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Southeast Florida Coral Reef Evaluation and Monitoring Project 2005 Year 3 Final Report

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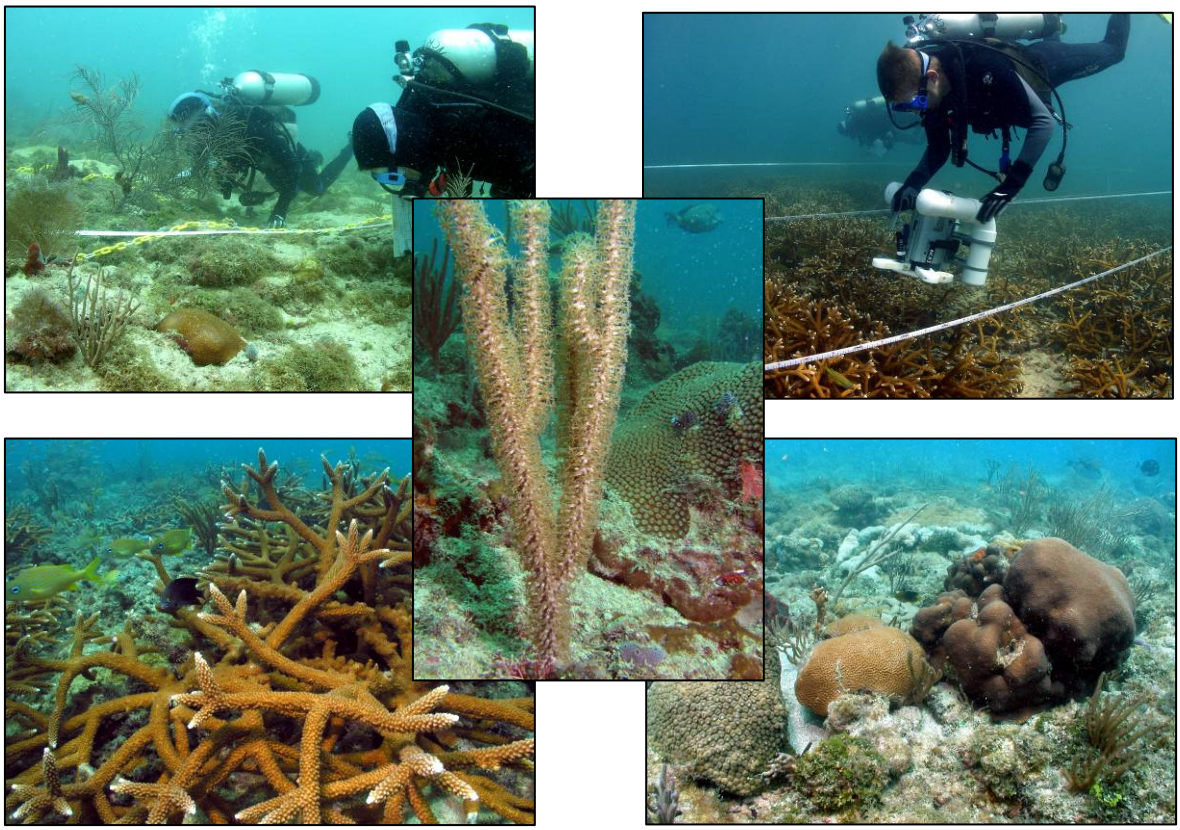

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for

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Southeast Florida Coral Reef Evaluation and Monitoring Project
2005
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INTRODUCTION

The coral reef ecosystem in Florida extends beyond the Florida Keys northward through Miami-Dade, Broward, Palm Beach, and Martin Counties; however, the primary focus for coral reef research and long-term monitoring has long been in the Florida Keys and Dry Tortugas. Coral reef monitoring efforts in the Keys grew exponentially with the establishment of the Florida Keys National Marine Sanctuary (FKNMS). 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. In 1999 the project was expanded to include 3 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. Three years (2003, 2004, and 2005) of sampling have been completed. This CREMP expansion, named the Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP), will assist in filling gaps in coverage of knowledge and monitoring of coral reef ecosystems nationwide and complement the goals of the National Monitoring Network to monitor a minimum suite of parameters at sites in the network. In addition, these efforts will assist the National Monitoring Network in building its capacity to archive biotic attributes of coral reef ecosystems nationwide.

The reef system from northern Monroe County to Palm Beach County can be characterized as a series of discontinuous reef lines that parallel the shoreline. As an example, in Broward County there are generally three lines of reef (terraces) present that crest in 3 to 5 m (First Reef), 7 to 9 m (Second Reef), and 16 to 23 m (Third Reef) water depths (Figure 1) (Moyer 2003).

Most previous monitoring efforts (Dodge et al., 1995; Gilliam et al., 2005) along the southeast coast originated as impact and mitigation studies from adverse environmental impacts to specific sites (dredge insults, ship groundings, pipeline and cable deployments, and beach renourishment). Monitoring efforts that are part of marine construction activities are generally of limited duration (1–3 years) and focus on monitoring for project effects to the specific reference areas.

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 was conducted at 18 sites. In 2000 Nova Southeastern University (NSU) assumed the 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 2007 (Gilliam et al., 2005).

Previous monitoring of reef habitats off Miami-Dade and Palm Beach counties has been short term and 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 is poorly defined. Because the area has few long-term data sets on abundance and/or cover for benthic components, it is 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 inception of coral reef monitoring along the southeast Florida coast. To ensure that this monitoring is of the highest scientific quality, and consistent with National Monitoring Network protocols, the Florida Department of Environmental Protection contracted this work *en toto* to the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWC-FWRI). The Coral Reef Research Group at FWC-FWRI has a long history of monitoring reefs in the FKNMS. Their on-going FKNMS Coral Reef Evaluation & Monitoring Project (CREMP) dates back to 1996 and has included parameters (e.g., depth, habitat delineation, and/or percent live/dead cover of corals, submerged aquatic vegetation, macroalgae, sponges) for benthic habitat characterization since its inception.

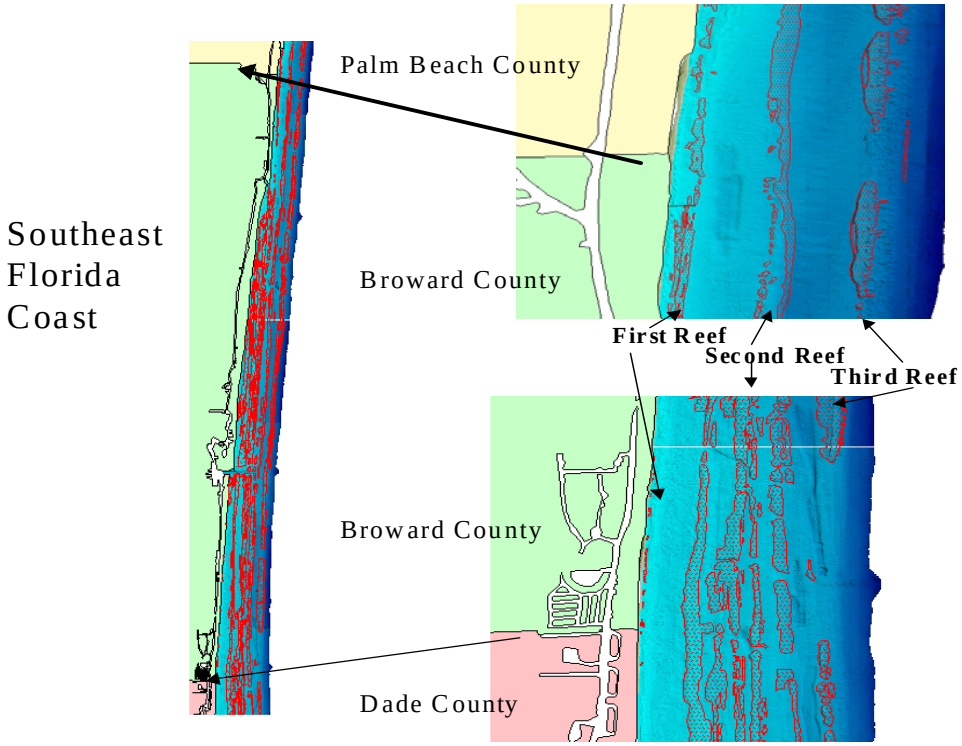

Figure 1. View of reef tracts along the southeast Florida coast.

Project Planning

Planning for the Year 1 fieldwork began in early 2003. Year 1 fieldwork included locating, installing, and monitoring 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) the Standard Operating Procedures for site selection and installation. 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 the site selection and sampling. On 16 June 2003 a workshop was held at Nova Southeastern University 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.

Planning for the Year 3 fieldwork began in early 2005. NCRI managed all the Year 3 planning and fieldwork. Prior to sampling, FWRI and DEP were notified of the proposed sampling dates and invited to participate.

Monitoring Site Selection and Sampling

The project initially required three sites 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 and installed on each off the three reef tracts from nearshore to offshore. Because Palm Beach does not have three separate reef tracts, one site was selected on a patch of nearshore hardbottom and two sites were selected on the offshore reef tract. Additionally, because of the unique *Acropora cervicornis* patches located off Broward County, a fourth site was added to the project in Broward to monitor one of these patches. All 10 sites include four standard CREMP stations.

Personnel from NCRI, FWRI, and each of the Counties were present during site selection. Each county assisted by providing vessel support. Industrial Divers Corporation (IDC) was subcontracted to install the reference stakes. Project Year 1 sampling was conducted between 17 June and 20 August 2003. Project Year 2 sampling was conducted between 3 June and 22 July 2004, and Year 3 sampling was conducted between 27 May and 10 August 2005. Table 1 provides depths and locations of each of the SECREMP sites, and Table 2 provides the Year 1, Year 2, and Year 3 work dates including the date sampling was completed at each site.

Table 1. Location and depth for the 10 SECREMP monitoring sites (BC = Broward County; DC = Miami-Dade County; PB = Palm Beach 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’

Table 2. Location and Year 1, Year 2, and Year 3 work dates (BC = Broward County; DC = Miami-Dade County; PB = Palm Beach County). (*BCA – stations 1 and 2 were sampled on 8 June and stations 3 and 4 on 30 June; **DC1 - stations 1 and 2 were sampled on 15 July and stations 3 and 4 on 10 August)

Site Code	Date Selected	Yr 1 Date Sampled	Yr 2 Date Sampled	Yr 3 Date Sampled
BCA	5-06-2003	6-19-2003	6-11-2004	*6-08-2005
				6-30-2005
BC1	5-06-2003	6-17-2003	6-14-2004	5-27-2005
BC2	5-12-2003	6-18-2003	6-03-2004	6-30-2005
BC3	5-06-2003	6-18-2003	6-09-2004	6-08-2005
DC1	5-16-2003	6-24-2003	6-15-2004	**7-15-2005
				8-10-2005
DC2	5-16-2003	6-24-2003	6-15-2004	7-15-2005
DC3	4-30-2003	6-23-2003	6-04-2004	8-10-2005
PB1	5-05-2003	8-20-2003	7-21-2004	7-29-2005
PB2	5-05-2003	8-18-2003	7-21-2004	7-28-2005
PB3	5-05-2003	8-19-2003	7-22-2004	7-27-2005

METHODS

Each of the 10 SECREMP monitoring sites consists of four monitoring stations delineated by permanent stainless steel markers. Stations are approximately 2 x 22 meters. The SECREMP stations have a north-south orientation, which is generally parallel to the reef terraces of southeast Florida. Within each station, field sampling consists of a station species inventory (SSI), three video transects (100, 300 & 500), and a bio-eroding sponge survey (Figure 2). The SECREMP sampling protocols generally follow standard CREMP sampling protocols.

Video Transects

Video was selected as the method for cover evaluation because it is a rapid and efficient means of field data collection that provides a permanent data record. Traditional transect and quadrat methods used in terrestrial environments are often too time consuming for underwater use, in addition to being less accurate and precise.

Percent cover of live coral, sessile benthic biota, and selected substrates is 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 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.

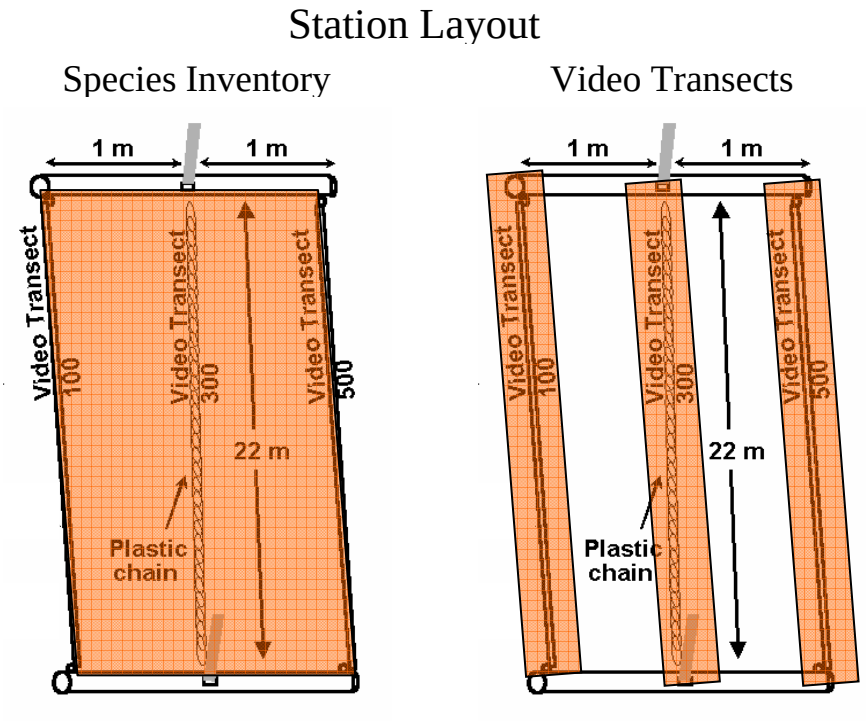

Figure 2. Typical layout of SECREMP station.

All transects are filmed with a SONY TRV 900 digital video camcorder. 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 were conducted using a custom software application, PointCount, 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 the master ACCESS data set.

Standard video protocol is modified slightly for site BCA (Broward County nearshore *Acropora 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.

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, the use of fiberglass tapes is 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 enumerates 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 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 clionid sponge species (*Cliona delitrix, C. lampa*, and *C. caribbaea*) recorded by CREMP 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 clionid sponge colony and species of stony coral affected by the clionid 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 clionid colony is recorded to the nearest half square.

YEAR 3 (2005) RESULTS

Stony Coral Species Richness

Stony coral species richness were summarized from SSI data. In 2005, a total of 27 stony coral species were identified within the 10 SECREMP sites (Table 3). The mean number of species identified per site was 9.22. Three species, *Montastraea cavernosa*, *Siderastrea siderea* and *Dichocoenia stokesii* were identified at all 10 sites, and 13 species were identified in all three

counties. Miami-Dade and Broward Counties had 23 stony coral species identified and Palm Beach County had 22 (Figure 3).

Miami-Dade County had a mean 11.58 stony coral species per station while Broward County had 9.88 species per station and Palm Beach had 9.83 species per station. Stony coral species 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 (11.17) of species per station. The offshore sites (third reef sites DC3, BC3, and PB3) had lower species richness than the first and second reef sites.

Table 3. Stony coral species presence/absence for all SECREMP sites in Broward, Miami-Dade, and Palm Beach Counties for 2004. Key: A, 1, 2, 3 = species present at sites; O = species absent.

Species List	Broward	Miami-Dade	Palm Beach
	Present/Absent	Present/Absent	Present/Absent
Acropora cervicornis	A	1	O
Agaricia agaricites	A, 1	1	2, 3
Agaricia fragilis	1, 2, 3	2	O
Agaricia lamarki	2, 3	O	O
Cladocora arbuscula	1	O	1
Colpophyllia natans	1	1	2
Dichocoenia stokesii	A, 1, 2, 3	1, 2, 3	1, 2, 3
Diploria clivosa	A	0	1
Diploria labyrinthiformis	1	1, 3	O
Diploria strigosa	O	2	2, 3
Eusimilia fastigiata	1, 2	2	2
Madracis decactis	1, 2, 3	2, 3	2, 3
Madracis mirabilis	O	O	2
Meandrina meandrites	1, 2, 3	1, 2, 3	2, 3
Millepora alcicornis	A, 1, 2, 3	1, 2, 3	1, 2, 3
Montastrea annularis complex	1, 2	1, 2	0
Montastrea cavernosa	A, 1, 2, 3	1, 2, 3	1, 2, 3
Mycetophyllia aliciae	2, 3	O	2, 3
Mycetophyllia lamarckiana	O	0	O
Oculina diffusa	1	O	0
Phyllangia americana	1	0	0
Porites astreoides	A, 1, 2, 3	1, 2, 3	2, 3
Porites porites	A, 1, 2	1, 2	O
Scolymia cubensis	2	2, 3	2, 3
Scolymia lacera	O	O	0
Siderastrea radians	A	1	1
Siderastrea siderea	1, 2, 3	1, 2, 3	1, 2, 3
Solenastrea bournoni	A, 1, 2, 3	1, 2, 3	0
Stephanocoenia michelinii	1, 2, 3	1, 2, 3	2, 3

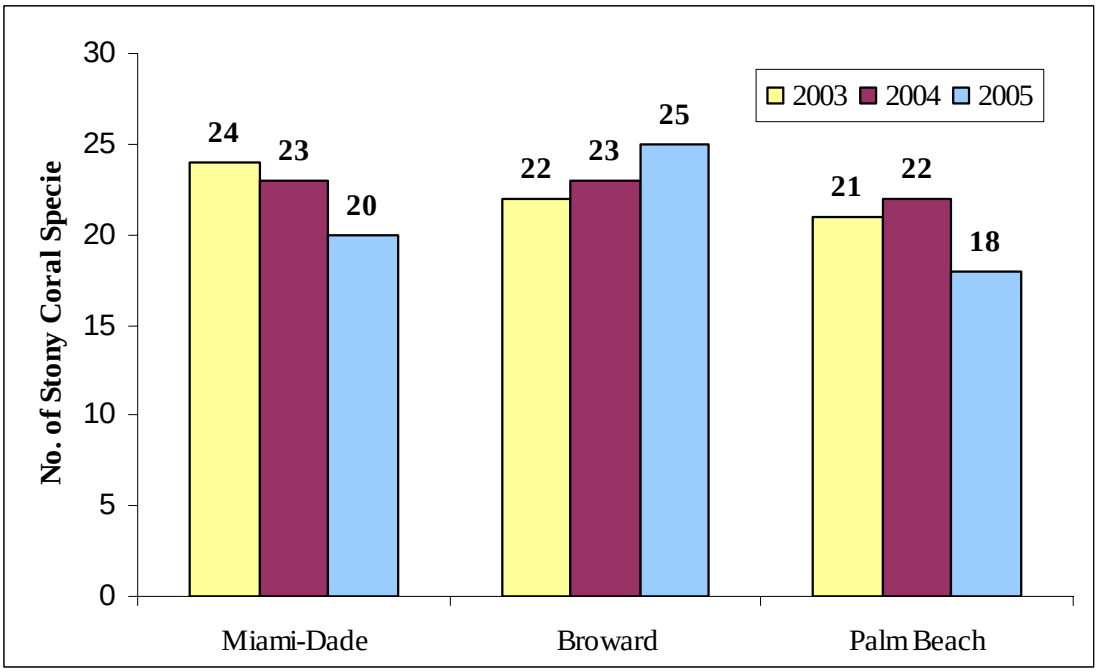

Figure 3. Stony coral species richness at SECREMP sites for Broward, Miami-Dade, and Palm Beach Counties for 2003, 2004, and 2005 (n= 3 sites, 12 stations, for Miami-Dade and Palm Beach Counties, n= 4 sites, 16 stations, for Broward County).

Stony Coral Condition

In addition to recording stony coral species presence, the SSI protocol also includes an assessment of stony coral condition, 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). In 2004 and 2005, images were taken of most diseased colonies in order to track the fate of these colonies.

Partially bleached colonies (no completely bleached colonies were observed) were observed more frequently (more sites with bleaching) than diseased colonies (Table 4). Bleaching was recorded at sites DC3, DC2, DC1, BC1, BC2, BC3, PB3, PB2, and PB1 (Table 4), with BC3, DC1, and DC2 having the greatest incidence of bleaching (all 4 stations). In 2005, diseased colonies were identified at six sites (BC1, BC2, BC3, BCA, DC1, and PB2). "Other" diseases were seen at four sites (BC1, BC3, DC1, and PB2), while "white complex" diseases were identified at six sites (BC1, BC2, BC3, BCA, DC1, and PB2) (Tables 4 and 5). Most of the "other" diseased colonies were *Siderastrea siderea* with Dark Spot. Table 5 lists the number of colonies of each stony coral species that displayed symptoms of disease at each site and station in 2004 and 2005. Table 4 compares stony coral species with the presence of disease and partial bleaching at each of the sites in 2003, 2004, and 2005. Quantitative data (number of diseased colonies) was not collected in 2003. Bleaching data is qualitative only (presence/absence) for each station. 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.

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. In 2005, the colonies mapped in 2004 were re-assessed for disease. New colonies identified with disease were also mapped in 2005. Images were taken of most of the colonies. Table 6 summarizes the fate of the 2004 diseased colonies in 2005, and Table 7 lists the new diseased colonies mapped in 2005. Of the 19 diseased colonies identified in 2004, 10 were still identified with disease in 2005. Nine of these colonies were *S. siderea* colonies categorized with "other" disease (dark spot). One S. siderea colony in BC2 was categorized with "other" on 2004 but was identified with white complex in 2005.

In 2005, 21 diseased colonies were mapped and images were taken of most colonies. Eleven of these colonies were not categorized as diseased in 2004. In 2005, six sites had identified diseased colonies compared to four sites in 2004. Similar to 2004, most of the diseased colonies were *S. siderea* (18 of the 21 colonies). Unlike 2004, more of these diseased colonies were categorized with white complex. Six of the 18 *S. siderea* colonies were categorized with white complex disease, and four of these were identified at site BC2.

Sea Urchin *Diadema* Abundance

Diadema sea urchin abundance was recorded for each station during the SSI sampling. No *Diadema* were seen at any of the 10 sites in 2003. In 2004, a total of six individuals were counted within four sites. In 2005, the total sites with *Diadema* increased to six and the total individuals increased to 15 (Table 8).

Table 4. Stony coral species within each site with the presence of disease or partial bleaching (A = absence of bleaching or disease; H = bleaching, O = other disease, W = white complex disease).

Site	Species	2003	2004	2005
DC1	*Dichocoenia stokesii*	A	W	A
DC1	*Meandrina meandrites*	A	A	H
DC1	*Montastrea annularis*	A	O	A
DC1	*Montastrea cavernosa*	A	A	W
DC1	*Porites astreoides*	H	H	H
DC1	*Porites porites*	A	A	H
DC1	*Siderastrea siderea*	O	H, O	H, O, W
DC2	*Montastrea annularis*	O	A	A
DC2	*Montastrea cavernosa*	A	A	H
DC2	*Solenastrea bournoni*	A	H	H
DC2	*Stephanocoenia michelinii*	A	A	H
DC2	*Siderastrea siderea*	A	A	H
DC3	*Montastrea annularis*	A	H	A
DC3	*Solenastrea bournoni*	A	A	H
DC3	*Stephanocoenia michelinii*	A	H	H
BC1	*Dichocoenia stokesii*	A	A	H
BC1	*Montastrea cavernosa*	O	H	A
BC1	*Porites astreoides*	H	A	A
BC1	*Siderastrea siderea*	H	H,O	O, W
BC2	*Dichocoenia stokesii*	A	H	A
BC2	*Meandrina meandrites*	A	H	A
BC2	*Montastrea cavernosa*	A	H	A
BC2	*Stephanocoenia michelinii*	A	H	A
BC2	*Porites astreoides*	A	H	H
BC2	*Siderastrea siderea*	H	H, O	H, W
BC2	*Solenastrea bournoni*	W	A	A
BC3	Agaricia fragelis	A	A	H
BC3	*Dichocoenia stokesii*	H	A	A
BC3	*Meandrina meandrites*	A	H	A
BC3	*Montastrea cavernosa*	A	A	H
BC3	*Siderastrea siderea*	H	H	H, O, W
BCA	*Acropora cervicornis*			O

Table 4. Continued.

Site	Species	2003	2004	2005
PB1	*Diploria clivosa*	A	H	A
PB1	*Meandrina meandrites*	H	A	A
PB1	*Oculina diffusa*	H	A	A
PB1	*Solenastrea bournoni*	H, O, W	H	A
PB1	*Siderastrea radians*	H	H	H
PB1	*Siderastrea siderea*	A	O	A
PB2	*Diploria strigosa*	A	A	O
PB2	*Meandrina meandrites*	A	H	A
PB2	*Montastrea cavernosa*	A	H	H
PB2	*Porites astreoides*	A	H	H
PB2	*Stephanocoenia michelinii*	A	H	A
PB2	*Siderastrea radians*	A	H	A
PB2	*Siderastrea siderea*	A	H	H, W
PB3	*Dichocoenia stokesii*	A	H	A
PB3	*Montastrea cavernosa*	A	A	H

Table 5. List of all sites and stations with diseased stony corals and the stony coral species affected (O = other disease, W = white complex disease).

			2004		2005	
Site	**Station**	**Species Affected**	**No. Colonies**	**Condition**	**No. Colonies**	**Condition**
DC1	1	*Siderastrea siderea*	3	O	0	---
DC1	1	*Montastrea cavernosa*	0	---	1	O
DC1	2	*Siderastrea siderea*	1	O	2	O
DC1	3	*Siderastrea siderea*	1	O	0	---
DC1	3	*Montastrea annularis*	1	O	0	---
DC1	4	*Acropora cervicornis*	0	---	P	O
DC1	4	*Siderastrea siderea*	2	O	1	O
DC1	4	*Dichocoenia stokesii*	1	W	0	---
DC2	1	None	0	---	0	---
DC2	2	None	0	---	0	---
DC2	3	None	0	---	0	---
DC2	4	None	0	---	0	---
DC3	1	None	0	---	0	---
DC3	2	None	0	---	0	---
DC3	3	None	0	---	0	---
DC3	4	None	0	---	0	---
BCA	1,2,3,4	*Acropora cervicornis*	NA	NA	P	O
BC1	1	*Siderastrea siderea*	1	O	2	O
BC1	2	*Siderastrea siderea*	1	O	2	O
BC1	3	*Siderastrea siderea*	1	O	1	O
BC1	4	None	0	---	0	---
BC2	1	*Siderastrea siderea*	0	---	1	W
BC2	2	None	0	---	0	---
BC2	3	*Siderastrea siderea*	1	O	1	W
BC2	4	*Siderastrea siderea*	0	---	2	W
BC3	1	None	0	---	0	---
BC3	2	*Siderastrea siderea*	0	---	1	O
BC3	3	None	0	---	0	---
BC3	4	None	0	---	0	---
PB1	1	*Siderastrea siderea*	2	O	0	---
PB1	1	*Solenastrea bournoni*	1	W	0	---
PB1	2	None	0	---	0	---
PB1	3	*Siderastrea siderea*	1	O	0	---
PB1	4	*Diploria clivosa*	1	O	0	---
PB2	1	*Siderastrea siderea*	0	---	1	W
PB2	1	*Diploria strigosa*	0	---	1	O
PB2	2	None	0	---	0	---
PB2	3	None	0	---	0	---
PB2	4	None	0	---	0	---
PB3	1	None	0	---	0	---
PB3	2	None	0	---	0	---
PB3	3	None	0	---	0	---
PB3	4	None	0	---	0	---

Table 6. List of all 2004 mapped diseased stony corals and the condition of these colonies in 2005 (O = other disease, W = white complex disease). All *S. siderea* colonies, except BC2 Station 3 in 2005, appeared to have Dark Spot disease.

Site	Station	Species	2004 Condition	2005 Condition
BC1	1	*S. siderea*	O	O
BC1	2	*S. siderea*	O	O
BC1	3	*S. siderea*	O	O
BC2	3	*S. siderea*	O	W
DC1	1	*S. siderea*	O	Not Diseased
DC1	1	*S. siderea*	O	Not Diseased
DC1	1	*S. siderea*	O	Not Diseased
DC1	2	*S. siderea*	O	O
DC1	3	*S. siderea*	O	Not Diseased
DC1	3	*S. siderea*	O	Not Diseased
DC1	3	*M. annularis*	W	Not Diseased
DC1	4	*S. siderea*	O	O
DC1	4	*S. siderea*	O	O
DC1	4	*D. stokesii*	W	Not Diseased
PB1	1	*S. bournoni*	W	Not Diseased
PB1	1	*S. siderea*	O	O
PB1	1	*S. siderea*	O	O
PB1	3	*S. siderea*	O	O
PB1	4	*D. clivosa*	W	Station buried

Table 7. List of new mapped diseased stony corals identified in 2005 (O = other disease, W = white complex disease).

Site	Station	Species	2005 Condition
BC1	1	*S. siderea*	O
BC1	2	*S. siderea*	O
BC2	1	*S. siderea*	W
BC2	4	*S. siderea*	W
BC2	4	*S. siderea*	W
BC3	1	*S. siderea*	W
DC1	1	*M. cavernosa*	B
DC1	2	*S. siderea*	O
DC1	4	*A. cervicornis*	W
PB2	1	*S. siderea*	W
PB2	1	*D. strigosa*	O

Table 8. *Diadema* sea urchin abundance at each sites in 2003, 2004, and 2005.

Site	2003	2004	2005
BCA	0	0	0
BC1	0	2	6
BC2	0	1	2
BC3	0	2	0
DC1	0	0	3
DC2	0	1	2
DC3	0	0	1
PB1	0	0	1
PB2	0	0	0
PB3	0	0	0

Stony Coral Cover

Mean stony coral cover for the 10 SECREMP sites was 5.9%. Broward County (13.31%) had the greatest mean stony coral cover followed by Miami-Dade (1.18%) and Palm Beach (0.90%) Counties (Figure 4). The disparity between the Broward sites and both the Miami-Dade and Palm Beach sites was due to the significantly greater coral cover at site BCA which had 39.86% stony coral cover and site BC1 which had 12.57% stony coral cover. Site BCA is dominated by *Acropora cervicornis* with a cover of 39%. The remaining Broward sites BC3 and BC2 had stony coral cover much more similar to that at Miami-Dade and Palm Beach sites. Mean stony coral coverage for all sties is presented in Table 9.

The offshore Miami-Dade (DC3) and Broward (BC3) sites had reduced coral cover compared to both second (DC2 and BC2) and first reef (DC1 and BC1) sites. Table 10 lists the 2005 mean cover for stony coral species at each site.

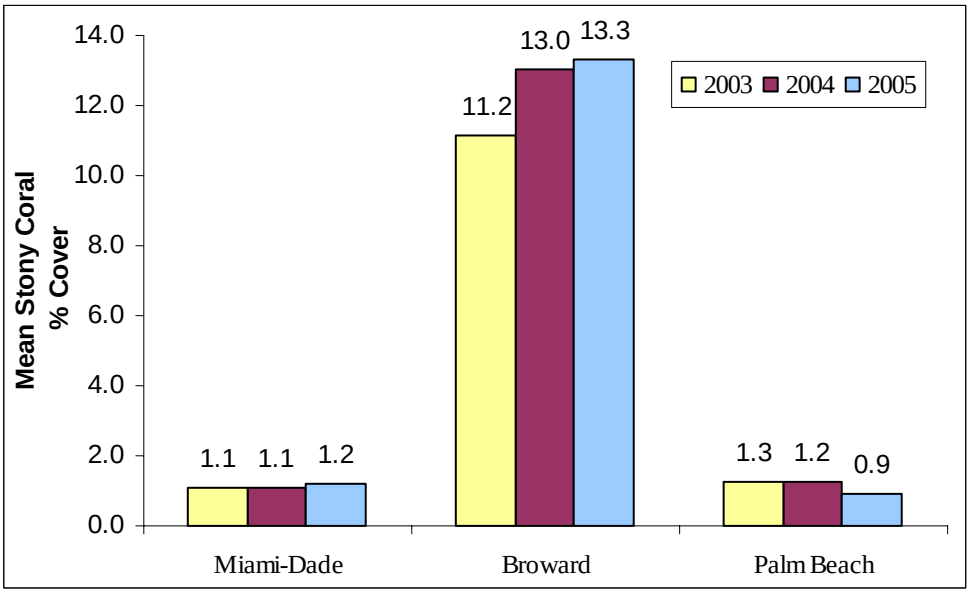

Figure 4. Mean percent stony coral cover at SECREMP sites in Broward, Miami-Dade, and Palm Beach Counties for 2003, 2004, and 2005.

Table 9. Mean stony coral cover for SECREMP sites by county and habitat for 2003, 2004, and 2005.

County	Site Code	Habitat	2003 Mean % Coral Cover	2004 Mean % Coral Cover	2005 Mean % Coral Cover
Broward	All	All	11.15	13.04	13.31
	BCA	Nearshore	31.72	39.63	39.86
	BC1	First Reef	12.21	11.76	12.57
	BC2	Second Reef	0.40	0.44	0.54
	BC3	Third Reef	0.28	0.35	0.27
Miami-Dade	All	All	1.07	1.09	1.18
	DC1	First Reef	2.40	2.57	2.79
	DC2	Second Reef	0.61	0.47	0.46
	DC3	Third Reef	0.20	0.23	0.29
Palm Beach	All	All	1.26	1.23	0.90
	PB1	First Reef	0.97	0.86	0.14
	PB2	Third Reef	1.79	1.80	1.60
	PB3	Third Reef	1.02	1.03	0.95

Table 10. Mean percent cover of stony coral species at SECREMP sites for 2005. BC = Broward County, DC = Miami-Dade County, and PB = Palm Beach County.

Coral Species	BCA	BC1	BC2	BC3	DC1	DC2	DC3	PB1	PB2	PB3
Acropora cervicornis	39.45	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00
Colpophyllia natans	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dichocoenia stokesii	0.00	0.05	0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.02
Diploria clivosa	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploria strigosa	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.10	0.00	0.04
Eusmilia fastigiata	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Meandrina meandrites	0.00	0.04	0.13	0.01	0.01	0.10	0.01	0.00	0.23	0.22
Millepora alcicornis	0.00	0.05	0.01	0.00	0.06	0.08	0.10	0.02	0.12	0.14
Montastraea annularis complex	0.00	0.99	0.05	0.00	0.28	0.00	0.00	0.00	0.00	0.00
Montastraea cavernosa	0.00	10.99	0.01	0.00	1.38	0.07	0.10	0.01	1.13	0.40
Porites astreoides	0.11	0.00	0.04	0.04	0.28	0.04	0.00	0.00	0.04	0.06
Porites poristes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Scleractinia	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderastrea radians	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Siderastrea siderea	0.00	0.25	0.18	0.05	0.30	0.04	0.01	0.00	0.04	0.03
Solenastrea bournoni	0.00	0.17	0.00	0.01	0.15	0.03	0.04	0.00	0.00	0.01
Stephanocoenia michelinii	0.00	0.00	0.05	0.01	0.04	0.03	0.02	0.00	0.00	0.00

Functional Group Benthic Cover

Tables 11, 12, and 13 list the mean functional group cover for each County (Broward, Miami-Dade, and Palm Beach, respectively) and Tables 14, 15, and 16 list the mean functional group cover for each site. Functional groups included substrate (rock, rubble, and sediments), stony corals, octocorals, zoanthids, sponges, and macroalgae. Substrate dominated benthic cover at all sites (>50%), ranging from 98.09% at PB1 (see Discussion) to 55.60% at BCA (Figure 5). Octocoral was generally the second most common functional group.

Table 11. Mean percent cover of functional groups in Broward County for SECREMP sites in 2003 2004, and 2005. Mean values are based on n = 16 for Broward County (BC).

Functional Group	2003	2004	2005
Substrate	77.17	73.59	67.62
Stony Coral	11.15	13.04	13.31
Octocoral	7.24	7.83	8.91
Macroalgae	1.94	2.16	6.53
Porifera	1.89	2.34	2.95
Zoanthidea	0.59	0.60	0.56
Other Biota	0.01	0.38	0.12

Table 12. Mean percent cover of functional groups in Miami-Dade County for SECREMP sites in 2003 2004, and 2005. Mean values are based on n = 12 stations for Miami-Dade County (DC).

Functional Group	2003	2004	2005
Substrate	73.42	70.25	74.76
Stony Coral	1.07	1.09	1.18
Octocoral	12.00	10.36	12.96
Macroalgae	8.51	12.87	5.71
Porifera	3.16	2.61	2.88
Zoanthidea	1.80	1.54	1.93
Other Biota	0.04	1.27	0.57

Table 13. Mean percent cover of functional groups in Palm Beach County for SECREMP sites in 2003 2004, and 2005. Mean values are based on n = 12 stations for Palm Beach County (PB).

Functional Group	2003	2004	2005
Substrate	68.71	66.72	75.44
Stony Coral	1.26	1.23	0.90
Octocoral	20.12	21.30	17.50
Macroalgae	0.12	1.40	1.00
Porifera	8.10	7.61	4.19
Zoanthidea	0.67	0.68	0.37
Other Biota	1.02	1.06	0.59

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Table 14. Mean percent cover of functional groups in Broward County for SECREMP sites in 2003, 2004, and 2005. Mean values are based on n = 16 for Broward County (BC).

	2003				2004				2005			
Functional Group	**BCA**	**BC1**	**BC2**	**BC3**	**BCA**	**BC1**	**BC2**	**BC3**	**BCA**	**BC1**	**BC2**	**BC3**
Substrate	64.96	77.37	86.58	79.76	55.85	73.21	87.09	78.2	55.60	63.97	80.39	70.52
Stony Coral	31.72	12.21	0.40	0.28	39.63	11.76	0.44	0.35	39.86	12.57	0.54	0.27
Octocoral	2.34	6.46	6.63	13.54	2.03	6.41	6.89	15.99	1.54	6.76	9.43	17.90
Macroalgae	0.03	0.43	3.70	3.62	0.96	4.04	1.92	1.74	1.78	11.89	5.41	7.01
Porifera	0.27	1.84	2.67	2.79	0.47	1.99	3.27	3.64	0.42	3.10	4.08	4.18
Zoanthidea	0.68	1.68	0.00	0.00	0.84	1.40	0.14	0.03	0.78	1.38	0.08	0.00
Other Biota	0.00	0.00	0.01	0.01	0.23	1.00	0.25	0.05	0.01	0.33	0.06	0.09

Table 15. Mean percent cover of functional groups in Miami-Dade County for SECREMP sites in 2003, 2004, and 2005. Mean values are based on n = 12 stations for Miami-Dade County (DC).

	2003			2004			2005		
Functional Group	**DC1**	**DC2**	**DC3**	**DC1**	**DC2**	**DC3**	**DC1**	**DC2**	**DC3**
Substrate	72.21	69.56	78.48	53.04	79.50	78.20	69.10	78.46	76.72
Stony Coral	2.40	0.61	0.20	2.57	0.47	0.23	2.79	0.46	0.29
Octocoral	5.86	14.67	15.48	7.31	11.54	12.25	7.96	15.90	15.04
Macroalgae	13.32	9.97	2.25	31.44	3.26	3.92	12.80	1.12	3.20
Porifera	0.85	5.14	3.50	1.08	4.02	2.74	1.54	4.03	3.08
Zoanthidea	5.36	0.03	0.00	4.57	0.05	0.00	5.77	0.01	0.01
Other Biota	0.00	0.03	0.09	0.00	1.16	2.66	0.04	0.01	1.66

Table 16. Mean percent cover of functional groups in Palm Beach County for SECREMP sites in 2003, 2004, and 2005. Mean values are based on n = 12 stations for Palm Beach County (PB).

	2003			2004			2005		
Functional Group	**PB1**	**PB2**	**PB3**	**PB1**	**PB2**	**PB3**	**PB1**	**PB2**	**PB3**
Substrate	83.54	67.23	55.37	82.55	61.92	55.69	98.09	67.13	61.12
Stony Coral	0.97	1.79	1.02	0.86	1.80	1.03	0.14	1.60	0.95
Octocoral	2.70	27.32	30.34	2.88	31.20	29.84	0.03	27.49	24.98
Macroalgae	0.10	0.00	0.27	1.39	0.26	2.54	0.84	0.72	1.45
Porifera	10.29	3.53	10.46	9.82	4.15	8.87	0.17	2.89	9.51
Zoanthidea	0.55	0.09	1.36	0.78	0.05	1.20	0.02	0.08	1.02
Other Biota	1.84	0.05	1.17	1.71	0.63	0.83	0.71	0.09	0.96

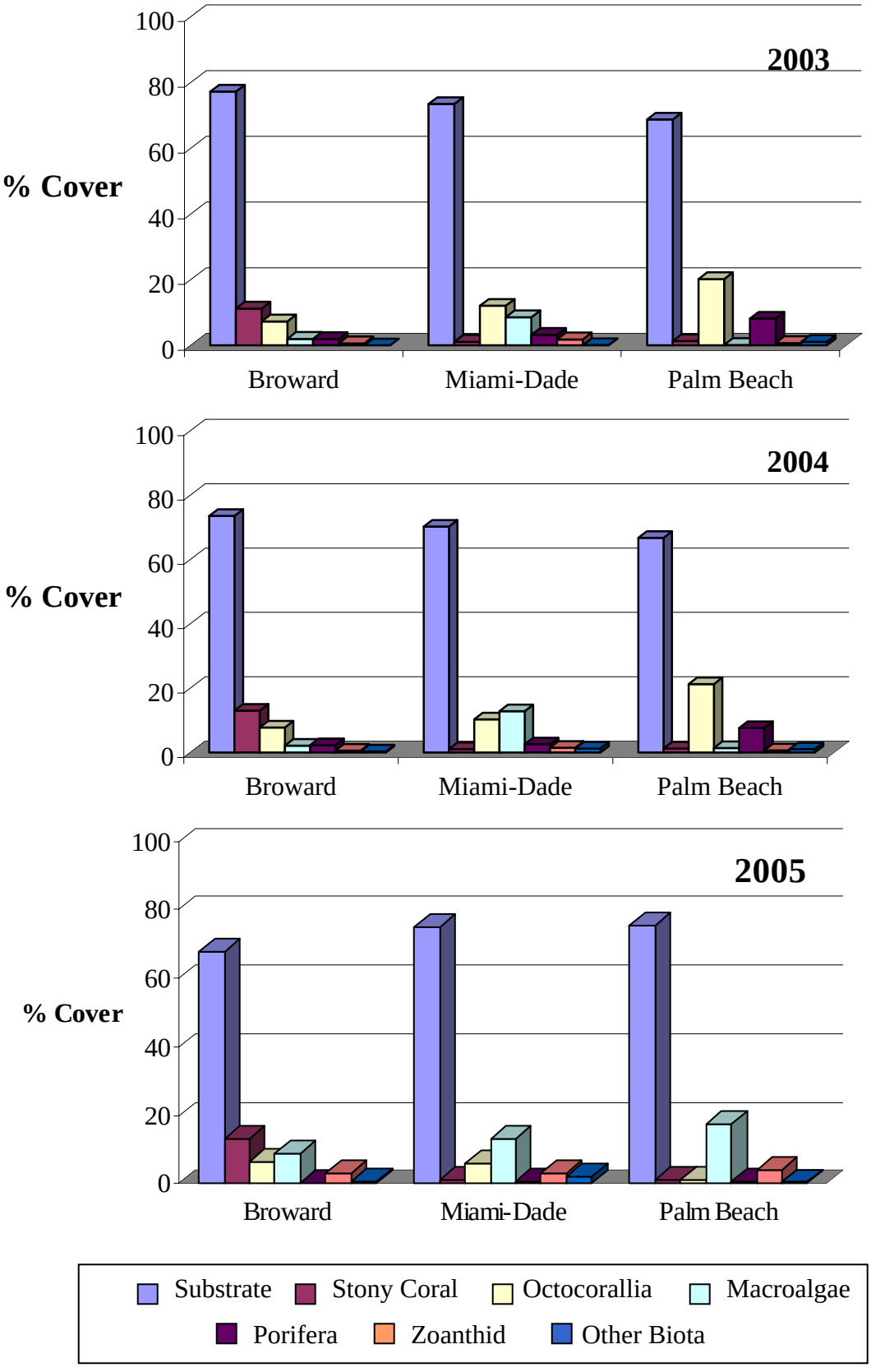

Figure 5. Mean percent cover of functional groups by county for 2003 2004, and 2005.

Bio-eroding Sponge

Cliona delitrix was the only bio-eroding sponge species identified at any SECREMP site. *C. delitrix* was seen in all three Counties (Table 17). Only site BCA did not have bio-eroding sponge present. Broward County had the greatest coverage of *C. delitrix* in 2003, 2004, and 2005. BC1 was the site with the greatest coverage of *C. delitrix* in 2003, 2004, and 2005. The area of sponge at BC1 in 2005 was much less than in 2003 or 2005 (~50% less). The reason for this is unknown. Table 18 list the coral species infected with *C. delitrix* in 2003, 2004, and 2005 and the total area of sponge coverage.

Table 17. Clionid sponge, *C. delitrix*, total colony area (cm^2/m^2) for each site in 2003, 2004, and 2005. Note: Site BCA had no *C. deletrix* present all years.

Site Code	Habitat Type	2003	2004	2005
All	All	107.00	105.49	55.01
BC1	First Reef	98.86	98.48	46.97
BC2	Second Reef	1.89	2.23	2.84
BC3	Third Reef	6.25	4.73	5.21
All	All	20.64	17.52	20.36
DC1	First Reef	4.36	5.49	4.54
DC2	Second Reef	15.15	11.46	14.30
DC3	Third Reef	1.14	0.57	1.52
All	All	48.67	43.75	25.47
PB1	First Reef	27.08	35.80	6.82
PB2	Third Reef	17.80	6.25	14.39
PB3	Third Reef	3.79	1.70	4.26

Table 18. Clionid sponge, *C. delitrix*, total colony area (cm^2/m^2)(all 10 sites) for each infected coral species in 2003, 2004, and 2005. Note: NA refers to sponge growing on unidentified coral or on substrate.

Coral Species	2003	2004	2005
M. cavernosa	36.93	36.36	37.12
M. meandrites	4.73	4.36	3.13
D. clivosa	0.95	4.73	0.00
P. asteroids	0.95	0.57	0.09
C. natans	0.76	1.33	2.94
S. michelinii	0.57	0.00	0.00
S. siderea	0.57	0.57	1.52
A. agaricites	0.38	0.00	0.38
D. strigosa	0.00	0.00	6.82
NA	130.49	118.84	48.86

DISCUSSION

The coral reef ecosystem off southeast Florida is a marginal system near the environmental threshold for significant reef growth. Southeast Florida reefs generally have reduced stony coral species richness and stony coral cover than the Dry Tortugas or Florida Keys coral reefs. Benthic cover by octocorals is, interestingly, very similar throughout the Florida reef system while southeast Florida reefs appear to have reduced macroalgae cover compared to reefs in the Dry Tortugas and the Florida Keys (Beaver et al. 2005; Gilliam 2005).

In 2005, site PB1 was greatly affected by sand movement. Stations 2 and 4 were completely covered with sand more than several inches in depth (Figure 6). All reef substrate was covered and therefore, no stony corals were identified and the cover was 100% substrate for stations 2 and 4. The cause of this sand movement is unknown although the 2004 hurricanes, Jeanne and Frances, may have contributed to significant sand movement. SSI, bio-eroding sponge, and video data was collected and included in this analysis. This impact on these stations greatly influenced summary data for PB1, and therefore, the between year and between County 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 (except substrate) coverage data, and reduced the total bio-eroding sponge coverage area. PB1 will be re-visited and included in subsequent sampling periods.

With three years of data, in general, the status of the southeast Florida reef system has changed little from 2003 to 2005 (except for PB1). Stony coral species richness (Table 3; Figure 3) and cover are very similar between years (Figure 4; Tables 9 and 10). The incidence of bleaching and disease in 2005 is similar to 2004, but the number of colonies with white complex disease is greater in 2005 while the number of colonies with ‘Other” (Dark Spot) is reduced. With only 19 infected colonies identified in 2004 and 21 identified in 2005, 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 PB1, there does not appear to be any consistent temporal changes in functional group cover between 2003 and 2005 (Tables 11-16; Figure 5). Substrate and octocorals remain the two groups with the most cover for the region. Site BCA was added to the project as the fourth site in Broward County for the purpose of monitoring one of the unique *Acropora cervicornis* patches. With the recent interest in listing *A. cervicornis* as a protected species, it is important to note that BCA *A. cervicornis* cover increased slightly from 31% in 2003 to 39% in 2005.

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 amounted to some 1.81 billion dollars and generated 61,300 jobs in Miami-Dade, Broward, and Palm Beach Counties (Johns et al., 2003).

These important economic and recreational benefits are threatened as 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, channel deepening, and channel maintenance can have significant 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 diverting of millions of gallons of fresh water into the ocean, and the resultant reduction in salinity and 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. Scientifically valid monitoring of reefs will help local resource managers understand the implications of actions occurring in terrestrial and adjacent marine habitats. This knowledge is necessary if resource managers are to development 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 Monitoring Project to include sites in Broward, Miami-Dade, and Palm Beach 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 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.

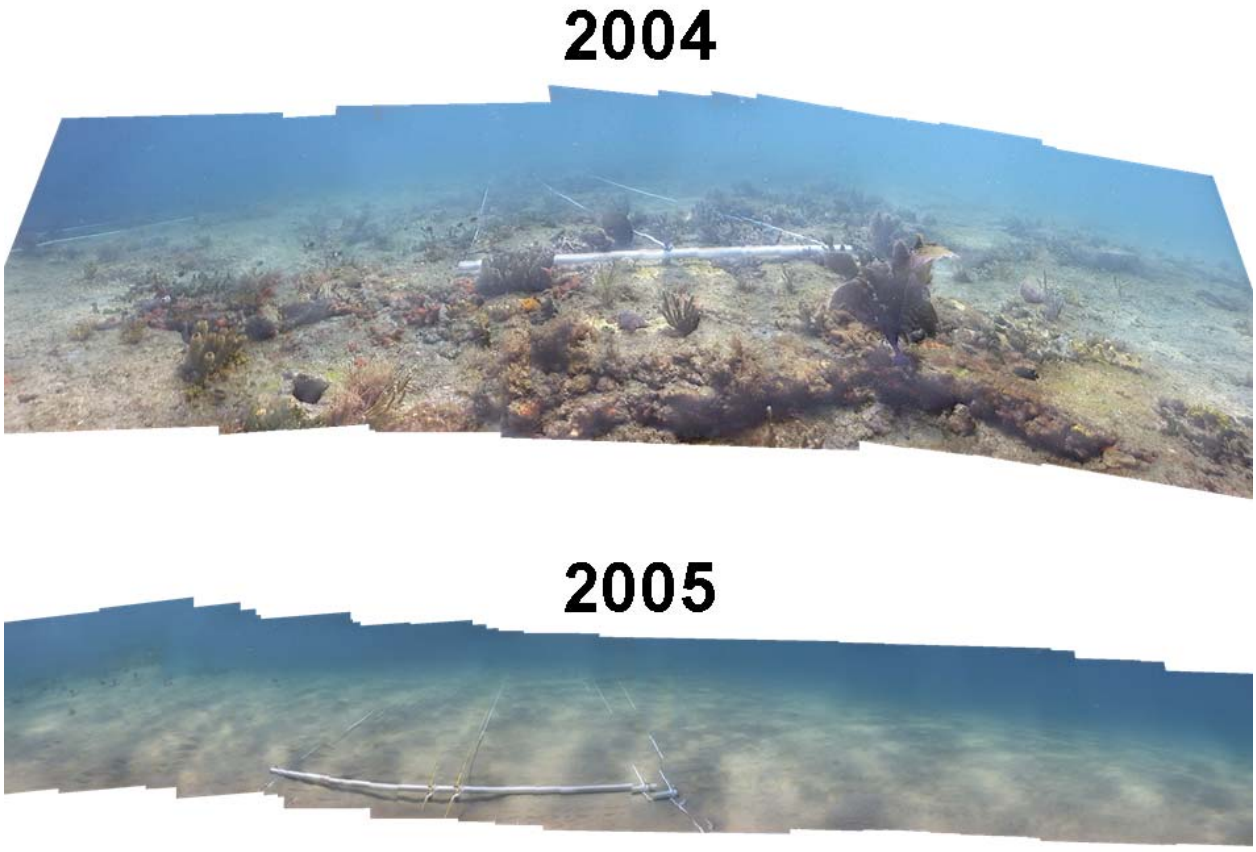

Figure 6. Photo mosaic of the north pin, Station 2, site PB1 in 2004 and 2005. Image clearly shows the station covered with sand in 2004.

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