

Rapid assessment and monitoring of coral reef habitats in the Florida Keys National Marine Sanctuary

Quick Look Report: Summer 2001 Zone Monitoring

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Project Summary:

This NURC/UNCW quick look report summarizes the accomplishments and significant findings from our summer 2001 benthic sampling of no-take zones and reference habitats in the Florida Keys National Marine Sanctuary. This year's sampling represents the fourth year of large-scale surveys of hard-bottom and coral reef habitats in the Sanctuary conducted by NURC/UNCW since 1998, not including two exploratory missions to the Tortugas region during 1999 and 2000.

The 2001 sampling focused primarily on two environments in the Sanctuary: the shallow fore reef from 1-7 m depth and the patch reef environment, specifically the central region of Hawk Channel to the shoreward edge of the platform margin. This effort complemented benthic surveys of 80 sites during 1999 Keys-wide and 45 sites across the continental shelf in the lower Keys region during 2000. The 2001 surveys assessed community structure and condition patterns of reef benthos on offshore, high relief spur and groove and hard-bottom habitats, but also included mid-channel and offshore patch reefs to supplement the 2000 surveys of 12 patch reefs in the lower Keys. Thirty-eight days of SCUBA surveys by a three to four person team between June 12 and September 4 resulted in assessments of 86 sites from southwest of Key West to northern Key Largo. Twelve of the Sanctuary's 23 zones were sampled. Most of the field sampling was accomplished aboard The Nature Conservancy's R/V *Oak Leaf*, but also included day-boat support from NURC/UNCW-Key Largo. Benthic surveys by the project team were

complemented by reef fish surveys conducted by personnel from RSMAS-University of Miami and NOAA-National Marine Fisheries Service.

Variables measured during 2001 included our “core” set of measurements, namely coverage, species richness, gorgonian density, coral density and size, coral condition, and video for archival purposes. We were also able to add several variables to the 2001 assessment: urchin density and size; density of anemones, corallimorpharians, opisthobranch mollusks, cleaner shrimps, spiny lobster, and arrow crabs; density and predation by the flamingo tongue *Cyphoma gibbosum*; *in situ* measurements of topographic complexity; and estimates of density, length, and biological impacts of remnant fishing gear and other marine debris. With the exception of the video transects, all of the variables were collected underwater on pre-formatted plastic slates, facilitating relatively rapid data processing for manuscript preparation. We were also able to take over 1,500 digital photographs for developing an archive of site photographs and tools for taxonomic identification of Florida Keys reef benthos.

Below we provide a brief narrative on the overall goals of the NURC/UNCW zone monitoring effort and a variable-by-variable summary of significant findings from the 2001 field surveys. We also include a list of published and planned papers and other products developed from this effort. Several appending tables summarize site-level coverage, species richness, and density estimates for many of the variables measured this year.

Goals and Objectives:

The 2001 sampling of coral reef and hard-bottom habitats in Sanctuary no-take zones and reference areas complemented a three-year effort dating back to 1999 to sample all of the shallow-water (< 15) hard-bottom habitat types in the Sanctuary, as well as most of the no-take zones established in 1997. The goals of the NURC/UNCW zone monitoring effort are three-fold:

- To assess the community structure and condition of reef benthos at multiple spatial scales, with particular reference to the no-take zones, but also inter-reef, among habitat type, and among region variations.
- To track the dynamics of coral reef benthos to assess changes due to protection from fishing within the zones, but also changes due to larger-scale factors, such as regional water quality phenomenon.
- To complement fishery-independent reef fish surveys with “fine-scale” or detailed habitat information, to facilitate experimental and modeling efforts for evaluating essential fishery habitat.

To accomplish these goals, the 2001 sampling built upon existing data collected during 1999 and 2000 to guide the underwater surveys. Our focus during 2001 was two-fold:

- To survey mid-channel and offshore patch reefs in the middle and upper Keys regions of the Sanctuary, to complement surveys of 12 mid-channel and offshore patch reef sites in the lower Keys during 2000.
- To survey high-relief spur and groove and low-relief hard-bottom habitats throughout the Florida Reef Tract from 1-7 m depth, with a particular emphasis on reefs constructed by elkhorn coral (*Acropora palmata*).

Together with the data collected during 1999-2000, this project has amassed an unprecedented data set on the abundance and habitat utilization patterns of algae and several invertebrate taxa, including stony corals, gorgonians, other benthic cnidarians, sponges, mollusks, echinoderms, and crustaceans. This information should be useful for preparing the five-year review of the Sanctuary zoning action plan, and

depending on the needs of the Sanctuary and funding, for developing a five to seven-year plan for continued monitoring of the zones.

Logistics and Methods:

A two-stage stratified random sampling design was used to randomly select sites during 2001. A grid system constructed in a geographic information system (GIS) was used to overlay the existing habitat map of the Florida Keys. Cells or blocks 200 m x 200 m in dimension were used to randomly select sites from the following habitat strata (Table 1):

- Lower Keys high-relief spur and groove (fore reef)
- Lower Keys shallow hard-bottom (fore reef)
- Middle Keys high-relief spur and groove (fore reef)
- Middle Keys shallow hard-bottom (fore reef)
- Middle Keys mid channel patch reef
- Middle Keys offshore patch reef
- Upper Keys high-relief spur and groove (fore reef)
- Upper Keys shallow hard-bottom (fore reef)
- Upper Keys mid channel patch reef
- Upper Keys offshore patch reef

Twelve of the Sanctuary's 23 zones were sampled during 2001, with all but one of the zones (Cheeca Rocks SPA) located on the outer platform margin or reef tract (Table 1). Two sites or blocks were assigned to each zone and a total of 86 sites were surveyed between June 12 and September 4 (Table 2). Figures 1 to 4 show the locations of the sampling locations Keys-wide and by regional sector. This year we were fortunate to sample the majority of offshore acroporid reefs from Key Largo to Key West, including both high relief and low-relief habitat types.

The 2001 sampling effort (86 sites) required 38 field days from mid-June to early September. An additional 12 days of scheduled field time were lost to inclement weather or other logistical issues. Of the 38 days, six days (16%) were supported by day-boat operations from NURC-Key Largo (Captain Mike Birns), in which 15 sites (17%) were sampled. The Nature Conservancy's R/V *Oak Leaf*, captained by Mr. Alex Creedon, supported the remaining field time (32 days, 84%), in which 71 sites (81%) were sampled. Our field effort depended upon 6-7 hours in the water daily by three to four divers. The 2001 sampling involved not only NURC/UNCW staff surveying the benthos, but fisheries scientists from RSMAS-UM and NOAA/NMFS who conducted four reef fish censuses at each site. Table 3 summarizes the diving statistics for this year. Over 700 hours of surveys by NURC/UNCW and reef fish surveyors were required to complete the sampling.

The 2001 surveys addressed the same variables measured during 1999-2000, in addition to several variables added to the existing design (Table 4). Briefly, at each site pre-determined GPS points were used to locate the position of transect deployment. Except for patch reefs (10 m transects), four pairs of 25 m transects were deployed in each block, labeled as 1A, 1B, 2A, 2B, etc. Along four of the primary transects (A), coverage was determined every 25 cm to yield 100 points per transect. Digital video along a 0.4 m swath was also taken along the primary transects. The number of species of stony corals, gorgonians, and sponges was determined on all four primary and secondary transects. Gorgonian density and height distribution using four size classes (< 20 cm, 20-50 cm, 50-100 cm, > 100 cm) were determined along transects 1A and 2A, as were coral density, size, and condition. The condition measurements included an assessment of competition between corals and other taxa, and the extent to which interactions caused tissue damage or mortality. Juvenile corals (< 4 cm maximum diameter) were assessed along transects 1A and 2A by randomly sampling ten 0.68 m x 0.45 m quadrats along each

transect. Urchin density and test diameter, as well as the density of incidental marine invertebrates (see Table 4) were assessed on all four primary and secondary transects.

We additionally assessed density and predation by the flamingo tongue snail (*Cyphoma gibbosum*), by noting the number of individuals, gorgonian prey, and gorgonian height on all transects deployed. We continued surveys of fishing gear and other marine debris during 2001, by surveying 1 m on each side of all primary and secondary transects. Noted were the type of gear, dimensions (typically length) to the nearest centimeter, whether the debris was biologically fouled or clean, and the number of sessile invertebrates impacted by the debris that caused tissue abrasion and/or mortality. Finally, *in situ* measurements of topographic complexity along the four primary transects were undertaken to provide an assessment of substratum angle, maximum vertical relief, and the coverage of different relief categories along 0.4 m x 25 m swaths. These surveys were supplemented by chain transect assessments for comparative purposes, in which a 5 m chain was draped over the contours of the substratum on the four primary transects and compared to the linear distance along the transects.

Also included during the 2001 surveys were surveys of two experimental and two control offshore patch reefs west of Pickles Reef that are being used for *Diadema antillarum* translocation (PIs Ken Nedimyer and Martin Moe). This is initially a one-year effort to evaluate the efficacy of translocating juvenile urchins from rubble to patch reef habitats in terms of time/effort, mortality, and community structure effects. We have included summary information in this report, although more detailed data for the four sites are presented in the PIs Sanctuary quarterly report. We were able to include our full complement of sampling, in addition to reef fish censuses conducted by divers from RSMAS-UM and NOAA/NMFS.

Summary of Significant Results:

Benthic cover

Table 5 summarizes mean percent coverage data for stony corals, total algae, sponges, and the colonial zoanthid *Palythoa mammilosa* for the 86 survey sites. Patterns in the coverage of these benthos exhibited significant differences among the four habitat types surveyed. Mid-channel patch reefs exhibited some of the highest coral cover we have surveyed in the Sanctuary, often exceeding 30%, but was also variable, ranging from about 5% to almost 43%. Quite unexpectedly, we sampled a mid-channel patch reef south of Sunshine Key, directly in the path of Moser Channel, that had up to 60% coral cover on individual transects. Not surprisingly, coral cover on mid-channel patch reefs was dominated by massive reef-building corals, namely *Montastraea cavernosa*, *M. faveolata*, *Colpophyllia natans*, and *Siderastrea siderea*, as well *Diploria* spp. on some sites. Sponges also exhibited the greatest coverage on mid-channel patch reefs, especially at several sites south of Vaca Key.

Offshore patch reefs exhibited considerable variability in physical structure and geomorphology, from dome-type structures dominated by head corals, to very eroded and small acroporid reefs (e.g. western extent of Carysfort SPA) or rubble/hard-bottom matrix communities, to high-relief transitional reefs (e.g. White Banks/Dry Rocks). Coverage by corals was mostly < 10%, and algae were more predominant than on mid-channel patch reefs. Sponge coverage was also generally lower than in central Hawk Channel.

Offshore sampling locations included both high-relief spur and groove and low-relief hard-bottom habitat types. Nearly all of the 63 locations surveyed were constructed by *Acropora palmata*, and ranged from very high-profile reefs (e.g. most of the SPAs surveyed) to highly eroded or remnant acroporid reef flats (e.g. Conch Reef, Davis Reef, Maryland Shoal). Not unexpectedly, coral cover offshore was greatest on high-relief spur and groove reefs, ranging from about 1% to 12.5%. Coral cover tended to be greatest within the zones and was dominated by *Porites astreoides* and *Millepora complanata*. Algae, consisting

mostly of algal turf, *Dictyota* spp., and *Halimeda* spp., and crustose coralline species, dominated high-relief spur and groove reefs throughout the Sanctuary. Sponge cover was mostly < 5% and dominated by encrusting species adapted to higher wave energy. An interesting coverage pattern was evident for *Palythoa mammilosa*. This species exhibited locally high coverage, especially in the lower and middle Keys, and was more abundant than reef-building corals at 12 of the 34 (35%) spur and groove reefs surveyed.

Offshore low-relief hard-bottom sites were sampled in-between most well-developed spur and groove reefs in the Sanctuary. Of the 29 sites, none had greater than 5% coral cover, and algae dominated all of the sites. Sponges and *Palythoa* were locally abundant, but coverage was generally < 6%. Dominant algal functional groups were primarily algal turfs and brown foliose algae, especially *Dictyota* spp., *Sargassum* spp., *Styopodium zonale*, and *Lobophora variegata*.

Species richness

Surveys of the number of species of stony corals, gorgonians, and sponges continued during the 2001 surveys. Similar to results from 2000 and probably contrary to popular perception, patch reefs typically yielded the greatest species density and number of species of reef-building corals (Table 6). Usually twice the number of sponges was found on patch reefs compared to offshore fore reef areas, despite a 60% smaller sampling area. One notable exception were the two sampling locations within Cheeca Rocks SPA, which exhibited the lowest species richness values for stony corals, gorgonians, and sponges of the patch reefs sampled.

Species richness on offshore spur and groove reefs exhibited several patterns. In general, coral species richness tended to be similar in the no-take zones and reference areas. This contrasts with the deeper fore reef (8-12 m) surveyed during 1999, in which the no-take zones had significantly greater coral species richness than the reference areas. Sponges were more speciose than corals in the majority of sites, but exhibited considerably lower numbers of species than mid-channel and offshore patch reefs. Gorgonians exhibited a wide range in species richness, with some spur and grooves reefs with very few species, to those with abundant and speciose gorgonian faunas. Although coral cover was very low on offshore hard-bottom sites, these areas tended to have much greater coral, sponge, and gorgonian species richness than spur and groove reefs.

Coral density, size and condition

Coral density, size, and condition measurements were made using a modified AGRRA approach as in previous years (Table 7). We also added assessments of competition with measured corals to ascertain the degree of damage caused by inter-specific competition. The total area surveyed during 2001 was 971.3 m². Over 4,000 corals were counted and measured from the 86 sites, 1,356 or 34% of which were *Millepora alcicornis* and *M. complanata*, 2,665 or 66% of which were scleractinian corals. Scleractinian corals exhibited marked differences in density and species composition among the four habitat types sampled. Patch reefs, particularly mid-channel sites, exhibited many of the highest densities we recorded this year, reflecting the predominance of massive, reef-building species. Coral densities offshore were highly variable and tended to be dominated by *Millepora* and *Porites astreoides*, especially in high-relief spur and groove areas.

The condition measurements during 2001 included assessments of competition, predation, bleaching, and disease. We were encouraged to find very few incidences of bleaching from the areas surveyed. As in previous years, disease incidence in the habitats we surveyed was very low (Table 7). Of the 2,665 scleractinian coral assessed, only 49 (1.8%) exhibited signs of disease. Disease conditions noted were:

- Dead white skeleton noted on several species, including *Porites astreoides*, *Siderastrea siderea*, *Stephanocoenia michelini*, *P. porites furcata*;
- Dark spot condition, noted primarily on *S. siderea*, but also *Agaricia agaricites* and *A. humilis*;
- Yellow band disease;
- White plague type II, noted on *Dichocoenia stokesi*, *A. humilis*, and *A. agaricites*;
- White band disease, noted on *Acropora palmata*; and
- Decaying tissue/skeleton, noted on *S. michelini*, and possibly indicative of shutdown reaction.

The percentage of scleractinian corals with symptoms of disease ranged among the habitat types as follows: mid-channel patch reefs (2.5%), offshore patch reefs (2.1%), high-relief spur and groove (1.7%), and low-relief hard-bottom (1.5%). No incidence of black-band disease was recorded from any of the colonies assessed.

We also included more and broader transect surveys of elkhorn coral and staghorn coral during 2001 (Table 8). Surveys assessed the number of colonies, defined as patches of continuous live tissue, with notes on colony size. We were encouraged to find large stands of *Acropora palmata* offshore, especially at Sand Key SPA, Sand Island, Elbow Reef SPA, and South Carysfort Reef. We were also surprised to find some live stands of elkhorn coral in offshore hard-bottom areas. Live patches of staghorn coral, most probably 2-3 years of age, were found on several patch reefs surveyed as well.

Juvenile coral density

Surveys of juvenile coral species composition, density, and maximum diameter continued during 2001. Table 9 lists the number of species found as juveniles, the density of juvenile corals, and the dominant species. Among the four habitat types sampled, juvenile densities were generally greater on mid-channel and offshore patch reefs, with different dominance patterns than offshore. We noted at several locations that one of the dominant recruiting corals was *Siderastrea siderea*. We were discouraged to find very low densities of juveniles in offshore fore reef habitats, especially in high-relief spur and groove (Table 9). Juvenile corals offshore were mostly dominated by smaller brooding species such as *Agaricia agaricites*, *Favia fragum*, and *Porites astreoides*.

Gorgonian density and height distribution

Over 13,000 gorgonians were identified, counted, and measured for colony height in the four habitat types surveyed this year (Table 10). Colonies were scored into height classes as a further indication of the disturbance history of particular sites. For example, we saw many fore reef areas, such as Crocker Reef, with high densities of sea plumes, but dominated by small (< 10 cm) colony sizes. In nearly all sites surveyed, gorgonians continue to comprise the dominant sessile macro-invertebrates, often two times or greater in density than stony corals. Many of the mid-channel and offshore patch reefs surveyed yielded some of the highest gorgonian densities (> 30 colonies per m²) we have found in the Sanctuary. One notable pattern in gorgonian density was evident on spur and groove reefs. Except for American Shoal, which is a moderately eroded acroporid reef, gorgonian densities were lower in the lower Keys compared to the upper Keys. We noted dominance by sea fans (*Gorgonia ventalina*) and sea plumes, especially *Pseudopterogorgia americana* and *P. bipinnata*, at many upper Keys reefs.

Urchin density and size

We continued surveys of urchin density and test size at all 86 sites sampled during 2001. Six species were encountered in transect surveys in mid-channel patch reef, offshore patch reef, and shallow fore reef habitats (Table 11). Similar to results from 1999 and 2000, all of the sampling locations yielded very low

densities of urchins, particularly *Diadema antillarum*. However, we found several locations with large (3.5-5 cm TD) *D. antillarum*, with clear effects of grazing on the substratum, as well as some locations, such as Pickles Reef, with relatively high densities of other urchins. During June surveys in the lower Keys region, we noted several sites with juvenile (< 0.6 cm TD) *D. antillarum*, even though the peak recruitment apparently occurs in the Florida Keys during August and September. Also noted was a clear shift from a predominance of *Echinometra viridis* on patch reefs to *Eucidaris tribuloides* offshore.

Incidental invertebrates

We assessed density patterns for a variety of sessile and mobile invertebrate species during the 2001 surveys (Table 12). We continued surveys of anemones and corallimorpharians, in addition to shrimp symbionts. During the first few days of sampling in mid-June, we noted several sites with abundant opisthobranch mollusks, particularly the lettuce sea slug *Tridachia crispata*, so we extended our surveys to include all visible opisthobranch mollusks within the strip transects. We were encouraged to find two nudibranch species, as well as 226 individuals of *T. crispata*, mostly associated with live or remnant *Millepora complanata*. As an additional ecological story, we also surveyed the density and predation by the flamingo tongue (*Cyphoma gibbosum*). Over 120 individuals were measured in fore reef habitats. We also included assessments of gorgonian prey, including species and colony height, and plan to publish a paper on the density and prey utilization of this gorgonian predator.

Fishing gear and other marine debris

We continued last year's surveys of fishing gear and other marine debris at all 86 sites during 2001. Based upon results from 2000, we assumed that relatively little fishing gear would be found throughout much of the shallow (1-6 m) fore reef. We were surprised at the amount of marine debris, represented mostly by recreational hook-and-line gear, that was recovered, even within the no-take zones (Table 13). The majority of the debris was recreational hook-and-line gear, represented by monofilament, wire, leaders, hooks, lead weights, and even a fishing pole, followed by remnant lobster/crab trap debris, including rope, wood slats, buoys, and cement. From all 86 sites representing a total survey area of only 25,200 m², we recovered more than 0.5 km of hook-and-line gear and trap rope. Of the 349.03 m of hook-and-line gear recovered from the fore reef, 111.81 m or 32% was recovered from the no-take zones. In fact, many of the no-take zones surveyed yielded some of the greatest densities of hook-and-line gear in the Sanctuary. While most of the gear within the zones was biologically fouled, clean or freshly lost hook-and-line gear was recovered from Sand Key SPA (7.4 m), Sombrero Key SPA (29.06 m), and Carysfort/S. Carysfort SPA (1.86 m). Most of the gear found on mid-channel and offshore patch reefs was lobster trap debris, especially buoy lines. However, several patch reefs near Molasses Reef Channel (near Three Sisters) and White Banks/Dry Rocks had significant quantities of hook-and-line gear.

Besides surveying the type, density, and extent of marine debris, we also assessed the number of organisms impacted by debris, specifically abrasion and tissue mortality to sessile marine invertebrates. On the fore reef alone (63 sites), we noted 319 incidences of damage to fire coral, stony corals, gorgonians, sponges, and the colonial zoanthid *Palythoa mammilosa*. Not surprisingly, most damage was caused by hook-and-line gear on the fore reef, especially to gorgonians, and secondarily to fire coral and sponges. While we recognize that remnant fishing gear is a relatively minor factor affecting Florida Keys reefs, quantitative surveys of this type will at least be one useful measure for assessing compliance to the no-fishing regulations within the zones in the future.

Plans for Use of the Data:

Significant progress in manuscript development was made since January 2001. Below is a list of manuscripts in press or published, those submitted for review, and those we intend to submit for

publication by January 2002. While many of these reports are descriptive in nature, many of the variables measured by this program have never been assessed at so many sites representing the complement of shallow-water hard-bottom and coral reef habitats in the Florida Keys. Moreover, these products will be timely for the five-year review of the Sanctuary zoning action plan in 2002. Synthesis papers are also in progress related to the methods developed for this assessment and monitoring program, as well as large-scale survey results in Dry Tortugas National Park and the Tortugas Bank.

In addition to specific analyses for manuscripts, a concerted effort will be made to re-evaluate our existing habitat classification for future surveys. This will be accomplished in a multivariate context and will help to further define habitat strata and thus will assist us in optimal allocation of future surveys. We also intend to continue to work closely with NMFS, RSMAS-UM, and FIU to compare community structure and condition variables with existing water quality, geological, and reef fish survey data. Other products planned for the fourth quarter of 2001 and the first quarter of 2002 include the development and dissemination of digital photographs on CD-ROM taken this year and during 2000 in the Dry Tortugas, as well as a web site with site descriptions and summarized data from 1999-2001, including links and pdf versions of manuscripts published.

Manuscripts in press or published

- Chiappone M, Miller SL, Swanson DW (2001) Status of an intensively fished aquarium-trade species in the Florida Keys: The giant Caribbean anemone (*Condylactis gigantea*). *Reef Encounter*
- Chiappone M, Miller SL, Swanson DW, Ault JS, Smith SG (2001) Comparatively high densities of the long-spined sea urchin in the Dry Tortugas, Florida. *Coral Reefs* 20: 137-138
- Chiappone M, White A, Swanson DW, Miller SL (In press) Occurrence and biological impacts of fishing gear and other marine debris in the Florida Keys. *Marine Pollution Bulletin*
- Miller SL, Chiappone M, Swanson DW, Ault JS, Smith SG, Meester GA, Luo J, Franklin EC, Bohnsack JA, Harper DE, McClellan DB (2001) An extensive deep reef terrace on the Tortugas Bank, Florida Keys National Marine Sanctuary. *Coral Reefs*
- Miller SL, Swanson DW, Chiappone M (2001) Multiple spatial scale assessment of coral reef and hard-bottom community structure in the Florida Keys National Marine Sanctuary. *Proceedings of the 9th International Coral Reef Symposium, Bali*

Manuscripts submitted for review

- Chiappone M, Swanson DW, Miller SL (submitted) Density and habitat utilization patterns of anemones and corallimorpharians (Anthozoa, Zoantharia) in the Florida Keys National Marine Sanctuary. *Coral Reefs*
- Chiappone M, Swanson DW, Miller SL (submitted) Density, spatial distribution, and size structure of sea urchins in coral reef and hard-bottom habitats of the Florida Keys. *Marine Ecology Progress Series*
- Chiappone M, Swanson DW, Miller SL (submitted) Large-scale density patterns of anemones and corallimorpharians on offshore coral reef habitats in the Florida Keys. *Bulletin of Marine Science*
- Chiappone M, Swanson DW, Miller SL, Smith SG (submitted) Large-scale surveys on the Florida Reef Tract indicate poor recovery of the long-spined sea urchin *Diadema antillarum*. *Coral Reefs*

Manuscripts in progress

- Ault JS, Smith SG, Meester GA, Luo J, Franklin EC, Bohnsack JA, Harper DE, McClellan DB, Miller SL, Swanson DW, Chiappone M (in progress) Synoptic habitat and reef fish surveys support marine reserves in the Dry Tortugas, Florida. *Reef Encounter*
- Chiappone M, Swanson DW, Miller SL, Sullivan-Sealey KM (in progress) A hierarchical structural classification of Florida Keys coral reef and hard-bottom habitats. *Environmental Conservation*

- Chiappone M, Swanson DW, Miller SL, White A, Dienes H (in progress) A rapid method for assessing topographic complexity of coral reef and hard-bottom habitats. *Journal of Experimental Marine Biology and Ecology*
- Dienes H, Chiappone M, Swanson DW, Franklin EC, Miller SL (in progress) Density and predation by the flamingo tongue, *Cyphoma gibbosum* (Gastropoda, Ovulidae), in Florida Keys fore reef habitats. *Caribbean Journal of Science*
- Dienes H, Chiappone M, Swanson DW, Franklin EC, Miller SL (in progress) Density of opisthobranch mollusks in Florida Keys shallow fore reef habitats. *Bulletin of Marine Science*
- Dienes H, Chiappone M, Swanson DW, Franklin EC, Miller SL (in progress) Spatial distribution and impacts of fishing gear to coral reef benthos in the Florida Keys National Marine Sanctuary. *Environmental Conservation*
- Miller SL, Chiappone M, Swanson DW (in progress) Long-term dynamics of Florida Keys acroporid reefs: History and implications of a phase shift. *Coral Reefs*
- Miller SL, Chiappone M, Swanson DW, Ault JS, Smith SG, Franklin EC (in progress) Design-based surveys of coral reef and hard-bottom habitats in Dry Tortugas National Park and the Tortugas Bank, Florida. *Ecological Applications*
- Miller SL, Gittings S, Chiappone M, Causey B, Swanson DW, White A (in progress) Changes (1994-2000) to benthic cover on a deep coral reef in the Florida Keys. *Coral Reefs*
- Smith SG, Swanson DW, Miller SL, Ault JS, Chiappone M (in progress) Sampling survey approaches for coral reef assessment and monitoring in the Florida Keys. *Marine Ecology Progress Series*
- Swanson DW, Chiappone M, Miller SM (in progress) Habitat and regional variations in coral species richness and coverage in the Florida Keys. *Coral Reefs*
- Swanson DW, Chiappone M, Miller SM (in progress) Disease incidence on reef-building corals in the Florida Keys National Marine Sanctuary. *Marine Ecology Progress Series*

Figure 1. Survey locations in the Florida Keys National Marine Sanctuary during June-September 2001.

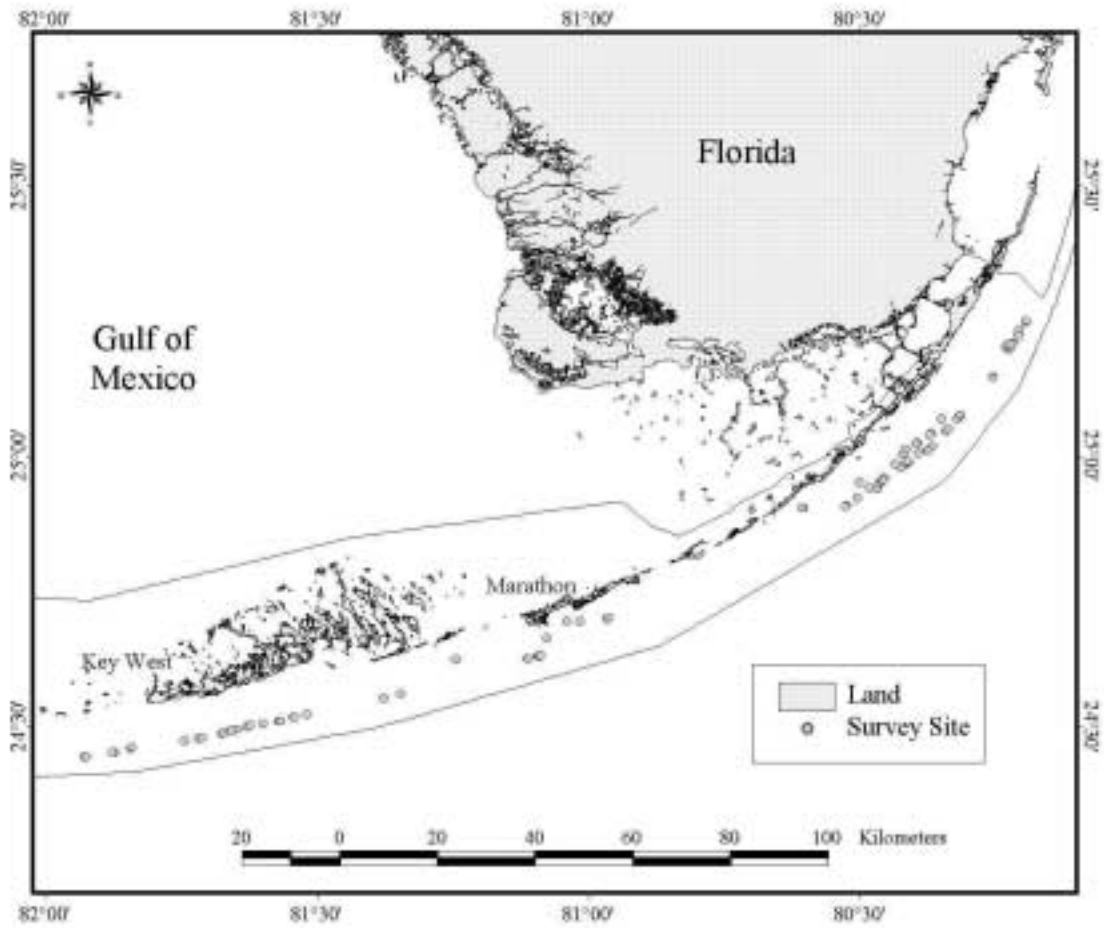


Figure 2. Survey locations in the lower Florida Keys by habitat type.

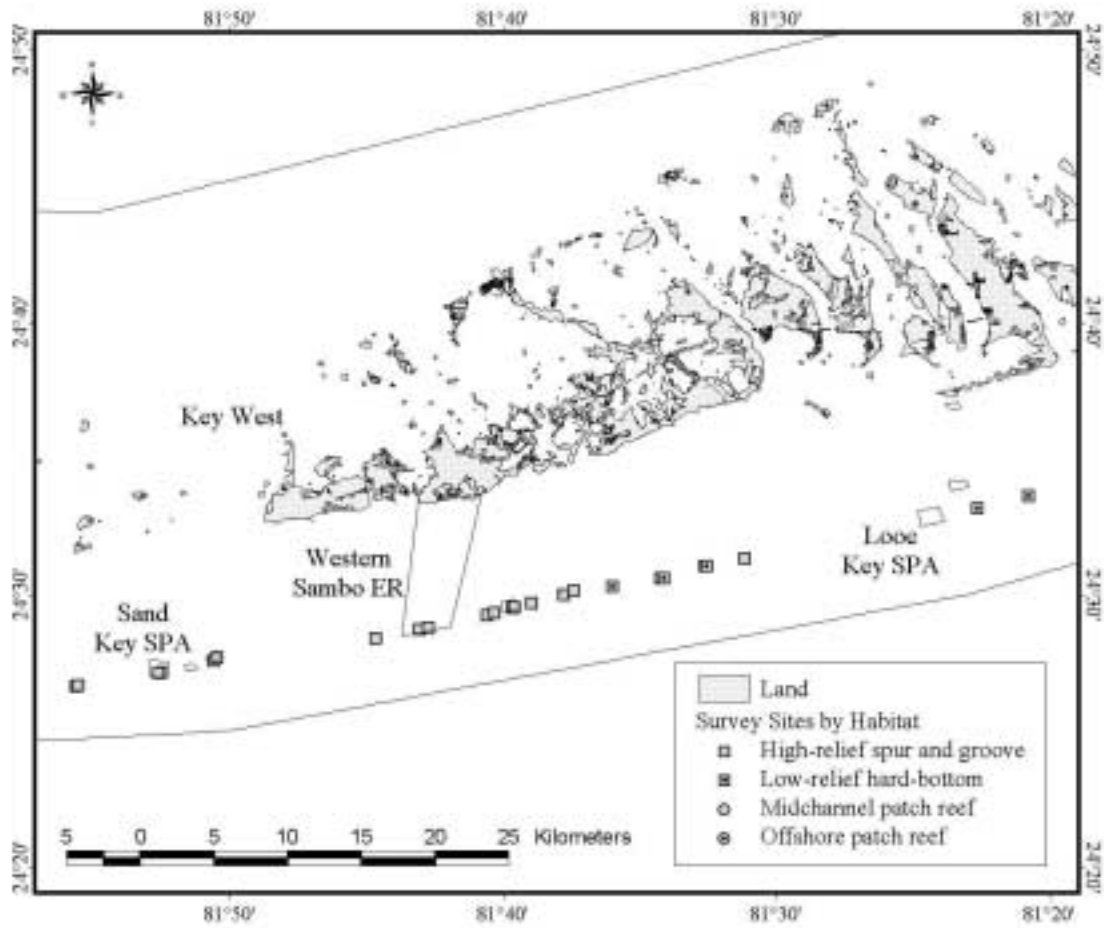


Figure 3. Survey locations in the middle Keys by habitat type.

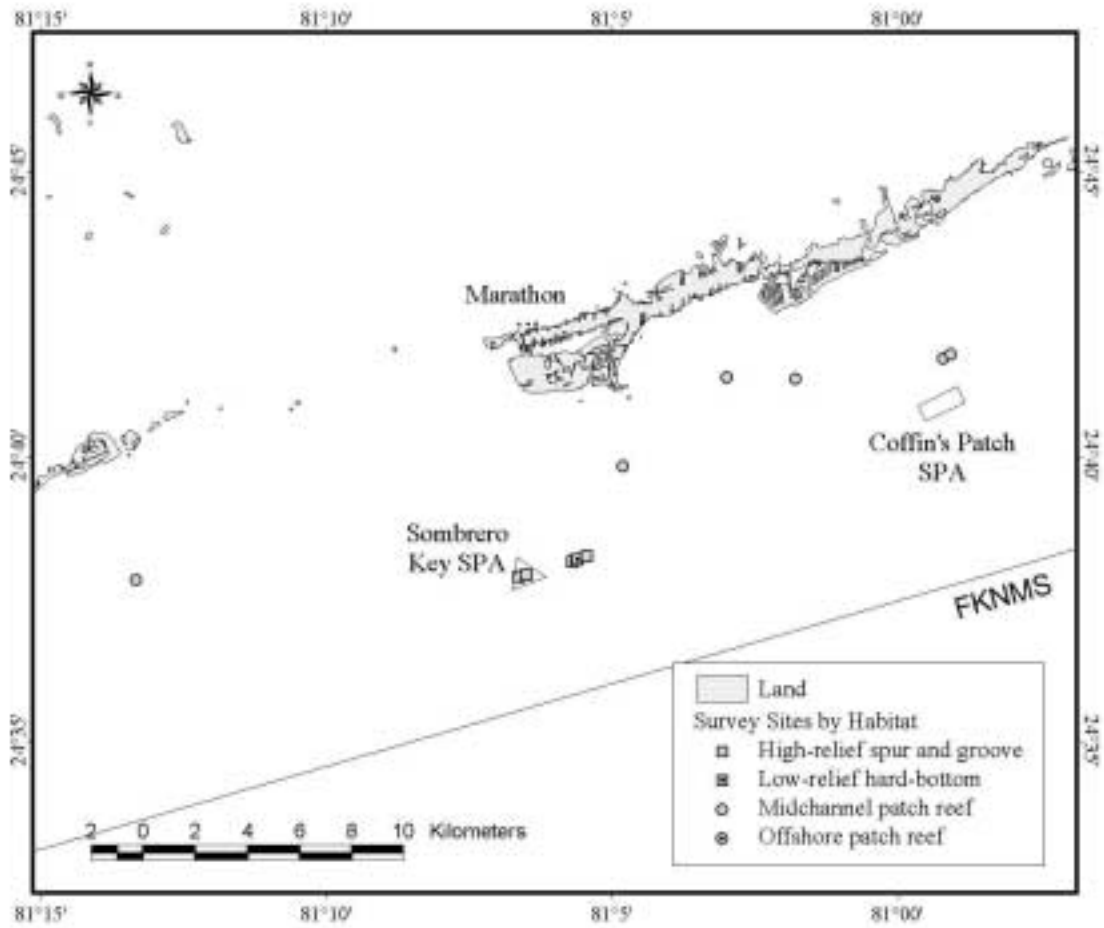


Figure 4. Survey locations in the upper Keys by habitat type.

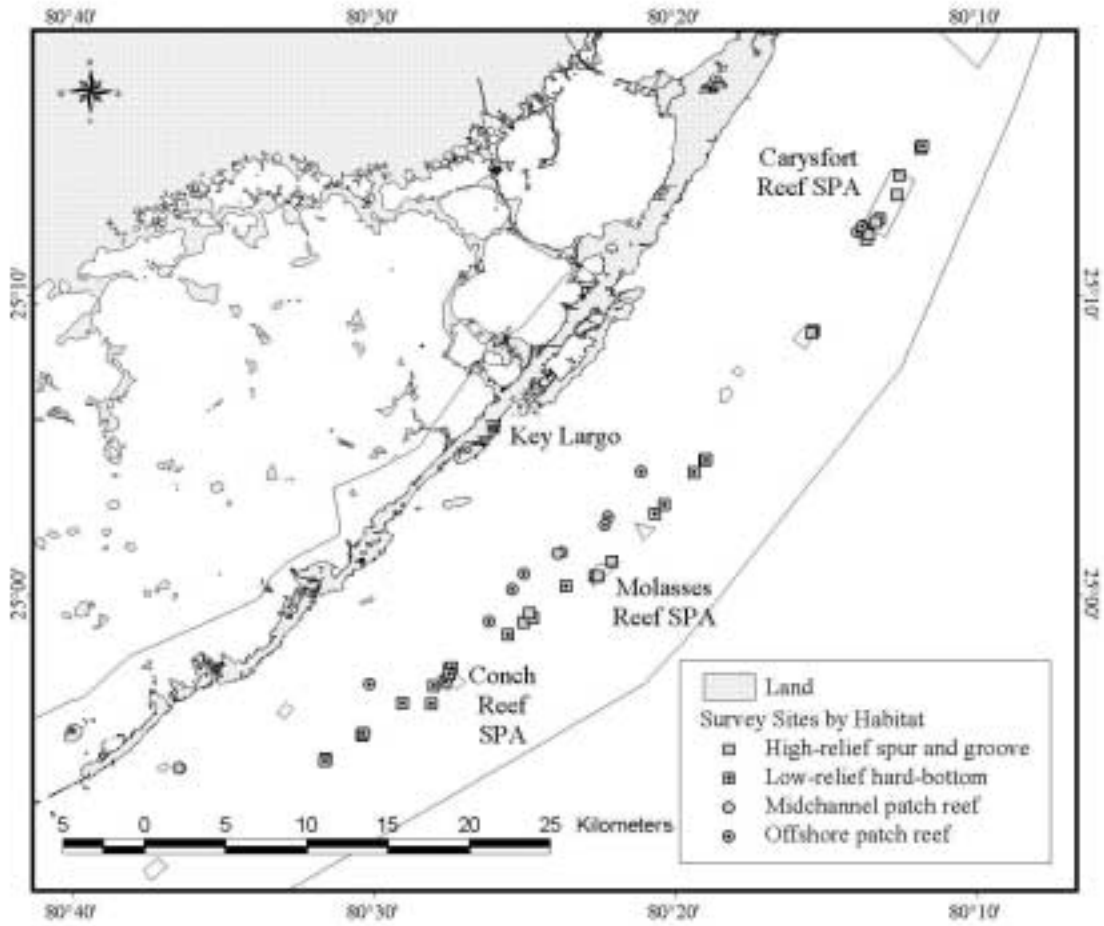


Table 1. Sampling effort by habitat type and regional sector in the Florida Keys.

Habitat type	Regional sector	Management type	No. of sites	Effort (%)
Mid-channel patch reef	Middle Keys	Reference areas	6	7.0
	Middle Keys	No-take zones	2	2.3
	Upper Keys	Reference areas	2	2.3
Offshore patch reef	Middle Keys	Reference areas	1	1.2
	Upper Keys	Reference areas	10	11.6
	Upper Keys	No-take zones	2	2.3
Shallow spur and groove	Lower Keys	Reference areas	9	10.5
	Lower Keys	No-take zones	8	9.3
	Middle Keys	Reference areas	1	1.2
	Middle Keys	No-take zones	2	2.3
	Upper Keys	Reference areas	6	7.0
	Upper Keys	No-take zones	8	9.3
Shallow hard-bottom	Lower Keys	Reference areas	7	8.1
	Middle Keys	Reference areas	9	10.5
	Middle Keys	No-take zones	4	4.7
	Upper Keys	Reference areas	9	10.5
Total		11 no-take zones	86	100.0

Table 2. Survey locations in the Florida Keys National Marine Sanctuary during June-September 2001. Sites are arranged from southwest to northeast within each habitat type. Sites within Sanctuary no-take zones are asterisked.

Habitat type/site location	Region	Latitude	Longitude	Depth (m)
<i>Mid-channel patch reefs</i>				
South of Sunshine Key	Middle Keys	24.37.455	81.14.655	5.7-8.1
East Washerwoman	Middle Keys	24.39.815	81.04.593	6.3-7.5
South of Key Vaca	Middle Keys	24.41.656	81.02.432	3.6-4.8
East of Marker 49	Middle Keys	24.41.630	81.01.014	5.1-6.9
Turtle Shoal	Middle Keys	24.42.043	80.57.956	3.6-4.5
East Turtle Shoal	Middle Keys	24.42.130	80.57.813	3.9-4.2
Cheeca Rocks SPA #2*	Middle Keys	24.54.248	80.36.426	1.5-3.6
Cheeca Rocks SPA #1*	Middle Keys	24.54.248	80.36.398	1.8-3.9
Molasses Channel #2	Upper Keys	25.01.384	80.23.846	3.0-3.6
Molasses Channel #1	Upper Keys	25.01.419	80.23.721	3.6-4.2
<i>Offshore patch reefs</i>				
NW of Davis Reef	Middle Keys	24.57.039	80.30.099	3.6-4.2
<i>Diadema</i> control #2	Upper Keys	24.59.101	80.26.124	7.8-8.1
<i>Diadema</i> control #1	Upper Keys	24.59.101	80.26.130	7.2-7.5
<i>Diadema</i> experimental #2	Upper Keys	24.59.101	80.26.128	7.2-7.5
<i>Diadema</i> experimental #1	Upper Keys	24.59.101	80.26.124	7.5-7.8
West of Molasses #1	Upper Keys	25.00.187	80.25.364	4.2-5.1
West of Molasses #2	Upper Keys	25.02.697	80.24.985	3.6-4.2
White Banks/Dry Rocks #2	Upper Keys	25.02.327	80.22.290	3.3-5.1
White Banks/Dry Rocks #1	Upper Keys	25.02.586	80.22.175	2.1-5.4
East of Mosquito Bank	Upper Keys	25.04.110	80.21.075	3.3-4.2
South of Carysfort SPA	Upper Keys	25.12.072	80.13.904	3.6-4.2
Carysfort SPA #1*	Upper Keys	25.12.280	80.13.713	4.5-5.4
Carysfort SPA #2*	Upper Keys	25.12.258	80.13.749	3.6-4.5
<i>High-relief spur and groove</i>				
Western Dry Rocks #1	Lower Keys	24.26.695	81.55.617	1.2-4.2
Western Dry Rocks #2	Lower Keys	24.26.718	81.55.522	2.4-5.4
Sand Key SPA #2*	Lower Keys	24.27.151	81.52.586	1.5-4.2
Sand Key SPA #1*	Lower Keys	24.27.184	81.52.463	2.4-5.1
Eastern Dry Rocks SPA #1*	Lower Keys	24.27.619	81.50.556	1.8-5.7
Eastern Dry Rocks SPA #2*	Lower Keys	24.27.733	81.50.443	2.4-4.5
Marker 32 Reef	Lower Keys	24.28.429	81.44.641	4.5-6.3
Western Sambo ER #1*	Lower Keys	24.28.764	81.43.037	2.4-5.1
Western Sambo ER #2*	Lower Keys	24.28.838	81.42.720	2.1-4.8
Middle Sambo Reef #1	Lower Keys	24.29.292	81.40.554	1.5-4.8
Middle Sambo Reef #2	Lower Keys	24.29.378	81.40.304	2.1-4.5
Eastern Sambo RO #1*	Lower Keys	24.29.562	81.39.636	1.8-3.6
Eastern Sambo RO #2*	Lower Keys	24.29.582	81.39.567	1.8-5.1
No Name Reef	Lower Keys	24.29.734	81.38.933	2.4-5.4
Pelican Shoal	Lower Keys	24.30.022	81.37.765	1.5-4.2
East of Pelican Shoal	Lower Keys	24.30.194	81.37.393	1.8-4.2
American Shoal	Lower Keys	24.31.370	81.31.142	4.2-4.8
Sombrero Key SPA #1*	Middle Keys	24.37.529	81.06.729	3.3-6.0
Sombrero Key SPA #2*	Middle Keys	24.37.559	81.06.588	2.7-6.6
East Delta Shoal	Middle Keys	24.37.951	81.05.337	3.9-5.1

Table 2 continued.

Habitat type/site location	Region	Latitude	Longitude	Depth (m)
Pickles Reef P1	Upper Keys	24.59.088	80.24.967	3.6-5.4
Pickles Reef P3	Upper Keys	24.59.229	80.24.682	2.4-3.9
Northeast Pickles Reef	Upper Keys	24.59.378	80.24.773	3.3-4.8
Molasses Reef SPA #1*	Upper Keys	25.00.619	80.22.629	3.0-5.4
Molasses Reef SPA #2*	Upper Keys	25.00.619	80.22.510	3.6-4.2
Sand Island	Upper Keys	25.01.101	80.22.043	3.3-5.7
Elbow Reef SPA #2*	Upper Keys	25.08.689	80.15.418	3.3-6.0
Elbow Reef SPA #1*	Upper Keys	25.08.770	80.15.368	5.4-7.5
South of S. Carysfort #1	Upper Keys	25.11.813	80.13.607	3.6-5.7
South of S. Carysfort #2	Upper Keys	25.11.978	80.13.522	3.0-5.7
South Carysfort SPA #2*	Upper Keys	25.12.408	80.13.277	2.4-6.0
South Carysfort SPA #1*	Upper Keys	25.12.499	80.13.178	1.5-5.1
Carysfort SPA #2	Upper Keys	25.13.294	80.12.594	3.6-5.7
Carysfort SPA #1	Upper Keys	25.13.963	80.12.502	3.0-6.6
<i>Low-relief hard-bottom</i>				
Marker 26	Lower Keys	24.30.342	81.35.975	4.5-5.7
West Maryland Shoal #1	Lower Keys	24.30.628	81.34.228	3.6-5.1
West Maryland Shoal #2	Lower Keys	24.30.632	81.34.090	4.2-5.1
East Maryland Shoal #1	Lower Keys	24.31.078	81.32.586	4.2-5.1
East Maryland Shoal #2	Lower Keys	24.31.077	81.32.529	4.2-6.0
East of Looe Key	Lower Keys	24.33.214	81.22.622	5.4-6.6
West of Big Pine Shoal	Lower Keys	24.33.672	81.20.748	4.8-6.0
Western Delta Shoal	Middle Keys	24.37.838	81.05.623	5.4-6.3
Central Delta Shoal	Middle Keys	24.37.886	80.05.525	3.9-5.7
Crocker Reef #2	Middle Keys	24.54.479	80.31.589	4.5-5.7
Crocker Reef #1	Middle Keys	24.54.529	80.31.539	4.2-6.6
Davis Reef DL1 SPA*	Middle Keys	24.55.330	80.30.351	6.0-6.6
Davis Reef DL3 SPA*	Middle Keys	24.55.383	80.30.309	5.1-6.0
Little Conch Reef #2	Middle Keys	24.56.386	80.28.038	4.2-5.1
Little Conch Reef #1	Middle Keys	24.56.408	80.28.991	4.8-5.7
SW of Conch Reef SPA	Middle Keys	24.56.973	80.27.973	4.2-6.3
Conch Reef SPA #1*	Middle Keys	24.57.126	80.27.568	5.1-5.7
Conch Reef SPA #2*	Middle Keys	24.57.370	80.27.445	5.1-6.0
NW of Conch Reef SPA #1	Middle Keys	24.57.510	80.27.432	3.6-5.4
NW of Conch Reef SPA #2	Middle Keys	24.57.574	80.27.368	3.3-3.6
Little Pickles Reef	Upper Keys	24.58.677	80.25.492	3.9-6.0
SW of Molasses Reef	Upper Keys	25.03.302	80.23.585	3.0-3.9
NE of French Reef #1	Upper Keys	25.02.713	80.20.616	3.0-4.8
NE of French Reef #2	Upper Keys	25.02.989	80.20.307	4.2-5.7
NE of French Reef #3	Upper Keys	25.04.082	80.19.341	4.5-6.3
Dixie Shoal #1	Upper Keys	25.04.482	80.18.987	5.4-6.3
Dixie Shoal #2	Upper Keys	25.04.510	80.18.920	6.0-6.9
North of Carysfort Reef #1	Upper Keys	25.14.868	80.11.789	4.5-6.6
North of Carysfort Reef #2	Upper Keys	25.14.951	80.11.755	4.8-5.7

Table 3. SCUBA diving effort in the Florida Keys during June-September 2001.

Diver	Affiliation	No. of dives	Depth range (ft.)	Bottom time
<i>Benthic surveys</i>				
Mark Chiappone	CMSR/UNCW	139	11-29	187 hr 22 min
Dione Swanson	CMSR/UNCW	134	9-28	199 hr 51 min
Helga Dienes	CMSR/UNCW	91	11-27	130 hr 35 min
Erik Franklin	RSMAS/UM	51	13-25	54 hr 53 min
Subtotal		415	9-29	572 hr 41 min
<i>Reef fish surveys</i>				
Doug Harper	NOAA/NMFS	14	15-25	12 hr 57 min
Mike Judge	NOAA/NMFS	43	12-32	45 hr 28 min
Dave McClellan	NOAA/NMFS	5	24-28	5 hr 39 min
Helena Molina	RSMAS/UM	58	12-27	75 hr 12 min
Steve Smith	RSMAS/UM	2	15-24	3 hr 24 min
Subtotal		122	12-32	142 hr 40 min
Total all divers		537	9-32	715 hr 21 min

Table 4. Variables measured in Sanctuary no-take zones and reference areas during 2001. Transects 25 m in length were used in all sites except patch reefs (10 m).

Variable	Method	Factors assessed
Percent cover	Point-intercept along 4 transects	Percent cover, relative abundance
Species richness	0.4 m x 25 m swaths along 8 transects	Species density, total species
Coral density and size	0.4 m x 25 m swaths along 2 transects	Density, size, condition
<i>Acropora</i> coral density	2 m x 25 m swaths along 8 transects	Density
Juvenile coral density	Twenty 0.68 m x 0.45 m quadrats	Species composition and density
Gorgonian density and height	0.4 m x 25 m swaths along 2 transects	Density, height distribution
Urchin density and size	0.4 m x 25 m swaths along 8 transects	Density, test diameter
Marine ornamentals	0.4 m x 25 m swaths along 8 transects	Density
Spiny lobster density	2 m x 25 m swaths along 8 transects	Density
<i>Cyphoma</i> density and prey	0.4 m x 25 m swaths along 8 transects	Density, prey utilization
Fishing gear density	2 m x 25 swaths along 8 transects	Density, length, biological impacts
Topography	0.4 m x 25 m swaths along 4 transects	Maximum relief, substratum slope

Table 5. Mean (1 SE) percent coverage of corals, total algae, sponges, and *Palythoa mammilosa*. Sites asterisked are within Sanctuary no-take zones. Data are based upon 100 points surveyed along each of four transects per site.

Habitat type/site location	Stony corals	Total algae	Sponges	<i>Palythoa</i>
<i>Mid-channel patch reefs</i>				
South of Sunshine Key	42.75 (7.79)	35.75 (3.01)	8.25 (2.32)	1.75 (1.75)
East Washerwoman	18.50 (3.93)	26.75 (8.86)	18.00 (5.82)	0 (0)
South of Key Vaca	31.50 (4.57)	39.00 (7.36)	5.75 (1.65)	0 (0)
East of Marker 49	36.75 (9.20)	27.00 (4.80)	13.25 (2.25)	1.00 (0.41)
Turtle Shoal	12.25 (2.63)	41.00 (3.03)	17.75 (3.17)	1.25 (0.95)
East Turtle Shoal	15.25 (1.49)	25.00 (0.82)	20.00 (1.87)	5.25 (0.75)
Cheeca Rocks SPA #2*	23.50 (6.06)	66.50 (3.88)	5.25 (2.29)	0 (0)
Cheeca Rocks SPA #1*	36.75 (8.98)	53.00 (6.72)	5.00 (1.35)	0 (0)
Molasses Channel #2	5.25 (1.31)	54.00 (3.00)	12.50 (1.26)	0.75 (0.75)
Molasses Channel #1	6.50 (1.55)	75.50 (1.71)	11.50 (2.02)	0.50 (0.50)
<i>Offshore patch reefs</i>				
NW of Davis Reef	8.50 (1.71)	64.50 (3.43)	3.00 (1.22)	1.25 (0.75)
<i>Diadema</i> control #2	12.00 (4.45)	45.25 (5.19)	2.00 (1.22)	0 (0)
<i>Diadema</i> control #1	6.25 (2.21)	52.00 (5.99)	6.75 (1.31)	0 (0)
<i>Diadema</i> experimental #2	5.50 (2.10)	51.75 (6.12)	8.25 (2.39)	0 (0)
<i>Diadema</i> experimental #1	14.00 (4.56)	56.75 (1.31)	5.75 (1.18)	0 (0)
West of Molasses #1	4.50 (0.50)	76.50 (1.94)	5.25 (0.85)	0 (0)
West of Molasses #2	7.00 (1.15)	65.50 (3.40)	8.75 (1.18)	1.00 (0.41)
White Banks/Dry Rocks #2	7.25 (2.14)	72.00 (1.73)	9.50 (2.06)	1.00 (0.41)
White Banks/Dry Rocks #1	3.75 (1.93)	91.00 (4.64)	1.00 (0.58)	0 (0)
East of Mosquito Bank	9.50 (2.22)	65.75 (4.13)	11.00 (1.00)	0.75 (0.75)
South of Carysfort SPA	1.50 (0.65)	78.75 (2.78)	5.50 (0.87)	1.00 (0.41)
Carysfort SPA #1*	2.50 (1.04)	81.00 (1.58)	6.00 (1.68)	1.25 (0.95)
Carysfort SPA #2*	2.75 (1.25)	80.25 (1.93)	5.75 (0.75)	1.75 (1.03)
<i>High-relief spur and groove</i>				
Western Dry Rocks #1	9.50 (2.22)	74.25 (3.15)	2.00 (1.08)	13.00 (2.52)
Western Dry Rocks #2	4.00 (1.47)	86.00 (1.22)	1.00 (1.00)	6.50 (1.55)
Sand Key SPA #2*	9.25 (2.87)	80.75 (2.17)	0.75 (0.75)	5.50 (2.10)
Sand Key SPA #1*	4.00 (1.22)	78.00 (2.27)	5.00 (0.58)	7.25 (1.55)
Eastern Dry Rocks SPA #1*	11.00 (2.35)	74.50 (2.87)	2.75 (0.85)	8.25 (1.31)
Eastern Dry Rocks SPA #2*	6.25 (1.44)	86.00 (2.04)	2.00 (0.71)	4.00 (1.00)
Marker 32 Reef	2.00 (0.41)	79.00 (1.58)	7.75 (0.75)	7.00 (1.58)
Western Sambo ER #1*	7.00 (1.47)	86.00 (2.86)	0.50 (0.29)	1.75 (0.48)
Western Sambo ER #2*	9.00 (1.08)	83.00 (2.86)	1.25 (0.48)	1.25 (1.25)
Middle Sambo Reef #1	12.50 (2.96)	75.75 (2.06)	2.50 (0.65)	8.00 (2.27)
Middle Sambo Reef #2	9.50 (2.60)	83.75 (2.78)	1.50 (0.87)	2.50 (1.85)
Eastern Sambo RO #1*	10.25 (2.59)	81.00 (1.96)	2.00 (1.08)	3.25 (1.18)
Eastern Sambo RO #2*	8.25 (2.53)	76.50 (5.92)	1.00 (0.41)	6.75 (1.44)
No Name Reef	6.25 (2.25)	71.50 (4.03)	1.75 (0.63)	19.25 (1.65)
Pelican Shoal	2.00 (0.71)	86.50 (1.85)	1.75 (0.75)	3.25 (1.18)
East of Pelican Shoal	7.00 (0.91)	69.50 (3.01)	4.50 (0.65)	9.50 (1.50)
American Shoal	1.25 (0.25)	67.25 (9.39)	4.25 (0.85)	6.50 (1.85)
Sombrero Key SPA #1*	5.50 (2.25)	50.25 (7.03)	7.25 (2.32)	30.50 (3.86)
Sombrero Key SPA #2*	11.50 (2.10)	66.00 (4.38)	4.00 (0.91)	11.00 (4.60)
East Delta Shoal	3.25 (1.11)	73.25 (5.39)	6.25 (1.49)	7.00 (2.12)

Table 5 continued.

Habitat type/site location	Stony corals	Total algae	Sponges	<i>Palythoa</i>
Pickles Reef P1	3.25 (0.48)	87.75 (2.50)	0 (0)	1.75 (1.11)
Pickles Reef P3	4.25 (2.02)	90.00 (3.76)	0.75 (0.48)	0.25 (0.25)
Northeast Pickles Reef	2.50 (0.50)	82.25 (5.12)	1.00 (0.41)	3.00 (1.47)
Molasses Reef SPA #1*	13.50 (2.72)	61.25 (5.28)	6.00 (1.22)	15.25 (6.75)
Molasses Reef SPA #2*	12.00 (2.16)	77.50 (2.02)	0.50 (0.50)	6.25 (1.11)
Sand Island	4.75 (1.93)	84.00 (4.34)	1.25 (0.95)	1.25 (0.75)
Elbow Reef SPA #2*	3.50 (0.65)	84.25 (4.55)	1.50 (0.50)	1.25 (0.63)
Elbow Reef SPA #1*	5.75 (4.77)	88.25 (4.59)	1.75 (0.48)	1.00 (0.71)
South of S. Carysfort #1	5.75 (2.02)	76.25 (3.45)	6.50 (0.65)	0.25 (0.25)
South of S. Carysfort #2	5.25 (0.95)	78.00 (1.47)	2.75 (0.85)	0.75 (0.48)
South Carysfort SPA #2*	11.50 (4.01)	74.50 (4.44)	1.00 (0.71)	1.50 (0.50)
South Carysfort SPA #1*	7.25 (1.44)	87.50 (1.76)	0.50 (0.29)	1.25 (0.48)
Carysfort SPA #2*	6.75 (1.11)	85.00 (1.58)	2.00 (0.71)	0.50 (0.29)
Carysfort SPA #1*	7.00 (1.47)	80.25 (3.47)	0 (0)	3.50 (1.89)
<i>Low-relief hard-bottom</i>				
Marker 26	2.50 (0.50)	44.75 (3.57)	5.75 (1.31)	4.00 (1.29)
West Maryland Shoal #1	0.50 (0.29)	64.25 (4.91)	3.75 (1.03)	7.25 (2.14)
West Maryland Shoal #2	3.00 (1.08)	78.25 (1.75)	0.75 (0.48)	1.25 (0.48)
East Maryland Shoal #1	2.75 (0.95)	45.50 (5.55)	6.25 (2.43)	3.00 (1.08)
East Maryland Shoal #2	2.75 (0.63)	37.25 (3.57)	2.75 (0.48)	4.00 (0.71)
East of Looe Key	2.00 (0.82)	50.25 (7.56)	5.75 (1.93)	6.75 (1.49)
West of Big Pine Shoal	1.25 (0.75)	53.75 (5.17)	3.00 (0.71)	3.50 (0.29)
Western Delta Shoal	2.50 (0.29)	60.00 (2.92)	14.25 (2.56)	6.25 (0.75)
Central Delta Shoal	4.75 (1.49)	60.50 (5.91)	10.25 (1.38)	6.75 (1.55)
Crocker Reef #2	1.25 (0.48)	74.25 (2.59)	3.00 (0.82)	4.75 (2.50)
Crocker Reef #1	1.75 (0.75)	66.00 (8.52)	1.75 (0.85)	1.25 (0.63)
Davis Reef DL1 SPA*	1.25 (0.63)	82.00 (4.30)	1.50 (0.65)	0.50 (0.29)
Davis Reef DL3 SPA*	1.25 (0.48)	80.25 (1.49)	1.50 (0.96)	3.50 (1.26)
Little Conch Reef #2	3.25 (1.03)	69.25 (3.12)	2.25 (0.25)	0.50 (0.29)
Little Conch Reef #1	2.00 (0.41)	60.75 (0.75)	3.25 (1.31)	0.25 (0.25)
SW of Conch Reef SPA	2.00 (0.41)	82.00 (3.63)	1.25 (0.48)	1.50 (0.29)
Conch Reef SPA #1*	1.75 (0.25)	83.75 (1.93)	2.50 (0.29)	2.50 (0.96)
Conch Reef SPA #2*	1.25 (0.48)	89.50 (1.26)	0.75 (0.25)	1.25 (0.25)
NW of Conch Reef SPA #1	2.00 (0.71)	67.25 (6.94)	1.00 (0.41)	2.00 (1.08)
NW of Conch Reef SPA #2	1.75 (0.85)	79.75 (2.10)	1.50 (0.65)	0.50 (0.29)
Little Pickles Reef	1.25 (0.95)	79.75 (3.04)	2.25 (0.48)	2.75 (1.11)
SW of Molasses Reef	1.75 (0.63)	81.75 (1.44)	0.25 (0.25)	0.75 (0.48)
NE of French Reef #1	2.25 (0.48)	81.00 (2.65)	2.50 (0.96)	1.50 (0.65)
NE of French Reef #2	2.75 (0.63)	71.75 (2.46)	1.75 (0.48)	4.00 (1.47)
NE of French Reef #3	2.25 (0.95)	85.50 (2.40)	2.00 (0.82)	2.25 (1.25)
Dixie Shoal #1	1.50 (0.65)	87.50 (1.04)	4.00 (0.41)	1.25 (0.48)
Dixie Shoal #2	1.00 (0.00)	88.00 (2.68)	2.75 (0.63)	0.50 (0.50)
North of Carysfort Reef #1	3.00 (0.91)	81.50 (4.35)	2.50 (1.26)	1.00 (0.41)
North of Carysfort Reef #2	2.25 (0.25)	80.75 (2.66)	4.75 (0.85)	2.50 (0.87)

Table 6. Mean (1 SE) number of species per 20 m² (per 8 m² for patch reefs) and total species surveyed for sponges, stony corals, and gorgonians. Data are based upon four 20 m² plots, except for patch reefs (four 8 m² plots). Sites asterisked are within Sanctuary no-take zones.

Habitat type/site location	Sponges		Stony corals		Gorgonians	
	Mean	Total	Mean	Total	Mean	Total
<i>Mid-channel patch reefs</i>						
South of Sunshine Key	19.8 (1.5)	28	15.3 (1.0)	21	9.5 (0.3)	16
East Washerwoman	21.8 (1.3)	28	15.0 (0.7)	20	14.3 (1.1)	20
South of Key Vaca	11.3 (1.6)	16	11.8 (0.6)	16	10.3 (1.3)	17
East of Marker 49	19.0 (0.4)	26	14.0 (1.1)	20	12.0 (0.4)	17
Turtle Shoal	22.0 (1.4)	30	12.0 (0.7)	17	15.3 (1.3)	20
East Turtle Shoal	22.5 (0.9)	30	12.3 (0.8)	17	18.5 (0.5)	21
Cheeca Rocks SPA #2*	4.5 (0.7)	9	10.0 (1.1)	15	1.5 (0.3)	3
Cheeca Rocks SPA #1*	4.8 (0.8)	10	8.5 (0.7)	14	2.5 (0.3)	4
Molasses Channel #2	23.5 (0.5)	32	9.3 (1.0)	13	16.5 (1.5)	22
Molasses Channel #1	23.0 (1.5)	29	12.5 (0.7)	18	14.5 (0.7)	19
<i>Offshore patch reefs</i>						
NW of Davis Reef	21.3 (0.9)	30	11.8 (0.8)	15	16.5 (0.7)	20
<i>Diadema</i> control #2	19.5 (0.5)	28	9.8 (0.8)	15	6.0 (0.4)	10
<i>Diadema</i> control #1	24.3 (1.9)	35	11.3 (1.1)	17	8.5 (1.0)	15
<i>Diadema</i> experimental #2	26.3 (1.8)	35	10.0 (1.1)	15	11.0 (0.7)	18
<i>Diadema</i> experimental #1	21.8 (0.6)	35	11.8 (0.3)	20	4.8 (0.5)	8
West of Molasses #1	25.3 (1.5)	35	12.0 (0.4)	16	16.0 (1.1)	19
West of Molasses #2	24.3 (0.8)	36	12.3 (0.9)	18	17.3 (1.0)	22
White Banks/Dry Rocks #2	16.0 (2.0)	26	10.5 (0.7)	17	12.5 (0.7)	17
White Banks/Dry Rocks #1	9.8 (1.7)	20	8.3 (1.4)	16	7.3 (1.0)	11
East of Mosquito Bank	20.8 (1.1)	27	10.0 (0.7)	16	9.8 (0.9)	16
South of Carysfort SPA	21.8 (1.3)	35	7.0 (0.0)	8	16.0 (1.2)	22
Carysfort SPA #1*	23.8 (1.4)	34	10.0 (0.8)	16	14.8 (1.7)	21
Carysfort SPA #2*	23.0 (2.5)	34	8.8 (0.8)	14	14.0 (1.1)	17
<i>High-relief spur and groove</i>						
Western Dry Rocks #1	8.3 (1.2)	16	7.8 (1.1)	12	3.3 (0.5)	5
Western Dry Rocks #2	13.0 (1.1)	19	8.3 (1.7)	14	5.8 (0.5)	10
Sand Key SPA #2*	8.0 (1.1)	13	9.5 (0.9)	15	2.8 (1.0)	7
Sand Key SPA #1*	14.3 (0.9)	22	8.3 (0.6)	12	8.8 (0.8)	13
Eastern Dry Rocks SPA #1*	12.8 (1.0)	19	10.0 (0.8)	19	4.3 (0.8)	8
Eastern Dry Rocks SPA #2*	11.8 (0.3)	14	10.0 (1.1)	15	5.5 (0.7)	8
Marker 32 Reef	19.3 (1.4)	27	11.5 (0.7)	15	6.5 (0.7)	10
Western Sambo ER #1*	9.3 (1.0)	15	10.8 (0.6)	15	7.0 (1.1)	12
Western Sambo ER #2*	12.0 (0.4)	16	10.0 (0.6)	16	5.8 (1.5)	12
Middle Sambo Reef #1	13.0 (1.1)	19	7.8 (1.0)	11	4.0 (0.7)	8
Middle Sambo Reef #2	13.8 (0.5)	18	8.3 (1.0)	11	5.0 (0.4)	8
Eastern Sambo RO #1*	14.0 (0.9)	21	9.5 (0.7)	12	6.8 (1.4)	12
Eastern Sambo RO #2*	18.0 (1.9)	26	10.0 (1.7)	15	6.3 (1.0)	9
No Name Reef	15.0 (1.6)	25	12.0 (1.6)	19	5.5 (0.3)	9
Pelican Shoal	16.8 (1.2)	24	8.0 (1.1)	13	5.8 (0.8)	12
East of Pelican Shoal	20.0 (1.4)	26	11.0 (0.8)	18	11.0 (0.4)	13
American Shoal	20.5 (1.0)	34	11.0 (1.5)	17	16.0 (1.1)	19
Sombrero Key SPA #1*	21.5 (2.4)	32	15.8 (0.9)	23	10.3 (1.7)	15
Sombrero Key SPA #2*	16.0 (1.1)	23	9.5 (0.3)	14	8.0 (0.4)	11

Table 6 continued.

Habitat type/site location	Sponges		Stony corals		Gorgonians	
	Mean	Total	Mean	Total	Mean	Total
East Delta Shoal	24.0 (1.2)	39	11.0 (1.7)	19	14.3 (1.0)	20
Pickles Reef P1	13.8 (0.6)	19	10.8 (0.5)	15	7.8 (0.9)	14
Pickles Reef P3	10.3 (0.9)	16	8.3 (0.6)	11	4.5 (1.0)	8
Northeast Pickles Reef	13.5 (1.2)	21	7.5 (1.0)	11	8.5 (0.9)	14
Molasses Reef SPA #1*	14.3 (0.3)	22	7.3 (0.3)	9	8.5 (0.7)	14
Molasses Reef SPA #2*	10.8 (1.3)	16	6.3 (0.9)	8	7.8 (0.5)	13
Sand Island	12.5 (1.3)	21	9.5 (0.3)	14	8.0 (1.5)	13
Elbow Reef SPA #2*	10.0 (0.7)	19	9.5 (0.7)	12	9.3 (1.0)	15
Elbow Reef SPA #1*	10.0 (0.7)	15	8.3 (0.8)	13	7.8 (0.9)	14
South of S. Carysfort #1	17.5 (1.6)	27	11.0 (1.1)	16	13.3 (0.3)	19
South of S. Carysfort #2	16.5 (0.5)	28	11.0 (1.7)	16	13.3 (2.2)	21
South Carysfort SPA #2*	13.3 (1.0)	21	10.0 (0.7)	17	10.3 (0.5)	14
South Carysfort SPA #1*	10.5 (0.7)	20	11.0 (0.6)	15	8.0 (0.4)	12
Carysfort SPA #2*	10.8 (1.4)	17	10.3 (1.0)	17	10.8 (0.8)	14
Carysfort SPA #1*	10.8 (0.5)	17	10.5 (0.9)	17	9.0 (1.3)	16
<i>Low-relief hard-bottom</i>						
Marker 26	17.0 (2.5)	30	9.8 (0.9)	15	17.5 (1.3)	22
West Maryland Shoal #1	18.0 (0.9)	30	10.0 (0.9)	16	9.8 (0.5)	16
West Maryland Shoal #2	18.3 (0.5)	29	8.5 (1.5)	14	13.5 (0.3)	17
East Maryland Shoal #1	20.8 (2.2)	34	10.3 (1.0)	18	12.5 (0.3)	14
East Maryland Shoal #2	20.0 (1.4)	33	11.5 (1.2)	15	16.3 (0.6)	19
East of Looe Key	21.0 (1.1)	31	15.8 (0.9)	19	15.3 (0.8)	19
West of Big Pine Shoal	22.3 (0.3)	36	12.3 (0.6)	18	16.8 (0.8)	20
Western Delta Shoal	25.3 (1.3)	37	15.3 (0.6)	21	15.8 (1.4)	20
Central Delta Shoal	24.5 (1.0)	38	11.3 (1.0)	16	16.5 (0.7)	18
Crocker Reef #2	20.3 (1.0)	32	9.3 (0.5)	12	16.5 (1.2)	20
Crocker Reef #1	14.8 (0.8)	23	9.0 (0.6)	14	10.0 (0.7)	16
Davis Reef DL1 SPA*	20.5 (1.7)	33	13.5 (1.4)	21	7.8 (1.1)	13
Davis Reef DL3 SPA*	19.8 (0.5)	30	12.0 (1.3)	19	10.5 (1.2)	16
Little Conch Reef #2	19.3 (1.4)	27	11.0 (0.7)	16	12.5 (0.3)	17
Little Conch Reef #1	17.3 (0.9)	27	10.8 (0.5)	17	15.3 (0.5)	18
SW of Conch Reef SPA	16.8 (1.9)	26	7.8 (0.5)	11	12.0 (0.7)	15
Conch Reef SPA #1*	17.8 (1.3)	28	9.0 (0.7)	15	12.5 (0.7)	18
Conch Reef SPA #2*	17.8 (1.6)	28	10.3 (0.3)	15	12.8 (1.1)	16
NW of Conch Reef SPA #1	9.8 (1.1)	18	6.0 (0.4)	10	6.8 (0.9)	13
NW of Conch Reef SPA #2	12.5 (1.0)	24	9.5 (0.7)	16	11.5 (1.0)	15
Little Pickles Reef	19.0 (1.8)	30	9.0 (0.4)	14	11.5 (0.5)	17
SW of Molasses Reef	13.0 (1.5)	20	8.5 (1.2)	13	6.8 (0.6)	12
NE of French Reef #1	20.8 (0.8)	33	9.3 (0.3)	12	8.5 (0.9)	13
NE of French Reef #2	16.5 (1.7)	27	13.0 (1.1)	18	8.3 (1.6)	15
NE of French Reef #3	17.8 (1.9)	33	9.8 (0.8)	15	9.8 (0.5)	17
Dixie Shoal #1	19.0 (1.1)	28	11.0 (0.7)	16	15.3 (0.5)	19
Dixie Shoal #2	18.8 (1.3)	29	8.5 (0.7)	13	13.3 (2.1)	21
North of Carysfort Reef #1	15.5 (1.2)	26	10.5 (1.3)	19	12.0 (1.1)	19
North of Carysfort Reef #2	15.5 (1.4)	27	9.5 (1.3)	16	11.8 (1.1)	16

Table 7. Mean (1 SE) stony coral density (no. colonies/m²) and percentage of scleractinian colonies with signs of disease (total colonies assessed). Sites asterisked are within Sanctuary no-take zones.

Habitat type/site location	Area (m ²)	Milleporina	Scleractinia	Disease (%)
<i>Mid-channel patch reefs</i>				
South of Sunshine Key	2.8	0.6 (0.6)	27.0 (5.5)	5.8 (69)
East Washerwoman	2.0	1.9 (0.6)	14.7 (2.8)	7.7 (26)
South of Key Vaca	5.2	0.3 (0.3)	9.6 (3.9)	0.0 (45)
East of Marker 49	2.0	1.3 (1.3)	24.2 (0.8)	4.2 (48)
Turtle Shoal	3.4	0.5 (0.5)	19.6 (7.1)	0.0 (51)
East Turtle Shoal	4.0	1.4 (0.7)	10.3 (1.6)	0.0 (40)
Cheeca Rocks SPA #2*	7.2	0.0 (0.0)	5.9 (0.3)	0.0 (43)
Cheeca Rocks SPA #1*	6.0	0.4 (0.4)	4.9 (0.6)	7.1 (28)
Molasses Channel #2	8.0	1.1 (0.4)	3.5 (2.0)	0.0 (28)
Molasses Channel #1	4.4	2.7 (0.7)	6.8 (0.8)	0.0 (30)
<i>Offshore patch reefs</i>				
NW of Davis Reef	5.6	1.9 (1.9)	5.1 (0.4)	3.6 (28)
<i>Diadema</i> control #2	8.0	1.0 (0.3)	4.0 (1.0)	3.1 (32)
<i>Diadema</i> control #1	6.0	2.5 (0.5)	4.5 (1.0)	3.5 (29)
<i>Diadema</i> experimental #2	3.6	3.0 (0.5)	11.6 (0.4)	4.8 (42)
<i>Diadema</i> experimental #1	3.8	1.1 (0.2)	8.3 (0.6)	3.1 (32)
West of Molasses #1	4.0	5.3 (1.8)	6.0 (0.5)	0.0 (24)
West of Molasses #2	4.4	3.6 (2.4)	4.5 (1.5)	10.5 (19)
White Banks/Dry Rocks #2	4.0	4.0 (1.0)	7.5 (1.0)	0.0 (30)
White Banks/Dry Rocks #1	6.4	2.3 (0.5)	4.4 (1.6)	0.0 (28)
East of Mosquito Bank	6.8	2.0 (0.0)	3.9 (0.6)	4.6 (22)
South of Carysfort SPA	8.0	1.6 (0.1)	2.0 (0.5)	0.0 (16)
Carysfort SPA #1*	6.0	4.6 (0.4)	2.3 (1.3)	0.0 (16)
Carysfort SPA #2*	8.0	2.1 (0.4)	3.0 (0.3)	0.0 (24)
<i>High-relief spur and groove</i>				
Western Dry Rocks #1	2.4	0.0 (0.0)	13.3 (2.3)	5.4 (37)
Western Dry Rocks #2	8.0	0.5 (0.5)	4.9 (0.1)	0.0 (39)
Sand Key SPA #2*	4.2	0.0 (0.0)	11.2 (1.9)	3.6 (46)
Sand Key SPA #1*	10.8	1.0 (0.3)	3.7 (0.3)	0.0 (39)
Eastern Dry Rocks SPA #1*	7.6	0.8 (0.1)	7.6 (3.0)	1.9 (52)
Eastern Dry Rocks SPA #2*	10.0	0.7 (0.4)	6.1 (1.4)	1.8 (55)
Marker 32 Reef	20.0	0.7 (0.2)	1.7 (0.6)	6.1 (33)
Western Sambo ER #1*	8.8	0.7 (0.3)	6.2 (0.5)	3.6 (55)
Western Sambo ER #2*	5.6	1.8 (1.3)	9.9 (2.6)	2.0 (49)
Middle Sambo Reef #1	6.2	2.5 (0.9)	10.6 (4.4)	2.0 (49)
Middle Sambo Reef #2	5.8	1.0 (0.5)	12.1 (2.4)	0.0 (66)
Eastern Sambo RO #1*	5.6	0.3 (0.3)	14.4 (5.6)	0.0 (67)
Eastern Sambo RO #2*	6.4	0.4 (0.4)	8.8 (0.3)	3.6 (56)
No Name Reef	14.0	0.9 (0.7)	3.1 (0.6)	2.2 (46)
Pelican Shoal	14.8	0.5 (0.2)	3.0 (0.7)	0.0 (47)
East of Pelican Shoal	10.0	0.3 (0.3)	6.3 (2.3)	0.0 (53)
American Shoal	16.0	2.4 (0.9)	2.1 (0.1)	0.0 (33)
Sombrero Key SPA #1*	7.6	0.7 (0.1)	5.0 (0.3)	0.0 (38)
Sombrero Key SPA #2*	10.0	0.2 (0.2)	4.2 (0.7)	0.0 (43)
East Delta Shoal	20.0	0.5 (0.1)	1.4 (0.3)	0.0 (27)

Table 7 continued.

Habitat type/site location	Area (m ²)	Milleporina	Scleractinia	Disease (%)
Pickles Reef P1	14.0	1.7 (0.1)	2.4 (0.3)	0.0 (32)
Pickles Reef P3	18.0	1.3 (0.7)	1.4 (0.9)	0.0 (23)
Northeast Pickles Reef	8.4	4.1 (0.9)	1.1 (0.3)	0.0 (9)
Molasses Reef SPA #1*	9.6	2.8 (1.1)	2.2 (0.6)	0.0 (20)
Molasses Reef SPA #2*	6.4	2.6 (0.2)	3.7 (0.4)	4.4 (23)
Sand Island	18.0	1.7 (0.1)	1.0 (0.5)	5.9 (17)
Elbow Reef SPA #2*	20.0	1.9 (1.0)	1.4 (0.1)	0.0 (27)
Elbow Reef SPA #1*	12.0	1.6 (0.1)	2.3 (0.3)	7.4 (27)
South of S. Carysfort #1	16.1	1.4 (0.3)	1.6 (0.6)	7.1 (28)
South of S. Carysfort #2	8.4	1.1 (1.1)	3.7 (2.2)	0.0 (23)
South Carysfort SPA #2*	5.2	3.2 (2.3)	6.2 (0.8)	3.2 (31)
South Carysfort SPA #1*	6.0	1.5 (1.0)	5.6 (0.9)	0.0 (32)
Carysfort SPA #2*	6.6	2.0 (0.5)	3.7 (0.3)	0.0 (25)
Carysfort SPA #1*	8.0	2.6 (0.9)	2.1 (0.4)	0.0 (15)
<i>Low-relief hard-bottom</i>				
Marker 26	20.0	0.8 (0.0)	0.9 (0.4)	11.8 (17)
West Maryland Shoal #1	20.0	0.4 (0.2)	0.9 (0.3)	5.9 (17)
West Maryland Shoal #2	18.4	1.1 (0.2)	1.7 (0.1)	0.0 (31)
East Maryland Shoal #1	11.6	2.4 (0.5)	2.9 (1.1)	0.0 (28)
East Maryland Shoal #2	14.8	1.6 (0.1)	1.3 (0.3)	0.0 (21)
East of Looe Key	12.0	1.9 (0.8)	2.4 (0.1)	3.5 (29)
West of Big Pine Shoal	15.6	1.3 (0.1)	1.5 (0.3)	0.0 (22)
Western Delta Shoal	14.0	1.7 (1.4)	3.2 (0.2)	0.0 (45)
Central Delta Shoal	12.0	1.2 (0.8)	3.0 (1.7)	0.0 (36)
Crocker Reef #2	20.0	3.3 (0.6)	0.8 (0.3)	0.0 (16)
Crocker Reef #1	20.0	1.6 (0.2)	0.3 (0.2)	0.0 (6)
Davis Reef DL1 SPA*	20.0	0.8 (0.1)	1.1 (0.1)	0.0 (21)
Davis Reef DL3 SPA*	20.0	1.7 (0.3)	0.9 (0.1)	0.0 (17)
Little Conch Reef #2	14.0	3.3 (0.1)	2.2 (0.9)	4.0 (25)
Little Conch Reef #1	15.6	2.1 (0.2)	2.4 (0.3)	0.0 (38)
SW of Conch Reef SPA	20.0	1.2 (0.1)	1.1 (0.4)	9.1 (22)
Conch Reef SPA #1*	20.0	1.3 (0.1)	1.0 (0.2)	0.0 (19)
Conch Reef SPA #2*	20.0	0.8 (0.1)	0.9 (0.3)	0.0 (17)
NW of Conch Reef SPA #1	20.0	0.9 (0.1)	0.3 (0.0)	0.0 (6)
NW of Conch Reef SPA #2	10.4	2.0 (0.5)	1.8 (0.3)	0.0 (19)
Little Pickles Reef	14.4	1.1 (0.4)	3.0 (1.4)	5.7 (35)
SW of Molasses Reef	20.0	0.8 (0.2)	1.1 (0.2)	0.0 (22)
NE of French Reef #1	14.0	2.6 (1.2)	2.4 (1.4)	0.0 (25)
NE of French Reef #2	20.0	1.0 (0.2)	1.2 (0.3)	0.0 (23)
NE of French Reef #3	20.0	1.1 (0.2)	1.8 (0.2)	2.8 (36)
Dixie Shoal #1	20.0	2.3 (0.3)	0.9 (0.1)	0.0 (17)
Dixie Shoal #2	20.0	1.6 (0.2)	0.4 (0.2)	0.0 (8)
North of Carysfort Reef #1	15.2	1.7 (0.3)	2.5 (0.3)	0.0 (36)
North of Carysfort Reef #2	20.0	1.3 (0.3)	1.5 (0.1)	0.0 (29)

Table 8. Mean (1 SE) densities (no. colonies with continuous live tissue/100 m²) of elkhorn coral (*Acropora palmata*) and staghorn coral (*A. cervicornis*), based upon surveys of four 100 m² plots on fore reef sites and four 40 m² plots on patch reefs. Sites asterisked are within Sanctuary no-take zones.

Site location	Area (m ²)	<i>Acropora palmata</i>		<i>Acropora cervicornis</i>	
		No. colonies	Density	No. colonies	Density
<i>Mid-channel patch reefs</i>					
South of Sunshine Key	160			2	1.25 (1.23)
East Washerwoman	160				
South of Key Vaca	160				
East of Marker 49	160			1	0.63 (0.56)
Turtle Shoal	160				
East Turtle Shoal	160				
Cheeca Rocks SPA #2*	160				
Cheeca Rocks SPA #1*	160				
Molasses Channel #2	160			18	11.25 (9.39)
Molasses Channel #1	160			11	6.88 (3.60)
<i>Offshore patch reefs</i>					
NW of Davis Reef	160				
<i>Diadema</i> control #2	160				
<i>Diadema</i> control #1	160				
<i>Diadema</i> experimental #2	160				
<i>Diadema</i> experimental #1	160				
West of Molasses #1	160			1	0.63 (0.56)
West of Molasses #2	160			16	10.00 (4.59)
White Banks/Dry Rocks #2	160				
White Banks/Dry Rocks #1	160				
East of Mosquito Bank	160				
South of Carysfort SPA	160				
Carysfort SPA #1*	160				
Carysfort SPA #2*	160				
<i>High-relief spur and groove</i>					
Western Dry Rocks #1	400	4	1.00 (1.00)		
Western Dry Rocks #2	400	1	0.25 (0.25)		
Sand Key SPA #2*	400	89	22.3 (11.0)		
Sand Key SPA #1*	400				
Eastern Dry Rocks SPA #1*	400	2	0.50 (0.50)		
Eastern Dry Rocks SPA #2*	400			11	2.75 (2.75)
Marker 32 Reef	400				
Western Sambo ER #1*	400	28	7.00 (7.00)	12	3.00 (1.29)
Western Sambo ER #2*	400			6	1.50 (0.96)
Middle Sambo Reef #1	400			2	0.50 (0.50)
Middle Sambo Reef #2	400				
Eastern Sambo RO #1*	400	1	0.25 (0.25)		
Eastern Sambo RO #2*	400				
No Name Reef	400			1	0.25 (0.25)
Pelican Shoal	400				
East of Pelican Shoal	400				
American Shoal	400			5	1.25 (0.48)
Sombrero Key SPA #1*	400				
Sombrero Key SPA #2*	400	12	3.00 (1.78)	1	0.25 (0.25)

Table 8 continued.

Site location	Area (m ²)	<i>Acropora palmata</i>		<i>Acropora cervicornis</i>	
		No. colonies	Density	No. colonies	Density
East Delta Shoal	400			5	1.25 (1.25)
Pickles Reef P1	400	1	0.25 (0.25)		
Pickles Reef P3	400				
Northeast Pickles Reef	400				
Molasses Reef SPA #1*	400	2	0.50 (0.29)		
Molasses Reef SPA #2*	400				
Sand Island	400	47	11.75 (8.25)		
Elbow Reef SPA #2*	400				
Elbow Reef SPA #1*	400	97	24.3 (16.9)		
South of S. Carysfort #1	400				
South of S. Carysfort #2	400				
South Carysfort SPA #2*	400				
South Carysfort SPA #1*	400	12	3.00 (1.08)		
Carysfort SPA #2*	400			4	1.00 (1.00)
Carysfort SPA #1*	400	2	0.50 (0.50)		
<i>Low-relief hard-bottom</i>					
Marker 26	400			6	1.50 (1.50)
West Maryland Shoal #1	400			3	0.75 (0.75)
West Maryland Shoal #2	400			7	1.75 (0.48)
East Maryland Shoal #1	400			17	4.25 (1.25)
East Maryland Shoal #2	400			4	1.00 (0.71)
East of Looe Key	400				
West of Big Pine Shoal	400				
Western Delta Shoal	400				
Central Delta Shoal	400			2	0.50 (0.50)
Crocker Reef #2	400				
Crocker Reef #1	400				
Davis Reef DL1 SPA*	400	1	0.25 (0.25)		
Davis Reef DL3 SPA*	400				
Little Conch Reef #2	400			10	2.50 (0.87)
Little Conch Reef #1	400			1	0.25 (0.25)
SW of Conch Reef SPA	400				
Conch Reef SPA #1*	400				
Conch Reef SPA #2*	400				
NW of Conch Reef SPA #1	400				
NW of Conch Reef SPA #2	400	17	4.25 (4.25)		
Little Pickles Reef	400				
SW of Molasses Reef	400				
NE of French Reef #1	400				
NE of French Reef #2	400				
NE of French Reef #3	400				
Dixie Shoal #1	400				
Dixie Shoal #2	400				
North of Carysfort Reef #1	400				
North of Carysfort Reef #2	400				

Table 9. Numbers of species and mean (1 SE) densities (no. per m²) of juvenile stony corals (< 4 cm maximum diameter). Sites asterisked are within Sanctuary no-take zones.

Site location	No. species	Mean density	Dominant recruiters	
			Species 1	Species 2
<i>Mid-channel patch reefs</i>				
South of Sunshine Key	6	7.05 (2.88)	<i>Siderastrea siderea</i>	<i>Steph. michelini</i>
East Washerwoman	10	10.42 (1.76)	<i>S. radians</i>	<i>S. siderea</i>
South of Key Vaca	6	1.92 (0.32)	<i>S. radians</i>	<i>S. siderea</i>
East of Marker 49	7	4.65 (1.44)	<i>S. radians</i>	<i>S. michelini</i>
Turtle Shoal	7	2.88 (0.32)	<i>S. siderea</i>	<i>Porites astreoides</i>
East Turtle Shoal	6	3.85 (0.00)	<i>S. radians</i>	<i>P. astreoides</i>
Cheeca Rocks SPA #2*	3	0.64 (0.00)	<i>P. astreoides</i>	<i>F. fragum</i>
Cheeca Rocks SPA #1*	3	1.12 (0.80)	<i>S. radians</i>	<i>Favia fragum</i>
Molasses Channel #2	4	2.72 (0.48)	<i>P. astreoides</i>	<i>S. radians</i>
Molasses Channel #1	5	2.88 (0.96)	<i>Agaricia agaricites</i>	<i>P. astreoides</i>
<i>Offshore patch reefs</i>				
NW of Davis Reef	7	4.17 (0.64)	<i>S. radians</i>	<i>P. astreoides</i>
<i>Diadema</i> control #2	7	7.21 (0.80)	<i>P. astreoides</i>	<i>A. agaricites</i>
<i>Diadema</i> control #1	7	5.93 (0.16)	<i>S. radians</i>	<i>P. astreoides</i>
<i>Diadema</i> experimental #2	5	5.77 (0.64)	<i>S. radians</i>	<i>P. astreoides</i>
<i>Diadema</i> experimental #1	6	6.57 (0.80)	<i>S. radians</i>	<i>P. astreoides</i>
West of Molasses #1	7	4.65 (0.48)	<i>S. sidereal</i>	<i>P. astreoides</i>
West of Molasses #2	8	5.93 (2.72)	<i>S. radians</i>	<i>A. agaricites</i>
White Banks/Dry Rocks #2	5	6.09 (1.92)	<i>S. radians</i>	<i>A. agaricites</i>
White Banks/Dry Rocks #1	5	0.80 (0.16)		
East of Mosquito Bank	4	2.72 (0.48)	<i>P. astreoides</i>	<i>A. agaricites</i>
South of Carysfort SPA	4	1.28 (0.32)	<i>P. furcata</i>	<i>F. fragum</i>
Carysfort SPA #1*	4	2.56 (0.64)	<i>S. radians</i>	<i>P. astreoides</i>
Carysfort SPA #2*	5	4.49 (0.96)	<i>S. radians</i>	<i>P. astreoides</i>
<i>High-relief spur and groove</i>				
Western Dry Rocks #1	4	10.58 (0.64)	<i>A. agaricites</i>	<i>P. astreoides</i>
Western Dry Rocks #2	4	6.09 (0.00)	<i>A. agaricites</i>	<i>P. astreoides</i>
Sand Key SPA #2*	3	8.17 (1.76)	<i>A. agaricites</i>	<i>F. fragum</i>
Sand Key SPA #1*	5	5.93 (2.21)	<i>F. fragum</i>	<i>P. astreoides</i>
Eastern Dry Rocks SPA #1*	3	5.45 (1.28)	<i>P. astreoides</i>	<i>A. agaricites</i>
Eastern Dry Rocks SPA #2*	3	7.21 (0.80)	<i>A. agaricites</i>	<i>P. astreoides</i>
Marker 32 Reef	4	2.24 (1.60)	<i>F. fragum</i>	<i>A. agaricites</i>
Western Sambo ER #1*	4	7.05 (2.26)	<i>A. agaricites</i>	<i>F. fragum</i>
Western Sambo ER #2*	6	7.37 (3.85)	<i>P. astreoides</i>	<i>A. agaricites</i>
Middle Sambo Reef #1	4	3.21 (0.00)	<i>A. agaricites</i>	<i>P. astreoides</i>
Middle Sambo Reef #2	4	8.01 (1.92)	<i>P. astreoides</i>	<i>A. agaricites</i>
Eastern Sambo RO #1*	4	1.92 (0.32)	<i>A. agaricites</i>	<i>P. astreoides</i>
Eastern Sambo RO #2*	2	2.88 (1.39)	<i>A. agaricites</i>	<i>P. astreoides</i>
No Name Reef	5	3.37 (0.48)	<i>F. fragum</i>	<i>A. agaricites</i>
Pelican Shoal	4	4.17 (0.64)	<i>A. agaricites</i>	<i>P. astreoides</i>
East of Pelican Shoal	6	3.69 (1.79)	<i>P. astreoides</i>	<i>A. agaricites</i>
American Shoal	4	2.24 (0.92)	<i>P. astreoides</i>	<i>F. fragum</i>
Sombrero Key SPA #1*	5	3.85 (0.64)	<i>A. agaricites</i>	<i>P. astreoides</i>
Sombrero Key SPA #2*	4	2.72 (1.44)	<i>P. astreoides</i>	<i>A. agaricites</i>
East Delta Shoal	5	1.76 (0.48)	<i>F. fragum</i>	<i>P. astreoides</i>

Table 9 continued.

Site location	No. species	Mean density	Dominant recruiters	
			Species 1	Species 2
Pickles Reef P1	6	2.08 (0.16)	<i>A. agaricites</i>	<i>S. radians</i>
Pickles Reef P3	1	0.80 (0.48)	<i>A. agaricites</i>	
Northeast Pickles Reef	3	0.80 (0.48)	<i>A. agaricites</i>	
Molasses Reef SPA #1*	4	1.76 (0.16)	<i>A. agaricites</i>	<i>P. astreoides</i>
Molasses Reef SPA #2*	2	1.76 (1.44)	<i>P. astreoides</i>	<i>A. agaricites</i>
Sand Island	6	1.76 (0.80)	<i>A. agaricites</i>	<i>P. astreoides</i>
Elbow Reef SPA #2*	3	1.60 (0.32)	<i>A. agaricites</i>	<i>F. fragum</i>
Elbow Reef SPA #1*	5	2.24 (0.96)	<i>F. fragum</i>	<i>A. agaricites</i>
South of S. Carysfort #1	4	1.60 (0.96)	<i>A. agaricites</i>	<i>P. astreoides</i>
South of S. Carysfort #2	3	1.92 (0.00)	<i>S. radians</i>	<i>P. astreoides</i>
South Carysfort SPA #2*	5	4.01 (2.08)	<i>P. astreoides</i>	<i>A. agaricites</i>
South Carysfort SPA #1*	3	2.56 (0.32)	<i>P. astreoides</i>	<i>A. agaricites</i>
Carysfort SPA #2*	5	2.56 (1.28)	<i>A. agaricites</i>	<i>P. astreoides</i>
Carysfort SPA #1*	3	1.60 (0.64)	<i>P. astreoides</i>	<i>A. agaricites</i>
<i>Low-relief hard-bottom</i>				
Marker 26	2	0.32 (0.00)	<i>S. siderea</i>	<i>Millepora alcicornis</i>
West Maryland Shoal #1	4	0.80 (0.48)	<i>A. agaricites</i>	<i>P. astreoides</i>
West Maryland Shoal #2	3	3.21 (1.92)	<i>P. astreoides</i>	<i>A. agaricites</i>
East Maryland Shoal #1	4	2.24 (0.00)	<i>P. astreoides</i>	<i>S. siderea</i>
East Maryland Shoal #2	5	1.92 (0.32)	<i>P. astreoides</i>	<i>F. fragum</i>
East of Looe Key	7	3.85 (0.00)	<i>P. astreoides</i>	<i>A. agaricites</i>
West of Big Pine Shoal	6	2.24 (0.64)	<i>P. astreoides</i>	<i>F. fragum</i>
Western Delta Shoal	7	2.88 (0.00)	<i>S. siderea</i>	<i>S. radians</i>
Central Delta Shoal	6	5.61 (1.44)	<i>P. astreoides</i>	<i>F. fragum</i>
Crocker Reef #2	8	1.92 (0.96)	<i>Mont. cavernosa</i>	<i>P. astreoides</i>
Crocker Reef #1	9	4.17 (0.64)	<i>S. radians</i>	<i>S. siderea</i>
Davis Reef DL1 SPA*	9	3.04 (0.80)	<i>S. siderea</i>	<i>P. astreoides</i>
Davis Reef DL3 SPA*	6	1.44 (0.48)	<i>S. siderea</i>	<i>A. agaricites</i>
Little Conch Reef #2	4	3.37 (0.80)	<i>P. astreoides</i>	<i>S. radians</i>
Little Conch Reef #1	7	1.92 (0.00)	<i>P. astreoides</i>	<i>P. furcata</i>
SW of Conch Reef SPA	6	1.28 (0.32)	<i>A. agaricites</i>	
Conch Reef SPA #1*	4	1.12 (0.48)	<i>S. radians</i>	<i>S. siderea</i>
Conch Reef SPA #2*	8	1.92 (0.64)	<i>A. agaricites</i>	<i>M. cavernosa</i>
NW of Conch Reef SPA #1	1	0.16 (0.16)	<i>A. agaricites</i>	
NW of Conch Reef SPA #2	4	1.60 (0.96)	<i>P. astreoides</i>	<i>P. furcata</i>
Little Pickles Reef	6	2.24 (0.64)	<i>P. astreoides</i>	<i>S. siderea</i>
SW of Molasses Reef	6	1.76 (0.16)	<i>P. astreoides</i>	
NE of French Reef #1	2	1.12 (0.16)	<i>A. agaricites</i>	<i>P. astreoides</i>
NE of French Reef #2	3	0.64 (0.00)	<i>A. agaricites</i>	
NE of French Reef #3	6	2.08 (0.16)	<i>A. agaricites</i>	<i>P. astreoides</i>
Dixie Shoal #1	5	0.80 (0.48)		
Dixie Shoal #2	6	1.76 (1.12)	<i>M. alcicornis</i>	
North of Carysfort Reef #1	6	1.76 (1.12)	<i>A. agaricites</i>	<i>P. astreoides</i>
North of Carysfort Reef #2	7	3.21 (1.60)	<i>A. agaricites</i>	<i>P. furcata</i>

Table 10. Mean (1 SE) gorgonian density (no. colonies/m²) based upon surveys of two 10 m² plots in each site, except for patch reefs (two 4 m² plots). Sites asterisked are within Sanctuary no-take zones.

Site location	Area (m ²)	No. colonies	Mean density	Dominant species
<i>Mid-channel patch reefs</i>				
South of Sunshine Key	8	32	4.13 (1.63)	<i>P. americana</i>
East Washerwoman	8	88	11.00 (0.75)	<i>G. ventalina</i>
South of Key Vaca	8	103	12.88 (5.38)	<i>E. caribaeorum</i>
East of Marker 49	8	92	11.50 (2.00)	<i>P. americana</i>
Turtle Shoal	8	103	12.88 (4.13)	<i>G. ventalina</i>
East Turtle Shoal	8	326	40.75 (0.50)	<i>B. asbestinum</i>
Cheeca Rocks SPA #2*	8	17	2.13 (0.63)	<i>E. caribaeorum</i>
Cheeca Rocks SPA #1*	8	43	5.38 (4.13)	<i>E. caribaeorum</i>
Molasses Channel #2	8	134	16.75 (0.25)	<i>P. americana</i>
Molasses Channel #1	8	109	13.63 (0.63)	<i>P. americana</i>
<i>Offshore patch reefs</i>				
NW of Davis Reef	8	114	14.25 (3.00)	<i>P. americana</i>
<i>Diadema</i> control #1	8	57	7.13 (1.38)	<i>P. americana</i>
<i>Diadema</i> experimental #2	8	68	8.50 (0.00)	<i>P. americana</i>
<i>Diadema</i> experimental #1	8	31	3.88 (1.13)	<i>P. americana</i>
<i>Diadema</i> control #2	8	34	4.25 (0.25)	<i>P. americana</i>
West of Molasses #1	8	170	21.25 (2.25)	<i>P. americana</i>
West of Molasses #2	8	145	18.13 (6.13)	<i>P. americana</i>
White Banks/Dry Rocks #2	8	208	26.00 (7.25)	<i>P. bipinnata</i>
White Banks/Dry Rocks #1	8	204	25.50 (4.75)	<i>P. bipinnata</i>
East of Mosquito Bank	8	252	31.50 (3.25)	<i>P. bipinnata</i>
South of Carysfort SPA	8	122	15.25 (1.00)	<i>P. americana</i>
Carysfort SPA #1*	8	199	24.88 (1.38)	<i>P. americana</i>
Carysfort SPA #2*	8	265	33.13 (1.38)	<i>P. bipinnata</i>
<i>High-relief spur and groove</i>				
Western Dry Rocks #1	20	19	0.95 (0.84)	<i>E. caribaeorum</i>
Western Dry Rocks #2	20	41	2.05 (1.15)	<i>E. caribaeorum</i>
Sand Key SPA #2*	20	8	0.40 (0.20)	<i>G. ventalina</i>
Sand Key SPA #1*	20	81	4.05 (0.45)	<i>E. caribaeorum</i>
Eastern Dry Rocks SPA #1*	20	12	0.60 (0.10)	<i>G. ventalina</i>
Eastern Dry Rocks SPA #2*	20	13	0.65 (0.25)	<i>G. ventalina</i>
Marker 32 Reef	20	46	2.30 (0.30)	<i>E. caribaeorum</i>
Western Sambo ER #1*	20	18	0.90 (0.30)	<i>G. ventalina</i>
Western Sambo ER #2*	20	29	1.45 (0.15)	<i>G. ventalina</i>
Middle Sambo Reef #1	20	16	0.80 (0.10)	<i>G. ventalina</i>
Middle Sambo Reef #2	20	16	0.80 (0.20)	<i>E. caribaeorum</i>
Eastern Sambo RO #1*	20	47	2.35 (0.55)	<i>E. fusca</i>
Eastern Sambo RO #2*	20	9	0.45 (0.05)	<i>E. caribaeorum</i>
No Name Reef	20	20	1.00 (0.20)	<i>E. caribaeorum</i>
Pelican Shoal	20	15	0.75 (0.25)	<i>G. ventalina</i>
East of Pelican Shoal	20	144	7.20 (0.10)	<i>G. ventalina</i>
American Shoal	20	294	14.70 (2.30)	<i>P. americana</i>
Sombrero Key SPA #1*	20	80	4.00 (0.60)	<i>G. ventalina</i>
Sombrero Key SPA #2*	20	30	1.50 (0.40)	<i>G. ventalina</i>
East Delta Shoal	20	166	8.30 (0.90)	<i>P. americana</i>
Pickles Reef P1	20	192	9.60 (0.80)	<i>P. americana</i>

Table 10 continued.

Site location	Area (m ²)	No. colonies	Mean density	Dominant species
Pickles Reef P3	20	84	4.20 (1.40)	<i>G. ventalina</i>
Northeast Pickles Reef	20	243	12.15 (1.55)	<i>G. ventalina</i>
Molasses Reef SPA #1*	20	151	7.55 (1.05)	<i>P. bipinnata</i>
Molasses Reef SPA #2*	20	131	6.55 (0.25)	<i>G. ventalina</i>
Sand Island	20	156	7.80 (0.40)	<i>P. americana</i>
Elbow Reef SPA #2*	20	292	14.60 (6.90)	<i>P. bipinnata</i>
Elbow Reef SPA #1*	20	129	6.45 (4.15)	<i>P. americana</i>
South of S. Carysfort #1	20	246	12.30 (2.20)	<i>P. americana</i>
South of S. Carysfort #2	20	312	15.60 (0.40)	<i>P. americana</i>
South Carysfort SPA #2*	20	258	12.95 (2.25)	<i>P. bipinnata</i>
South Carysfort SPA #1*	20	45	2.25 (0.35)	<i>P. bipinnata</i>
Carysfort SPA #2*	20	208	10.40 (1.50)	<i>P. americana</i>
Carysfort SPA #1*	20	208	10.40 (1.20)	<i>P. americana</i>
<i>Low-relief hard-bottom</i>				
Marker 26	20	232	11.60 (2.10)	<i>P. americana</i>
West Maryland Shoal #1	20	70	3.50 (0.30)	<i>P. americana</i>
West Maryland Shoal #2	20	157	7.85 (0.45)	<i>P. americana</i>
East Maryland Shoal #1	20	216	10.80 (1.60)	<i>P. americana</i>
East Maryland Shoal #2	20	212	10.60 (2.10)	<i>P. americana</i>
East of Looe Key	20	211	10.55 (1.55)	<i>P. americana</i>
West of Big Pine Shoal	20	185	9.20 (1.20)	<i>P. americana</i>
Western Delta Shoal	20	165	8.25 (2.05)	<i>P. americana</i>
Central Delta Shoal	20	164	8.20 (3.40)	<i>P. americana</i>
Crocker Reef #2	20	294	14.70 (0.70)	<i>P. americana</i>
Crocker Reef #1	20	361	18.05 (0.75)	<i>P. americana</i>
Davis Reef DL1 SPA*	20	151	7.55 (1.75)	<i>P. americana</i>
Davis Reef DL3 SPA*	20	225	11.25 (0.65)	<i>P. americana</i>
Little Conch Reef #2	20	153	7.65 (0.65)	<i>P. americana</i>
Little Conch Reef #1	20	229	11.45 (1.35)	<i>P. americana</i>
SW of Conch Reef SPA	20	360	18.00 (3.00)	<i>P. americana</i>
Conch Reef SPA #1*	20	191	9.55 (0.85)	<i>P. americana</i>
Conch Reef SPA #2*	20	205	10.25 (2.75)	<i>P. americana</i>
NW of Conch Reef SPA #1	20	116	5.80 (0.20)	<i>G. ventalina</i>
NW of Conch Reef SPA #2	20	327	16.35 (0.85)	<i>E. mammosa</i>
Little Pickles Reef	20	353	17.65 (1.35)	<i>P. americana</i>
SW of Molasses Reef	20	119	5.95 (0.55)	<i>P. americana</i>
NE of French Reef #1	20	112	5.60 (2.00)	<i>P. americana</i>
NE of French Reef #2	20	89	4.45 (2.05)	<i>P. americana</i>
NE of French Reef #3	20	196	9.80 (0.70)	<i>P. americana</i>
Dixie Shoal #1	20	585	29.25 (0.45)	<i>P. americana</i>
Dixie Shoal #2	20	555	27.75 (4.65)	<i>P. americana</i>
North of Carysfort Reef #1	20	111	5.55 (4.85)	<i>P. americana</i>
North of Carysfort Reef #2	20	162	8.10 (3.08)	<i>P. americana</i>

Table 11. Mean (1 SE) densities of urchins (no. per m²) from surveys of four 20 m² plots in fore reef habitats and four 8 m² plots in patch reefs. Sites asterisked are within Sanctuary no-take zones. Species abbreviations are: Dant = *Diadema antillarum*, Eluc = *Echinometra lucunter*, Evir = *E. viridis*, Etri = *Eucidaris tribuloides*, Lvar = *Lytechinus variegatus*, and Tven = *Tripneustes ventricosus*.

Site location	<i>D. ant</i>	<i>E. luc</i>	<i>E. vir</i>	<i>E. tri</i>	<i>L. var</i>	<i>T. ven</i>
<i>Mid-channel patch reefs</i>						
South of Sunshine Key				0.03 (0.03)		
East Washerwoman						
South of Key Vaca						
East of Marker 49			0.03 (0.03)			
Turtle Shoal	0.16 (0.06)	0.03 (0.03)	0.19 (0.08)	0.06 (0.04)		
East Turtle Shoal			0.53 (0.22)			
Cheeca Rocks SPA #2*			0.03 (0.03)			
Cheeca Rocks SPA #1*						
Molasses Channel #2			0.09 (0.06)			0.03 (0.03)
Molasses Channel #1			0.09 (0.03)			
<i>Offshore patch reefs</i>						
NW of Davis Reef				0.03 (0.03)		
<i>Diadema</i> control #2	0.16 (0.08)			0.03 (0.03)		
<i>Diadema</i> control #1				0.03 (0.03)		
<i>Diadema</i> experimental #2			0.03 (0.03)	0.03 (0.03)		
<i>Diadema</i> experimental #1			0.03 (0.03)	0.03 (0.03)		
West of Molasses #1			0.03 (0.03)	0.03 (0.03)		
West of Molasses #2	0.09 (0.03)		0.03 (0.03)	0.09 (0.03)		0.03 (0.03)
White Banks/Dry Rocks #2						
White Banks/Dry Rocks #1						
East of Mosquito Bank						
South of Carysfort SPA	0.03 (0.03)		0.03 (0.03)			
Carysfort SPA #1*				0.01 (0.01)		
Carysfort SPA #2*				0.01 (0.01)		
<i>High-relief spur and groove</i>						
Western Dry Rocks #1	0.03 (0.01)		0.01 (0.01)	0.05 (0.03)		
Western Dry Rocks #2	0.03 (0.01)	0.01 (0.01)		0.04 (0.01)		
Sand Key SPA #2*			0.01 (0.01)	0.05 (0.00)		
Sand Key SPA #1*	0.03 (0.02)			0.06 (0.04)		
Eastern Dry Rocks SPA #1*						
Eastern Dry Rocks SPA #2*	0.01 (0.01)			0.03 (0.01)		
Marker 32 Reef						
Western Sambo ER #1*				0.01 (0.01)		
Western Sambo ER #2*	0.01 (0.01)			0.01 (0.01)		
Middle Sambo Reef #1			0.01 (0.01)	0.06 (0.01)		
Middle Sambo Reef #2	0.03 (0.01)		0.01 (0.01)	0.06 (0.02)		
Eastern Sambo RO #1*				0.06 (0.05)		
Eastern Sambo RO #2*				0.03 (0.01)		
No Name Reef				0.03 (0.01)		
Pelican Shoal	0.01 (0.01)		0.03 (0.03)	0.01 (0.01)		
East of Pelican Shoal	0.01 (0.01)		0.01 (0.01)	0.09 (0.06)		
American Shoal						
Sombrero Key SPA #1*						

Table 11 continued.

Site location	<i>D. ant</i>	<i>E. luc</i>	<i>E. vir</i>	<i>E. tri</i>	<i>L. var</i>	<i>T. ven</i>
Sombrero Key SPA #2*				0.05 (0.02)		
East Delta Shoal	0.03 (0.01)			0.01 (0.01)		
Pickles Reef P1	0.04 (0.02)		0.08 (0.04)	0.23 (0.03)		
Pickles Reef P3	0.05 (0.02)	0.05 (0.04)	0.11 (0.07)	0.35 (0.05)		
Northeast Pickles Reef				0.05 (0.02)		
Molasses Reef SPA #1*				0.03 (0.03)		
Molasses Reef SPA #2*	0.01 (0.01)			0.05 (0.00)		
Sand Island						
Elbow Reef SPA #2*	0.01 (0.01)					
Elbow Reef SPA #1*			0.03 (0.01)			
South of S. Carysfort #1	0.03 (0.01)			0.03 (0.01)		
South of S. Carysfort #2						
South Carysfort SPA #2*			0.01 (0.01)			
South Carysfort SPA #1*						
Carysfort SPA #2*						
Carysfort SPA #1*						
<i>Low-relief hard-bottom</i>						
Marker 26						
West Maryland Shoal #1	0.03 (0.01)			0.01 (0.01)		
West Maryland Shoal #2	0.04 (0.02)				0.01 (0.01)	
East Maryland Shoal #1	0.01 (0.01)					
East Maryland Shoal #2						
East of Looe Key				0.03 (0.01)		
West of Big Pine Shoal				0.04 (0.01)		
Western Delta Shoal						
Central Delta Shoal				0.01 (0.01)		
Crocker Reef #2		0.01 (0.01)		0.05 (0.03)		
Crocker Reef #1	0.01 (0.01)	0.01 (0.01)				
Davis Reef DL1 SPA*	0.01 (0.01)		0.01 (0.01)	0.04 (0.01)		
Davis Reef DL3 SPA*	0.01 (0.01)		0.01 (0.01)	0.01 (0.01)		
Little Conch Reef #2			0.01 (0.01)			
Little Conch Reef #1				0.01 (0.01)		
SW of Conch Reef SPA	0.01 (0.01)			0.01 (0.01)		
Conch Reef SPA #1*				0.03 (0.03)		
Conch Reef SPA #2*			0.01 (0.01)	0.01 (0.01)		
NW of Conch Reef SPA #1		0.01 (0.01)		0.03 (0.01)		
NW of Conch Reef SPA #2	0.04 (0.02)			0.03 (0.03)		
Little Pickles Reef	0.01 (0.01)		0.01 (0.01)			
SW of Molasses Reef	0.05 (0.02)		0.03 (0.01)	0.03 (0.01)		0.01 (0.01)
NE of French Reef #1			0.01 (0.01)	0.01 (0.01)		
NE of French Reef #2	0.01 (0.01)			0.01 (0.01)		
NE of French Reef #3	0.01 (0.01)			0.01 (0.01)		
Dixie Shoal #1						
Dixie Shoal #2						
North of Carysfort Reef #1						
North of Carysfort Reef #2				0.08 (0.03)		

Table 12. Incidental marine invertebrates surveyed for density during 2001. Listed are only those species recorded within four 20 m² plots per site, except for patch reefs (four 8 m² plots).

Species	Common name	Phylum	Class	Order
Anemones				
<i>Bartholomea annulata</i>	corkscrew anemone	Cnidaria	Anthozoa	Actiniaria
<i>Condylactis gigantea</i>	pink-tipped anemone	Cnidaria	Anthozoa	Actiniaria
<i>Epicystis crucifera</i>	spotted anemone	Cnidaria	Anthozoa	Actiniaria
<i>Lebrunia danae</i>		Cnidaria	Anthozoa	Actiniaria
Corallimorpharians				
<i>Ricordea florida</i>	Florida corallimorph	Cnidaria	Anthozoa	Corallimorpharia
Annelids				
<i>Hermodice carunculata</i>	fireworm	Annelida	Polychaeta	Amphinomida
Mollusks				
<i>Cyphoma gibbosum</i>	flamingo tongue snail	Mollusca	Gastropoda	Prosobranchia
<i>Hypselodoris bayeri</i>	black-spotted sea goddess	Mollusca	Gastropoda	Nudibranchia
<i>H. edenticulata</i>	Florida regal sea goddess	Mollusca	Gastropoda	Nudibranchia
<i>Tridachia crispata</i>	lettuce slug	Mollusca	Gastropoda	Sacoglossa
Crustaceans				
<i>Periclemenes pedersoni</i>	Pederson's cleaner shrimp	Arthropoda	Crustacea	Decapoda
<i>Stenopus hispidus</i>	banded cleaner shrimp	Arthropoda	Crustacea	Decapoda
<i>Stenorhyncus seticornis</i>	arrow crab	Arthropoda	Crustacea	Decapoda
Echinoderms				
<i>Astrophyton muricatum</i>	basket star	Echinodermata	Ophiuroidea	Euryalae

Table 13. Mean (1 SE) density (frequency per 100 m²) and total length (m) of fishing gear and other marine debris, based upon surveys of four 100 m² plots in all sites, except patch reefs (four 40 m² plots). Sites asterisked are within Sanctuary no-take zones.

Site location	Hook-and-line gear		Lobster trap gear		Other debris	
	Density	Length (m)	Density	Length (m)	Density	Length (m)
<i>Mid-channel patch reefs</i>						
South of Sunshine Key	1.25 (1.25)	2.15	1.25 (0.72)	9.10		
East Washerwoman			0.63 (0.63)	27.0		
South of Key Vaca						
East of Marker 49	0.63 (0.63)	2.18	1.25 (0.72)	31.72		
Turtle Shoal			1.25 (1.25)	17.31	0.63 (0.63)	
East Turtle Shoal	0.63 (0.63)	1.71	0.63 (0.63)	7.20		
Cheeca Rocks SPA #2*	1.25 (1.25)	2.05				
Cheeca Rocks SPA #1*	2.50 (1.02)	3.95				
Molasses Channel #2	1.88 (1.88)	4.73	1.25 (0.72)	9.30		
Molasses Channel #1	6.88 (1.88)	16.83				
<i>Offshore patch reefs</i>						
NW of Davis Reef	2.50 (1.02)	5.35	0.63 (0.63)	0.60		
Diadema control #2	0.63 (0.63)	3.22				
Diadema control #1						
Diadema experimental #2						
Diadema experimental #1						
West of Molasses #1	1.25 (1.25)	0.94	0.63 (0.63)	0.75	1.88 (1.20)	0.53
West of Molasses #2			1.88 (1.20)	10.76		
White Banks/Dry Rocks #2	4.38 (0.63)	7.28	0.63 (0.63)	0.79		
White Banks/Dry Rocks #1	0.63 (0.63)	2.10				
East of Mosquito Bank						
South of Carysfort SPA	0.63 (0.63)	1.96	0.63 (0.63)	0.80		
Carysfort SPA #1*			0.63 (0.63)	17.05		
Carysfort SPA #2*			0.63 (0.63)	16.85		
<i>High-relief spur and groove</i>						
Western Dry Rocks #1						
Western Dry Rocks #2	1.00 (0.41)	3.40				
Sand Key SPA #2*	1.00 (1.00)	12.34				
Sand Key SPA #1*	0.50 (0.50)	5.10	0.25 (0.25)	5.80		
E. Dry Rocks SPA #1*	2.75 (1.55)	6.68	0.50 (0.29)	5.20		
E. Dry Rocks SPA #2*	0.75 (0.25)	1.10	0.25 (0.25)	10.55		
Marker 32 Reef	2.75 (0.63)	21.95				
Western Sambo ER #1*	0.25 (0.25)	1.75				
Western Sambo ER #2*	0.25 (0.25)	0.65			0.25 (0.25)	0.35
Middle Sambo Reef #1	0.25 (0.25)	0.30				
Middle Sambo Reef #2	0.25 (0.25)	0.60				
Eastern Sambo RO #1*	0.50 (0.29)	6.04	0.50 (0.29)	1.50	0.25 (0.25)	0.30
Eastern Sambo RO #2*	0.25 (0.25)	0.85	0.25 (0.25)	0.40		
No Name Reef	1.75 (0.25)	9.35	0.50 (0.29)	34.40		
Pelican Shoal	0.25 (0.25)	0.60	0.25 (0.25)	4.83		
East of Pelican Shoal	0.75 (0.75)	2.47	0.25 (0.25)	11.30	0.25 (0.25)	0.20
American Shoal	1.75 (1.03)	12.62	0.25 (0.25)	3.90		
Sombrero Key SPA #1*	2.75 (1.55)	32.63			0.25 (0.25)	0.02
Sombrero Key SPA #2*	1.00 (0.41)	2.11				

Table 13 continued.

Site location	Hook-and-line gear		Lobster trap gear		Other debris	
	Density	Length (m)	Density	Length (m)	Density	Length (m)
East Delta Shoal	0.75 (0.48)	20.20				
Pickles Reef P1	1.75 (0.85)	7.95				
Pickles Reef P3	1.00 (0.71)	5.71				
Northeast Pickles Reef	0.75 (0.75)	4.06	0.25 (0.25)	16.21		
Molasses Reef SPA #1*	3.00 (0.71)	7.87				
Molasses Reef SPA #2*	1.75 (0.75)	3.33				
Sand Island	1.00 (0.58)	7.91				
Elbow Reef SPA #2*	0.75 (0.48)	3.28				
Elbow Reef SPA #1*	0.75 (0.25)	2.41				
South of S. Carysfort #1						
South of S. Carysfort #2			0.75 (0.75)	2.45		
South Carysfort SPA #2*	1.25 (0.75)	9.18				
South Carysfort SPA #1*	0.25 (0.25)	0.57				
Carysfort SPA #2*	1.25 (0.48)	5.59				
Carysfort SPA #1*	1.00 (0.41)	5.52				
<i>Low-relief hard-bottom</i>						
Marker 26	3.50 (1.94)	15.53	0.75 (0.48)	9.97		
West Maryland Shoal #1			0.25 (0.25)	3.60		
West Maryland Shoal #2						
East Maryland Shoal #1			0.25 (0.25)	0.25		
East Maryland Shoal #2						
East of Looe Key	0.25 (0.25)	1.42				
West of Big Pine Shoal	0.75 (0.25)	5.40	0.25 (0.25)	16.00		
Western Delta Shoal	0.75 (0.48)	8.60				
Central Delta Shoal	1.00 (0.41)	2.86				
Crocker Reef #2	1.25 (0.25)	5.01				
Crocker Reef #1	1.75 (0.85)	15.79				
Davis Reef DL1 SPA*	2.00 (0.58)	9.37				
Davis Reef DL3 SPA*	0.75 (0.48)	2.12				
Little Conch Reef #2			0.50 (0.29)	0.80		
Little Conch Reef #1			0.25 (0.25)	0.55		
SW of Conch Reef SPA	0.50 (0.50)	0.56				
Conch Reef SPA #1*	0.75 (0.75)	2.48				
Conch Reef SPA#2*	1.00 (0.41)	1.95			0.25 (0.25)	0.22
NW of Conch Reef SPA #1	2.00 (1.41)	4.11			0.25 (0.25)	
NW of Conch Reef SPA #2	0.75 (0.48)	1.38	0.25 (0.25)	0.61		
Little Pickles Reef	0.50 (0.29)	0.83				
SW of Molasses Reef						
NE of French Reef #1	1.50 (0.87)	7.94				
NE of French Reef #2	2.25 (0.85)	15.28	0.25 (0.25)	2.40	0.25 (0.25)	0.32
NE of French Reef #3	0.25 (0.25)	0.23			0.25 (0.25)	
Dixie Shoal #1	0.50 (0.50)	9.08				
Dixie Shoal #2			0.25 (0.25)	0.75		
North of Carysfort Reef #1	3.25 (1.60)	16.32				
North of Carysfort Reef #2	2.75 (1.11)	18.65	0.25 (0.25)	0.38		