0.012
PB1	D	< 0.001	D	< 0.001	D	< 0.001	NC	0.961
PB2	NC	0.490	NC	0.008	I	< 0.001	NC	0.111
PB3	NC	0.337	D	< 0.001	I	< 0.001	NC	0.426
MC1	NC	0.892	NC	0.323	NC	0.119	NC	0.821
MC2	NC	0.544	NC	0.569	NC	0.340	NC	0.803

Table 10. The five species which contributed most to total stony coral cover for each site from 2003-2011 (n = 9 years). The species order for each site is in decreasing cover.

BC1	BC2	BC3	BCA
M. cavernosa	*M. meandrites*	*M. cavernosa*	*A. cervicornis*
P. astreoides	*S. siderea*	*M. alcicornis*	*D. clivosa*
M. annularis complex	*M. alcicornis*	*S. siderea*	*M. cavernosa*
S. siderea	*D. stokesii*	*M. meandrites*	*P. astreoides*
S. bournoni	*P. astreoides*	*S. intersepta*	*S. siderea*
DC1	**DC2**	**DC3**	**DC4**
M. cavernosa	*M. alcicornis*	*M. cavernosa*	*M. alcicornis*
P. astreoides	*M. meandrites*	*M. alcicornis*	*M. cavernosa*
S. siderea	*M. cavernosa*	*S. siderea*	*M. meandrites*
A. cervicornis	*S. bournoni*	*M. decactis*	*S. siderea*
S. bournoni	*S. siderea*	*S. siderea*	*P. astreoides*
DC5	**PB1**	**PB2**	**PB3**
M. meandrites	*D. clivosa*	*M. cavernosa*	*M. cavernosa*
M. alcicornis	*S. bournoni*	*M. alcicornis*	*M. meandrites*
A. agaricites	*M. alcicornis*	*M. meandrites*	*M. alcicornis*
P. astreoides	*M. cavernosa*	*M. mirabilis*	*P. astreoides*
M. cavernosa	*S. siderea*	*P. astreoides*	*S. siderea*
PB4	**PB5**	**MC1**	**MC2**
M. cavernosa	*M. cavernosa*	*D. clivosa*	*D. clivosa*
M. meandrites	*P. astreoides*	*M. alcicornis*	*M. alcicornis*
P. astreoides	*D. strigosa*	*S. siderea*	*S. siderea*
D. strigosa	*M. meandrites*	*D. strigosa*	-----
M. alcicornis	*S. siderea*	*O. diffusa*	-----

Functional Group Benthic Cover

Tables 11, 12, 13 and 14 list the mean functional group cover for each site. Functional groups included substrate (rock, rubble, and sediments), stony corals, octocorals, zoanthids, sponges, macroalgae, and 'other biota' (in Tables 11-14 this category includes other biota such as: hydroids, cyanobacteria [*Lyngbya* spp. and substrate tufts] and polychaete worms). As found with all previous years, substrate dominated benthic cover at all sites (>50%), ranging from 97% at site PB1 (Table 13) to 53% at site PB5 (Table 13). As seen in previous monitoring years, octocorals, and sponges (porifera) were the biota functional groups which contributed most to benthic cover.

In 2008, site DC3 was largely covered with the cyanobacteria *Lyngbya* spp. and since has been an important substrate cover component. Cover for *Lyngbya* is listed as part of 'other biota' in Tables 11-14. DC3 other biota cover was 12% in 2008. In 2009, the other biota cover (still dominated by cyanobacteria) in site DC3 dropped to 3.3%, but increased to 8.7% in 2010 and increased greatly to 28% in 2011. In 2011, 10 sites had increased other biota (cyanobacteria) cover compared to 2010 (Tables 11-14).

Some sites showed significant changes in functional group cover 2003-2010. Octocoral cover at sites DC3, PB1, and PB3 all show a significantly decreasing trend in cover from 2003 to 2010 (Table 9). Four sites had significant differences in octocoral cover between 2010 and 2011. Three sites, BC2 (ANOVA, p=0.03), DC1 (ANOVA, p=0.01), and DC2 (ANOVA, p=0.001) had significant increases, while PB2 (ANOVA, p=0.002) had a significant decrease. For sites DC1 and DC2, the cover estimated in 2011 was the greatest since 2003. In contrast, the cover estimated in PB2 was the lowest since 2003.

The long-term trends in sponge cover indicate an increasing trend at sites DC1, PB2, and PB3, but a decreasing trend at PB1 from 2003 to 2010 (Table 9). BCA was the only site with significant difference in sponge cover between 2010 and 2011, and this site had a significant increase in cover in 2011 (ANOVA, p=0.04).

The long-term analysis indicated that macroalgal cover had not changed at any site between 2003 and 2010 except BC1 which exhibited a significant increasing trend (Table 9). Three sites, DC3 (ANOVA, p=0.001), DC5 (ANOVA, p=0.002), and PB5 (ANOVA, p=0.001) had a significant decrease in macroalgae in 2011 compared to 2010.

Table 11. Functional group mean percent coverage for the Broward County sites (Sub = substrate, SC = stony coral, Oct = octocoral, MA = macroalgae, Por = porifera, Zoa = zoanthid, and Oth = other biota).

Site	Year	Sub	SC	Oct	MA	Por	Zoa	Oth
BCA	2003	64.96	31.7	2.34	0.03	0.27	0.68	0.00
	2004	55.85	39.6	2.03	0.96	0.47	0.84	0.23
	2005	55.60	39.9	1.54	1.78	0.42	0.78	0.01
	2006	64.95	25.4	1.35	6.75	1.10	0.50	0.00
	2007	62.53	31.0	2.30	2.51	0.96	0.54	0.13
	2008	63.82	30.8	1.40	2.54	0.65	0.68	0.00
	2009	70.20	26.0	2.00	0.77	0.60	0.46	0.00
	2010	71.97	20.2	2.16	3.31	1.25	0.44	0.71
	2011	76.65	14.0	2.61	2.12	3.05	0.38	1.18
BC1	2003	77.37	12.2	6.46	0.43	1.84	1.68	0.00
	2004	73.21	11.8	6.41	4.04	1.99	1.40	1.00
	2005	63.97	12.6	6.76	11.89	3.10	1.38	0.33
	2006	66.72	13.1	6.70	8.07	3.62	1.71	0.09
	2007	68.59	12.5	7.48	6.77	3.25	1.31	0.07
	2008	64.30	11.8	6.33	12.57	3.64	1.20	0.30
	2009	65.03	12.5	6.41	10.27	3.89	1.31	0.60
	2010	63.18	11.8	8.42	10.98	3.55	1.69	0.43
	2011	65.84	12.0	6.42	8.57	5.32	1.69	0.19
BC2	2003	86.58	0.4	6.63	3.70	2.67	0.00	0.01
	2004	87.09	0.4	6.89	1.92	3.27	0.14	0.25
	2005	80.39	0.5	9.43	5.41	4.08	0.08	0.06
	2006	76.03	0.4	6.37	12.13	5.05	0.03	0.00
	2007	85.96	0.3	6.92	2.56	4.12	0.05	0.08
	2008	85.42	0.3	6.14	2.66	5.12	0.02	0.30
	2009	78.74	0.3	5.82	7.04	5.05	0.08	2.95
	2010	85.23	0.4	5.35	3.25	5.44	0.07	0.21
	2011	77.43	0.6	7.61	3.00	6.82	0.15	4.43
BC3	2003	79.76	0.3	13.54	3.62	2.79	0.00	0.01
	2004	78.20	0.4	15.99	1.74	3.64	0.03	0.05
	2005	70.52	0.3	17.90	7.01	4.18	0.00	0.09
	2006	46.46	0.5	14.06	34.64	4.30	0.00	0.02
	2007	76.42	0.3	13.89	3.73	5.48	0.00	0.16
	2008	70.05	0.3	10.08	15.24	4.30	0.00	0.05
	2009	75.21	0.3	13.86	5.50	4.02	0.00	1.13
	2010	72.38	0.2	15.14	5.30	6.86	0.01	0.11
	2011	76.71	0.3	12.90	2.06	7.20	0.00	0.86

Table 12. Functional group mean percent coverage for Miami-Dade County (Sub = substrate, SC = stony coral, Oct = octocoral, MA = macroalgae, Por = porifera, Zoa = zoanthid, and Oth = other biota) (DC4 and DC5 sampling started in 2010).

Site	Year	Sub	SC	Oct	MA	Por	Zoa	Oth
DC1	2003	72.21	2.4	5.86	13.32	0.85	5.36	0.00
	2004	53.04	2.6	7.31	31.44	1.08	4.57	0.00
	2005	69.10	2.8	7.96	12.80	1.54	5.77	0.04
	2006	71.02	3.0	7.67	10.25	2.09	5.89	0.05
	2007	57.58	2.5	10.35	20.32	3.42	5.57	0.26
	2008	57.67	2.5	7.30	23.19	2.84	5.73	0.74
	2009	72.56	2.8	8.26	8.08	2.24	5.98	0.07
	2010	70.13	2.9	7.97	10.23	3.11	5.43	0.19
	2011	64.19	2.6	11.18	10.54	4.23	6.44	0.76
DC2	2003	69.56	0.6	14.67	9.97	5.14	0.03	0.03
	2004	79.50	0.5	11.54	3.26	4.02	0.05	1.16
	2005	78.46	0.5	15.90	1.12	4.03	0.01	0.01
	2006	61.69	0.8	12.15	20.50	4.81	0.01	0.07
	2007	77.82	0.7	12.41	3.60	5.35	0.01	0.12
	2008	67.38	0.7	12.83	12.23	5.31	0.03	1.55
	2009	83.34	0.7	10.40	0.50	5.03	0.02	0.06
	2010	75.71	0.7	12.75	4.75	5.95	0.02	0.16
	2011	63.80	0.6	19.74	4.10	7.69	0.05	3.98
DC3	2003	78.48	0.2	15.48	2.25	3.50	0.00	0.09
	2004	78.20	0.2	12.25	3.92	2.74	0.00	2.66
	2005	76.72	0.3	15.04	3.20	3.08	0.01	1.66
	2006	70.01	0.2	10.38	16.41	2.57	0.01	0.37
	2007	79.46	0.3	8.96	5.06	2.99	0.00	3.19
	2008	71.02	0.1	5.92	9.18	1.91	0.00	11.83
	2009	68.71	0.3	5.70	17.14	4.88	0.00	3.31
	2010	73.56	0.4	6.38	6.30	4.67	0.00	8.65
	2011	57.93	0.4	7.43	0.53	5.59	0.00	28.11
DC4	2010	74.39	1.0	15.31	1.77	7.49	0.03	0.06
	2011	67.35	0.9	16.58	1.45	6.04	0.08	7.62
DC5	2010	52.62	1.9	19.07	19.88	4.78	1.75	0.02
	2011	61.13	1.9	20.06	6.59	6.69	2.49	1.15

Table 13. Functional group mean percent coverage for the Palm Beach County sites (Sub = substrate, SC = stony coral, Oct = octocoral, MA = macroalgae, Por = porifera, Zoa = zoanthid, and Oth = other biota) (PB4 and PB5 sampling started in 2010).

Site	Year	Sub	SC	Oct	MA	Por	Zoa	Oth
PB1	2003	83.54	1.0	2.70	0.10	10.29	0.55	1.84
	2004	82.55	0.9	2.88	1.39	9.82	0.78	1.71
	2005	98.09	0.1	0.03	0.84	0.17	0.02	0.71
	2006	95.44	0.4	0.00	3.85	0.14	0.00	0.00
	2007	97.87	0.2	0.05	0.03	0.23	0.00	1.63
	2008	95.87	0.1	0.03	0.83	0.55	0.00	2.63
	2009	96.17	0.2	0.09	0.97	0.72	0.00	1.83
	2010	96.50	0.3	0.02	1.02	0.80	0.01	1.39
	2011	97.10	0.4	0.00	0.07	1.14	0.00	1.34
PB2	2003	67.23	1.8	27.32	0.00	3.53	0.09	0.05
	2004	61.92	1.8	31.20	0.26	4.15	0.05	0.63
	2005	67.13	1.6	27.49	0.72	2.89	0.08	0.09
	2006	57.28	1.8	23.40	12.39	4.90	0.24	0.00
	2007	64.30	1.8	25.44	1.80	6.46	0.11	0.05
	2008	65.76	1.9	23.00	3.12	5.51	0.09	0.67
	2009	67.50	1.8	22.26	0.39	7.02	0.19	0.86
	2010	59.41	1.9	27.45	2.67	7.95	0.07	0.53
	2011	67.50	1.5	19.95	1.48	6.74	0.06	2.81
PB3	2003	55.37	1.0	30.34	0.27	10.46	1.36	1.17
	2004	55.69	1.0	29.84	2.54	8.87	1.20	0.83
	2005	61.12	1.0	24.98	1.45	9.51	1.02	0.96
	2006	61.18	1.0	19.61	7.55	9.32	1.20	0.17
	2007	59.23	1.3	21.30	0.75	14.41	1.46	1.55
	2008	57.23	1.2	20.97	4.69	12.42	1.25	2.22
	2009	58.96	1.2	17.72	1.73	13.14	1.50	5.72
	2010	56.18	1.1	20.37	2.63	13.92	1.13	4.63
	2011	54.49	1.2	20.35	4.17	14.45	1.31	4.05
PB4	2010	57.73	1.2	23.35	3.04	12.88	0.38	1.42
	2011	57.10	1.4	20.57	1.75	15.44	0.59	3.16
PB5	2010	52.03	1.2	23.91	11.90	10.20	0.70	0.06
	2011	53.30	1.3	26.70	0.58	13.65	0.69	3.78

Table 14. Functional group mean percent coverage for the Martin County sites (Sub = substrate, SC = stony coral, Oct = octocoral, MA = macroalgae, Por = porifera, Zoa = zoanthid, and Oth = other biota). (Martin County sampling started in 2006)

Site	Year	Sub	SC	Oct	MA	Por	Zoa	Oth
MC1	2006	61.89	1.6	0.01	34.54	1.06	0.66	0.00
	2007	52.72	2.2	0.01	42.33	1.38	1.00	0.31
	2008	58.58	2.1	0.01	37.10	1.05	1.05	0.07
	2009	62.58	2.2	0.01	33.10	1.09	0.82	0.12
	2010	59.36	2.0	0.13	34.51	2.76	0.97	0.31
	2011	70.95	2.4	0.15	21.93	3.05	1.03	0.54
MC2	2006	53.20	1.0	0.01	41.99	2.63	1.08	0.00
	2007	38.20	0.9	0.00	56.86	2.89	0.95	0.19
	2008	50.58	0.8	0.02	44.85	2.47	1.05	0.08
	2009	50.82	1.0	0.03	43.82	3.05	1.06	0.22
	2010	48.74	0.8	0.05	45.52	3.77	0.80	0.27
	2011	70.95	0.8	0.00	21.62	5.31	0.98	0.37

Site MC3 Stony Coral Colony Condition

In 2006, within the five staked locations at site MC3, 49 colonies were mapped within 10m of the center stake and data (including images) collected (Table 15). Although ten stony coral species were recorded within sites MC1 and MC2 in 2006, only six species were included in this effort (colonies of *D. stokesii* and *I. sinuosa* were not present within this site area and colonies of *P. americana* and *M. alcicornis* were not targeted for imaging). Images were taken of all 49 mapped colonies; however, four colonies did not have images of appropriate quality to permit image analysis to be completed (blurry images or colony edges obstructed).

In 2007, all 49 colonies mapped in 2006 were re-visited. Images were taken of 35 colonies and 14 colonies were not found and presumed dead and/or missing (Table 15). Eight new colonies were mapped, assessed and added to the monitoring effort (Tag numbers 108, 411, 412, 412, 413, 414, 506A, 506B, 507).

In 2008, two new colonies were added to the effort. The total number of monitored colonies assessed was 45 (35 colonies found living in 2007 plus eight new colonies mapped in 2007 and two new colonies mapped in 2008).

In 2009, four new colonies were added to the effort. In 2010, no new colonies were added, but an attempt was made to locate all 63 colonies that have been mapped (49 in 2006 plus eight new mapped in 2007, two new mapped in 2008, and four new mapped in 2009).

Eleven new colonies were added in 2011. Table 15 summarizes the status (2006-2011) of the 49 colonies mapped in 2006 and the new colonies mapped in 2007, 2008, 2009, and 2011. Table 16 includes the colony tissue area measured in 2006-2011 and the change in tissue area 2011-2006. Table 17 summarizes for each species, the number of colonies that increased and decreased in tissue area from 2006-2011 and the number of colonies not found.

Of the original 49 colonies mapped in 2006, 23 were found alive in 2011, two were found dead, and 24 were not found. During this six year period, greater than 50% of the *O. diffusa*, *S. siderea*, and *D clivosa* colonies have become missing (dislodged) and were categorized as not found (NF). *Montastraea cavernosa* appears to be much more stable with 10 of the original colonies still attached and alive (Table 17).

Five colonies that were found alive in 2010 were not found (dislodged) in 2011. Of the 14 new colonies mapped since 2006, 12 were found alive and two were not found.

Fifteen colonies were assessed for tissue area change (images taken and used in 2006 and 2011). One had reduced tissue area and 14 had increased tissue area. The remaining eight colonies mapped in 2006 and alive in 2011 either had images in 2006 and/or 2011 that were not adequate for image analysis.

No diseased colonies were identified in 2006-2011. However, fishing line was noted entangling seven of the 15 *O. diffusa* colonies mapped in 2006. In 2007, three of those seven *O. diffusa* colonies were not found, two had measurable reduced tissue area, and the remaining two had images, which although inadequate for quantitative tissue area analysis, showed reduced tissue area (Table 16). In 2008, only seven *O. diffusa* colonies remained alive and of these seven, three had fishing line and only one had a measurable increase in tissue area. In 2009, only four remained alive, two of those had fishing line and only two had a measurable increase in tissue area. Three of the four remaining *O. diffusa* colonies identified in 2009 remained alive in 2010. The fourth living *O. diffusa* colony was missed in 2009. In 2010 and 2011, fishing line was seen entangling one living *O. diffusa* colony. Of the original 15 *diffusa* colonies mapped in 2006, only one colony has had a measurable increase in tissue area in 2011.

Table. 15. Site MC3 monitored colony condition data. Initial colony size (maximum diameter, cm) and the condition of each colony during each sample date are presented. (* = new colonies added to the effort in 2007; ** added in 2008, *** added in 2009, **** added in 2011; A = alive; D = dead; FL = fishing line present on colony; PB = partially bleached colony; NF = colony not found)

Tag	Species	Size	2006	2007	2008	2009	2010	2011
101	*O. diffusa*	20	A, FL	A, FL	A, FL	A, FL	A,FL	A,FL
102	*S. siderea*	8	A	A	NF	NF	NF	NF
103	*O. diffusa*	30	A, FL	A, FL	A	D, FL	D	NF
104	*D. clivosa*	18	A	A	NF	NF	NF	NF
105	*S. bournoni*	14	A, PB	A	A	A, PB	A	A
106	*S. siderea*	5	A	NF	NF	NF	NF	NF
107	*S. siderea*	9	A	A	A	A	A	A
*108	*M. cavernosa*	14	NA	A	A	A	A	A
**109	*S. siderea*	5	NA	A	A	NF	A	NF
***110	*O. diffusa*	12	NA	NA	NA	A	A	A
****111	*D. clivosa*	40	NA	NA	NA	NA	NA	A
****112	*O. diffusa*	14	NA	NA	NA	NA	NA	A
201	*D. clivosa*	28	A	NF	NF	NF	NF	NF
202	*S. siderea*	6	A	A	A	A	A	A
203	*D. clivosa*	35	A	A	NF	NF	NF	NF
204	*D. clivosa*	35	A	NF	NF	NF	NF	NF
205	*D. clivosa*	22	A	A	A	A	A	A
206	*S. siderea*	6	A	A	A	NF	NF	NF
207	*D. clivosa*	35	A	A	A	A	A	A
208	*D. clivosa*	20	A	NF	A	NF	NF	NF
209	*O. diffusa*	20	A, FL	A, FL	A	NF	A	NF
210	*M. cavernosa*	15	A	A	A	A	A	A
211	*O. diffusa*	16	A, FL	NF	NF	NF	NF	NF
212A	*S. siderea*	4	A	A	A	A	A	NF
212B	*S. siderea*	6	A	A	A	A	A	NF
212C	*S. siderea*	5	A	A	A	A	A	NF
213	*M. cavernosa*	12	A	A	A	A, FL	A	A
***214	*O. diffusa*	17	NA	NA	NA	A	A	A
***215	*M. cavernosa*	12	NA	NA	NA	A	A	A
****216	*D. clivosa*	40	NA	NA	NA	NA	NA	A
****217	*D. clivosa*	16	NA	NA	NA	NA	NA	A
****218	*O. diffusa*	15	NA	NA	NA	NA	NA	A
301	*S. siderea*	7	A	A	A	A	A	A
302	*O. diffusa*	20	A, PB	NF	D	D	D	D
303	*O. diffusa*	10	A	NF	NF	NF	NF	NF
304	*M. cavernosa*	15	A	A	A	A	A	A
305	*O. diffusa*	25	A, PB	NF	NF	NF	NF	NF

Table 15. Continued

Tag #	Species	Size	2006	2007	2008	2009	2010	2011
306	*D. clivosa*	20	A	NF	NF	NF	NF	NF
307	*M. cavernosa*	18	A	A	A	A	A	A
308	*S. siderea*	6	A	A	A	A	A	A
309	*M. cavernosa*	10	A	A	A	A	A	A
310	*M. cavernosa*	43	A	A	A	A	A	A
311	*O. diffusa*	19	A, FL, PB	A	A	A	A,PB	A
312	*M. cavernosa*	80	A	A	A	A	A	A
***313	*O. diffusa*	20	NA	NA	NA	A	A,PB	A
****314	*O. diffusa*	20	NA	NA	NA	NA	NA	A
****315	*O. diffusa*	13	NA	NA	NA	NA	NA	A
401	*D. clivosa*	60	A	A	A	A	A	A
402	*O. diffusa*	28	A	NF	NF	NF	NF	NF
403	*O. diffusa*	13	A	A	A	A, PB	NF	NF
404	*S. siderea*	9	A	A	NF	NF	NF	NF
405	*D. clivosa*	55	A	A	A	A	A	A
406	*O. diffusa*	19	A, PB	A	A, FL	NF	NF	NF
407	*O. diffusa*	13	A, PB	A, FL	A, FL	A	A	A
408	*P. astreoides*	14	A	NF	NF	NF	NF	NF
409	*O. diffusa*	35	A, FL	NF	NF	NF	NF	NF
410	*M. cavernosa*	25	A	A	A	A	A	A
*411	*O. diffusa*	14	NA	A	NF	NF	NF	NF
*412	*S. siderea*	33	NA	A	A	A	A	A
*413	*S. siderea*	32	NA	A	A	A	A,PB	A
*414	*D. clivosa*	30	NA	A	A	A	A	A
**415	*S. siderea*	13	NA	NA	A	A	A	A
****416	*M. cavernosa*	20	NA	NA	NA	NA	NA	A
****417	*S. siderea*	9	NA	NA	NA	NA	NA	A
501	*M. cavernosa*	35	A	A	A	A	A	A
502	*O. diffusa*	22	A, FL, PB	NF	NF	NF	NF	NF
503	*O. diffusa*	15	A	NF	NF	D	D	D
504	*M. cavernosa*	55	A	A	A	A	A	A
505	*S. siderea*	40	A, NT, PB	A	A	A	A	A
*506A	*S. siderea*	18	NA	A	A	A	A	A
*506B	*S. siderea*	9	NA	A	A	A	A	A
*507	*S. siderea*	11	NA	A	A	A	A	A
****508	*M. cavernosa*	15	NA	NA	NA	NA	NA	A
****509	*M. cavernosa*	57	NA	NA	NA	NA	NA	A

Table 16. MC3 monitored colony area (cm²) data. The 2006-2011 colony area measurements were determined by image analysis. Species codes include the first initial of the genus and first three letters of the species. (* = new colonies added to the effort since 2006; NA = colony not part of project that year, NI = colony alive but no image adequate for image analysis, NT = no image taken because colony dead or not found, NF = colony not found).

Tag	Species	2006	2007	2008	2009	2010	2011	Area Change 2010-2011
101	*O. dif*	113.1	16.5	27.5	65.5	13.3	29.9	16.7
102	*S. sid*	25.6	29.1	NT	NT	NF	NF	
103	*O. dif*	248.3	NI	NI	NT	D	NT	
104	*D. cli*	176.1	169.5	NT	NT	NF	NF	
105	*S. bou*	115.7	130.2	NI	176.3	188.9	208.4	19.5
106	*S. sid*	12.6	NT	NT	NT	NF	NF	
107	*S. sid*	15.0	10.3	8.4	10.4	9.9	10.5	0.6
*108	*M. cav*	NA	50.9	53.1	62.2	61.6	80.8	19.24
*109	*S. sid*	NA	NA	4.5	NT	2.1	NT	
*110	*O. dif*	NA	NA	NA	45.9	63.6	113.5	49.9
*111	*D. cli*	NA	NA	NA	NA	NA	766.8	
*112	*O. dif*	NA	NA	NA	NA	NA	89.5	
201	*D. cli*	412.9	NT	NT	NT	NF	NF	
202	*S. sid*	8.2	8.7	8.7	12.3	10.8	11.5	0.6
203	*D. cli*	352.9	270.2	NT	NT	NF	NF	
204	*D. cli*	618.5	NT	NT	NT	NF	NF	
205	*D. cli*	172.8	169.2	184.6	211.1	212.9	240.1	27.2
206	*S. sid*	13.0	8.1	4.6	NT	NF	NF	
207	*D. cli*	437.8	288.8	320.3	315.6	337.3	369.7	32.4
208	*D. cli*	242.6	NI	NI	NT	NF	NF	
209	*O. dif*	56.6	19.1	NI	NT	24.9	NT	
210	*M. cav*	129.0	116.1	136.2	147.1	151.4	167.9	16.5
211	*O. dif*	49.2	NT	NT	NT	NF	NF	
212A	*S. sid*	2.0	1.9	1.4	2.3	1.5	NT	
212B	*S. sid*	5.0	5.1	3.4	2.3	1.5	NT	
212C	*S. sid*	4.7	3.3	2.5	1.8	2.6	NT	
213	*M. cav*	56.7	59.2	66.8	72.3	73.8	89.5	15.7
*214	*O. dif*	NA	NA	NA	39.7	56.9	80.8	23.9
*215	*M. cav*	NA	NA	NA	76.6	86.1	100.9	14.7
*216	*D. cli*	NA	NA	NA	NA	NA	818.9	
*217	*D. cli*	NA	NA	NA	NA	NA	110.0	
*218	*O. dif*	NA	NA	NA	NA	NA	74.9	
301	*S. sid*	33.1	31.5	38.6	48.9	51.2	60.2	9.0
302	*O. dif*	127.8	NT	NT	NT	D	NT	

Table 16. Continued.

Tag #	Species	2006	2007	2008	2009	2010	2011	Area Change 2010-2011
303	*O. dif*	43.8	NT	NT	NT	NF	NF	
304	*M. cav*	112.7	85.3	69.9	124.6	153.6	181.5	27.9
305	*O. dif*	166.7	NT	NT	NT	NF	NF	
306	*D. cli*	369.1	NT	NT	NT	NF	NF	
307	*M. cav*	NI	190.4	221.4	234.2	265.7	303.3	37.6
308	*S. sid*	12.4	11.8	13.6	13.1	9.2	11.4	2.2
309	*M. cav*	62.4	42.3	45.5	73.6	96.9	105.1	8.3
310	*M. cav*	266.9	325.5	216.4	373.1	415.4	NT	
311	*O. dif*	159.5	NI	NI	284.5	368.5	194.8	-173.7
312	*M. cav*	657.1	NI	NI	NI	NT	NT	
*313	*O. dif*	NA	NA	NA	101.9	105.5	156.2	50.8
*314	*O. dif*	NA	NA	NA	NA	NA	158.5	
*315	*O. dif*	NA	NA	NA	NA	NA	93.9	
401	*D. cli*	974.8	1700.2	NI	NI	NT	NT	
402	*O. dif*	380.1	NT	NT	NT	NF	NF	
403	*O. dif*	83.5	116.3	155.8	152.8	NF	NT	
404	*S. sid*	42.3	15.6	NT	NT	NF	NF	
405	*D. cli*	NI	730.5	524.0	NI	884.5	NT	
406	*O. dif*	118.4	96.2	22.0	76.5	NF	NF	
407	*O. dif*	71.6	74.2	26.8	8.6	3.8	NT	
408	*P. ast*	NI	NT	NT	NT	NF	NF	
409	*O. dif*	819.5	NT	NT	NT	NF	NF	
410	*M. cav*	270.2	263.6	255.6	310.7	338.6	367.4	28.8
*411	*O. dif*	NA	43.1	NI	NT	NF	NF	
*412	*S. sid*	NA	373.5	666.3	NI	NT	NT	
*413	*S. sid*	NA	166.0	182.3	190.8	164.6	153.5	-11.1
*414	*D. cli*	NA	421.2	472.9	547.5	617.3	733.3	116.0
*415	*S. sid*	NA	NA	55.7	NI	54.8	51.9	-2.8
*416	*M. cav*	NA	NA	NA	NA	NA	197.4	
*417	*S. sid*	NA	NA	NA	NA	NA	27.3	
501	*M. cav*	224.8	210.2	267.0	244.6	289.9	349.4	59.6
502	*O. dif*	338.4	NT	NT	NT	NF	NT	
503	*O. dif*	94.4	NT	NT	NT	D	NT	
504	*M. cav*	928.2	921.6	NI	NI	NT	NT	
505	*S. sid*	NI	310.5	150.7	219.4	187.0	111.1	-75.9
*506A	*S. sid*	NA	79.3	81.8	86.3	96.0	81.3	-14.8
*506B	*S. sid*	NA	20.4	21.7	25.8	28.4	21.9	-6.4
*507	*S. sid*	NA	35.8	31.6	NI	60.3	32.3	-27.9
*508	*M. cav*	NA	NA	NA	NA	NA	85.9	
*509	*M. cav*	NA	NA	NA	NA	NA	NT	

Table 17. Summary data for colonies mapped in 2006 and assessed in 2007, 2008 2009, 2010, and 2011, the number of colonies not traced (NT) in 2006 and/or 2011, the number of colonies alive (A), dead (D), and not found (NF) in 2011, and the number of colonies with an increase in tissue area in 2011 and a decrease in tissue area in 2011.

Species	2006 # Col	2006 NT	2011 NT	2011 Status A	D	NF	Increase	Decrease
O. diffusa	15	0	4	9	3	7	4	1
S. siderea	12	1	5	11	0	4	4	6
D. clivosa	10	1	2	6	0	6	3	0
M. cavernosa	10	1	4	11	0	0	9	0
S. bournoni	1	0	0	1	0	0	1	0
P. astreoides	1	1	0	0	0	1	0	0

Monitoring Site Temperature Record

Temperature loggers have been present at three Miami-Dade sites (DC1, DC2, and DC3), all four Broward and all three Martin County sites since February 2007 (ten sites). Loggers have been present at three Palm Beach County sites (PB1, PB2, and PB3) since August 2007. Loggers are collected and replaced during each sampling event. Loggers were deployed at the four new sites (DC4, DC5, PB4, and PB5) during the 2010 sampling event. During the 2011 sites visits, temperature data were successfully downloaded from 15 of the 17 sites. Both temperature loggers at sites MC3 and PB3 failed.

The 2011 sample dates shown in Table 2 are the same dates that temperature loggers were redeployed or deployed at each of the 17 SECREMP sites. Table 18 presents the dates and maximum and minimum temperatures (°C) for each site from late winter 2007 into summer 2011. Figure 8 shows the mean monthly temperatures for 17 sites. This figure illustrates the general warming trend (as expected) at all sites from February to August/September. Figure 8 also shows that the three Martin County sites tend to have lower winter temperatures while much of the remaining year is similar to the southern counties. Figures 9-12 show the mean daily temperatures for each of the sites by county. For all sites, for some period during which temperatures have been recorded, the maximum temperature recorded was over 30°C. These warm temperatures were generally recorded during the later summer months of 2007 and 2009 (August-September). The low temperatures ranged from 13.4°C (site MC1) to 20.9°C (site BC3). The coolest temperatures were recorded during the winter months (January-March) of 2009, 2010, and 2011, and these years were cooler than the temperatures recorded in 2008 and part of 2007. Figures 8-12 all show that, in general, the summer period in 2008 was cooler than the summer periods in 2007, 2009 and 2011.

Table 18. Maximum and minimum temperatures (°C) and dates for the 13 sites with temperature loggers winter 2007 through winter 2011.

Site	Max Temp	Date	Min Temp	Date
BCA	30.9	12 Aug 09	19.0	6 Feb 09
BC1	30.8	11 Aug 09	19.6	6 Feb 09
BC2	30.4	24 Aug 11	20.4	5 Mar 10
BC3	30.4	13 Sep 09	20.0	22 Feb 11
DC1	31.4	4 Aug 11	19.7	23 Jan 09
DC2	30.7	5 Aug 11	20.1	4 Mar 10
DC3	30.5	19 Aug 07	20.4	1 Feb 11
DC4	30.1	3 Jul 10	20.3	31 Jan 11
DC5	30.8	6 Aug 11	20.3	31 Jan 11
PB1	30.4	11 Aug 09	19.5	3 Mar 10
PB2	30.3	31 Aug 10	18.5	5 Apr 11
PB3	30.1	29 Aug 07	19.7	7 Mar 10
PB4	30.3	31 Aug 10	19.6	23 Feb 11
PB5	30.3	21 Aug 11	19.7	23 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

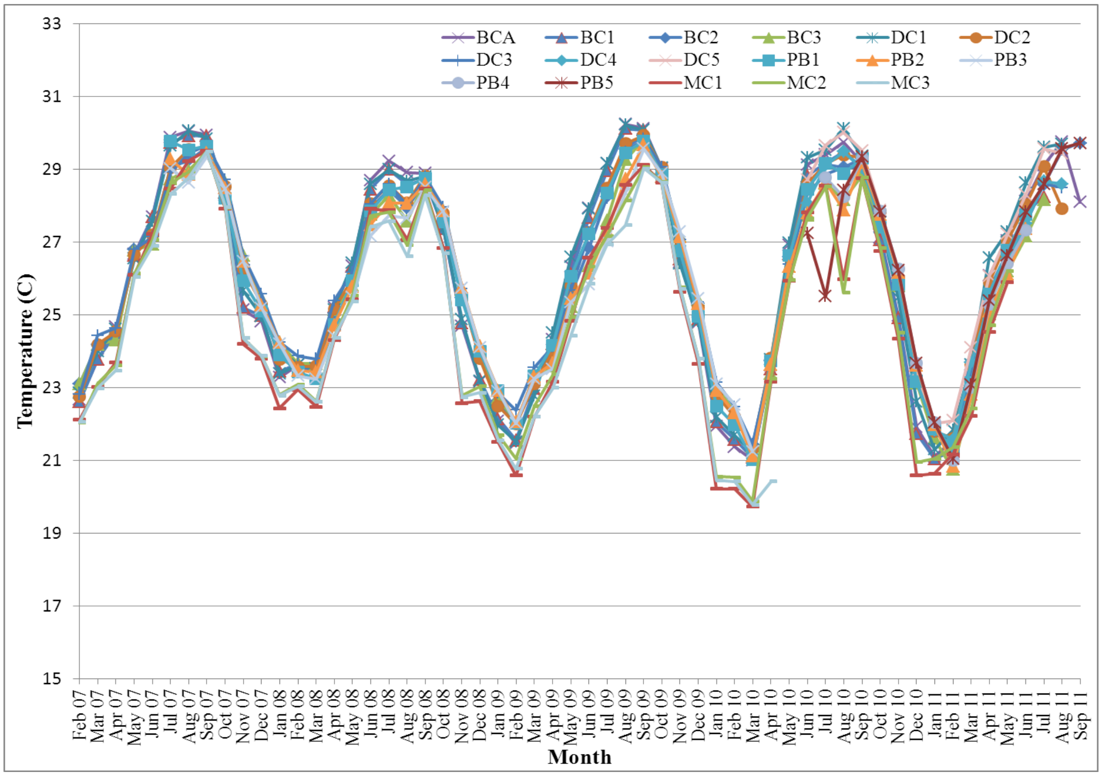

Figure 8. Mean monthly temperatures (°C) for 16 sites, February 2007 – September 2011.

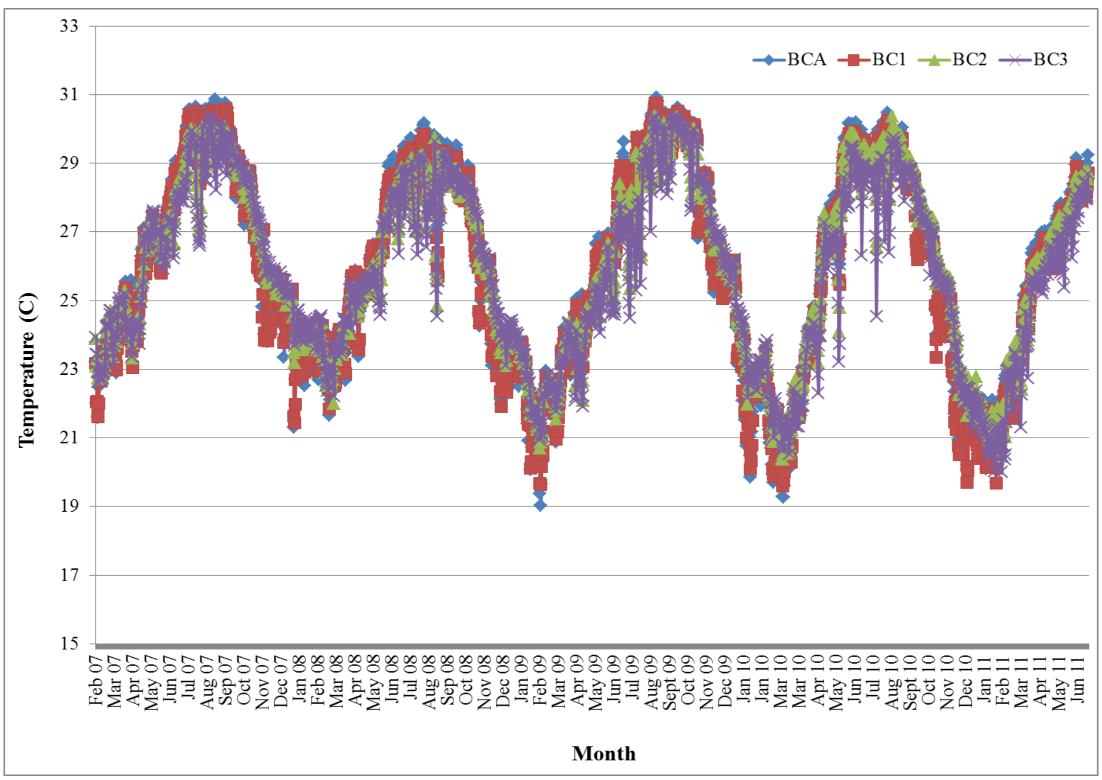

Figure 9. Mean daily temperatures (°C) for the four Broward County sites, February 2007 – June 2011.

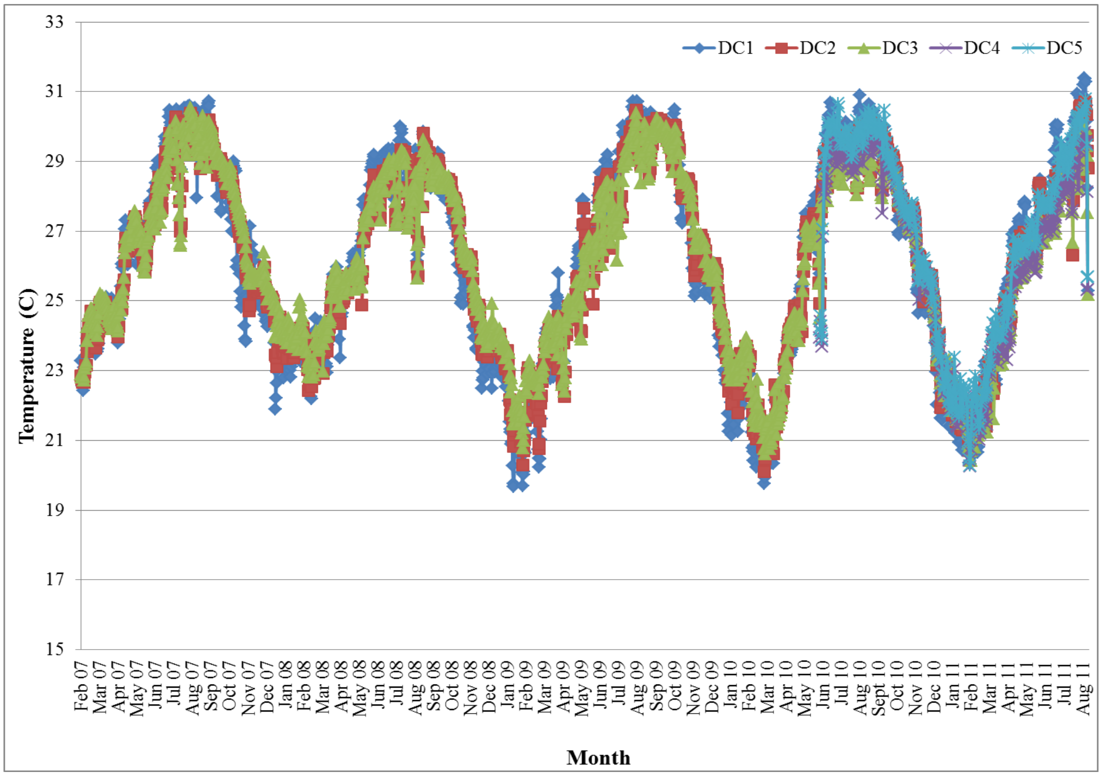

Figure 10. Mean daily temperatures (°C) for the three Miami-Dade County sites, February 2007 – August 2011.

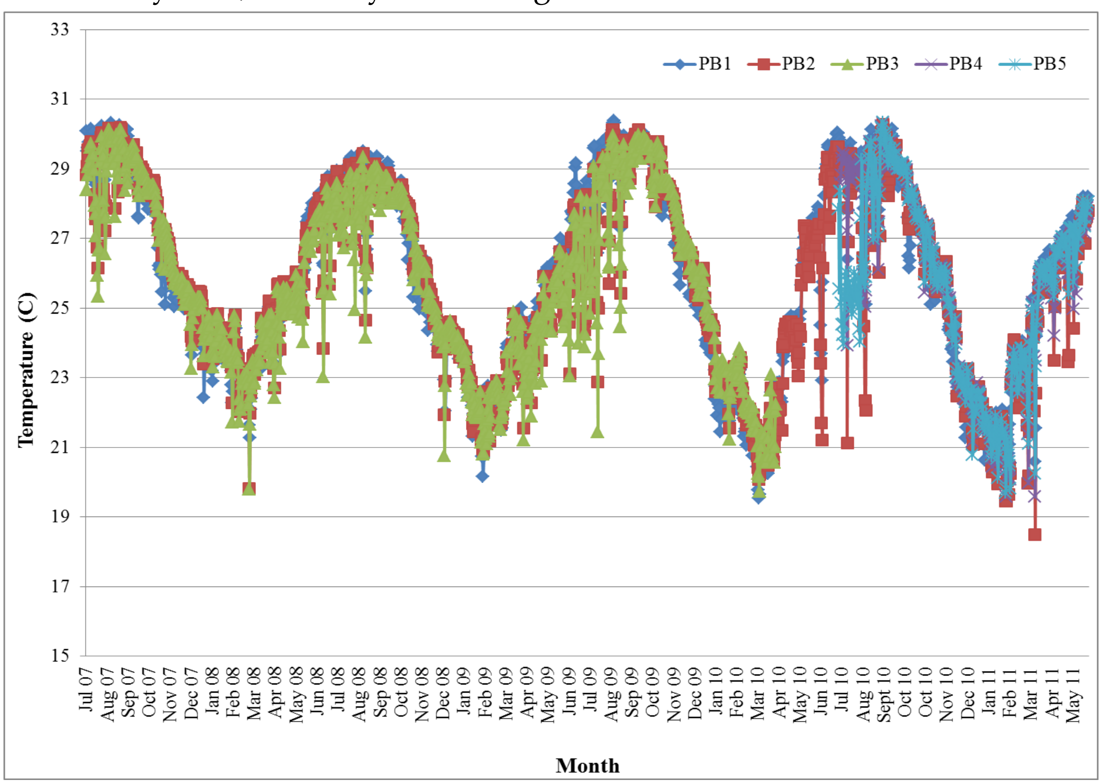

Figure 11. Mean daily temperatures (°C) for the three Palm Beach County sites, July 2007 – May 2011.

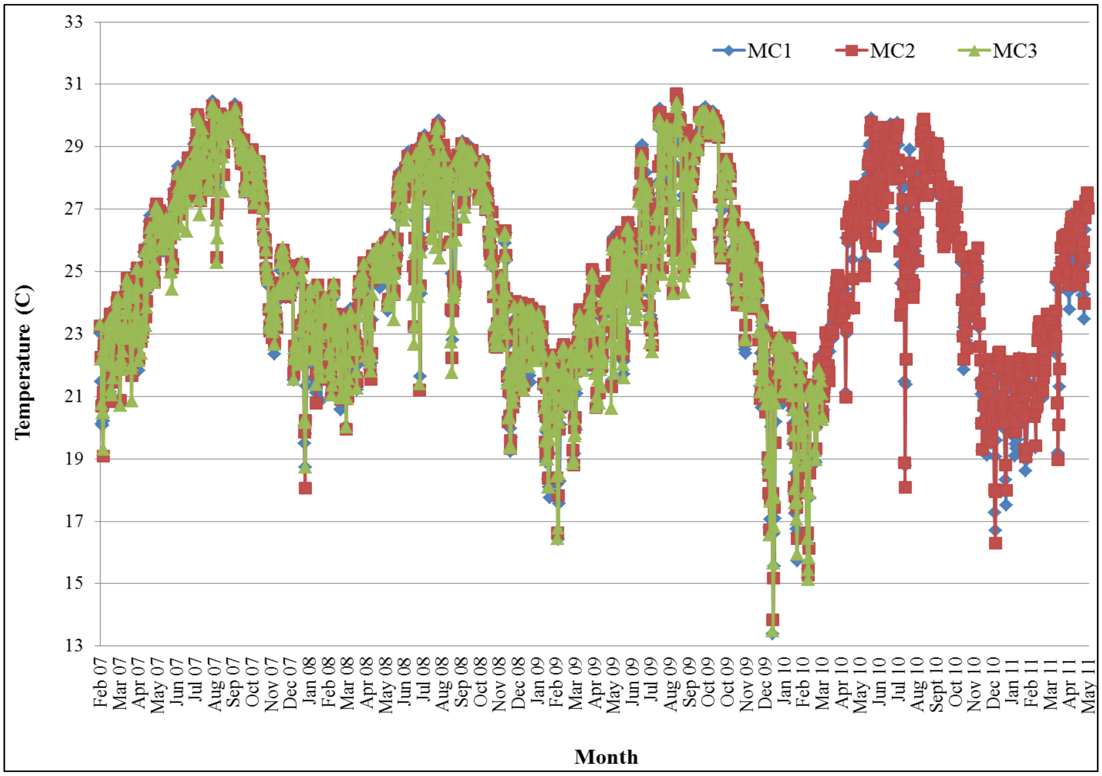

Figure 12. Mean daily temperatures (°C) for the three Martin County sites, February 2007 – May 2011.

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 similar throughout the Florida Reef Tract, while sponges appear to contribute more cover off southeast Florida than in the Florida Keys or Dry Tortugas (Ruzicka et al. 2010; Ruzicka et al. 2012).

With nine years of data, in general, the status (as defined by percent cover of stony corals, octocorals, sponges, and macroalgae) of the southeast Florida reef system has changed little from 2003 to 2011. The long term trend analysis completed for year 2003-2010 did not indicate change in cover at most sites (Table 9). Stony coral species richness (Table 3; Figure 5) and cover are very similar across years (Table 8; Figures 6 and 7). The incidence of disease in 2011 (13 colonies) (Tables 5 and 6) was not high and was much less than the high of 46 colonies identified in 2007. This limited number of diseased colonies is even more evident with the addition of four new sites in 2010. Of these 13 colonies, five were still diseased from 2010 and eight were newly diseased colonies. Although determining colony density has not been a part of this project, upon examining all 16 standard sites within this project, diseases do not appear to be a major factor affecting stony coral condition or cover in the SECREMP sites, especially since the presence of 'disease' within the sites is primarily in *S. siderea* colonies (23 of the 31 colonies in 2009, eight of 10 in 2010, and 10 of 13 in 2011).

For the functional groups (stony coral, octocoral, sponge, and macroalgae) analyzed there is no apparent consistent regional trends in temporal changes in cover from 2003 to 2010 (Table 9). A few sites, however, have shown significant changes in functional group cover (Table 9). Two sites, BCA and PB1, have significantly decreased in stony coral cover since 2003. Three sites PB1, PB2, and PB3, have decreased in octocoral cover since project inception, while three sites DC1, PB2, and PB3 have increased in sponge cover. Similar to the trends for stony corals and octocorals at PB1, sponge cover has also significantly declined at this site. Only one site, BC1, has had a change (an increase) in macroalgae cover. These sites with significant cover trends are discussed below.

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 2011, stations 2 and 4 have very slowly started to become uncovered; but both stations remain dominated by sand. From 2006 to 2011, stony coral, octocoral, and sponge cover were very low (essentially zero) in these stations. 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 (see Table 9 and Table 14).

Site BCA was added to the project as the fourth site in Broward County for the purpose of monitoring one of the unique southeast Florida *A. cervicornis* patches. With the recent listing of *A. cervicornis* as a Threatened species under the U.S. Endangered Species Act (http://www.nmfs.noaa.gov/pr/pdfs/fr/fr71-26852.pdf), it is important to make special note of site BCA. *Acropora cervicornis* cover decreased from a high of 39% in 2004 and 2005 to a low of 14% in 2011 (Table 8). In 2006 *A. cervicornis* cover was 25% and increased to 31% in 2007 remaining essentially at this level in 2008 (Table 8). The cover decreased again in 2009 to 25% and further in 2011 to 14%. Sampling of the site has been conducted at the same time each year (June in 2004-2011, Table 2). The passing of Hurricane

Wilma over the area in October 2005 may have contributed to some of the decline in 2006. The cyanobacteria, *Lyngbya* spp., bloom seen in previous years (2004) appeared to be in decline between 2005 and 2010 (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 north, has suggested that disease and predation by the fireworm, *Hermodice carunculata*, may be the primary causes of tissue loss (Gilliam, unpublished data). The cover within the *A. cervicornis* patch has also been record as declining by two additional projects (Walker et al. 2012; Gilliam et al. 2011). 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). This is evident from the increase in cover observed in 2007, stability in 2008, and a reduction again in 2009, 2010, and 2011. The cover in 2011 was significantly less than the cover in 2010.

The cyanobacteria, *Lyngbya* spp., covered much of site DC3 in 2008. Cyanobacteria are part of the other biota function group for the image analysis cover estimates. In 2008, *Lyngbya* spp. cover was >11%, compared to 3% or less in previous years (Table 12). In 2009, cover dropped back to 3%, but increased again to 8% in 2010. *Lyngbya* covered many octocorals at this site in 2008. The high cover in 2008 and continuous cover since then, has likely contributed to the significant decline in octocoral cover (Table 9). 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. There was no significant difference determined in octocoral cover for DC3 between 2010 and 2011.

Octocoral cover also showed a decreasing trend at site PB3 since 2003 (Table 9). The trend was similar at PB2, however, the decrease in octocoral cover at this site was slightly above the adjusted Bonferroni corrected p value of $p \leq 0.004$ ($p=0.008$; Table 9). 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. Conversely, both PB2 and PB3 showed an increasing trend in sponge cover (Table 9). The reduction in octocoral canopy cover at both of these sites 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. There was no significant difference determined in octocoral cover for PB3 between 2010 and 2011. There was, however, a significant lower percent cover estimated for PB2 in 2011 compared to 2010 which may indicate that the trend for reduced octocoral cover is continuing.

In contrast to DC3, PB3, and PB2, octocoral cover was determined to be significantly greater in sites BC2, DC1, and DC2 in 2011 compared to 2010. None of these sites showed any significant long-term trends in cover changes (Table 9).

Temperature loggers were deployed at ten sites in February 2007 and the three original Palm Beach County sites in July 2007. Loggers were deployed at the four newest sites in 2010. With more than four years of temperature data recorded, some trends in water temperatures are becoming evident. All sites (Figures 8-12) 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 four complete summer period data records (2007-2010). 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 within the region within at least two sites all summers except 2008 when no temperatures above 30.5°C were recorded. In 2010, two sites (DC1 and DC5), had temperatures recorded above 30.5°C, and these warm waters remained at DC1 and DC5 for five days and two days respectively. The number of sites with temperatures recorded above 30.5°C in 2010 was less than the number of sites recorded for 2009 (five sites) and 2007 (four sites). Palm Beach is the only county which has not had any site over this four summer period with temperatures above 30.5°C recorded. The SECREMP sampling period is generally conducted between late May and early August (Table 2), prior to the warmest recorded temperatures and the time of year warm water 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 appears to be unlikely.

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 and 2011 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 renourishment, 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. A possible example of this can be seen in the site MC3 colony fate tracking effort with nearly over half of the mapped *O. diffusa* colonies showing effect from entanglement from fishing line (Table 15). 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. Ships occasionally run aground and anchor on reefs causing extensive and often long-lasting damage. Other recent impacts include those of the installation of fiber optic cables deployed across the reefs, which may cause abrasion and detachment of corals and sponges (Jaap 2000).

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 site-specific monitoring are necessary if resource managers are to develop sound management plans for coral reefs that permit 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, has insured that this minimum 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 renourishment, 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 Coral Reef Conservation Grant Program for the Florida southeast coast, the SECREMP will continue characterization of baseline ecosystem condition, inventory/mapping of biotic resources, and data base development, providing resource managers with the critical information required to manage this valuable natural resource.

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