

II. Study area and methods

Study area and sampling objectives

The Florida Keys are an archipelago of limestone islands stretching more than 360 km from near Miami to the Dry Tortugas and represent the only region of extensive reef development in the continental United States, with the exception of isolated banks in the Flower Gardens region of the Gulf of Mexico (Jaap 1984). The islands are part of the larger south Florida shelf, a submerged Pleistocene platform 6-35 km wide and generally < 12 m deep (Lidz et al. 2003). The primary influences on the distribution and development of Florida Keys reefs are paleotopography and fluctuating sea level (Shinn et al. 1989; Lidz et al. 2003). Bedrock throughout south Florida is Pleistocene limestone, either exposed on the seafloor or lying underneath Holocene reefs and sands (Shinn et al. 1989). From inshore to offshore of the Pleistocene islands, a nearshore rock ledge extends ~2.5 km seaward from the shoreline, and consists of hard-bottom, seagrass, and some inshore patch reefs (FMRI 1998). Further seaward is Hawk Channel, a broad trough-like depression dominated by non-coralline, non-oolitic grainstone, but also harboring several thousand patch reefs whose distribution is affected by the number and width of tidal passes connecting Florida Bay and the Atlantic Ocean (Marszalek et al. 1977). Bands of rock ridges exist further offshore along the outer shelf and on the upper slope from 30-40 m depth before tapering off into the Florida Straits. The main, semi-continuous reef tract is emergent in places, in which Holocene reefs sit atop a ridge of Pleistocene corals (~86-78 ka), forming a shelf-margin ledge (Lidz et al. 2003), with a series of outlier reefs seaward of this main reef tract at 30-40 m depth (Lidz 2006). Coral reef distribution reflects exchange processes between Florida Bay and the Atlantic Ocean (Marszalek et al. 1977; Shinn et al. 1989), which is related to the size and orientation of the Pleistocene islands, the locations of major tidal passes, and the proximity of the Florida Current to the platform margin (Pitts 1994; Smith 1994).

The 2008 sampling of coral reef benthic invertebrates and marine debris in the Florida Keys National Marine Sanctuary (FKNMS) was undertaken as a spatially intensive effort to quantify the abundance and size of selected invertebrates, as well as the abundance and impacts of marine debris. The 2008 surveys conducted during June 21 to September 21 were an outgrowth of previous efforts conducted by the authors dating back to 1999 to quantify the abundance and condition of coral reef benthos throughout the FKNMS, including the Tortugas region, and represent a subset of the total number of variables measured by the program (Miller et al. 2002). Previous surveys in the FKNMS, excluding the Tortugas region, included 80 sites sampled in 1999, 45 sites in 2000, 108 sites in 2001, 195 sites in 2005, 107 sites in the upper Keys region in 2006, and 235 sites Keyswide in 2007. Data obtained from these earlier efforts, together with existing habitat mapping information for the FKNMS, were used to guide the sampling of

benthic coral reef organisms and marine debris in 2008. The objectives of the 2008 sampling effort were to provide information on:

- Depth and physical structure (maximum vertical relief) of survey sites;
- Habitat-based presence-absence distribution patterns of *Acropora* corals within diverse hard-bottom and coral reef habitat types from 1 m to 16 m depth, including a photographic archival record of where both *Acropora* coral species were found;
- Density and size (maximum colony heights) of gorgonians, as well as gorgonian host occupation patterns of flamingo-tongue snails;
- Density and size (test diameter) of all sea urchins encountered, representing a continuing effort to monitor recovery of the historically abundant long-spined sea urchin *Diadema antillarum*;
- Density of sea anemones and corallimorpharians; and
- Density, amount (length and wet weight), and biological impacts of marine debris.

Sampling design and field methodology

The sampling design for assessing benthic coral reef invertebrates and marine debris encompassed 145 sites visited during June-September 2008. Sites were distributed from northern Key Largo near the boundary between the FKNMS and Biscayne National Park to southwest of Key West at Satan Shoal (Figure 1). The sampling design included five habitat types in three regions, as well as 22 of the 23 no-take marine reserves designated as Sanctuary Preservation Areas (SPA), Ecological Reserves (ER), and Research Only Areas (RO) in the FKNMS, not including the Tortugas region (Table 1). Table 2 chronologically lists the sampling locations during June-September 2008. The original sampling plan was delayed somewhat due to Hurricanes Faye and Gustav in August and September. In contrast to the previous two years, generally windy conditions prevailed during the 2008 summer sampling.

The habitat strata selected for the 2008 sampling incorporated most of the hard-bottom and coral reef habitat types from the shoreward edge of Hawk Channel to 16 m depth along the reef tract, but did not include back reef rubble, nearshore hard-bottom, or hard-bottom/seagrass matrix habitats. Habitats sampled during 2008 were inshore and mid-channel patch reefs, offshore patch reefs along the platform margin, inner line reef tract spur and groove from Grecian Rocks northward to Turtle Reef, shallow (< 6 m) high-relief spur and groove along the platform margin, and deeper fore-reef habitats from 6 m to 16.5 m depth. Deeper fore-reef habitats encompassed continuous, low-relief hard-bottom, patchy hard-bottom and sand, and low-relief spur and groove. The list of sites organized by benthic habitat type is provided in Table 3, together with site-level data on depth and maximum vertical relief. Besides habitat type, sites

were further stratified according to regional sector and management zone. Figures 2-3 show the spatial distribution of sampling locations by habitat type for the upper, middle, and lower Florida Keys regional sectors, along with the boundaries of existing no-take marine reserves in the FKNMS. Figures 4-6 illustrate examples of each of the hard-bottom and coral reef habitats sampled during 2008.

A geographic information system (GIS) containing digital layers for benthic habitat (FMRI 1998), bathymetry, and no-take marine reserve boundaries was used to facilitate delineation of the sampling survey domain, strata, and sample units. Map resolution was such that the survey domain was divided into a grid with individual cells of size 200 m by 200 m (40,000 m²) that defined unique habitat classes (Table 1). A two-stage sampling scheme following Cochran (1977) was employed to control for spatial variation in population metrics at scales smaller than the grid cell minimum mapping unit. Grid cells containing targeted reef and hard-bottom habitats were designated as primary sample units. A second-stage sample unit was defined as a belt transect of fixed area (15-m x 1-m in dimension) within a primary sample unit. The size of an individual primary sampling unit allowed divers to swim to the location of any given second-stage sampling unit from a moored or anchored vessel.

To control for spatial variation in population abundance metrics, we divided the Florida Keys survey domain into strata based upon: 1) habitat class; 2) geographic region; and 3) management zones of the Florida Keys National Marine Sanctuary (FKNMS). 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 combination of habitat type, regional sector, and management zone. Habitats were designated using regional benthic habitat maps (FMRI 1998). The habitat classification scheme accounted for features that correlate with benthic fauna distributions, including cross-shelf position, topographic complexity, and the proportion of sand interspersed among hard-bottom structures. A geographic regional stratification variable was used to account for oceanographic and geological features in the Florida Keys that influence the distribution, community dynamics, and biotic composition of reefs (Marszalek et al. 1977; Shinn et al. 1989). Regional sectors were defined as follows: upper Florida Keys (BNP boundary south to Pickles Reef), middle Florida Keys (Conch Reef southwest to Moser Channel), and lower Florida Keys (Big Pine Shoal west to Satan Shoal). Regional sectors potentially reflect differences in oceanographic influences, geological history, and habitat distribution. FKNMS management zones (i.e. no-take marine reserves) were incorporated as a third stratification variable that delineated areas open and closed to consumptive activities. This stratification included sites inside and outside of FKNMS no-take marine reserves (SPA, ER, and RO). Within each no-take zone, two replicate sites were sampled in a given habitat type.

The power of this stratified random sampling approach is essentially two-fold. First, the habitats comprising the most area are allocated more sites than those with less area (i.e., a proportional design). Second, habitats with more variability in a particular metric are allocated more sites than those with less variability. The ultimate power of this approach is derived from the number of sites sampled rather than the effort expended per site.

The underwater surveys consisted first of locating randomly selected, pre-determined coordinates with a differential global positioning system. A Garmin® global positioning system receiver (model GPS76) was used to determine the position at each site. The original sampling list included 150 sampling locations, with an additional 150 alternate sites for the upper, middle, and lower Florida Keys regions. If the original waypoint was not the intended habitat type, the closest alternate site was sampled instead. Once on-site, a two-person benthic diver team oriented four transect tapes 15 in length, marked in 1-m increments, along the bottom. A 60 m² area (a 1-m wide belt centered on each 15-m long transect tape) was surveyed at each site for most variables, except marine debris, where a 240 m² area (a 4-m wide belt centered on each 15-m transect tape) was surveyed. Each of divers surveyed two of the four transects for: depth and maximum vertical relief; *Acropora* coral presence-absence; gorgonian numbers and sizes (maximum colony heights) by genera, as well as *Cyphoma* snail numbers, sizes, and gorgonian hosts; urchin numbers and sizes (test diameter); anemone and corallimorpharian numbers; and the type, frequency, amount, and biological impacts of marine debris. Transects were placed in a haphazard fashion, but in a way that best represented the habitat at the randomly selected site coordinates. Once transects were deployed, divers determined the minimum and maximum depth along the transect using a digital depth gauge, as well as the maximum vertical relief along each transect using a 50-cm scale bar marked in 5-cm increments. Maximum vertical relief took into consideration hard substratum, corals, and sponges, but did not include gorgonian height. Digital photographs of each site were taken to record general site features and organisms encountered.

For *Acropora* coral presence-absence, any colonies observed within the 15-m x 1-m belt transects were noted (sample size of 60 m² per site). For gorgonian densities and colony heights, all branching gorgonians identified along two 8-m x 1-m belt transects were counted and measured for maximum colony height (sample size of 16 m² per site). Gorgonians were identified to genus to minimize inconsistencies in field identification of species. In the same sampling area, any flamingo-tongue snails (*Cyphoma gibbosum* and *C. signatum*) encountered were counted, measured for shell length, and the gorgonian hosts they occupied were noted. The numbers of anemones and corallimorpharians, as well as

the numbers and sizes (test diameter) of urchins were recorded along each 15-m x 1-m belt transect, for a sample size of 60 m² per site.

Marine debris was surveyed along all four 15-m x 4-m belt transects per site, yielding a total sample area of 240 m² per site. Along each belt transect, any marine debris encountered was identified, counted, and collected. The number of organisms impacted by marine debris was also noted, considered as debris causing abrasion stress of *Millepora* and scleractinian corals, gorgonians, sponges, and the colonial zoanthid *Palythoa*. For derelict hook-and-line angling gear, measurements of total length of monofilament, wire leaders, wire, and hooks (not lead weights) were made either underwater or on-board the research vessel. For derelict trap gear, total length of trap rope was measured, not including plastic pot openings, wooden slats, and cement used to weight the traps. For each transect, all marine debris encountered was recovered from the bottom and placed into labeled mesh gear bags to determine total wet weight per transect once on-board the research vessel. A digital 50-pound scale was used (Rapala® model RSDS-50) to obtain the wet weight of marine debris collected along each transect. Debris was also categorized according to whether it was biologically fouled or not.

The 2008 sampling effort (145 sites) required 25 field days from June 21 to September 21 (Table 2). Several days were lost due to inclement weather in August and September. The June-September sampling was generally marked by windy conditions, but rather outstanding underwater visibility, especially in the middle and lower Keys. A private research vessel (R/V *Expedition II*, New World Expeditions, Key Largo, captained by Bernie Altmair) provided on-the-water diving support. The survey team consisted of personnel from the Center for Marine Science/UNCW (Mark Chiappone and Leanne Rutten) (Table 4). SCUBA tank fills and lodging were provided by the National Undersea Research Center-UNCW facility on Key Largo and local area dive shops and hotels/marinas in Marathon and Key West. The sampling effort depended upon 6 to 7 hours in the water daily by a two-person benthic team to complete an average of 6-8 sites per day. Typically 35-60 minutes per site were needed to sample all of the variables. Table 4 summarizes the diving statistics for 2008. The benthic surveys for targeted marine invertebrates and marine debris at the 145 sites required 145 two-person dives (290 dives total) comprising nearly 263 hours of underwater bottom time.

Figure 1. Sampling locations for marine debris and benthic coral reef organisms from southwest of Key West to northern Key Largo during June-September 2008.

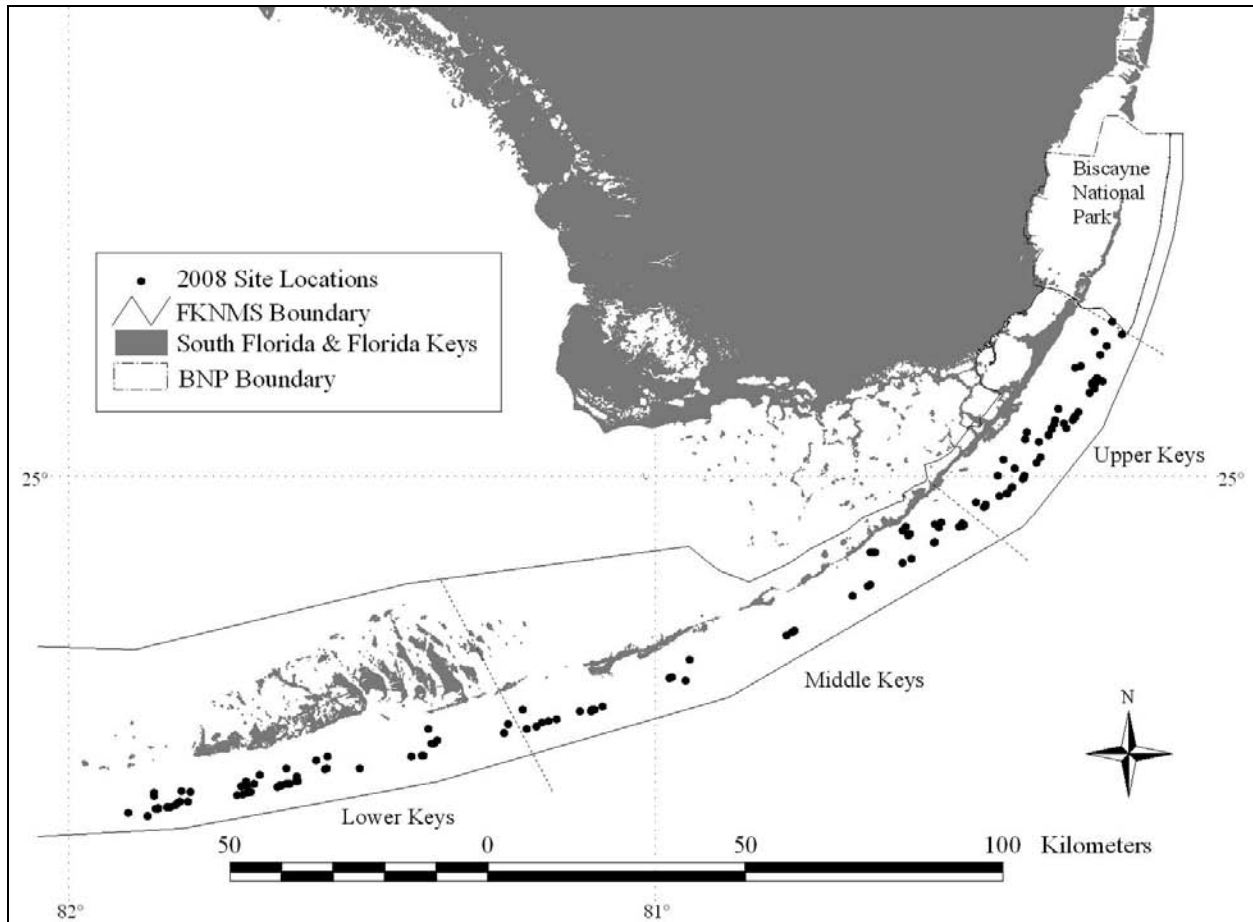


Figure 2. Sampling locations by benthic habitat type from the southern Biscayne National Park boundary to Tavernier (top) and Tavernier to Bahia Honda (bottom) in the Florida Keys during 2008.

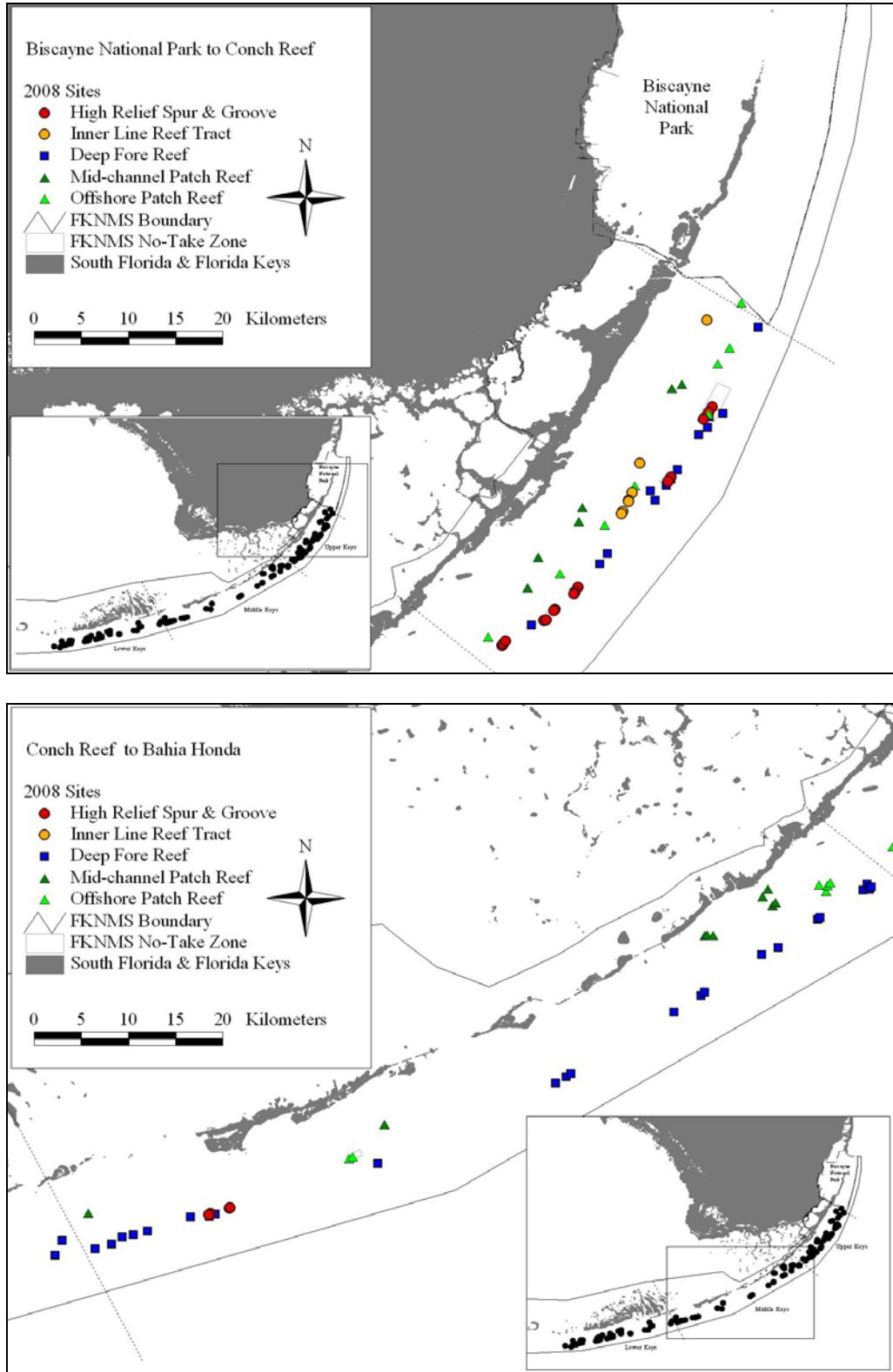


Figure 3. Sampling locations by benthic habitat type from Bahia Honda to Satan Shoal in the Florida Keys during 2008.

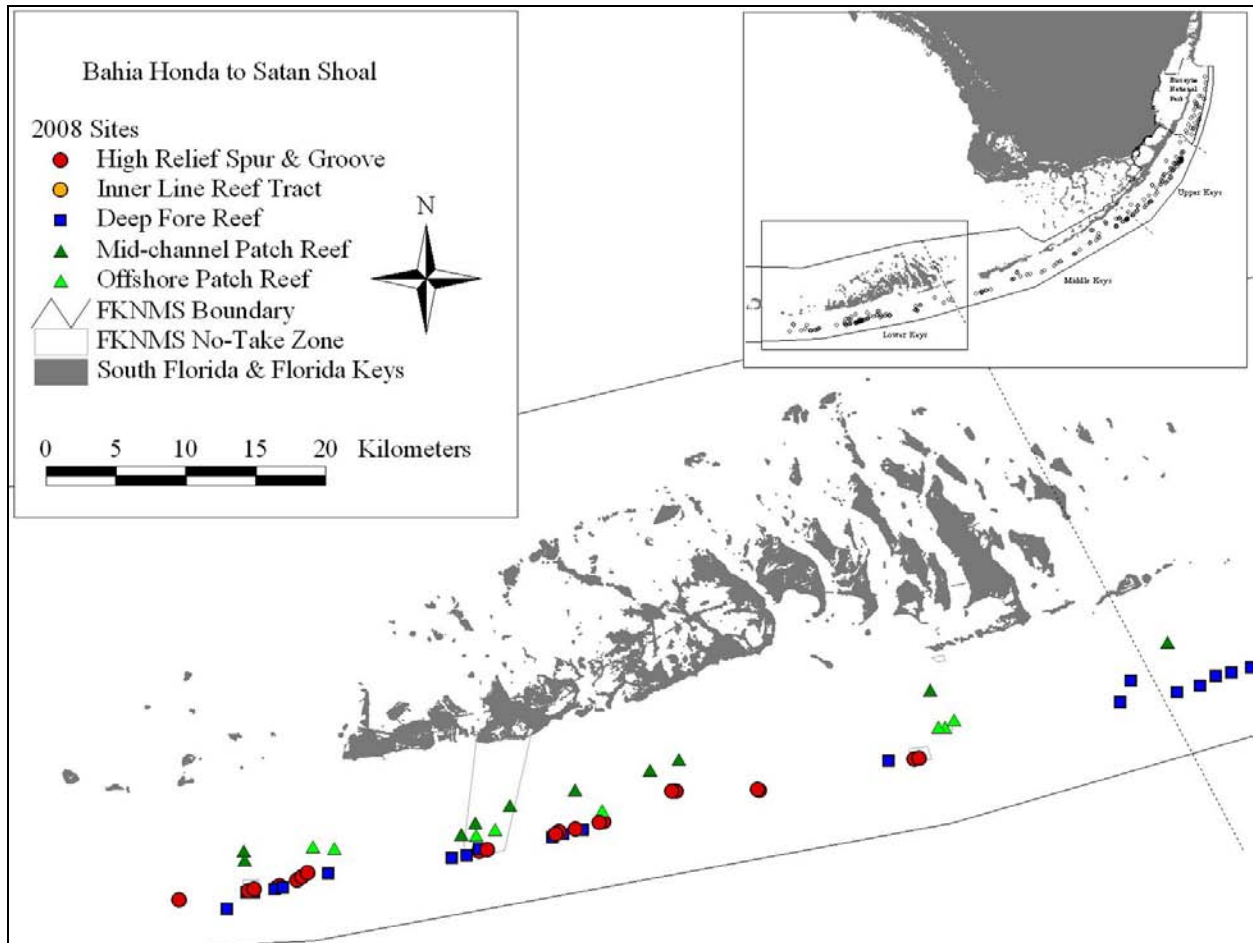


Figure 4. Examples of mid-channel and offshore patch reefs sampled in the Florida Keys during 2008.

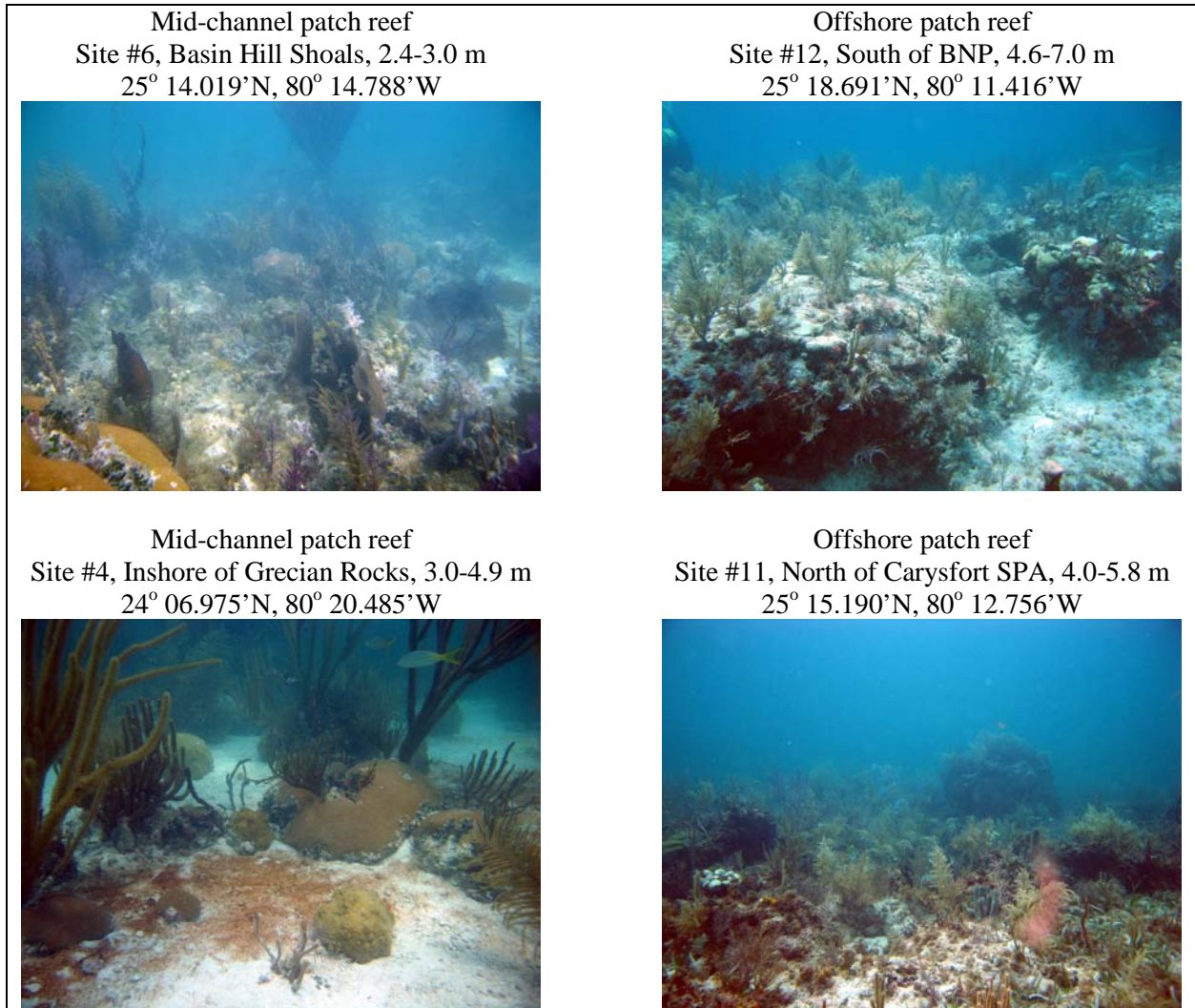


Figure 5. Examples of inner line reef tract and high-relief spur and groove reefs sampled in the Florida Keys during 2008.

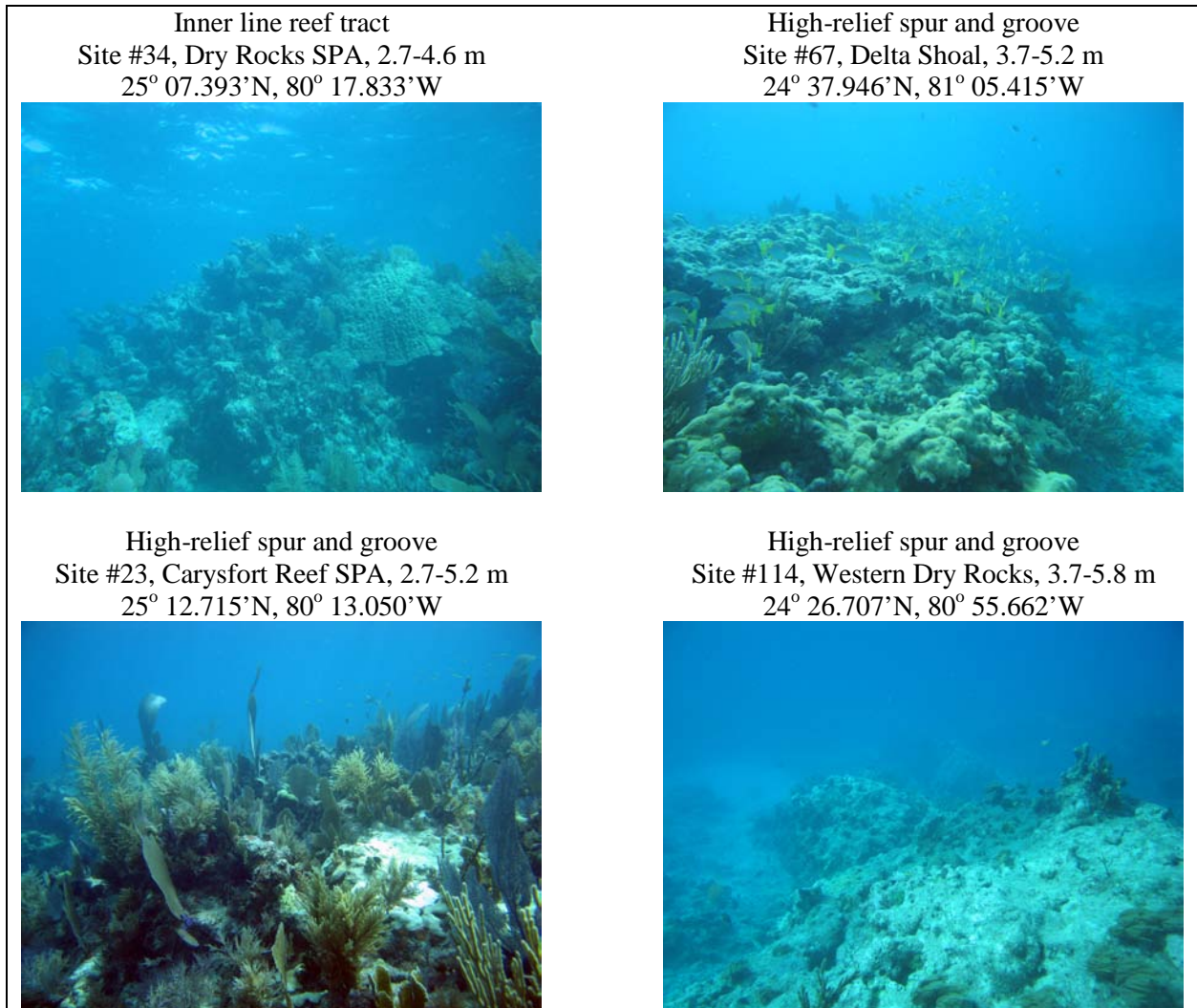


Figure 6. Examples of deeper (6-15 m) fore-reef habitats sampled in the Florida Keys during 2008.

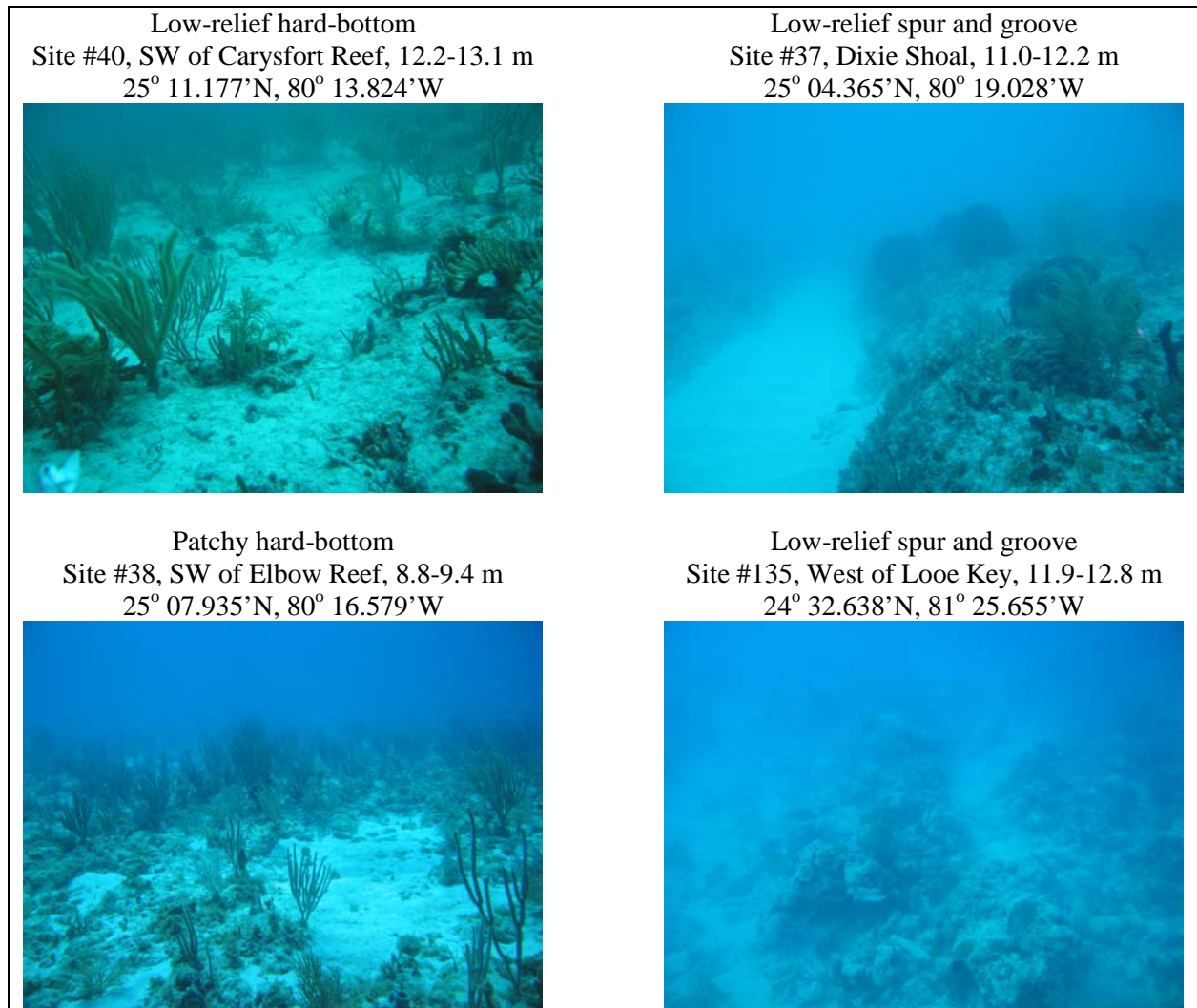


Table 1. Survey effort for marine debris and benthic coral reef organisms in the Florida Keys National Marine Sanctuary during June-September 2008. Sites are arranged by habitat type, regional sector, and management zone. Available sites (n_{tot}) reflect the number of 200 m x 200 m sites based upon FMRI (1998) habitat mapping data. Asterisked sites (***) are Sanctuary Preservation Areas (SPA), Ecological Reserves (ER), or Research Only Areas (RO). n_{tot} (%) = proportion of sites available in a particular stratum relative to the total number of sites in the sampling domain.

Habitat type/region/protection	Sites sampled (n)	% of Effort	Sites available (n_{tot})	n_{tot} (%)	n/n_{tot} (%)
Mid-channel patch reef (MPR)					
Upper Florida Keys					
Reference sites	6	4.14	787	10.45	0.76
Middle Florida Keys					
Reference sites	5	3.45	326	4.33	1.53
Hen and Chickens SPA**	2	1.38	10	0.13	20.00
Cheeca Rocks SPA**	2	1.38	11	0.15	18.18
Lower Florida Keys					
Reference sites	7	4.83	1,025	13.61	0.68
Western Sambo ER**	2	1.38	35	0.46	5.71
MPR Habitat Total	24	16.55	2,194	29.14	1.09
Offshore patch reef (OPR)					
Upper Florida Keys					
Reference sites	7	4.83	719	9.55	0.97
Carysfort/S. Carysfort SPA**	2	1.38	7	0.09	28.57
Middle Florida Keys					
Reference sites	4	2.76	55	0.73	7.27
Coffins Patch SPA**	2	1.38	5	0.07	40.00
Lower Florida Keys					
Reference sites	4	2.76	125	1.66	3.20
Looe Key RO**	2	1.38	13	0.17	15.38
Western Sambo ER**	2	1.38	55	0.73	3.64
OPR Habitat Total	23	15.86	979	13.00	2.35
Inner line spur and groove (IRT)					
Upper Florida Keys					
Reference sites	3	2.07	68	0.90	4.41
Dry Rocks SPA**	2	1.38	5	0.07	40.00
Grecian Rocks SPA**	2	1.38	14	0.19	14.29
IRT Habitat Total	7	4.83	87	1.12	8.05
High-relief spur and groove (HSG)					
Upper Florida Keys					
Reference sites	7	4.83	32	0.42	21.88
Carysfort/S. Carysfort SPA**	2	1.38	34	0.45	5.88
Elbow Reef SPA**	2	1.38	15	0.20	13.33
French Reef SPA**	2	1.38	12	0.16	16.67
Molasses Reef SPA**	2	1.38	18	0.24	11.11
Middle Florida Keys					
Reference sites	2	1.38	2	0.03	100.00
Sombrero Reef SPA**	2	1.38	7	0.09	28.57
Lower Florida Keys					
Reference	9	6.21	42	0.56	21.43
Looe Key SPA**	2	1.38	15	0.20	13.33
Eastern Sambo RO**	2	1.38	6	0.08	33.33
Western Sambo ER**	2	1.38	14	0.19	14.29
Eastern Dry Rocks SPA**	2	1.38	4	0.05	50.00
Rock Key SPA**	2	1.38	6	0.08	33.33
Sand Key SPA**	2	1.38	3	0.04	66.67
HSG Habitat Total	40	27.59	210	2.79	19.05

Habitat type/region/protection	Sites sampled (n)	% of Effort	Sites available (n_{tot})	n_{tot} (%)	n/n_{tot} (%)
Fore-reef (6-15 m)					
Upper Florida Keys					
Reference sites	9	6.21	1,036	13.76	0.87
Carysfort/S. Carysfort SPA**	2	1.38	93	1.24	2.15
Elbow Reef SPA**	2	1.38	13	0.17	15.38
Middle Florida Keys					
Reference sites	10	6.90	1,669	22.16	0.60
Conch Reef SPA**	2	1.38	14	0.19	14.29
Conch Reef RO**	2	1.38	6	0.08	33.33
Davis Reef SPA**	2	1.38	10	0.13	20.00
Alligator Reef SPA**	2	1.38	6	0.08	33.33
Tennessee Reef RO**	2	1.38	16	0.21	12.50
Sombrero Reef SPA**	2	1.38	8	0.11	25.00
Lower Florida Keys					
Reference sites	8	5.52	1,150	15.27	0.70
Eastern Sambo RO**	2	1.38	7	0.09	28.57
Western Sambo ER**	2	1.38	28	0.37	7.14
Rock Key SPA**	2	1.38	2	0.03	100.00
Sand Key SPA**	2	1.38	2	0.03	100.00
Fore-reef (6-15 m) Total	51	35.17	4,060	53.92	1.26
Sampling Design Total	145	100.00	7,530	100.00	100.00

Table 2. Chronological list of site locations for marine debris and benthic coral reef organism surveys in the Florida Keys National Marine Sanctuary during June-September 2008. Asterisked sites (**) are Sanctuary Preservation Areas (SPA), Ecological Reserves (ER), or Research Only Areas (RO).

Site #	Date	Site location	Latitude (N)	Longitude (W)	Habitat type
42	6/21/2008	South of BNP Boundary	25°17.304'	80°10.439'	Patchy hard-bottom (6-15 m)
12	6/21/2008	South of BNP Boundary	25°18.691'	80°11.416'	Offshore patch reef
32	6/21/2008	Turtle Rocks	25°17.686'	80°13.342'	Inner line reef tract
41	6/21/2008	North of Carysfort Reef SPA	25°16.119'	80°12.083'	Offshore patch reef
11	6/21/2008	North of Carysfort Reef SPA	25°15.190'	80°12.756'	Offshore patch reef
5	6/22/2008	Basin Hill Shoals	25°13.795'	80°15.376'	Mid-channel patch reef
6	6/22/2008	Basin Hill Shoals	25°14.019'	80°14.788'	Mid-channel patch reef
52	6/22/2008	Carysfort Reef SPA**	25°12.384'	80°12.488'	Low-relief spur and groove (6-15 m)
51	6/22/2008	Carysfort Reef SPA**	25°12.174'	80°13.222'	Low-relief spur and groove (6-15 m)
23	6/22/2008	Carysfort Reef SPA**	25°12.715'	80°13.050'	High-relief spur and groove (< 6 m)
22	6/22/2008	Carysfort Reef SPA**	25°12.415'	80°13.242'	High-relief spur and groove (< 6 m)
50	6/23/2008	SW of Carysfort Reef SPA	25°11.579'	80°13.323'	Low-relief spur and groove (6-15 m)
14	6/23/2008	Carysfort Reef SPA**	25°12.326'	80°13.302'	Offshore patch reef
13	6/23/2008	Carysfort Reef SPA**	25°12.189'	80°13.624'	Offshore patch reef
21	6/23/2008	Maitland Grounding Site	25°12.024'	80°13.569'	High-relief spur and groove (< 6 m)
40	6/23/2008	SW of Carysfort Reef SPA	25°11.177'	80°13.824'	Low-relief hard-bottom (6-15 m)
31	6/23/2008	Inshore of Elbow Reef SPA	25°09.483'	80°17.184'	Inner line reef tract
39	6/24/2008	North of Elbow Reef SPA	25°09.158'	80°15.051'	Patchy hard-bottom (6-15 m)
46	6/24/2008	Elbow Reef SPA**	25°08.252'	80°15.672'	Reef-sand-rubble matrix (6-15 m)
245	6/24/2008	Elbow Reef SPA**	25°08.630'	80°15.418'	Reef-sand-rubble matrix (6-15 m)
24	6/24/2008	Elbow Reef SPA**	25°08.729'	80°15.391'	High-relief spur and groove (< 6 m)
223	6/24/2008	Elbow Reef SPA**	25°08.450'	80°15.560'	High-relief spur and groove (< 6 m)
38	6/24/2008	SW of Elbow Reef SPA	25°07.935'	80°16.579'	Patchy hard-bottom (6-15 m)
49	6/25/2008	South of Elbow Reef SPA	25°07.419'	80°16.298'	Low-relief spur and groove (6-15 m)
10	6/25/2008	North of Dry Rocks SPA	25°08.227'	80°17.488'	Offshore patch reef
30	6/25/2008	North Dry Rocks	25°07.825'	80°17.625'	Inner line reef tract
9	6/25/2008	SW of Grecian Rocks SPA	25°05.962'	80°19.208'	Offshore patch reef
4	6/25/2008	Inshore of Grecian Rocks	25°06.975'	80°20.485'	Mid-channel patch reef
114	7/19/2008	Western Dry Rocks	24°26.707'	81°55.662'	High-relief spur and groove (< 6 m)
142	7/19/2008	SW of Sand Key SPA	24°26.364'	81°53.633'	Low-relief hard-bottom (6-15 m)
150	7/19/2008	Sand Key SPA**	24°27.052'	81°52.799'	Low-relief spur and groove (6-15 m)
347	7/19/2008	Sand Key SPA**	24°27.053'	81°52.491'	Low-relief spur and groove (6-15 m)
328	7/19/2008	Sand Key SPA**	24°27.117'	81°52.729'	High-relief spur and groove (< 6 m)
131	7/19/2008	Sand Key SPA**	24°27.173'	81°52.501'	High-relief spur and groove (< 6 m)
98	7/20/2008	Middle Ground	24°28.801'	81°52.949'	Mid-channel patch reef
97	7/20/2008	Middle Ground	24°28.427'	81°52.897'	Mid-channel patch reef
130	7/20/2008	Rock Key SPA**	24°27.258'	81°51.505'	High-relief spur and groove (< 6 m)
327	7/20/2008	Rock Key SPA**	24°27.296'	81°51.400'	High-relief spur and groove (< 6 m)
149	7/21/2008	Rock Key SPA**	24°27.224'	81°51.604'	Low-relief spur and groove (6-15 m)
346	7/21/2008	Rock Key SPA**	24°27.295'	81°51.253'	Low-relief spur and groove (6-15 m)
128	7/21/2008	Eastern Dry Rocks SPA**	24°27.560'	81°50.657'	High-relief spur and groove (< 6 m)
129	7/21/2008	Eastern Dry Rocks SPA**	24°27.707'	81°50.461'	High-relief spur and groove (< 6 m)
115	7/21/2008	East of E. Dry Rocks SPA	24°27.879'	81°50.217'	High-relief spur and groove (< 6 m)
132	7/21/2008	East of E. Dry Rocks SPA	24°27.854'	81°49.334'	Low-relief spur and groove (6-15 m)
106	7/22/2008	NE of E. Dry Rocks SPA	24°28.975'	81°49.999'	Offshore patch reef
133	7/22/2008	NE of E. Dry Rocks SPA	24°28.915'	81°49.112'	Offshore patch reef
143	7/22/2008	West of Western Sambo ER	24°28.547'	81°44.116'	Low-relief spur and groove (6-15 m)
140	7/22/2008	Western Sambo ER**	24°28.649'	81°43.502'	Low-relief spur and groove (6-15 m)
126	7/22/2008	Western Sambo ER**	24°28.770'	81°42.985'	High-relief spur and groove (< 6 m)
141	7/23/2008	Western Sambo ER**	24°28.907'	81°42.985'	Low-relief spur and groove (6-15 m)
127	7/23/2008	Western Sambo ER**	24°28.852'	81°42.643'	High-relief spur and groove (< 6 m)
112	7/23/2008	Western Sambo ER**	24°29.701'	81°42.303'	Offshore patch reef
113	7/23/2008	Western Sambo ER**	24°29.466'	81°43.108'	Offshore patch reef
99	7/23/2008	West of Western Sambo ER	24°29.509'	81°43.729'	Mid-channel patch reef

Site #	Date	Site location	Latitude (N)	Longitude (W)	Habitat type
135	7/24/2008	West of Looe Key SPA	24°32.638'	81°25.655'	Low-relief spur and groove (6-15 m)
123	7/24/2008	Looe Key SPA**	24°32.691'	81°24.564'	High-relief spur and groove (< 6 m)
124	7/24/2008	Looe Key SPA**	24°32.726'	81°24.380'	High-relief spur and groove (< 6 m)
110	7/24/2008	Looe Key RO**	24°34.041'	81°23.307'	Offshore patch reef
111	7/24/2008	Looe Key RO**	24°34.029'	81°23.574'	Offshore patch reef
109	7/24/2008	East of Looe Key RO	24°34.367'	81°22.922'	Offshore patch reef
103	7/24/2008	North of Looe Key RO	24°35.590'	81°23.904'	Mid-channel patch reef
122	7/25/2008	American Shoal	24°31.345'	81°31.129'	High-relief spur and groove (< 6 m)
120	7/25/2008	American Shoal	24°31.383'	81°31.190'	High-relief spur and groove (< 6 m)
119	7/25/2008	Maryland Shoal	24°31.327'	81°34.649'	High-relief spur and groove (< 6 m)
121	7/25/2008	Maryland Shoal	24°31.318'	81°34.837'	High-relief spur and groove (< 6 m)
102	7/25/2008	North of Maryland Shoal	24°32.677'	81°34.545'	Mid-channel patch reef
118	7/25/2008	Pelican Shoal	24°30.036'	81°37.716'	High-relief spur and groove (< 6 m)
101	7/26/2008	North of Maryland Shoal	24°32.238'	81°35.752'	Mid-channel patch reef
107	7/26/2008	North of Pelican Shoal	24°30.520'	81°37.787'	Offshore patch reef
117	7/26/2008	Pelican Shoal	24°29.994'	81°37.895'	High-relief spur and groove (< 6 m)
134	7/26/2008	West of Pelican Shoal	24°29.723'	81°38.599'	Low-relief spur and groove (6-15 m)
116	7/26/2008	No Name Reef	24°29.730'	81°38.910'	High-relief spur and groove (< 6 m)
100	7/26/2008	North of Eastern Sambo RO	24°31.382'	81°38.940'	Mid-channel patch reef
336	7/27/2008	Eastern Sambo RO**	24°29.391'	81°39.891'	Low-relief spur and groove (6-15 m)
139	7/27/2008	Eastern Sambo RO**	24°29.534'	81°39.416'	Low-relief spur and groove (6-15 m)
322	7/27/2008	Eastern Sambo RO**	24°29.610'	81°39.579'	High-relief spur and groove (< 6 m)
125	7/27/2008	Eastern Sambo RO**	24°29.525'	81°39.719'	High-relief spur and groove (< 6 m)
105	7/27/2008	Western Sambo ER**	24°30.710'	81°41.699'	Mid-channel patch reef
104	7/27/2008	Western Sambo ER**	24°30.003'	81°43.149'	Mid-channel patch reef
136	8/15/2008	South of Bahia Honda	24°35.131'	81°15.869'	Patchy hard-bottom (6-15 m)
138	8/15/2008	South of Bahia Honda	24°36.028'	81°15.421'	Patchy hard-bottom (6-15 m)
137	8/15/2008	South of Bahia Honda	24°35.532'	81°13.471'	Low-relief spur and groove (6-15 m)
90	8/15/2008	South of Moser Channel	24°35.811'	81°12.482'	Low-relief spur and groove (6-15 m)
70	8/15/2008	South of Moser Channel	24°36.239'	81°11.836'	Patchy hard-bottom (6-15 m)
53	8/15/2008	South of Ohio Key	24°37.637'	81°13.872'	Mid-channel patch reef
72	8/16/2008	South of Moser Channel	24°36.369'	81°11.177'	Patchy hard-bottom (6-15 m)
71	8/16/2008	South of Moser Channel	24°36.568'	81°10.325'	Low-relief spur and groove (6-15 m)
73	8/16/2008	West of Sombrero Key SPA	24°37.404'	81°07.790'	Patchy hard-bottom (6-15 m)
96	8/16/2008	Sombrero Key SPA**	24°37.438'	81°06.636'	Low-relief spur and groove (6-15 m)
293	8/16/2008	Sombrero Key SPA**	24°37.586'	81°06.302'	Low-relief spur and groove (6-15 m)
69	8/16/2008	Sombrero Key SPA**	24°37.581'	81°06.579'	High-relief spur and groove (< 6 m)
266	8/16/2008	Sombrero Key SPA**	24°37.539'	81°06.666'	High-relief spur and groove (< 6 m)
66	8/17/2008	Delta Shoal	24°37.927'	81°05.467'	High-relief spur and groove (< 6 m)
67	8/17/2008	Delta Shoal	24°37.946'	81°05.451'	High-relief spur and groove (< 6 m)
88	8/17/2008	Coffins Patch SPA**	24°40.890'	80°58.321'	Offshore patch reef
89	8/17/2008	Coffins Patch SPA**	24°41.020'	80°58.107'	Offshore patch reef
75	8/17/2008	East of Coffins Patch SPA	24°40.633'	80°56.603'	Low-relief spur and groove (6-15 m)
54	8/21/2008	South of Duck Key	24°42.933'	80°56.224'	Mid-channel patch reef
78	8/22/2008	SW of Crocker Reef	24°53.125'	80°33.689'	Low-relief hard-bottom (6-15 m)
79	8/22/2008	SW of Crocker Reef	24°53.571'	80°32.701'	Low-relief spur and groove (6-15 m)
83	8/22/2008	Davis Reef SPA**	24°55.241'	80°30.338'	Low-relief spur and groove (6-15 m)
84	8/22/2008	Davis Reef SPA**	24°55.334'	80°30.204'	Low-relief spur and groove (6-15 m)
80	8/22/2008	Conch Reef SPA**	24°56.992'	80°27.640'	Low-relief hard-bottom (6-15 m)
81	8/22/2008	Conch Reef SPA**	24°57.347'	80°27.378'	Low-relief hard-bottom (6-15 m)
62	8/23/2008	North of Davis Reef SPA	24°56.895'	80°29.843'	Offshore patch reef
63	8/23/2008	North of Davis Reef SPA	24°57.241'	80°29.775'	Offshore patch reef
64	8/23/2008	North of Davis Reef SPA	24°57.266'	80°30.280'	Offshore patch reef
65	8/23/2008	North of Davis Reef SPA	24°57.410'	80°29.603'	Offshore patch reef
15	8/23/2008	Pickles Reef	24°59.406'	80°25.026'	High-relief spur and groove (< 6 m)
16	8/23/2008	Pickles Reef	24°59.141'	80°24.964'	High-relief spur and groove (< 6 m)
17	8/23/2008	Pickles Reef	24°59.329'	80°24.825'	High-relief spur and groove (< 6 m)
279	8/24/2008	Conch Reef RO**	24°57.037'	80°27.254'	Low-relief spur and groove (6-15 m)
82	8/24/2008	Conch Reef RO**	24°57.162'	80°27.152'	Low-relief spur and groove (6-15 m)
7	8/24/2008	Inshore of Pickles Reef	24°59.549'	80°25.860'	Offshore patch reef

Site #	Date	Site location	Latitude (N)	Longitude (W)	Habitat type
47	8/24/2008	SW of Molasses Reef SPA	25°00.252'	80°23.376'	Low-relief spur and groove (6-15 m)
27	8/24/2008	Molasses Reef SPA**	25°00.503'	80°22.651'	High-relief spur and groove (< 6 m)
28	8/24/2008	Molasses Reef SPA**	25°00.519'	80°22.534'	High-relief spur and groove (< 6 m)
1	8/30/2008	Inshore of Molasses Reef	25°02.359'	80°23.605'	Mid-channel patch reef
2	8/30/2008	Mosquito Bank	25°04.113'	80°23.010'	Mid-channel patch reef
3	8/30/2008	South of Cannon Patch Reef	25°06.182'	80°20.683'	Mid-channel patch reef
8	8/30/2008	Inshore of French Reef	25°03.619'	80°21.766'	Offshore patch reef
37	9/01/2008	Dixie Shoal	25°04.365'	80°19.028'	Low-relief spur and groove (6-15 m)
48	9/01/2008	Dixie Shoal	25°03.741'	80°19.481'	Low-relief hard-bottom (6-15 m)
19	9/01/2008	North of French Reef SPA	25°02.400'	80°20.727'	High-relief spur and groove (< 6 m)
25	9/01/2008	French Reef SPA**	25°02.139'	80°20.869'	High-relief spur and groove (< 6 m)
26	9/01/2008	French Reef SPA**	25°02.015'	80°20.951'	High-relief spur and groove (< 6 m)
20	9/01/2008	Sand Island	25°01.140'	80°22.017'	High-relief spur and groove (< 6 m)
18	9/01/2008	Sand Island	25°01.072'	80°22.094'	High-relief spur and groove (< 6 m)
34	9/19/2008	Dry Rocks SPA**	25°07.393'	80°17.833'	Inner line reef tract
33	9/19/2008	Dry Rocks SPA**	25°07.317'	80°17.839'	Inner line reef tract
36	9/19/2008	Grecian Rocks SPA**	25°06.738'	80°18.166'	Inner line reef tract
35	9/19/2008	Grecian Rocks SPA**	25°06.606'	80°18.222'	Inner line reef tract
76	9/20/2008	NE of Tennessee Light	24°45.426'	80°45.975'	Low-relief spur and groove (6-15 m)
86	9/20/2008	Tennessee Reef RO**	24°45.806'	80°45.331'	Low-relief spur and groove (6-15 m)
87	9/20/2008	Tennessee Reef RO**	24°45.981'	80°45.072'	Low-relief spur and groove (6-15 m)
77	9/20/2008	SW of Alligator Light	24°49.680'	80°38.917'	Low-relief spur and groove (6-15 m)
68	9/20/2008	Alligator Reef SPA**	24°50.662'	80°37.313'	Low-relief spur and groove (6-15 m)
85	9/20/2008	Alligator Reef SPA**	24°50.879'	80°37.069'	Low-relief spur and groove (6-15 m)
60	9/21/2008	Cheeca Rocks SPA**	24°54.259'	80°37.078'	Mid-channel patch reef
61	9/21/2008	Cheeca Rocks SPA**	24°54.288'	80°36.942'	Mid-channel patch reef
57	9/21/2008	NE of Cheeca Rocks SPA	24°54.242'	80°36.583'	Mid-channel patch reef
58	9/21/2008	Hen and Chickens SPA**	24°56.039'	80°33.040'	Mid-channel patch reef
59	9/21/2008	Hen and Chickens SPA**	24°56.223'	80°32.880'	Mid-channel patch reef
55	9/21/2008	Tavernier Rocks	24°56.560'	80°33.647'	Mid-channel patch reef
56	9/21/2008	Tavernier Rocks	24°57.029'	80°33.307'	Mid-channel patch reef

Table 3. Site locations and physical data for marine debris and benthic coral reef organism surveys in the Florida Keys National Marine Sanctuary during June-September 2008. Sites are arranged from northeast to southwest by habitat type. Asterisked sites (***) are Sanctuary Preservation Areas (SPA), Ecological Reserves (ER), or Research Only Areas (RO). Mean \pm 1 SE transect depth and maximum vertical relief are based upon surveys of four 15-m x 1-m transects per site.

Site number/site location	Latitude (N)	Longitude (W)	Mean depth (m)	Max. vertical relief (cm)
<i>Mid-channel patch reefs</i>				
Upper Florida Keys NMS				
6 - Basin Hill Shoals	25°14.019'	80°14.788'	2.7 \pm 0.1	26 \pm 5
5 - Basin Hill Shoals	25°13.795'	80°15.376'	3.6 \pm 0.3	40 \pm 6
4 - Inshore of Grecian Rocks SPA	25°06.975'	80°20.485'	4.1 \pm 0.1	89 \pm 2
3 - South of Cannon Patch Reef	25°06.182'	80°20.683'	2.5 \pm 0.1	62 \pm 13
2 - Mosquito Bank	25°04.113'	80°23.010'	2.0 \pm 0.1	83 \pm 3
1 - Inshore of Molasses Reef	25°02.359'	80°23.605'	4.1 \pm 0.1	94 \pm 22
Upper Florida Keys Total (6)			3.2 \pm 0.4	66 \pm 11
Middle Florida Keys NMS				
56 - Tavernier Rocks	24°57.029'	80°33.307'	3.1 \pm 0.0	64 \pm 20
55 - Tavernier Rocks	24°56.560'	80°33.647'	3.8 \pm 0.1	44 \pm 21
59 - Hen and Chickens SPA**	24°56.223'	80°32.880'	5.4 \pm 0.3	249 \pm 27
58 - Hen and Chickens SPA**	24°56.039'	80°33.040'	5.2 \pm 0.2	201 \pm 30
61 - Cheeca Rocks SPA**	24°54.288'	80°36.942'	3.4 \pm 0.0	105 \pm 8
60 - Cheeca Rocks SPA**	24°54.259'	80°37.078'	3.8 \pm 0.2	97 \pm 10
57 - NE of Cheeca Rocks SPA	24°54.242'	80°36.583'	3.7 \pm 0.2	151 \pm 16
54 - South of Duck Key	24°42.933'	80°56.224'	7.0 \pm 0.2	67 \pm 7
53 - South of Ohio Key	24°37.637'	81°13.872'	6.4 \pm 0.2	91 \pm 15
Middle Florida Keys Total (9)			4.6 \pm 0.5	119 \pm 23
Lower Florida Keys NMS				
103 - North of Looe Key RO	24°35.590'	81°23.904'	6.5 \pm 0.1	81 \pm 5
102 - North of Maryland Shoal	24°32.677'	81°34.545'	6.1 \pm 0.1	60 \pm 7
101 - North of Maryland Shoal	24°32.238'	81°35.752'	3.0 \pm 0.0	50 \pm 4
100 - North of Eastern Sambo RO	24°31.382'	81°38.940'	3.9 \pm 0.0	51 \pm 12
105 - Western Sambo ER**	24°30.710'	81°41.699'	6.2 \pm 0.2	75 \pm 6
104 - Western Sambo ER**	24°30.003'	81°43.149'	6.9 \pm 0.2	66 \pm 6
99 - West of Western Sambo ER	24°29.509'	81°43.729'	9.0 \pm 0.4	76 \pm 3
98 - Middle Ground	24°28.801'	81°52.949'	5.7 \pm 0.1	39 \pm 3
97 - Middle Ground	24°28.427'	81°52.897'	5.8 \pm 0.2	32 \pm 4
Lower Florida Keys Total (9)			5.9 \pm 0.6	59 \pm 6
Mid-channel Patch Reef Total (24)			4.7 \pm 0.4	83 \pm 11
<i>Offshore patch reefs</i>				
Upper Florida Keys NMS				
12 - South of BNP boundary	25°18.691'	80°11.416'	5.6 \pm 0.3	80 \pm 12
41 - North of Carysfort Reef SPA	25°16.119'	80°12.083'	10.7 \pm 0.2	67 \pm 4
11 - North of Carysfort Reef SPA	25°15.190'	80°12.756'	4.8 \pm 0.2	74 \pm 16
14 - Carysfort Reef SPA**	25°12.326'	80°13.302'	4.0 \pm 0.2	40 \pm 2
13 - Carysfort Reef SPA**	25°12.189'	80°13.624'	5.4 \pm 0.2	80 \pm 12
10 - North of Dry Rocks SPA	25°08.227'	80°17.488'	5.1 \pm 0.1	35 \pm 3
9 - SW of Grecian Rocks SPA	25°05.962'	80°19.208'	4.0 \pm 0.1	61 \pm 11
8 - Inshore of French Reef SPA	25°03.169'	80°21.766'	2.8 \pm 0.3	48 \pm 6
7 - Inshore of Pickles Reef	24°59.549'	80°25.860'	5.3 \pm 0.1	58 \pm 15
Upper Florida Keys Total (9)			5.3 \pm 0.7	60 \pm 6
Middle Florida Keys NMS				
65 - North of Davis Reef SPA	24°57.410'	80°29.603'	4.0 \pm 0.1	36 \pm 3
64 - North of Davis Reef SPA	24°57.266'	80°30.280'	4.0 \pm 0.0	61 \pm 12
63 - North of Davis Reef SPA	24°57.241'	80°29.775'	3.9 \pm 0.1	39 \pm 6
62 - North of Davis Reef SPA	24°56.895'	80°29.843'	4.0 \pm 0.1	44 \pm 4
89 - Coffins Patch SPA**	24°41.020'	80°58.107'	6.2 \pm 0.0	45 \pm 1
88 - Coffins Patch SPA**	24°40.890'	80°58.321'	6.9 \pm 0.2	56 \pm 8

Site number/site location	Latitude (N)	Longitude (W)	Mean depth (m)	Max. vertical relief (cm)
Middle Florida Keys Total (6)			4.8 ± 0.6	47 ± 4
Lower Florida Keys NMS				
109 - East of Looe Key RO	24°34.367'	81°22.922'	6.3 ± 0.0	63 ± 7
110 - Looe Key Research Only**	24°34.041'	81°23.307'	6.5 ± 0.1	76 ± 11
111 - Looe Key Research Only**	24°34.029'	81°23.574'	7.6 ± 0.1	75 ± 10
107 - North of Pelican Shoal	24°30.520'	81°37.787'	4.4 ± 0.2	39 ± 7
112 - Western Sambo ER**	24°29.701'	81°42.303'	8.6 ± 0.1	66 ± 9
113 - Western Sambo ER**	24°29.466'	81°43.108'	8.1 ± 0.1	49 ± 3
106 - NE of E. Dry Rocks SPA	24°28.975'	81°49.999'	6.5 ± 0.1	64 ± 10
133 - NE of E. Dry Rocks SPA	24°28.915'	81°49.112'	9.9 ± 0.3	106 ± 20
Lower Florida Keys Total (8)			7.2 ± 0.6	67 ± 7
Offshore Patch Reef Total (23)			5.9 ± 0.4	59 ± 4
<i>Inner line reef tract spur & groove</i>				
Upper Florida Keys NMS				
32 - Turtle Rocks	25°17.686'	80°13.342'	3.2 ± 0.1	60 ± 10
31 - Inshore of Elbow Reef SPA	25°09.483'	80°17.184'	4.3 ± 0.2	63 ± 14
30 - North Dry Rocks	25°07.825'	80°17.625'	4.9 ± 0.2	95 ± 25
34 - Dry Rocks SPA**	25°07.393'	80°17.833'	3.8 ± 0.2	106 ± 14
33 - Dry Rocks SPA**	25°07.317'	80°17.839'	4.2 ± 0.2	123 ± 13
36 - Grecian Rocks SPA**	25°06.738'	80°18.166'	4.8 ± 0.3	135 ± 13
35 - Grecian Rocks SPA**	25°06.606'	80°18.222'	4.0 ± 0.4	87 ± 18
Upper Florida Keys Total (7)			4.2 ± 0.2	95 ± 11
Inner Line Spur & Groove Total (7)			4.2 ± 0.2	95 ± 11
<i>High-relief spur & groove</i>				
Upper Florida Keys NMS				
23 - Carysfort Reef SPA**	25°12.715'	80°13.050'	3.7 ± 0.2	149 ± 16
22 - Carysfort Reef SPA**	25°12.415'	80°13.242'	3.5 ± 0.3	194 ± 11
21 - Maitland grounding site	25°12.024'	80°13.569'	3.7 ± 0.3	58 ± 13
24 - Elbow Reef SPA**	25°08.729'	80°15.391'	6.0 ± 0.2	160 ± 10
223 - Elbow Reef SPA**	25°08.450'	80°15.560'	5.4 ± 0.1	138 ± 34
19 - North of French Reef SPA	25°02.400'	80°20.727'	4.0 ± 0.1	43 ± 7
25 - French Reef SPA**	25°02.139'	80°20.869'	6.5 ± 0.2	113 ± 6
26 - French Reef SPA**	25°02.015'	80°20.951'	7.0 ± 0.3	82 ± 49
20 - Sand Island	25°01.140'	80°22.017'	5.3 ± 0.4	72 ± 10
18 - Sand Island	25°01.072'	80°22.094'	4.5 ± 0.2	105 ± 27
28 - Molasses Reef SPA**	25°00.519'	80°22.534'	4.5 ± 0.3	94 ± 22
27 - Molasses Reef SPA**	25°00.503'	80°22.651'	4.9 ± 0.2	112 ± 16
17 - Pickles Reef	24°59.329'	80°24.825'	3.5 ± 0.1	43 ± 9
16 - Pickles Reef	24°59.141'	80°24.964'	3.9 ± 0.2	69 ± 14
15 - Pickles Reef	24°59.046'	80°25.026'	4.9 ± 0.2	42 ± 4
Upper Florida Keys Total (15)			4.8 ± 0.3	98 ± 12
Middle Florida Keys NMS				
67 - Delta Shoal	24°37.946'	81°05.415'	4.4 ± 0.0	113 ± 22
66 - Delta Shoal	24°37.927'	81°05.467'	5.4 ± 0.2	83 ± 39
69 - Sombrero Key SPA**	24°37.581'	81°06.579'	3.2 ± 0.3	173 ± 39
266 - Sombrero Key SPA**	24°37.539'	81°06.666'	4.1 ± 0.4	186 ± 43
Middle Florida Keys Total (4)			4.3 ± 0.5	138 ± 24
Lower Florida Keys NMS				
124 - Looe Key SPA**	24°32.726'	81°24.380'	5.4 ± 0.1	124 ± 16
123 - Looe Key SPA**	24°32.691'	81°24.564'	4.3 ± 0.3	106 ± 26
120 - American Shoal	24°31.383'	81°31.190'	4.2 ± 0.1	118 ± 11
122 - American Shoal	24°31.345'	81°31.129'	6.4 ± 0.1	32 ± 4
119 - Maryland Shoal	24°31.327'	81°34.649'	3.4 ± 0.3	89 ± 15
121 - Maryland Shoal	24°31.318'	81°34.837'	1.8 ± 0.2	109 ± 18
118 - Pelican Shoal	24°30.036'	81°37.716'	4.5 ± 0.2	141 ± 26
117 - Pelican Shoal	24°29.994'	81°37.895'	4.3 ± 0.5	133 ± 12
116 - No Name Reef	24°29.730'	81°38.910'	3.7 ± 0.2	66 ± 7

Site number/site location	Latitude (N)	Longitude (W)	Mean depth (m)	Max. vertical relief (cm)
322 - Eastern Sambo RO**	24°29.610'	81°39.579'	4.3 ± 0.3	109 ± 11
125 - Eastern Sambo RO**	24°29.525'	81°39.719'	3.2 ± 0.3	89 ± 7
127 - Western Sambo ER**	24°28.852'	81°42.643'	3.4 ± 0.1	63 ± 6
126 - Western Sambo ER**	24°28.770'	81°42.985'	4.5 ± 0.2	94 ± 14
115 - East of E. Dry Rocks SPA	24°27.879'	81°50.217'	4.6 ± 0.2	120 ± 31
129 - Eastern Dry Rocks SPA**	24°27.707'	81°50.461'	3.7 ± 0.1	71 ± 12
128 - Eastern Dry Rocks**	24°27.560'	81°50.657'	4.0 ± 0.3	60 ± 21
327 - Rock Key SPA**	24°27.296'	81°51.400'	4.4 ± 0.4	104 ± 21
130 - Rock Key SPA**	24°27.258'	81°51.505'	3.2 ± 0.1	77 ± 23
131 - Sand Key SPA**	24°27.173'	81°52.501'	3.5 ± 0.1	50 ± 9
328 - Sand Key SPA**	24°27.117'	81°52.729'	3.6 ± 0.3	108 ± 11
114 - Western Dry Rocks	24°26.707'	81°55.662'	4.6 ± 0.3	110 ± 18
Lower Florida Keys Total (21)			4.1 ± 0.2	94 ± 6
High-relief Spur & Groove Total (40)			4.3 ± 0.2	100 ± 6
<i>Fore-reef (6-15 m)</i>				
Upper Florida Keys NMS				
42 - South of BNP boundary	25°17.304'	80°10.439'	9.6 ± 0.1	42 ± 4
52 - Carysfort Reef SPA**	25°12.384'	80°12.448'	12.6 ± 0.1	50 ± 3
51 - Carysfort Reef SPA**	25°12.174'	80°13.222'	14.2 ± 0.1	59 ± 9
50 - SW of Carysfort Reef SPA	25°11.579'	80°13.323'	15.7 ± 0.1	51 ± 2
40 - SW of Carysfort Reef SPA	25°11.177'	80°13.824'	12.6 ± 0.1	43 ± 9
39 - North of Elbow Reef SPA	25°09.158'	80°15.051'	10.9 ± 0.1	46 ± 5
245 - Elbow Reef SPA**	25°08.630'	80°15.418'	8.6 ± 0.2	60 ± 4
46 - Elbow Reef SPA**	25°08.252'	80°15.672'	7.4 ± 0.1	32 ± 6
38 - SW of Elbow Reef SPA	25°07.935'	80°16.579'	9.0 ± 0.1	33 ± 6
49 - South of Elbow Reef SPA	25°07.419'	80°16.298'	16.0 ± 0.1	54 ± 11
37 - Dixie Shoal	25°04.365'	80°19.028'	11.5 ± 0.1	40 ± 8
48 - Dixie Shoal	25°03.741'	80°19.481'	11.3 ± 0.1	45 ± 2
47 - SW of Molasses Reef SPA	2500.252'	80°23.376'	11.2 ± 0.1	47 ± 2
Upper Florida Keys Total (13)			11.6 ± 0.7	46 ± 2
Middle Florida Keys NMS				
81 - Conch Reef SPA**	24°57.347'	80°27.738'	10.0 ± 0.1	23 ± 6
80 - Conch Reef SPA**	24°56.992'	80°27.640'	9.3 ± 0.1	32 ± 6
82 - Conch Reef RO**	24°57.162'	80°27.152'	13.4 ± 0.1	70 ± 10
279 - Conch Reef RO**	24°57.037'	80°27.254'	12.8 ± 0.1	62 ± 19
84 - Davis Reef SPA**	24°55.334'	80°30.204'	11.1 ± 0.1	40 ± 5
83 - Davis Reef SPA**	24°55.241'	80°30.388'	10.9 ± 0.1	25 ± 5
79 - SW of Crocker Reef	24°53.571'	80°32.701'	11.0 ± 0.2	69 ± 8
78 - SW of Crocker Reef	24°53.125'	80°33.689'	8.0 ± 0.1	44 ± 3
85 - Alligator Reef SPA**	24°50.879'	80°37.069'	8.8 ± 0.1	39 ± 9
68 - Alligator Reef SPA**	24°50.662'	80°37.313'	12.0 ± 0.0	40 ± 7
77 - SW of Alligator Reef SPA	24°49.680'	80°38.917'	11.9 ± 0.2	107 ± 19
87 - Tennessee Reef RO**	24°45.981'	80°45.072'	10.1 ± 0.2	40 ± 6
86 - Tennessee Reef RO**	24°45.806'	80°45.331'	10.0 ± 0.0	73 ± 8
76 - NE of Tennessee Light	24°45.426'	80°45.975'	9.3 ± 0.0	37 ± 7
75 - East of Coffins Patch SPA	24°40.633'	80°56.603'	13.6 ± 0.1	47 ± 6
293 - Sombrero Key SPA**	24°37.586'	81°06.302'	10.7 ± 0.1	60 ± 9
96 - Sombrero Key SPA**	24°37.438'	81°06.636'	11.1 ± 0.1	47 ± 2
73 - West of Sombrero Key SPA	24°37.404'	81°07.790'	8.8 ± 0.1	34 ± 7
71 - South of Moser Channel	24°36.568'	81°10.325'	12.6 ± 0.1	73 ± 9
72 - South of Moser Channel	24°36.369'	81°11.177'	9.0 ± 0.1	39 ± 6
70 - South of Moser Channel	24°36.239'	81°11.836'	8.8 ± 0.1	48 ± 7
90 - South of Moser Channel	24°35.811'	81°12.482'	11.8 ± 0.1	29 ± 6
Middle Florida Keys Total (22)			10.7 ± 0.3	49 ± 4
Lower Florida Keys NMS				
136 - South of Bahia Honda Key	24°35.131'	81°15.869'	10.9 ± 0.1	20 ± 2
138 - South of Bahia Honda Key	24°36.028'	81°15.421'	8.6 ± 0.0	48 ± 6
137 - South of Bahia Honda Key	24°35.532'	81°13.471'	11.2 ± 0.2	47 ± 10

Site number/site location	Latitude (N)	Longitude (W)	Mean depth (m)	Max. vertical relief (cm)
135 - West of Looe Key SPA	24°32.638'	81°25.655'	12.4 ± 0.0	80 ± 6
134 - West of Pelican Shoal	24°29.723'	81°38.599'	9.8 ± 0.1	35 ± 4
139 - Eastern Sambo RO**	24°29.534'	81°39.416'	9.5 ± 0.2	21 ± 12
336 - Eastern Sambo RO**	24°29.391'	81°39.891'	10.4 ± 0.1	74 ± 11
141 - Western Sambo ER**	24°28.907'	81°42.985'	10.9 ± 0.1	72 ± 14
140 - Western Sambo ER**	24°28.649'	81°43.502'	12.2 ± 0.1	71 ± 11
143 - West of Western Sambo ER	24°28.547'	81°44.116'	11.4 ± 0.1	39 ± 6
132 - East of E. Dry Rocks SPA	24°27.854'	81°49.334'	10.7 ± 0.2	55 ± 8
346 - Rock Key SPA**	24°27.295'	81°51.253'	9.8 ± 0.1	60 ± 5
149 - Rock Key SPA**	24°27.224'	81°51.604'	9.9 ± 0.6	83 ± 5
347 - Sand Key SPA**	24°27.053'	81°52.491'	13.8 ± 0.1	58 ± 9
150 - Sand Key SPA**	24°27.052'	81°52.799'	12.1 ± 0.2	51 ± 3
142 - SW of Sand Key SPA	24°26.364'	81°53.633'	12.4 ± 0.2	54 ± 7
Lower Florida Keys Total (16)			11.0 ± 0.3	54 ± 5
Fore-reef Total (51)			11.0 ± 0.3	50 ± 2

Table 4. SCUBA diving effort for surveys of marine debris and benthic coral reef organisms in the Florida Keys National Marine Sanctuary during June-September 2008.

Diver	Affiliation	No. of dives	Depth range (m)	Bottom time
<i>Benthic surveys</i>				
Mark Chiappone	CMS/UNCW	145	0.5-16.8 m	134 hr 09 min
Leanne Rutten	CMS/UNCW	145	0.5-16.5 m	128 hr 24 min
Total all divers		290	0.5-16.8 m	262 hr 33 min