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Southeast Florida Coral Reef Evaluation and Monitoring Project 2007 Year 5 Final Report

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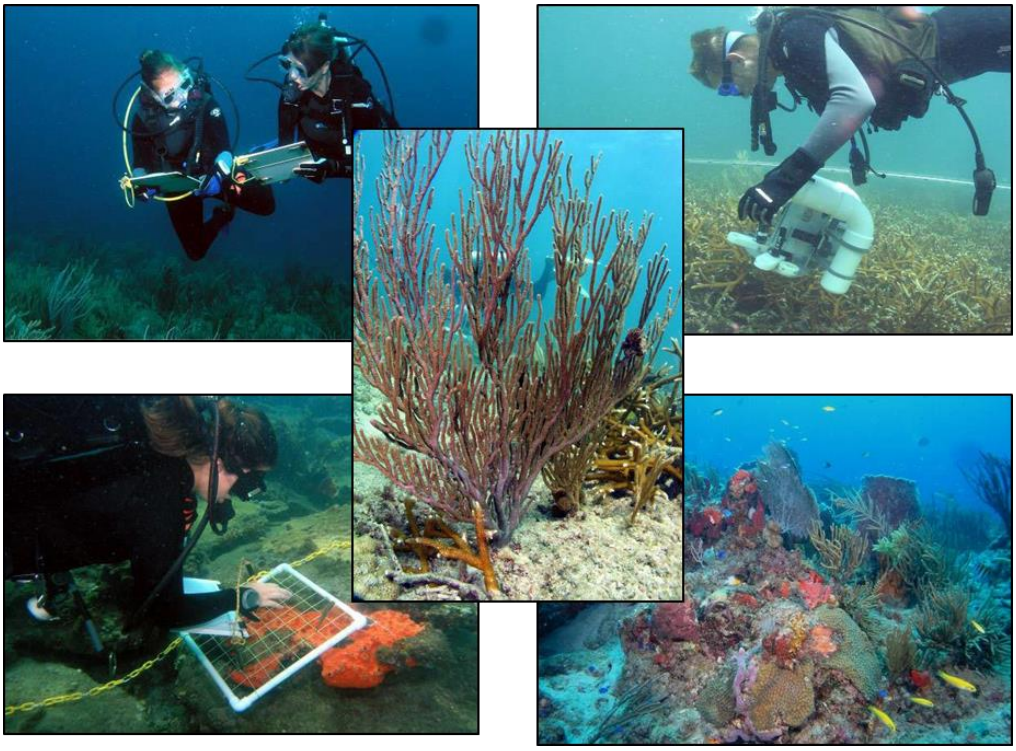

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for the

Florida Department of Environmental Protection
Office of Coastal & Aquatic Managed Areas
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Southeast Florida Coral Reef Evaluation and Monitoring Project
2007 Year 5 Final Report

INTRODUCTION

The coral reef ecosystem in Florida extends from the Dry Tortugas in the south to the St. Lucie Inlet in the north. However, until recently, the primary focus for coral reef research and long-term monitoring has long been 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 throughout the Florida reef tract from Key West to Carysfort (Callahan et al. 2007). In 1999, the project was expanded to include three 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 was expanded again in 2006 with the establishment of three sites in Martin County. 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. Five years (2003-2007) of SECREMP sampling have been completed.

The southeast Florida reef system extends north of the Florida Keys reef tract, approximately 170 km from Miami-Dade into Martin County. From Cape Florida (Miami-Dade County), north to central Palm Beach County, in particular offshore Broward County, the southeast Florida 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. In Press) (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 (Dodge et al. 1995; Gilliam et al. 2007) along the southeast coast originated as impact and mitigation studies from adverse environmental impacts to specific sites (dredge impacts, ship groundings, pipeline and cable deployments, and beach renourishment). Monitoring efforts that were part of marine construction activities have in the past been of limited duration (1–3 years) and focused on monitoring for project effects to the specific reference areas.

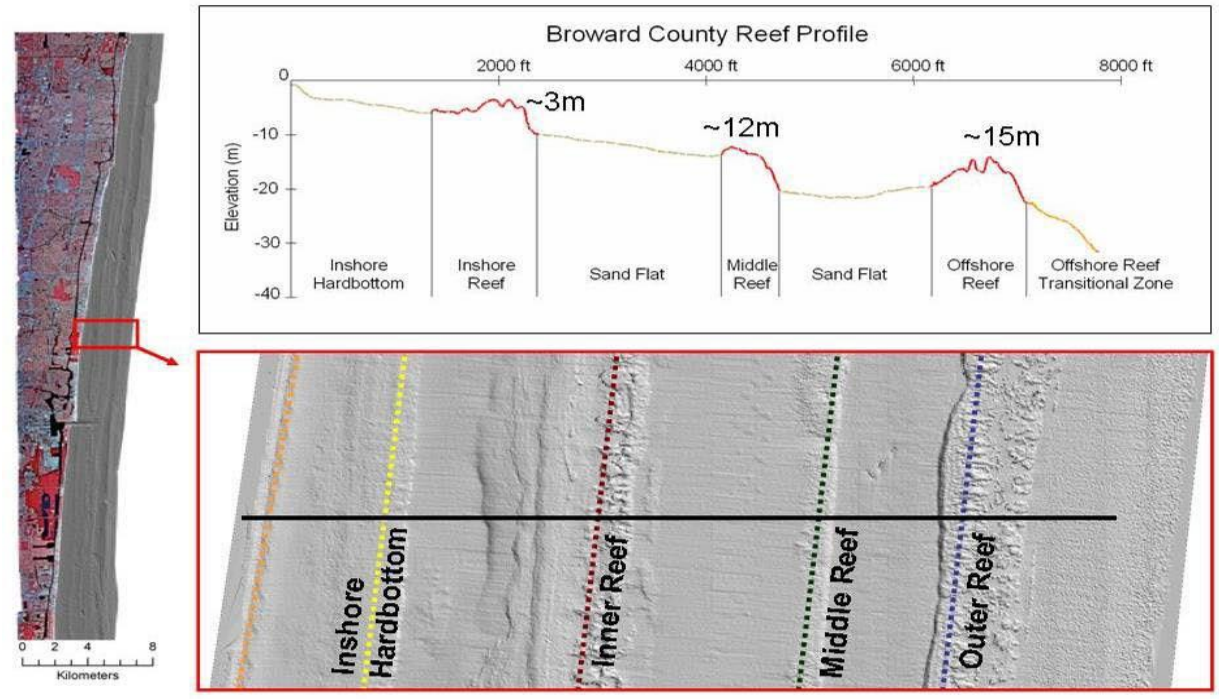

Figure 1: Panel A (at left): View of the southeast Florida coastline of Broward County, showing the land area in red and offshore reefs in gray. Panel B (bottom right): The sea floor shown is bathymetry from LIDAR data. The red square is enlarged in Panel B, showing the LIDAR bathymetry in greater detail. 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, sponge, and fish abundance/cover data has been conducted at 18 sites. In 2000, Nova Southeastern University (NSU) assumed this monitoring responsibility from the County. During that year, five new sites were added. In 2003, two additional sites were added. Monitoring of these 25 sites is ongoing and is scheduled to continue through 2009 (Gilliam et al. 2007).

Previous monitoring of reef habitats 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 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 coast offshore 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 economic annual input for southeast Florida at over 5.7 billion dollars (Johns et al. 2003, 2004). The uniqueness, proximity and value 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, 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

Planning for Year 1 fieldwork began in early 2003. Year 1 fieldwork included locating, installing, and monitoring ten sites in Miami-Dade, Broward, and Palm Beach Counties. Principal investigators from FWRI supplied to, and discussed with, researchers from the National Coral Reef Institute (NCRI) at Nova Southeastern University, the CREMP Standard Operating Procedures for site selection, installation and monitoring. Representatives from Miami-Dade County Department of Environmental Resource Management (DERM), Broward County of Environmental Protection Department (EPD), and Palm Beach County Environmental Resource Management (ERM) were kept informed on the progress of the project and invited to participate in site selection and sampling. On 16 June 2003, a workshop was held at Nova Southeastern University Oceanographic Center to discuss the purpose, background, and methods of CREMP and SECREMP. Participants included personnel from NCRI, FWRI (St. Petersburg and Tequesta), EPD, DERM, and ERM.

During Year 1 (2003) of the project, NCRI worked closely with FWRI on site selection, methods training, and site sampling. NCRI was responsible for communicating with FWRI and FDEP and for managing and completing the sampling efforts for Years 2 (2004) through 5 (2007). Planning for all years began in January. Prior to sampling, FWRI and FDEP were notified of the proposed sampling dates and invited to participate.

In 2004, discussions were initiated to expand SECREMP into Martin County, offshore the St. Lucie Inlet Preserve State Park (http://www.floridastateparks.org/stlucieinlet/default.cfm). In addition to expanding upon the overall SECREMP goal of providing reef monitoring data for the southeast Florida reef system, expanding SECREMP to include sites offshore the St. Lucie Inlet Preserve State Park will provide coral community monitoring data in 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 Park system were involved in all Martin County planning discussions.

Monitoring Site Selection and Sampling

Initially (2003), three sites were proposed to be installed and sampled in each of three southeast Florida counties (Miami-Dade, Broward, and Palm Beach). For Miami-Dade and Broward Counties one site was to be selected on each of the three reef tracts from nearshore to offshore. Because Palm Beach does not have three separate reef tracts, one site was selected on a nearshore patch reef and two sites were selected on the offshore reef tract. Additionally, because of the

unique *Acropora cervicornis* patches located off Ft. Lauderdale, a fourth site was added in Broward County to the project to monitor one of these patches. These initial ten sites (Figure 2) each include four standard CREMP stations. In 2003, during the initial SECREMP site selection process, personnel from NCRI, FWC-FWRI, and each of the Counties were present. Each county assisted by providing vessel support. Industrial Divers Corporation (IDC) of Fort Lauderdale, FL was subcontracted to install the reference stakes.

In 2005, site selection efforts began in Martin County. Researchers and managers from NCRI, FWC-FWRI, FWC, FDEP Office of Coastal and Aquatic Managed Areas (CAMA), and the St. Lucie Inlet Preserve State Park (SLIPSP) met several times in 2005 with the purpose of selecting sites, but each time, conditions (rough seas or very poor water visibly) did not permit fieldwork. Martin County site selection was completed in February 2006. Three sites (sites MC1, MC2, and MC3) were selected within the offshore boundaries of the SLIPSP (Figure 2). Researchers and managers from NCRI, FWC-FWRI, FWC, FDEP, and the Park were present during site selection. The total number of SECREMP sites, beginning with the Year 4 event (2006), became, and is currently, thirteen.

For all years, project sampling has been conducted between June 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.

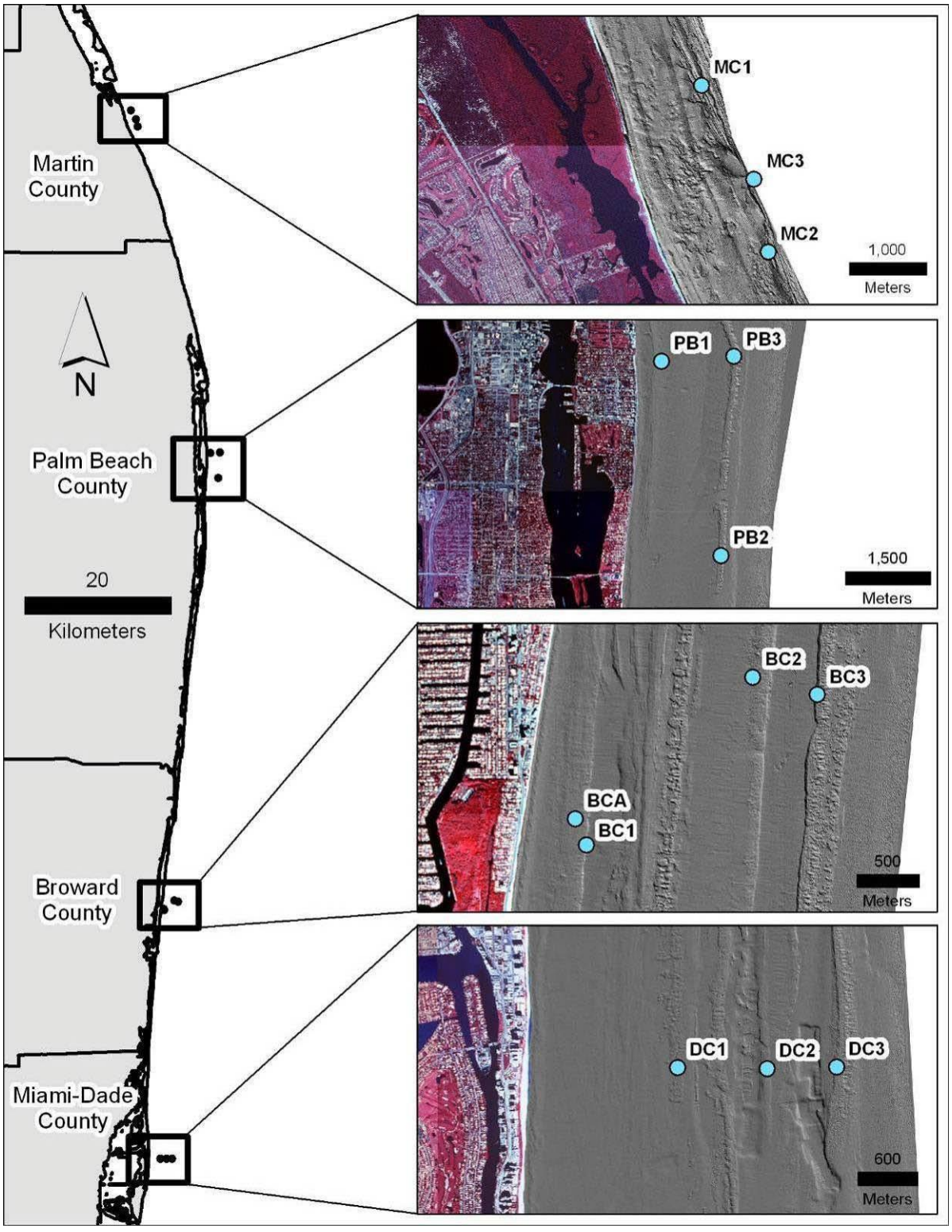

Figure 2. Map of the thirteen SECREMP sites illustrating their locations off Miami-Dade, Broward, Palm Beach, and Martin Counties.

Table 1. Location and depth for the thirteen SECREMP monitoring sites (BC = Broward County; DC = Miami-Dade County; PB = Palm Beach County; MC = Martin County).

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’
PB1	25	26° 42.583’	80° 01.714’
PB2	55	26° 40.710’	80° 01.095’
PB3	55	26° 42.626’	80° 00.949’
MC1	15	27° 07.900’	80° 08.042’
MC2	15	27° 06.722’	80° 07.525’
MC3	15	27° 07.236’	80° 07.633’

Table 2. Site selection and sample dates (BC = Broward County; DC = Miami- Dade County; PB = Palm Beach County; MC = Martin County).

Site Code	Date Selected	Yr 1 Date Sampled	Yr 2 Date Sampled	Yr 3 Date Sampled	Yr 4 Date Sampled	Yr 5 Date Sampled
BCA	5-06-03	6-19-03	6-11-04	6-08-05	6-16-06	6-14-07
				6-30-05		
BC1	5-06-03	6-17-03	6-14-04	5-27-05	6-16-06	6-04-07
						6-13-07
BC2	5-12-03	6-18-03	6-03-04	6-30-05	6-18-06	6-04-07
BC3	5-06-03	6-18-03	6-09-04	6-08-05	6-27-06	6-13-07
DC1	5-16-03	6-24-03	6-15-04	7-15-05	7-07-06	6-05-07
				8-10-05	8-04-06	8-14-07
DC2	5-16-03	6-24-03	6-15-04	7-15-05	8-04-06	6-05-07
DC3	4-30-03	6-23-03	6-04-04	8-10-05	7-07-06	8-14-07
PB1	5-05-03	8-20-03	7-21-04	7-29-05	6-21-06	7-19-07
PB2	5-05-03	8-18-03	7-21-04	7-28-05	6-21-06	7-18-07
PB3	5-05-03	8-19-03	7-22-04	7-27-05	6-22-06	7-17-07
MC1	2-22-06	NA	NA	NA	5-31-06	7-30-07
MC2	2-22-06	NA	NA	NA	5-31-06	7-30-07
MC3	2-23-06	NA	NA	NA	9-28-06	7-31-07

METHODS

Twelve of the thirteen SECREMP monitoring sites consist of four monitoring stations delineated by permanent stainless steel markers (the thirteenth site, MC3, is described separately below). Stations are approximately 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 a bio-eroding sponge survey (Figure 3). The SECREMP sampling protocols generally follow standard CREMP sampling protocols.

Video Transects

Video was selected as the method for benthic cover evaluation because it is a rapid and efficient means of field data collection that provides a permanent data record. Percent cover of live stony coral, sessile benthic biota, and selected substrates are determined annually from video transects filmed at each station. The videographer films a clapperboard prior to filming each transect. This provides a complete record of date and location of each segment recorded. Three video transects are filmed at a constant distance (40cm) above the substrate at each station.

Two lasers converge 40 cm from the camera lens and guide the videographer 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.

All transects are filmed with a SONY TRV 900 digital video camcorder. The minimum number of digital images necessary to represent each station are frame grabbed 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 ten 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.

Standard video protocol is modified slightly for site BCA (Broward County nearshore *A. cervicornis* patch), and the Palm Beach County sites. Standard protocol calls for a plastic chain to be laid across the substrate to delineate the transect, and act as a guide for the videographer. At site BCA, extensions are added to the transect end stakes in order to raise transect lines above the coral. Fiberglass tapes are used to delineate the transects and guide the videographer instead of chains. All transect videos are taken on the east side of the transect tapes. These modifications reduce the potential for damage to the *A. cervicornis* colonies during sampling.

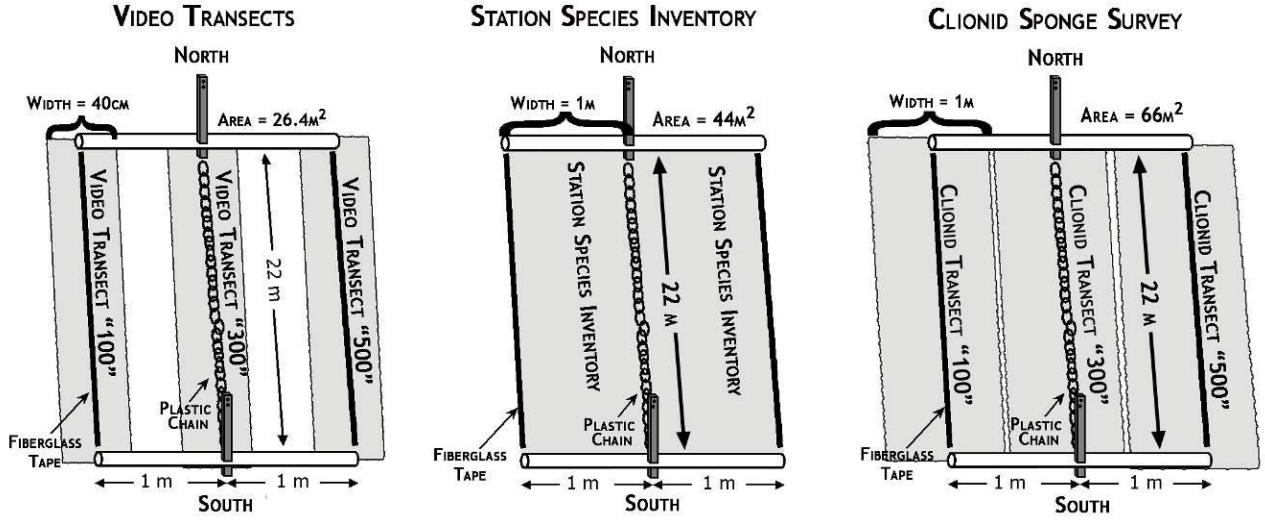

Figure 3. Typical layout of each SECREMP station showing the areas (hatch areas) within which the video, station species inventory (SSI), and bioerosion data are collected.

Off Palm Beach County, there is generally a strong north-flowing current present at offshore sites (PB2 and PB3). This current adds safety risk and greatly increases the effort required to complete the sampling. In order to reduce risk, fiberglass tapes are used in lieu of chains to mark transects and guide the videographer. Transect videos at all Palm Beach County sites are taken on the east side of the transect tapes. Additionally, all transects are videotaped with the diver swimming into the current to slow the divers speed (all stations in Miami-Dade and Broward Counties are sampled north-south).

Station Species Inventory (SSI)

Stony coral species (Milleporina and Scleractinia) presence is recorded at each station. Two observers conduct simultaneous, timed (15 minute) 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. During the species inventory, any species within a station that exhibits specific signs of either bleaching or disease 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, and idiopathic diseases). After conducting the survey, the observers compare data (5 minutes) underwater and each confirms the species recorded by each observer. Data sheets are verified aboard the vessel and entered into the database. All data and data sheets are then forwarded to the Fish & Wildlife Research Institute for quality assurance checks. This method facilitates robust data collection with broad spatial coverage at optimal expenditure of time and labor.

Bio-eroding Sponge Survey

Three clionaid sponge species (*Cliona delitrix, C. lampa*, and *C. caribbaea*) recorded by SECREMP are known to be aggressive coral bio-eroders and over-growers. Three 1 meter wide belt transects provide the maximum spatial coverage within each station. A 22-meter survey tape marks the center of reference for each transect. A diver delineates the survey area by swimming directly above the tape holding a meter stick perpendicular to the tape and parallel to the reef

surface. The location, species, and size of each clionaid sponge colony and species of stony coral affected by the clionaid colony is recorded. Area is measured by means of a 40 cm^2 quadrat frame subdivided into 5 cm squares. The area occupied by the clionaid colony is recorded to the nearest quarter square.

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 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 will be added to the project by mapping and tagging colonies that are greater than 10 m from the stake or by adding colonies within 10 m of the stake that were not included in 2006.

Total colony size (length and width) and colony condition (presence of bleaching, disease, etc.) were recorded *in situ*. In addition to the *in situ* measurements, a digital image was taken of each colony. The images were taken with a digital camera attached to a PVC framer (0.38m^2). Date and colony tag numbers were included within each image. The framer allows all images from each monitoring event to be a consistent planar view of the colony. These consistent planar view images 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 (cm^2) in each colony planar image. The software automatically calculates the area (cm^2) encompassed by the traced portion of the image (Figure 4). If dead areas are present within the living area of a colony, these dead areas are also traced. The dead area(s) subtracted from the previously traced living tissue area provides a more accurate measure of the living tissue area.

Monitoring Site Temperature Record

In 2007, the deployment of StowAway TidbiT™ (www.onsetcomp.com) temperature loggers was added to the SECREMP sampling protocol. Two 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.

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

YEAR 5 (2007) RESULTS

Stony Coral Species Richness

Stony coral species richness was summarized from SSI data. In 2007, a total of 27 stony coral species were identified within the twelve standard SECREMP sites (Table 3). The mean number of species identified per site was twelve. Six species were identified in all four counties (*Diploria clivosa*, *Millepora alcicornis*, *Montastraea cavernosa*, *Porites astreoides*, *Siderastrea siderea*, and *Solenastrea bournoni*), and thirteen species were identified in Miami-Dade, Broward, and Palm Beach counties. Common species included: *Siderastrea siderea* which was identified in the most site stations (45 total stations) followed by *Millepora alcicornis* (44 stations), *Montastraea cavernosa* (37 stations), and *Porites astreoides* (35 stations). Miami-Dade County sites contained the most species identified (23) followed by Broward County (22), Palm Beach County (19), and then Martin County (12). Figure 5 shows the number of species identified for each site 2003-2007. Two species, *Cladocora arbuscula* and *Mycetophyllia lamarckiana*, identified in 2006 were not identified in 2007. Each species was identified in only one station in 2006. No new species were identified in Broward, Miami-Dade, or Palm Beach Counties, but with the addition of the Martin County sites, one new species was added to the SECREMP list in 2006, *Isophyllia sinuosa*.

Miami-Dade County had a mean 11.4 stony coral species per station (n=12 stations), Broward County had 8.2 species per station (n=14 stations), Palm Beach had 8.7 species per station (n-12 stations), and Martin County had 7.5 species per station (n=8 stations). Counts at Broward County sites were slightly skewed by site BCA, which is dominated by *Acropora cervicornis*. Without site BCA, Broward County had a greater mean number (9.3) of species per station.

Table 3. Stony coral species presence/absence for the twelve standard SECREMP sites in Broward, Miami-Dade, Palm Beach, and Martin Counties for 2007. Key: A, 1, 2, 3 = sites with species present; 0 = species absent.

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

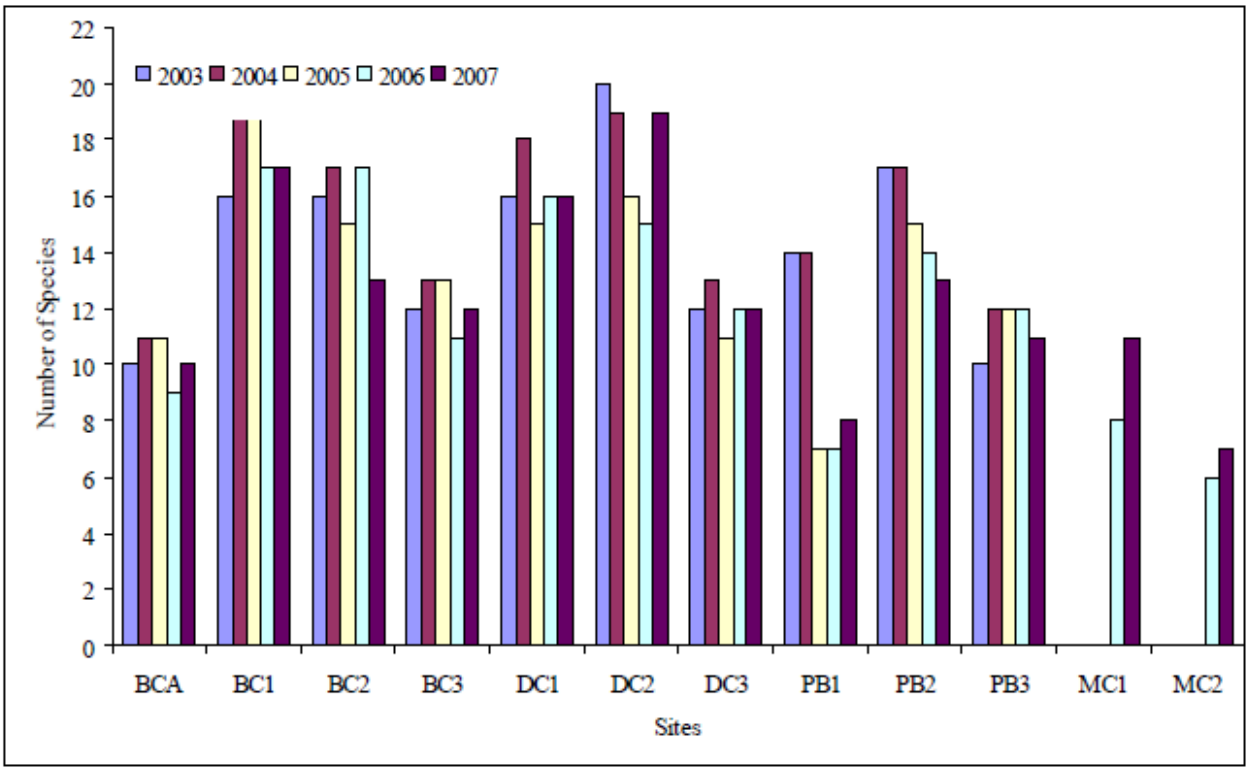

Figure 5. Stony coral species richness for the Broward (BC), Miami-Dade (DC), Palm Beach (PB), and Martin (MC) County sites for 2003-2007 (n= 3 sites, 12 stations, for Miami-Dade and Palm Beach Counties; n= 4 sites, 16 stations, for Broward County; n = 2 sites, 8 stations for Martin County).

Stony Coral Condition

In addition to recording stony coral species presence, the SSI protocol also includes an assessment of stony coral condition – defined as the presence or absence of bleaching and diseases. Disease categories included black band, white complex (white plague, white band, white pox), and "other" (dark spot, yellow band, and idiopathic diseases). Starting in 2004, images were taken of most diseased colonies in order to track the fate of these colonies.

In 2007, partially bleached colonies (no completely bleached colonies were observed) were observed more frequently (more sites with bleaching) than diseased colonies (Table 4). Partial bleaching was recorded at sites MC1, MC2, PB3, PB2, BC3, BC2, and BC1. No partially bleached colonies were recorded in Miami-Dade County. In 2007, diseased colonies were identified at seven sites (DC1, DC2, BCA, BC1, BC2, BC3, and PB2). "Other" diseases were seen at four sites (BC1, BC2, BC3, and DC1), and all cases were 'Dark Spots' on *S. siderea* colonies. "White complex" diseases were identified at six sites (DC1, DC2, BC1, BC3, BCA, PB3, and PB2) (Tables 4 and 5). Table 4 compares stony coral species with the presence of disease and partial bleaching at each of the sites, 2003-2007.

Table 4. Stony coral species within each site compared with the presence of disease or partial bleaching (A = absence of bleaching or disease; H = bleaching, O = other disease, W = white complex disease) (Note: Disease and bleaching were not recorded in 2003 and 2004 for site BCA).

Site	Species Affected	2003	2004	2005	2006	2007
DC1	*A. cervicornis*	A	A	A	W	W
DC1	*A. agaricites*	A	A	A	H	A
DC1	*D. stokesii*	A	W	A	A	W
DC1	*M. meandrites*	A	A	H	H	A
DC1	*M. annularis*	A	O	A	A	A
DC1	*M. cavernosa*	A	A	W	A	A
DC1	*P. astreoides*	H	H	H	H	A
DC1	*P. porites*	A	A	H	H	A
DC1	*S. siderea*	O	H, O	H, O, W	H, O	O
DC1	*S. bournoni*	A	A	A	W	A
DC2	*A. agaricites*	A	A	A	H	A
DC2	*E. fastigiata*	A	A	A	H	A
DC2	*M. annularis*	O	A	A	A	A
DC2	*M. cavernosa*	A	A	H	A	A
DC2	*P. astreoides*	A	A	A	H	A
DC2	*S. bournoni*	A	H	H	O, W	A
DC2	*S. intersepta*	A	A	H	H, W	A
DC2	*S. siderea*	A	A	H	H, O, W	W
DC3	*M. annularis*	A	H	A	A	A
DC3	*S. bournoni*	A	A	H	H	A
DC3	*St. intersepta*	A	H	H	A	A
BC1	*D. stokesii*	A	A	H	H, W	A
BC1	*M. annularis*	A	A	A	H	A
BC1	*M. cavernosa*	O	H	A	H, W	H,B
BC1	*P. astreoides*	H	A	A	A	A
BC1	*S. siderea*	H	H,O	O, W	H	O
BC1	*S. intersepta*	A	A	A	H	A
BC2	*D. stokesii*	A	H	A	H	A
BC2	*M. meandrites*	A	H	A	A	A
BC2	*M. cavernosa*	A	H	A	A	A
BC2	*P. astreoides*	A	H	H	A	H
BC2	*S. radians*	A	A	A	H, W	A
BC2	*S. siderea*	H	H, O	H, W	H, O, W	O
BC2	*S. bournoni*	W	A	A	A	A
BC2	*S. intersepta*	A	H	A	A	H
BC3	*A. fragilis*	A	A	H	A	A
BC3	*D. stokesii*	H	A	A	A	A
BC3	*M. meandrites*	A	H	A	H	A
BC3	*M. cavernosa*	A	A	H	A	H,W
BC3	*S. siderea*	H	H	H, O, W	H, O, W	W,O
BC3	*S. intersepta*	A	A	A	H	A
BCA	*A. cervicornis*	NA	NA	H, W	H, W	W

Table 4. Continued.

Site	Species Affected	2003	2004	2005	2006	2007
PB1	*D. clivosa*	A	H	A	A	A
PB1	*M. meandrites*	H	A	A	A	A
PB1	*O. diffusa*	H	A	A	A	A
PB1	*S. bournoni*	H, O, W	H	A	A	A
PB1	*S. radians*	H	H	H	A	A
PB1	*S. siderea*	A	O	A	A	A
PB2	*D. strigosa*	A	A	O	A	A
PB2	*M. meandrites*	A	H	A	H	A
PB2	*M. cavernosa*	A	H	H	H	H
PB2	*P. astreoides*	A	H	H	A	W
PB2	*S. michelinii*	A	H	A	A	W
PB2	*S. radians*	A	H	A	A	A
PB2	*S. siderea*	A	H	H, W	A	H
PB2	*M. decatis*	A	A	A	A	W
PB3	*D. stokesii*	A	H	A	A	A
PB3	*M. cavernosa*	A	A	H	A	H
PB3	*M. alicia*	A	A	A	A	W
MC1	*D. clivosa*	NA	NA	NA	H	H
MC1	*M. cavernosa*	NA	NA	NA	H	A
MC1	*P. astreoides*	NA	NA	NA	A	H
MC1	*S. siderea*	NA	NA	NA	H	H,O
MC2	*D. clivosa*	NA	NA	NA	H	H
MC2	*O. diffusa*	NA	NA	NA	H	A
MC2	*S. siderea*	NA	NA	NA	H	H,O

Table 5. List of all sites and stations with diseased stony corals and the stony coral species affected (# = number of colonies; C = condition [O = other disease, W = white complex disease; only presence, P, is noted for site BCA and DC1]) (Note: No diseased colonies have been identified in sites PB3, MC1, or MC2).

		Species	2004		2005		2006		2007	
Site	**Station**	**Affected**	**#**	**C**	**#**	**C**	**#**	**C**	**#**	**C**
DC1	1	*S. siderea*	3	O	0	---	1	O	5	O
DC1	1	*M. cavernosa*	0	---	1	O	0	---	0	---
DC1	2	*S. siderea*	1	O	2	O	0	---	1	O
DC1	3	*S. siderea*	1	O	0	---	0	---	1	W
DC1	3	*M. annularis*	1	O	0	---	0	---	0	---
DC1	3	*A. cervicornis*	0	---	0	---	P	W	P	W
DC1	3	*D. stokesii*	0	---	0	---	0	---	1	W
DC1	4	*A. cervicornis*	0	---	P	O	0	---	0	---
DC1	4	*S. siderea*	2	O	1	O	0	---	1	O
DC1	4	*S. siderea*	0	---	---	0	0	---	1	W
DC1	4	*S. bournoni*	0	---	0	---	1	W	1	W
DC1	4	*D. stokesii*	1	W	0	---	0	---	1	W
DC2	1	None	0	---	0	---	0	---	0	---
DC2	2	*S. intersepta*	0	---	0	---	1	W	0	---
DC2	3	*S. siderea*	0	---	0	---	1	W	1	W
DC2	3	*S. bournoni*	0	---	0	---	1	W	0	---
DC2	4	None	0	---	0	---	0	---	0	---
DC3	1	*S. siderea*	0	---	0	---	1	O	0	---
DC3	2	None	0	---	0	---	0	---	0	---
DC3	3	None	0	---	0	---	0	---	0	---
DC3	4	*S. siderea*	0	---	0	---	1	O	0	---
BCA	1,2,3,4	*A. cervicornis*	NA	NA	P	W	P	W	P	W
BC1	1	*S. siderea*	1	O	2	O	0	---	2	O
BC1	2	*S. siderea*	1	O	2	O	0	---	5	O
BC1	2	*M. cavernosa*	0	---	0	---	0	---	1	B
BC1	3	*S. siderea*	1	O	1	O	0	---	2	O
BC1	3	*S. siderea*	0	---	0	---	0	---	1	W
BC1	4	None	0	---	0	---	0	---	0	---
BC2	1	*S. siderea*	0	---	1	W	1	O	3	O
BC2	2	*S. siderea*	0	---	0	---	1	O	1	O
BC2	2	*S. siderea*	0	---	0	---	0	---	1	W
BC2	3	*S. siderea*	1	O	1	W	3	O	3	O
BC2	4	*S. siderea*	0	---	0	---	1	O	4	O
BC2	4	*S. siderea*	0	---	2	W	4	W	0	---
BC3	1	*S. siderea*	0	---	0	---	1	O	2	O
BC3	2	*S. siderea*	0	---	1	O	0	---	1	O
BC3	3	None	0	---	0	---	0	---	0	---
BC3	4	*S. siderea*	0	---	0	---	1	O	2	W

Table 5. Continued

Site	Station	Species Affected	2004 #	C	2005 #	C	2006 #	C	2007 #	C
PB1	1	*S. siderea*	2	O	0	---	0	---	0	---
PB1	1	*S. bournoni*	1	W	0	---	0	---	0	---
PB1	2	None	0	---	0	---	0	---	0	---
PB1	3	*S. siderea*	1	O	0	---	0	---	0	---
PB1	4	*D. clivosa*	1	O	0	---	0	---	0	---
PB2	1	*S. siderea*	0	---	1	W	0	---	0	---
PB2	1	*P. astreoides*	0	---	0	---	0	---	1	W
PB2	1	*M. decatis*	0	---	0	---	0	---	1	W
PB2	1	*D. strigosa*	0	---	1	O	0	---	0	---
PB2	2	None	0	---	0	---	0	---	0	---
PB2	3	None	0	---	0	---	0	---	0	---
PB2	4	*S. intersepta*	0	---	0	---	0	---	1	W

In 2007, disease (probably white band) and bleaching was present within site BCA, *A. cervicornis* thicket, however, due to the "thicket" growth form of *A. cervicornis* it is not possible to quantify the number of affected colonies within a station. Table 5 lists the number of colonies of each stony coral species that displayed symptoms of disease at each site and station 2004-2007.

Beginning in 2004, diseased colonies were mapped at each station and images were taken of most diseased colonies. This permits the condition of these colonies to be tracked over time. During each sampling event, mapped colonies from the previous year were located, and if the colonies remained diseased, new images were taken. In 2007, the colonies mapped in 2006 were re-assessed for disease. New colonies identified with disease were also mapped in 2007. Table 6 summarizes the condition of the 2006 diseased colonies in 2007, and Table 7 lists the new diseased colonies mapped in 2007. Of the seventeen diseased colonies identified in 2006, nine were still identified with disease in 2007. Seven of the colonies were *S. siderea* colonies, one colony was *S. bournoni*, and one colony was *A. cervicornis* (Table 6).

In 2007, 46 diseased colonies were mapped and images were taken of most colonies. Thirty-seven of these colonies were not categorized as diseased in 2006. In 2007, seven sites had identified diseased colonies compared to five sites in 2006. Similar to 2006, most of the diseased colonies were *S. siderea* (36 of the 46 colonies). Twenty-four of these *S. siderea* diseased colonies were categorized with "other" disease (Dark Spot). Twelve of the 36 *S. siderea* colonies were categorized with "white complex" disease.

Table 6. List of all 2006 mapped diseased stony corals and the condition of these colonies in 2007 (O = other disease, W = white complex disease; B = Black band).

Site	Station	Species	2006 Condition	2007 Condition
BC2	1	*S. siderea*	O	Not Diseased
BC2	2	*S. siderea*	W	W
BC2	3	*S. siderea*	W	Not Diseased
BC2	3	*S. siderea*	O	Not Diseased
BC2	3	*S. siderea*	O	Not Diseased
BC2	4	*S. siderea*	W	W
BC2	4	*S. siderea*	W	W
BC2	4	*S. siderea*	O	O
BC2	4	*S. siderea*	O	Not Diseased
BC3	1	*S. siderea*	O	O
BC3	4	*S. siderea*	O	W
BC3	4	*S. siderea*	O	W
DC1	1	*S. siderea*	O	O
DC1	3	*A. cervicornis*	W	W
DC1	4	*S. bournoni*	W	W
DC2	2	*S. intersepta*	W	Not Diseased
DC2	3	*S. bournoni*	W	Colony dead
DC2	3	*S. siderea*	O	Not Found

Table 7. List of new mapped diseased stony corals identified in 2007 (O = other disease, W = white complex disease; B = Black Band disease).

Site	Station	Species	2007 Condition
BC1	1	*S. siderea*	O
BC1	1	*S. siderea*	O
BC1	2	*S. siderea*	O
BC1	2	*S. siderea*	O
BC1	2	*S. siderea*	O
BC1	2	*S. siderea*	O
BC1	2	*S. siderea*	O
BC1	2	*M. cavernosa*	O
BC1	3	*S. siderea*	O
BC1	3	*S. siderea*	W
BC1	3	*S. siderea*	W
BC2	1	*S. siderea*	O
BC2	1	*S. siderea*	O
BC2	1	*S. siderea*	O
BC2	2	*S. siderea*	O
BC2	3	*S. siderea*	O
BC2	3	*S. siderea*	O
BC2	3	*S. siderea*	O
BC2	4	*S. siderea*	O
BC2	4	*S. siderea*	O
BC2	4	*S. siderea*	O
BC3	1	*M. cavernosa*	O
BC3	2	*S. siderea*	W

Table 7. Continued.

Site	Station	Species	2007 Condition
DC1	1	*S. siderea*	O
DC1	1	*S. siderea*	O
DC1	1	*S. siderea*	O
DC1	1	*S. siderea*	O
DC1	2	*S. siderea*	O
DC1	3	*D. stokesii*	W
DC1	3	*S. siderea*	W
DC1	4	*S. bournoni*	W
DC1	4	*D. stokesii*	W
DC1	4	*S. siderea*	O
DC2	2	*S. siderea*	W
PB2	1	*P. astreoides*	W
PB2	1	*M. decatis*	W
PB2	4	*S. intersepta*	W

Sea Urchin (*Diadema antillarum)* Abundance

Diadema antillarum sea urchin abundance was recorded for each station during the SSI sampling. No *Diadema* were seen at any of the ten sites in 2003. In 2007, a total of 27 *Diadema* were identified within six sites (Table 8). *Diadema* were seen within the BCA sample area, but none were in the stations at the time of sampling. *Diadema* continue to be more abundant in the Martin County sites than the sites in the other three counties. Thirteen *Diadema* were identified in site MC1 and five were identified in site MC2.

Table 8. Diadema antillarum sea urchin abundance at each of the twelve standard SECREMP sites in 2003-2007.

Site	2003	2004	2005	2006	2007
BCA	0	0	0	4	0
BC1	0	2	6	0	4
BC2	0	1	2	3	0
BC3	0	2	0	0	1
DC1	0	0	3	4	3
DC2	0	1	2	1	0
DC3	0	0	1	2	1
PB1	0	0	1	0	0
PB2	0	0	0	1	0
PB3	0	0	0	0	0
MC1	NA	NA	NA	7	13
MC2	NA	NA	NA	2	5
Total (n= 10)	0	6	15	15	9
Total (All sites)	0	6	15	24	27

Stony Coral Cover

Table 9 lists and Figures 6 and 7 illustrate the mean (±SD) percent stony coral coverage for each of the standard SECREMP sites, 2003-2007. Two sites, PB1 (Figure 6) and BCA (Figure 7), have shown obvious variable stony coral cover since the start of this monitoring effort in 2003. 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 have started to become uncovered, re-exposing substrate. In 2006, site BCA was the only site with significantly reduced cover from previous years ($p < 0.05$, Kruskal-Wallis ANOVA, multiple comparisons of mean ranks).

BCA cover is dominated by *A. cervicornis*, contributing on average 98% of stony coral cover at this site since 2003. In 2006, *A. cervicornis* dropped to 25% from 39% in 2005. In 2007, BCA cover increased to 31%. In 2007, no other sites had significant changes in cover from previous years.

Table 10 lists the five species for each site which contributed most to stony coral cover 2003-2007. The mean cover for each species over this five year span was used to determine this list. The two most prevalent species in the SECREMP sites were *S. siderea* and *M. cavernosa*. *S. siderea* was one of the top five species contributing most to stony coral cover in all 12 sites while *M. cavernosa* contributed in nine of the sites.

Table 9. Mean (±SD) percent stony coral cover for each site from 2003-2007 (n = 4 stations). Martin County sites were not sampled prior to 2006.

	2003		2004		2005		2006		2007	
Site	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
BC1	12.2	3.7	11.8	3.9	12.6	3.8	13.1	3.7	12.5	3.2
BC2	0.4	0.2	0.4	0.2	0.5	0.4	0.4	0.2	0.3	0.3
BC3	0.3	0.1	0.4	0.1	0.3	0.1	0.5	0.2	0.3	0.2
BCA	31.7	4.9	39.6	3.6	39.9	2.3	25.4	2.8	31.0	3.0
DC1	2.4	0.9	2.6	1.3	2.8	1.4	3.0	1.3	2.5	0.9
DC2	0.6	0.4	0.5	0.2	0.5	0.0	0.8	0.1	0.7	0.2
DC3	0.2	0.1	0.2	0.0	0.3	0.2	0.2	0.3	0.3	0.3
PB1	1.0	0.7	0.9	0.7	0.1	0.3	0.4	0.8	0.2	0.2
PB2	1.8	1.1	1.8	1.4	1.6	1.1	1.8	0.7	1.8	1.2
PB3	1.0	0.4	1.0	0.2	1.0	0.3	1.0	0.2	1.3	0.8
MC1	NA	NA	NA	NA	NA	NA	1.6	1.1	2.2	1.5
MC2	NA	NA	NA	NA	NA	NA	1.0	0.5	0.9	0.3

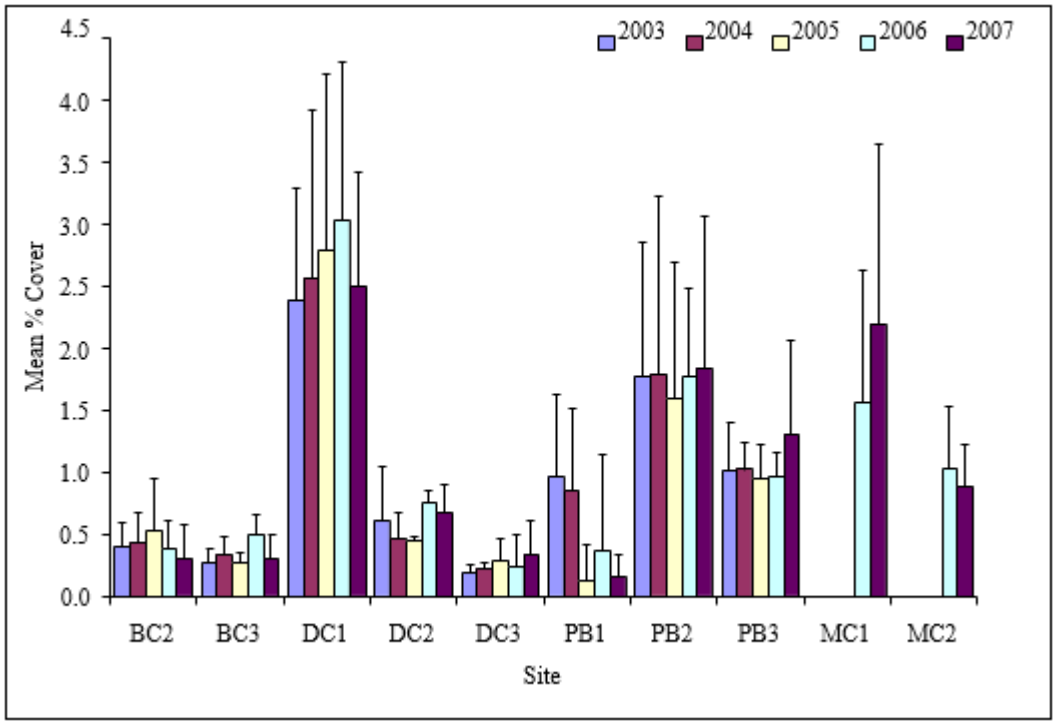

Figure 6. Mean (±SD) percent stony coral cover at the SECREMP sites from 2003-2007. Martin County sites were not sampled prior to 2006.

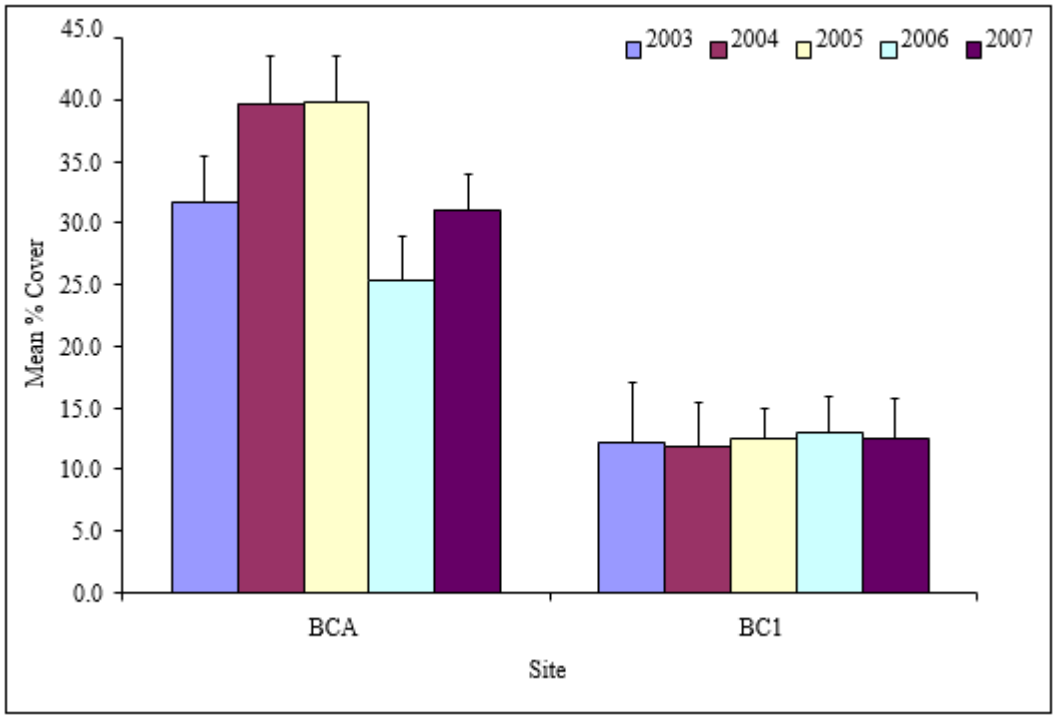

Figure 7. Mean (±SD) percent stony coral cover at BCA and BC1 sites from 2003-2007.

Table 10. The five species which contributed most to total stony coral cover for each site from 2003-2007 (n = 5 years). The species order for each site is in decreasing cover.

BC1	**BC2**	**BC3**	**BCA**
M. cavernosa	*S. siderea*	*M. cavernosa*	*A. cervicornis*
M. annularis complex	*M. alcicornis*	*S. siderea*	*M. cavernosa*
S. siderea	*M. meandrites*	*M. meandrites*	*D. clivosa*
S. bournoni	*M. cavernosa*	*M. alcicornis*	*P. astreoides*
C. natans	*S. intersepta*	*P. astreoides*	*S. siderea*
DC1	**DC2**	**DC3**	
M. cavernosa	*M. meandrites*	*M. alcicornis*	
S. siderea	*M. alcicornis*	*P. astreoides*	
P. astreoides	*S. bournoni*	*S. intersepta*	
M. annularis complex	*M. cavernosa*	*S. siderea*	
A. cervicornis	*S. siderea*	*M. meandrites*	
PB1	**PB2**	**PB3**	
D. clivosa	*M. cavernosa*	*M. cavernosa*	
M. cavernosa	*M. alcicornis*	*M. meandrites*	
S. siderea	*M. meandrites*	*M. alcicornis*	
M. alcicornis	*S. intersepta*	*P. astreoides*	
	S. siderea	*S. siderea*	
MC1	**MC2**		
D. clivosa	*D. clivosa*		
M. alcicornis	*O. diffusa*		
S. siderea	*S. siderea*		
O. diffusa	*M. alcicornis*		
P. astreoides			

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' (since 2003 this category has included hydroids, cyanobacteria and sabellid worms). Substrate dominated benthic cover at all sites (>50%), except site MC2 (38%), ranging from 98% at site PB1 (Table 13) to 53% at site MC1 (Table 14). During previous monitoring years, macroalgae was the second most dominant group for most sites, but in 2007 macroalgae cover was reduced in nine sites. Octocorals were the second most dominant group in eight sites.

In 2007, there were a few examples of significant changes ($p < 0.05$, Kruskal-Wallis ANOVA, multiple comparisons of mean ranks) in functional group coverage at four sites. At site BCA, sponge (Porifera) coverage was significantly greater in 2006 and 2007 than in previous years. Site DC1 had significantly greater octocoral and sponge coverage in 2007 than in 2003. Site DC3 had significantly less octocoral coverage in 2007 than in 2005 and 2003. PB2 had significantly greater sponge coverage in 2007 than in 2005.

Table 11. Functional group mean percent coverage for the Broward County sites.

Site	Year	Substrate	Stony Coral	Octocoral	Macroalgae	Porifera	Zoanthid	Other Biota
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
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
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
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

Table 12. Function group mean percent coverage for the Miami-Dade County sites.

Site	Year	Substrate	Stony Coral	Octocoral	Macroalgae	Porifera	Zoanthid	Other Biota
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
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
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

Table 13. Functional group mean percent coverage for the Palm Beach County sites.

Site	Year	Substrate	Stony Coral	Octocoral	Macroalgae	Porifera	Zoanthid	Other Biota
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	45.44	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
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
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

Table 14. Functional group mean percent coverage for the Martin County sites.

Site	Year	Substrate	Stony Coral	Octocoral	Macroalgae	Porifera	Zoanthid	Other Biota
MC1	2003	NA	NA	NA	NA	NA	NA	NA
	2004	NA	NA	NA	NA	NA	NA	NA
	2005	NA	NA	NA	NA	NA	NA	NA
	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
MC2	2003	NA	NA	NA	NA	NA	NA	NA
	2004	NA	NA	NA	NA	NA	NA	NA
	2005	NA	NA	NA	NA	NA	NA	NA
	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

Bio-eroding Sponge

Cliona delitrix was the only bio-eroding sponge species reported during the 2007 sample period. *C. delitrix* was seen in all four counties (Table 15). Only site BCA did not have bio-eroding sponge present. In 2007, site MC1 had the greatest sponge cover followed by site BC1 which was the site with the greatest clionaid sponge coverage in 2003, 2004, 2005, and 2006. The area of bio-eroding sponge at all sites, except site BC1, increased in 2007. Table 16 lists the coral species eroded by *C. delitrix* in 2003-2007 (Martin County sites are not included in this table because these sites were not part of the project prior to 2006). *M. cavernosa* colonies continue to have the greatest area impacted by *C. delitrix*. In Martin County (sites MC1 and MC2), all *C. delitrix* colonies were identified growing on substrate.

Table 15. Clionaid sponge, C. delitrix, total colony area (cm^2/m^2) (total sponge area/total site area) for each site in 2003-2007. Note: Site BCA had no C. deletrix present all years. The total area for years 2006 and 2007 does not include sites MC1 and MC2.

Site	2003	200	200	200	200
BC1	24.7	24.6	11.7	32.1	30.3
BC2	0.5	0.6	0.7	1.5	1.8
BC3	1.6	1.2	1.3	1.5	2.2
DC1	1.1	1.4	1.1	2.1	3.9
DC2	3.8	2.9	3.6	3.4	3.8
DC3	0.3	0.1	0.4	0.4	0.7
PB1	6.8	8.9	1.7	1.3	3.2
PB2	4.5	1.6	3.6	2.9	3.6
PB3	0.9	0.4	1.1	0.7	2.4
MC1	NA	NA	NA	26.0	32.1
MC2	NA	NA	NA	4.2	4.5
Total	44.1	41.7	25.2	45.8	52.0

Table 16. Clionaid sponge, C. delitrix, total colony area (cm^2/m^2) (total sponge area/total site area) for each sponge-eroded coral species within the nine sites shown in Table 15. NA refers to sponge growing on unidentified coral or on substrate. Martin County sites are not included because these sites were not part of the project prior to 2006.

Coral Species	2003	2004	2005	2006	2007
M. cavernosa	1.03	1.01	1.03	2.87	2.96
M. meandrites	0.13	0.12	0.09	0.07	0.06
D. clivosa	0.03	0.13	0.00	0.05	0.36
P. asteroids	0.03	0.02	0.00	0.00	0.00
C. natans	0.02	0.04	0.08	0.13	0.42
S. intersepta	0.02	0.00	0.00	0.04	0.06
S. siderea	0.02	0.02	0.04	0.41	0.09
A. agaricites	0.01	0.00	0.01	0.00	0.00
D. strigosa	0.00	0.00	0.19	0.09	0.15
NA	3.62	3.30	1.36	1.42	1.83

Site MC3 Stony Coral Colony Condition

In 2006, within the five staked locations at MC3, 49 colonies were mapped and data (including images) collected (Table 17). Although ten stony coral species were recorded within sites MC1 and MC2 (Table 3), 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, 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 were re-visited. Images were taken of 35 colonies and 14 colonies were not found and presumed dead and/or missing. Eight new colonies were mapped and assessed and added to the monitoring effort.

Table 17 includes the colony tissue area measured in 2006 and 2007 and the change in tissue area. Table 18 summarizes for each species the number of colonies that increased and decreased in tissue area and the number of colonies not found. Of the 29 colonies that were assessed for tissue area change (images taken and used in 2006 and 2007), 20 had reduced tissue area in 2007 compared to 2006.

No diseased colonies were identified in 2006 or 2007. Fishing line was noted entangling seven of the fifteen *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 were not adequate for quantitative tissue area analysis, showed reduced tissue area (Table 17).

Table. 17. Site MC3 monitored colony data. Colony size (cm) was recorded during the initial 2006 effort. The 2006 and 2007 area (cm^2) measurements were determined by image analysis. (= new colonies added to the effort in 2007; FL = fishing line present on colony; PB = partially bleached colony; NT = image taken but not adequate for image analysis; NF = colony not found in 2007)*

Tag #	Species	Colony L (cm)	Size W (cm)	2006 Area (cm2)	2006 Condition Notes	2007 Area (cm2)	2007 Condition Notes	Area (cm2) Change 2007-2006
101	*O. diffusa*	20	13	113.1	FL	16.5	FL	-96.7
102	*S. siderea*	8	7	25.6		29.1		3.5
103	*O. diffusa*	30	25	248.3	FL	----	NT, FL	----
104	*D. clivosa*	18	15	176.1		169.5		-6.6
105	*S. bournoni*	14	12	115.7	PB	130.2		14.6
106	*S. siderea*	5	4	12.6		----	NF	----
107	*S. siderea*	9	6	15.0		10.3	Pale	-4.7
*108	*M. cavernosa*	14	14	----		50.9		----
201	*D. clivosa*	28	20	412.9		----	NF	----
202	*S. siderea*	6	5	8.2		8.7	Pale	0.5
203	*D. clivosa*	35	28	352.9		270.2		-82.7
204	*D. clivosa*	35	32	618.5		----	NF	----
205	*D. clivosa*	22	16	172.8		169.2		-3.6
206	*S. siderea*	6	6	13.0		8.1	Pale	-4.9
207	*D. clivosa*	35	30	437.8		288.8		-149.0
208	*D. clivosa*	20	19	242.6		----	NF	----
209	*O. diffusa*	20	15	56.6	FL	19.1	FL	-37.5
210	*M. cavernosa*	15	14	129.0		116.1	Pale	-12.9
211	*O. diffusa*	16	11	49.2	FL	----	NF	----
212A	*S. siderea*	4	4	2.0		1.9	Pale	-0.1
212B	*S. siderea*	6	5	5.0		5.1	Pale	0.1
212C	*S. siderea*	5	5	4.7		3.3	Pale	-1.4
213	*M. cavernosa*	12	8	56.7		59.2		2.5
301	*S. siderea*	7	7	33.1		31.5		-1.6
302	*O. diffusa*	20	20	127.8	PB	----	NF	----
303	*O. diffusa*	10	10	43.8		----	NF	----
304	*M. cavernosa*	15	12	112.7		85.3		-27.4
305	*O. diffusa*	25	18	166.7	PB	----	NF	----
306	*D. clivosa*	20	20	369.1		----	NF	----
307	*M. cavernosa*	18	17	----	NT	190.4		----
308	*S. siderea*	6	5	12.4		11.8	Pale	-0.6
309	*M. cavernosa*	10	10	62.4		42.3		-20.1
310	*M. cavernosa*	43	28	266.9		325.5		58.6
311	*O. diffusa*	19	14	159.5	FL, PB	----	NT	----
312	*M. cavernosa*	80	70	657.10		-----	NT	----

Table 17. Continued

Tag #	Species	Colony L (cm)	Size W (cm)	2006 Area (cm2)	2006 Condition Notes	2007 Area (cm2)	2007 Condition Notes	Area (cm2) Change 2007-2006
401	*D. clivosa*	60	55	974.8		1700.2		725.4
402	*O. diffusa*	28	27	380.1		----	NF	----
403	*O. diffusa*	13	10	83.5		116.3		32.9
404	*S. siderea*	9	7	42.3		15.6	Pale	-26.7
405	*D. clivosa*	55	35	----	NT	730.5		----
406	*O. diffusa*	19	15	118.4	PB	96.2		-22.2
407	*O. diffusa*	13	11	71.6	PB	74.2	FL	2.7
408	*P. astreoides*	14	12	----	NT	----	NF	----
409	*O. diffusa*	35	35	819.5	FL	----	NF	----
410	*M. cavernosa*	25	22	270.2		263.6		-6.6
*411	*O. diffusa*	14	11	----	NA	43.1		----
*412	*S. siderea*	33	25	----	NA	373.5		----
*413	*S. siderea*	32	30	----	NA	166.0		----
*414	*D. clivosa*	30	25	----	NA	421.2		----
501	*M. cavernosa*	35	30	224.8		210.2		-14.6
502	*O. diffusa*	22	22	338.4	FL, PB	----	NF	----
503	*O. diffusa*	15	14	94.4		----	NF	----
504	*M. cavernosa*	55	50	928.2		921.6		-6.6
505	*S. siderea*	40	25	----	NT, PB	310.5		----
*506A	*S. siderea*	18	18	----	NA	79.3		----
*506B	*S. siderea*	9	9	----	NA	20.4		----
*507	*S. siderea*	11	7	----	NA	35.8		----

Table 18. Total number of colonies assessed in 2006, the number of colonies not traced (NT) in 2006 and 2007, the number of colonies not found (NF) in 2007, and the number of colonies with an increase in tissue area in 2007 and a decrease in tissue area in 2007.

Species	2006 # Colonies	2006 NT	2007 NT	2007 NF	Increase	Decrease
O. diffusa	15	0	2	8	2	3
S. siderea	12	1	0	1	3	7
D. clivosa	10	1	0	4	1	4
M. cavernosa	9	1	0	0	2	6
S. bournoni	1	0	0	0	1	0
P. astreoides	1	1	0	1	0	0

Monitoring Site Temperature Record

Temperature loggers were deployed at all three Miami-Dade, all four Broward and all three Martin County sites in February 2007 (ten sites). Loggers were not deployed at the Palm Beach County sites. These loggers were collected during the summer 2007 sampling event. Temperature data was successfully downloaded from all ten sites. Loggers were redeployed at the Miami-Dade, Broward, and Martin County sites. Loggers were also deployed at the three Palm Beach sites during the Year 5 (2007) sampling event.

The year 5 sample dates shown in Table 2 are the same dates that temperature loggers were redeployed or deployed at each of the 13 SECREMP sites. From the ten sites with temperature data starting in February 2007, the temporal range of temperature data included sites that were sampled in June (BC1 – 4 June) up to August (DC3 – 14 August). For clarity in this report, only temporal data common to all ten sites (February - June 2007) is presented. Starting with the year 6 (2008) report, complete yearly temperature data will be presented for all sites.

Figure 8 shows the mean daily temperatures for all ten sites from 23 February to 3 June 2007 (dates common to all ten sites). This figure illustrates the general warming trend (as expected) at all ten sites from February to June. Figure 8 also shows that the three Martin County sites tended to have more extreme low temperatures and greater fluctuations in temperature through at least May 2007. Figures 9-11 show the monthly mean temperatures for each of the sites. Table 19 provides the dates and temperatures (°C) of the maximum and minimum temperature recorded for all ten sites. For the Miami-Dade and Broward sites (except DC1 which had a maximum temperature in early May) the maximum temperate was recorded in mid-May (19-21 May) and was approximately 27.5 °C; the minimum temperature for these seven sites was recorded 25-26 February and was approximately 22.7 °C. The 3 Martin County sites recorded a maximum temperature of approximately 27 °C in mid-May and a minimum temperature of approximately 21 °C in mid-March.

Table 19. Maximum and minimum temperatures (°C) and dates for the ten sites with temperature loggers from 23 February to 3 June 2007.

Site	Max Temp	Date	Min Temp	Date	Mean Temp
BCA	27.6	19-May	22.7	25-Feb	25.0
BC1	27.5	19-May	22.7	25-Feb	24.9
BC2	27.5	20-May	22.7	26-Feb	25.1
BC3	27.6	20-May	22.7	26-Feb	25.0
DC1	27.3	6-May	22.4	26-Feb	25.0
DC2	27.4	21-May	22.7	25-Feb	25.0
DC3	27.6	21-May	22.7	27-Feb	25.2
MC1	27.1	13-May	20.7	17-Mar	24.2
MC2	27.2	14-May	20.8	5-Mar	24.3
MC3	27.1	14-May	20.7	18-Mar	24.1

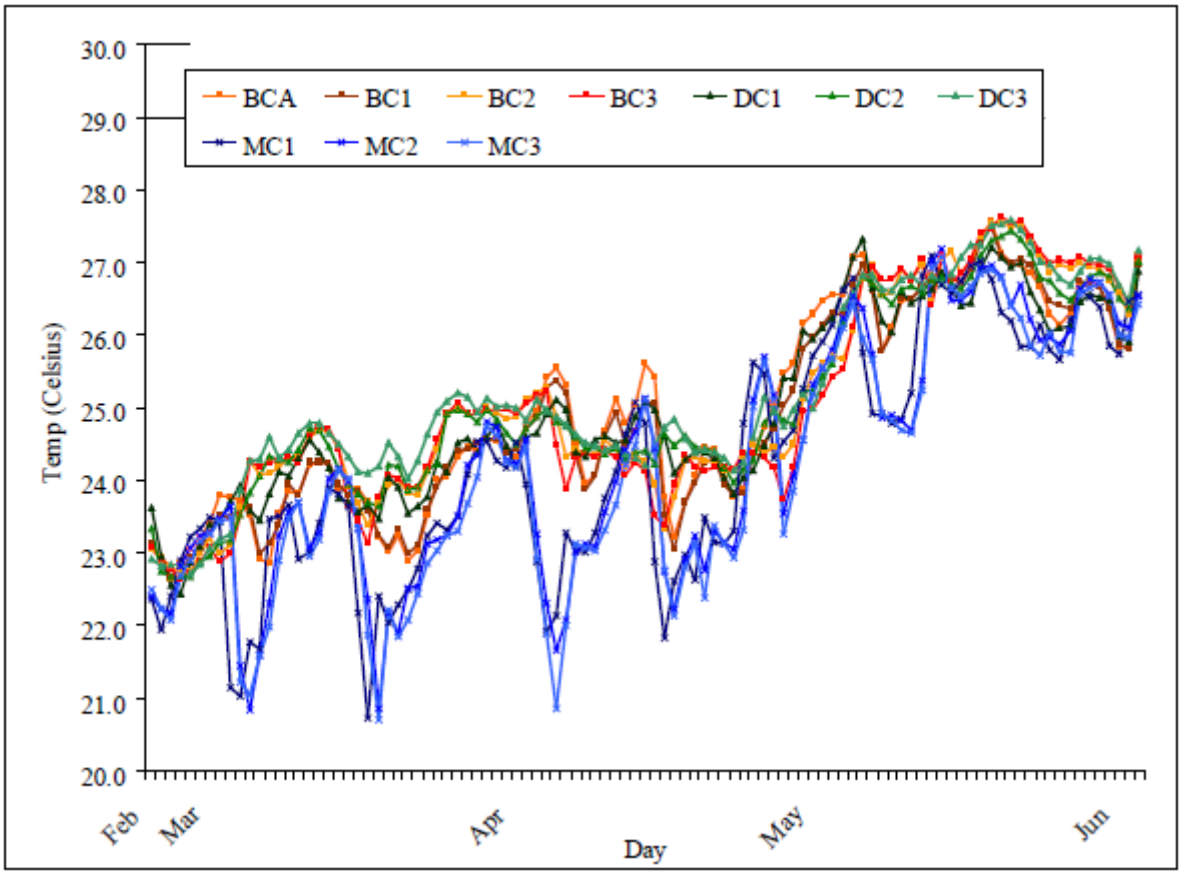

Figure 8. Mean daily temperatures (°C) for the ten sites with temperature loggers from 23 February to 3 June 2007.

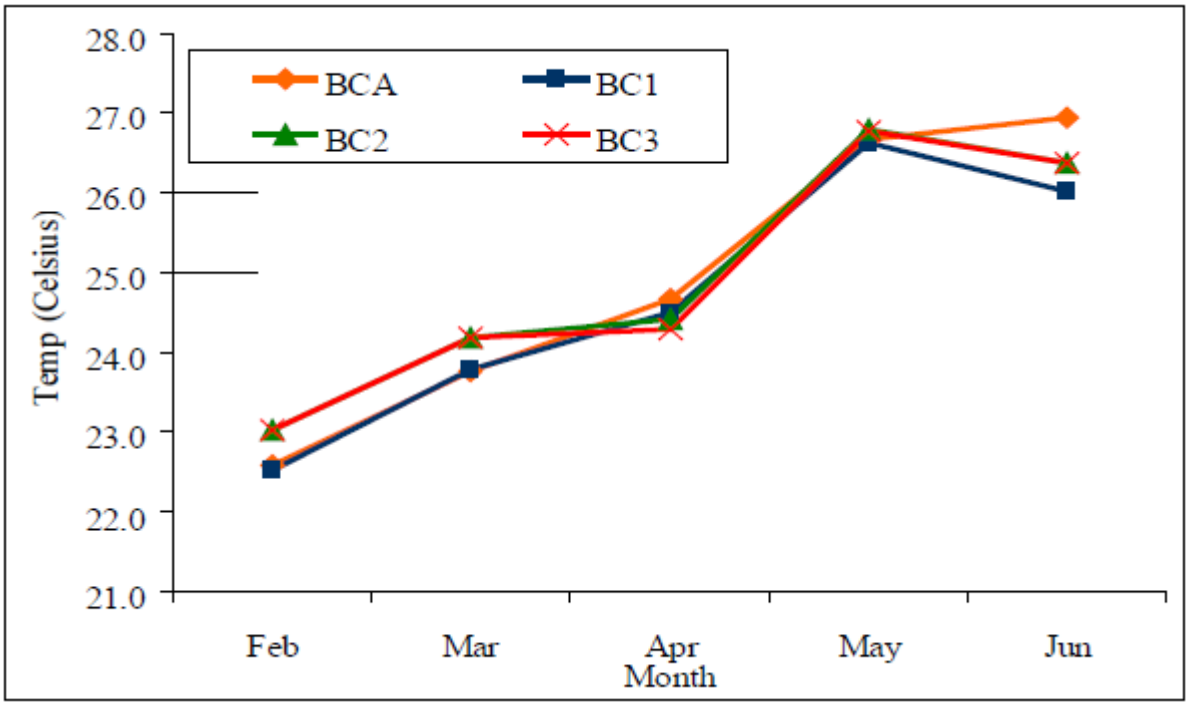

Figure 9. Mean monthly temperatures (°C) for the four Broward County sites.

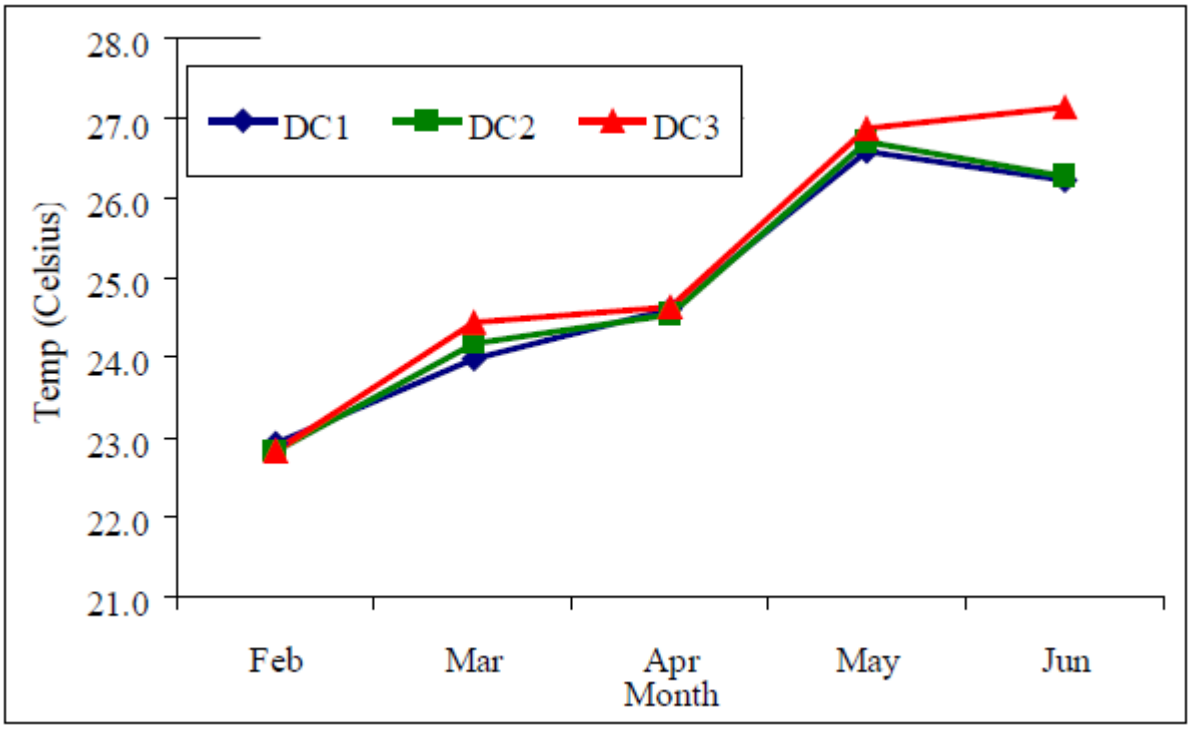

Figure 10. Mean monthly temperatures (°C) for the three Miami-Dade County sites.

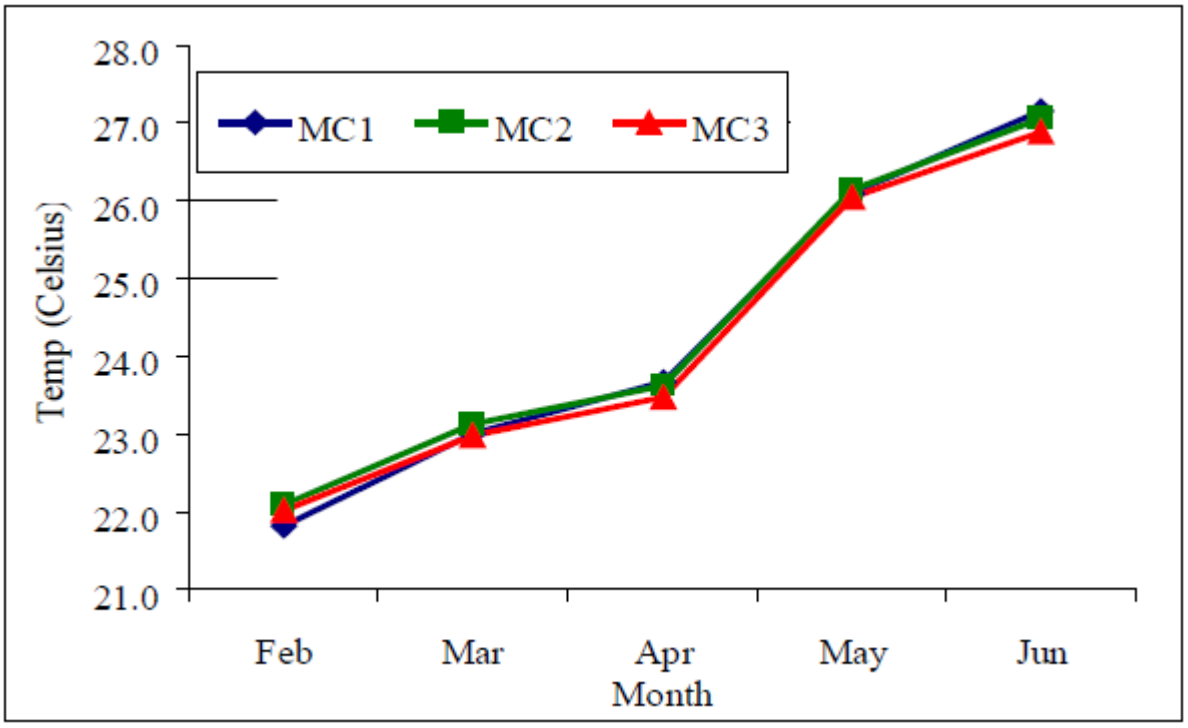

Figure 11. Mean monthly temperatures (°C) for the three Martin County sites.

DISCUSSION

The coral reef ecosystem off southeast Florida is a system near the environmental threshold for significant reef growth. Southeast Florida reefs generally have similar stony coral species richness but reduced stony coral cover compared to the Dry Tortugas or Florida Keys coral reefs (Callahan et al. 2007). Benthic cover by octocorals is similar throughout the Florida reef system while macroalgae appears contribute less cover and sponges appear to contribute more cover off southeast Florida (Callahan et al. 2007).

With five years of data, in general, the status of the southeast Florida reef system has changed little from 2003 to 2007 (except for site PB1 and in some respects BCA). Stony coral species richness (Table 3; Figure 5) and cover are very similar between years (Table 9; Figure 6 and 7). The incidence of disease in 2007 was greater than what was identified in 2006. In 2006, 17 infected colonies were identified; while in 2007, the number of diseased colonies increased to 46. Of these 46 colonies, 37 were new in 2007. Twenty-five of these 46 colonies were *S. siderea* colonies with what appeared to be 'Dark Spot'. Even with this increase in disease, examining all thirteen sites within this project, diseases do not appear to be a major factor affecting stony coral condition or cover in the SECREMP sites. Other than the reduced cover for site PB1 following burial between the 2004 and 2005 sample events, there do not appear to be any consistent trends in temporal changes in functional group cover between 2003 and 2007 (Tables 11-14). Macroalgae and octocorals remain the two (non-substrate) benthic functional groups with the highest cover for the region. In 2006, there was a significant increase in macroalgae cover in four of the ten sites and a decrease in octocoral cover in three (includes PB1) sites. In 2007, macroalgae returned to cover levels comparable to years preceding 2006, while two sites (BC3 and DC3) continued to have a decrease in octocoral cover (although not significant from 2006).

In 2005, site PB1 was greatly affected by sand movement. Stations 2 and 4 were completely covered with sand more than several centimeters in depth. In 2006, stations 2 and 4 remained buried in sand. Stations 2 and 4 had started to become uncovered at the time of the 2007 sampling event. These two stations continued to be mostly covered with sand, but the station pins were exposed and some hard substrate was present. The cause of this sand movement is unknown although the 2004 hurricanes, Jeanne and Frances, may have contributed to this significant sand movement. SSI, bio-eroding sponge, and video data on all four stations was collected and included in this analysis. This variable sand cover at this site greatly influenced summary data for PB1, and therefore, the between year comparisons. The loss of reef habitat at these two stations reduced the number of coral species identified in Palm Beach, the percent stony coral cover, reduced functional group coverage data, and reduced the total bio-eroding sponge coverage area. Site PB1 will continue to be re-visited and included in subsequent sampling periods.

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 *Acropora cervicornis* patches. With the recent listing of *A. cervicornis* as a Threatened species under the Endangered Species Act (http://www.nmfs.noaa.gov/pr/pdfs/fr/fr71-26852.pdf), it is important to make special note of site BCA. *A. cervicornis* cover decreased from a high of 39% in 2004 and 2005 to a low of 25% in 2006 (Table 9). *A. cervicornis* cover increased to 31% in 2007 (Table 9). The reason(s) for the decline in 2006, measured within the permanent transects, is unknown. The site has been sampled during the same time of year each event (June in 2004-2007, Table 2). The passing of

Hurricane Wilma over the area in October 2005 may have contributed to some of the decline. The cyanobacteria, *Lyngbya* spp., bloom seen in previous years (2004) appeared to be in decline between 2005 and 2006 (D. Gilliam, personal observation). SECREMP is a monitoring project designed with the use of permanent transects. This permanent transect design may not provide all the data appropriate for monitoring the 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 (as evident from the increase in cover in 2007). The SECREMP research team has noted that the larger *A. cervicornis* patch, within which the BCA transects were deployed, appears to be generally healthy (qualitative observations), but the patch also appears to be moving away (south and west) from the permanent transect locations. This patch "behavior" needs to be addressed in order to confidently document changes in the condition of this *A. cervicornis* population.

Temperature loggers were deployed at ten sites in February 2007. Temperature (°C) is presented for those ten sites from February to June 2007. Loggers were redeployed at these ten sites, and loggers were deployed at the remaining three sites, during the 2007 sampling event.

Despite their reduced diversity and coral cover compared to reefs in the Florida Keys, 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 related 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, introduction of agricultural and industrial chemical contamination, and excess nutrients.

Impacts from boating and fishing activities are a significant threat to reef areas as damage from fishing gear and anchoring can be severe. Adverse impacts from SCUBA divers can also occur. Traffic from large ports (Miami, Port Everglades, and Palm Beach) including cruise and container ships, military vessels, and oil tankers, can conflict with reef resources. 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, the southeast Florida reefs requires comprehensive, long-term monitoring be conducted to define change and 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 Coral Reef Evaluation and Monitoring Project to include sites in Broward, Miami-Dade, Palm Beach, and Martin Counties 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 gauge 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 *Acropora 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.

The partnership with Nova Southeastern University Oceanographic Center and its constituent National Coral Reef Institute has worked to expand local capacity for maintaining long-term monitoring sites, complementing those being sampled as part of the National Coral Reef Monitoring Network. As a monitoring project under the Coral Reef Conservation Grant Program for the Florida east 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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