II. Study Area and Survey Methods

Study area and sampling objectives

The Florida Keys comprise an archipelago of limestone islands spanning more than 360 km from south of Miami to the Dry Tortugas. With the exception of isolated banks in the Flower Gardens area in the Gulf of Mexico, the Florida Keys ecosystem represents the only region of extensive coral reef development in the continental U.S. (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). As one proceeds seaward from the shoreline of the Pleistocene islands, a nearshore rock ledge extends ~2.5 km from the shoreline, with the seabed consisting of hard-bottom, seagrass, and isolated inshore patch reefs (FMRI 1998). Seaward of the island platform is Hawk Channel, a broad trough-like depression dominated by non-coralline, non-oolitic grainstone, dotted with 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; Shinn et al. 1989). 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 Straits of Florida. The semi-continuous offshore 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). As with inner shelf margin patch reefs, the distribution platform margin reefs 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 and thus the presence and size of tidal passes, as well as the proximity of the Florida Current to the platform margin (Pitts 1994; Smith 1994).

The 2010 sampling of coral reef benthic invertebrates and marine debris in the upper Florida Keys National Marine Sanctuary (FKNMS) was undertaken as a spatially intensive effort to quantify the distribution, abundance, size, and condition of benthic coral reef organisms. The 2010 surveys conducted from June 28th to August 28th were an outgrowth of previous efforts conducted by our program dating back to 1998 to quantify the abundance and condition of coral reef benthos throughout the FKNMS, including the Tortugas region (Miller et al. 2002). Previous surveys in the FKNMS, excluding the Tortugas region, consist of 80 sites sampled Keyswide in 1999, 45 sites in the lower Keys region in 2000, 108 sites Keyswide in 2001, 195 sites Keyswide in 2005, 107 sites in the upper Keys region in 2006, 235 sites Keyswide in 2007, 145 sites Keyswide in 2008, and 160 sites Keyswide in 2009. 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 2010. The overall goals of the 2010 sampling effort were two-fold:

- Provide detailed surveys of the species richness, density, size, and condition of benthic coral reef organisms at Conch Reef, including the area around the Aquarius Undersea Habitat; and
- Continue the temporal data sets on the abundance and size of *Acropora* corals, urchins, anemones and corallimorpharians, and selected mollusks, as well as the frequency and impacts of marine debris throughout the upper Florida Keys region.

The 2010 surveys provided the opportunity to conduct detailed benthic sampling at nine sites along a depth gradient at Conch Reef that encompassed low-relief hard-bottom and low-relief spur and groove habitats from the shallow inshore reef edge to the Aquarius Undersea Habitat. We were able to continue population temporal data sets on the population status of several groups of benthic invertebrates dating back to 1999 throughout the upper Keys area. The objectives of the 2010 sampling effort were to provide information on:

- Depth and physical structure (maximum vertical relief) of survey sites;
- Species richness and frequency of occurrence of stony corals, gorgonians, and sponges at Conch Reef;
- Percent cover of abiotic and biotic components at Conch Reef;
- Density, size, and condition (percent live tissue, disease, bleaching, predation) of all stony corals at Conch Reef;
- Density of gorgonians and density and maximum diameter of juvenile (< 4 cm) scleractinian corals at Conch Reef;
- Distribution, density, size, and condition of *Acropora* corals throughout the upper Florida Keys;
- Density and size (test diameter) of sea urchins throughout the upper Florida Keys, representing an ongoing effort to monitor recovery of the historically abundant long-spined sea urchin *Diadema antillarum*;
- Density of sea anemones and corallimorpharians, as well as selected mollusks such as sea slugs, nudibranchs, and certain other gastropods (*Thais*, *Leucozonia*, *Coralliophila*) throughout the upper Florida Keys; and
- Frequency and impacts of marine debris, including lost fishing gear, representing a continuation of efforts carried out in 2000-01 and 2008.

Sampling design and field methodology

The sampling design for assessing benthic coral reef organisms and marine debris encompassed 120 sites visited during June-August 2010. Sites were distributed from northern Key Largo at Turtle Rocks and Turtle Reef, near the boundary between the FKNMS and Biscayne National Park, to SW of Crocker Reef near Alligator Light (Figure 2-1). The sampling design included eight major habitat types, as well as all nine no-take zones designated as Sanctuary Preservation Areas (SPA) or Research Only Areas (RO) in the upper Keys region from Hen and Chickens SPA and Davis Reef SPA northward to Carysfort/S. Carysfort Reef SPA (Table 2-1). Table 2-2 chronologically lists the sampling locations during June-August 2010.

The habitat strata selected for the 2010 sampling incorporated most of the hard-bottom and coral reef habitat types from the island platform (e.g. inshore patch reefs such as Tavernier Rocks) inshore of Hawk Channel to ~15 m depth along the reef tract. However, the 2010 effort did not include nearshore hard-bottom, hard-bottom/seagrass matrix habitats, or deeper (> 15 m) fore reef areas. The habitats sampled during 2010 were inshore and mid-channel patch reefs, offshore patch reefs, back reef rubble, shallow (< 6 m) hard-bottom, 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 7-15 m depth. Deeper fore-reef habitats encompassed continuous, low-relief hard-bottom, patchy hard-bottom, and low-relief spur and groove. Table 2-3 lists the sites by benthic habitat type, along with site-level data on depth and maximum vertical relief. Besides habitat type, sites were further categorized by along-shelf position and management zone (i.e. inside and outside of FKNMS no-take zones). Figures 2-2 to 2-4 show the spatial distribution of sampling locations by habitat type for the 120 sampling locations, along with the boundaries of existing no-take marine reserves in the upper FKNMS. Figures 2-5 to 2-7 provide examples of each of the hard-bottom and coral reef habitat types sampled during 2010.

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. Existing resolution of benthic habitats is such that the survey domain was divided into a grid of individual cells 200 m by 200 m (40,000 m^2) in area that that serve as primary sampling units (Table 2-1). 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 the benthic variables assessed, the upper Florida Keys survey domain was partitioned into strata based upon: 1) habitat class, 2) geographic region (along-shelf position), 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 may influence the distribution and community composition of hard-bottom and reef habitats (Marszalek et al. 1977; Shinn et al. 1989). Regional sectors are 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). FKNMS no-take zones are incorporated as a third stratification variable that delineates areas open and closed to consumptive activities. Within each no-take zone, a minimum of two replicate sites are sampled in a given habitat type. The power of the stratified random sampling approach is essentially two-fold: 1) the habitats comprising the most area are initially allocated more sites than those with less area (i.e., a proportional design); and 2) habitats exhibiting more variability with respect to particular metrics (e.g. coral density) are allocated more sites than those with less variability. The ultimate power of this approach is derived more 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 encompassed 120 sampling locations, with an additional 120 alternate sites between Alligator Light and the northern FKNMS boundary. 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-m in length, marked in 1-m increments, along the bottom. A 1-m wide belt centered on each 15-m long transect tape was surveyed at each site for most of the benthic variables described below, with a total of 60-m^2 surveyed. At all 120 sites sampled during 2010, 15-m^2 belt transect areas were surveyed for:

- Minimum and maximum depth;
- Maximum vertical relief of the substratum such as ledges, spur edges, crevices, coral heads, and sponges;
- Number of colonies, skeletal unit size, live tissue surface area, and condition (bleaching, disease, predation, overgrowth) of *Acropora* corals;
- Numbers and test diameters of sea urchins;
- Numbers of anemones and corallimorpharians;
- Numbers and total lengths or shell lengths of nudibranchs, the lettuce sea slug (*Elysia crispata*), and the gastropods *Coralliophila* sp., *Leucozonia nassa*, and *Thais deltoidea*; and
- The frequency of marine debris and the numbers of benthic organisms exhibiting abrasion stress (partial mortality due to tissue loss).

At Conch Reef, nine sites were sampled from the inshore ledge to the deeper fore-reef along the depth contour of the Aquarius Undersea Habitat. Three sites were selected in each of three depth zones comprising: the inshore ledge (low-relief hard-bottom) of Conch Reef SPA at mooring buoys C1, C2, and C3; offshore of the mooring buoys within the SPA at ~9-12 m depth; and three sites along the depth contour of Aquarius (~14-15 m depth). The three sites in each depth zone were distributed from the northeastern to the central to the southwestern areas of Conch Reef. In addition to the variables described above, measurements at Conch Reef also included benthic cover, species richness, and the density, size, and condition of benthic coral reef organisms. Specifically, transects were surveyed for: depth and maximum vertical relief; stony coral, gorgonian, and sponge species presence-absence; stony coral numbers, colony sizes, and colony condition; juvenile scleractinian coral numbers and maximum diameter; gorgonian colony numbers. Transects were placed in an inshore-to-offshore pattern in each of the three depth zones. 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. Benthic cover was assessed by sampling 100 points spaced 15 cm apart along each transect. Digital photographs of each site were taken to record general site features and organisms encountered.

The 2010 sampling effort (120 sites) required 19 field days from June 28 to August 28th (Table 2-2). Only a few field days were lost due to personnel issues or inclement weather in July and August. The June-August sampling was generally marked by calm conditions, except for late June and during the

third week of July. A private research vessel (M/V *Dual Porpoise*, Key Largo, captained by Scott Fowler) and NOAA/UNCW's Aquarius Reef Base (ARB) in Key Largo provided on-the-water diving support. The survey team consisted of personnel from the Center for Marine Science/UNCW (Mark Chiappone, Leanne Rutten and Thor Dunmire) (Table 2-4). SCUBA tank fills and lodging were provided by NOAA's ARB facility on Key Largo. The sampling effort depended upon 6 to 7 hours in the water daily by a two- or three-person benthic team to complete an average of 6-8 sites per day. Typically 30-40 minutes per site were needed to sample the targeted benthic variables, except at Conch Reef, where 70-90 minute divers were needed per site. Table 2-4 summarizes the diving statistics for 2010. The benthic surveys at the 120 sites required 240 dives comprising ~137 hours of underwater bottom time.

Figure 2-1. Sampling locations for benthic coral reef organisms in the upper Florida Keys National Marine Sanctuary from southwest of Crocker Reef to northern Key Largo during June-August 2010.

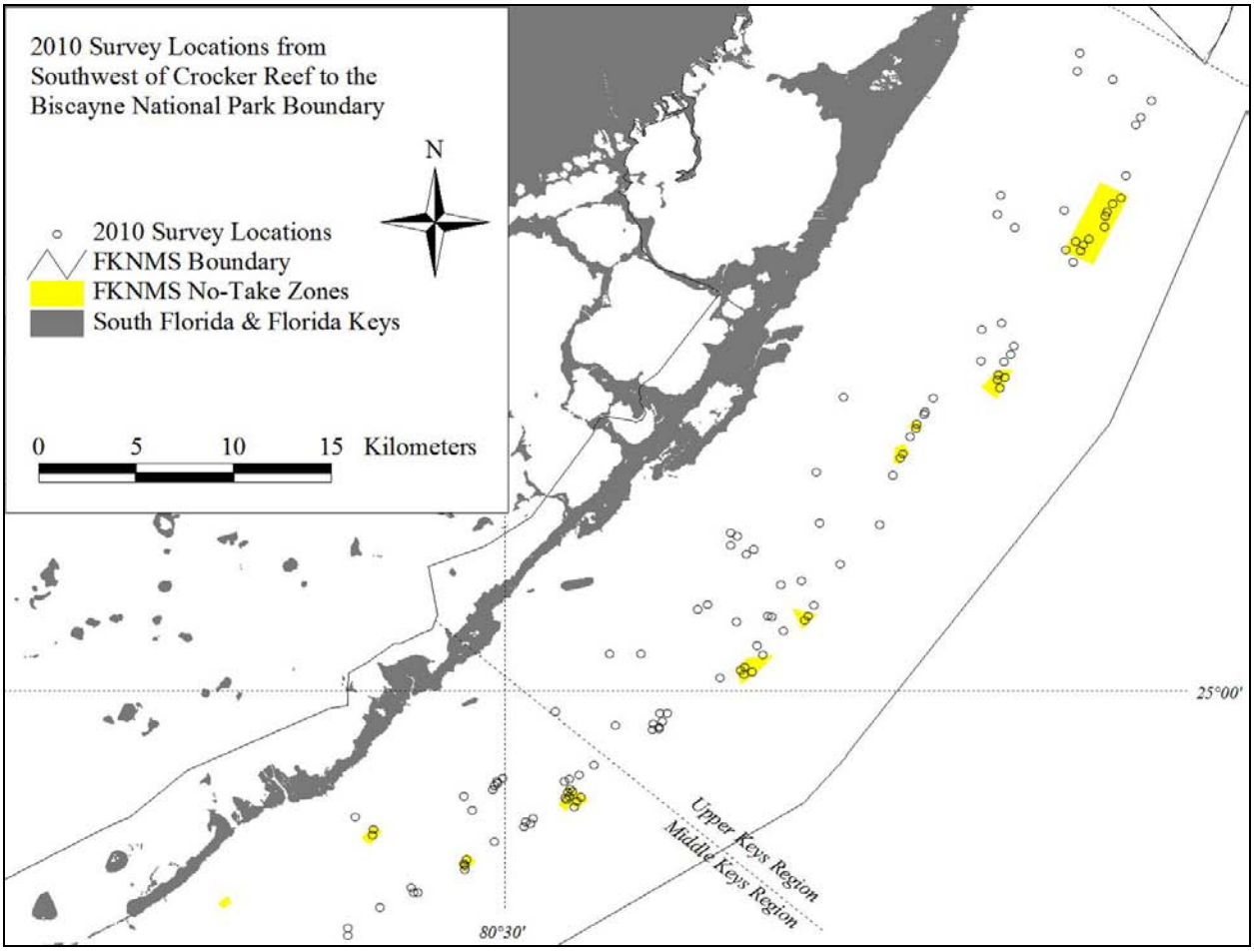


Figure 2-2. Upper Florida Keys sampling locations by benthic habitat type from the southern Biscayne National Park boundary to Carysfort Reef during 2010.

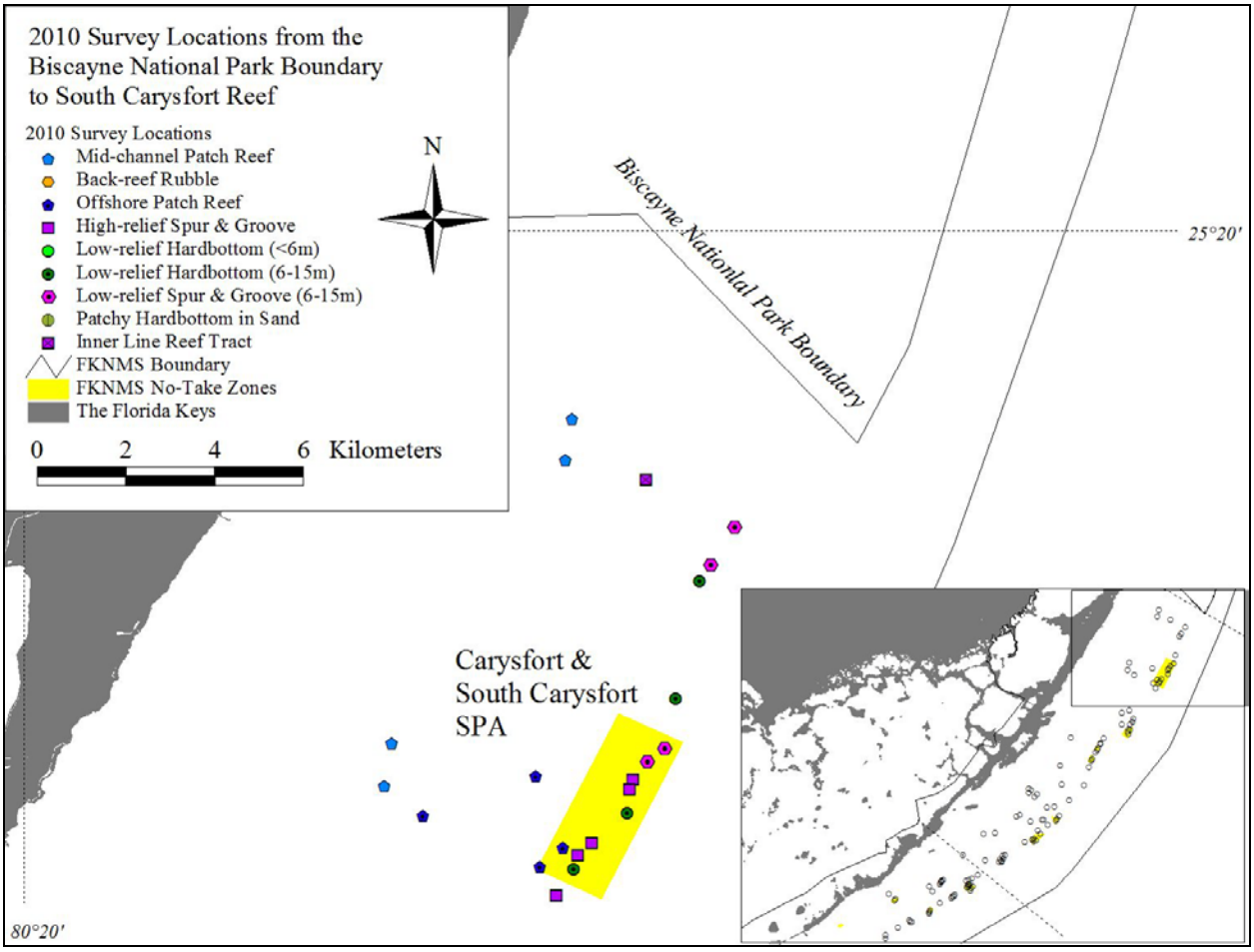


Figure 2-3. Upper Florida Keys sampling locations by benthic habitat type from Elbow Reef to Pickles Reef during 2010.

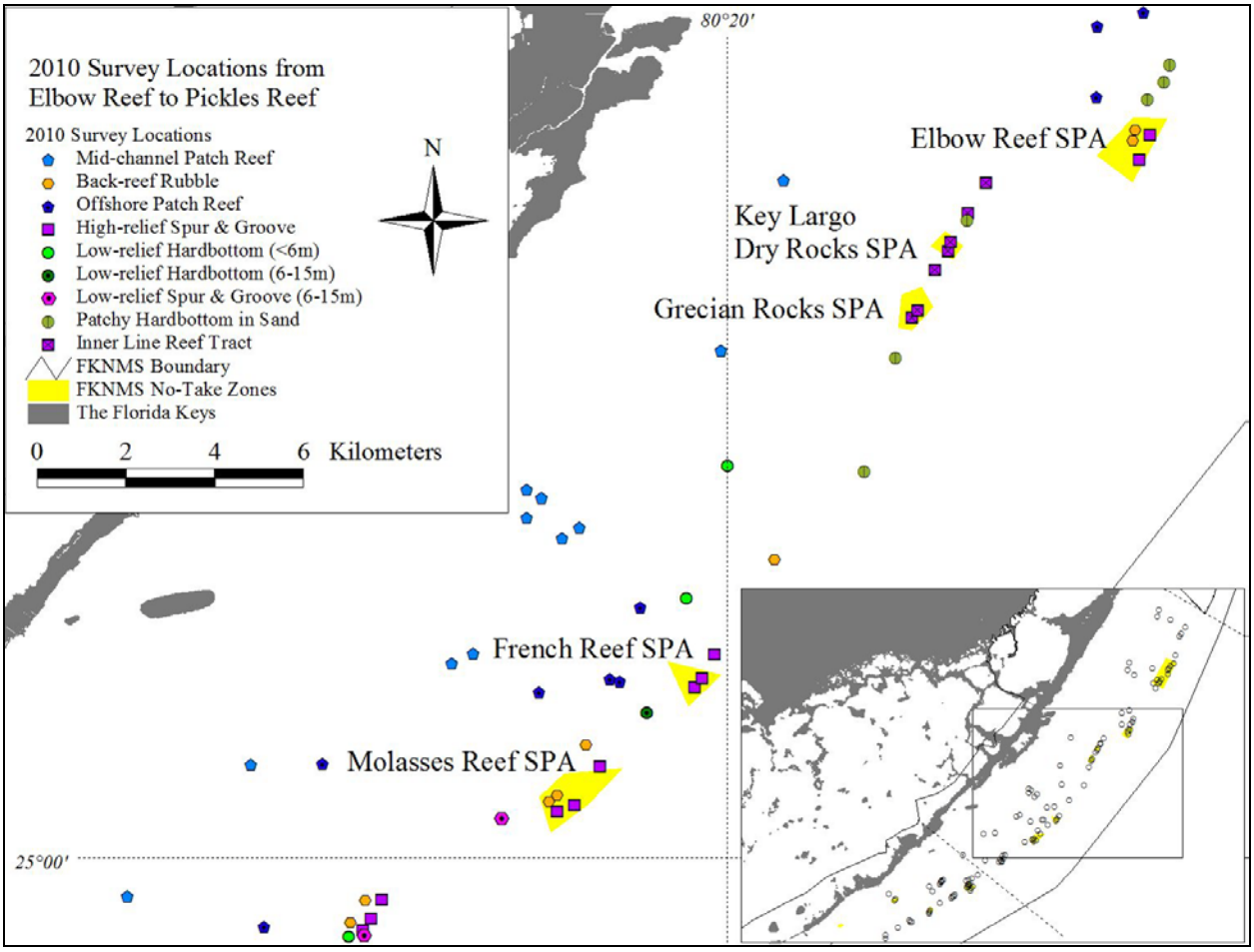


Figure 2-4. Upper Florida Keys sampling locations by benthic habitat type from Conch Reef to Crocker Reef during 2010.

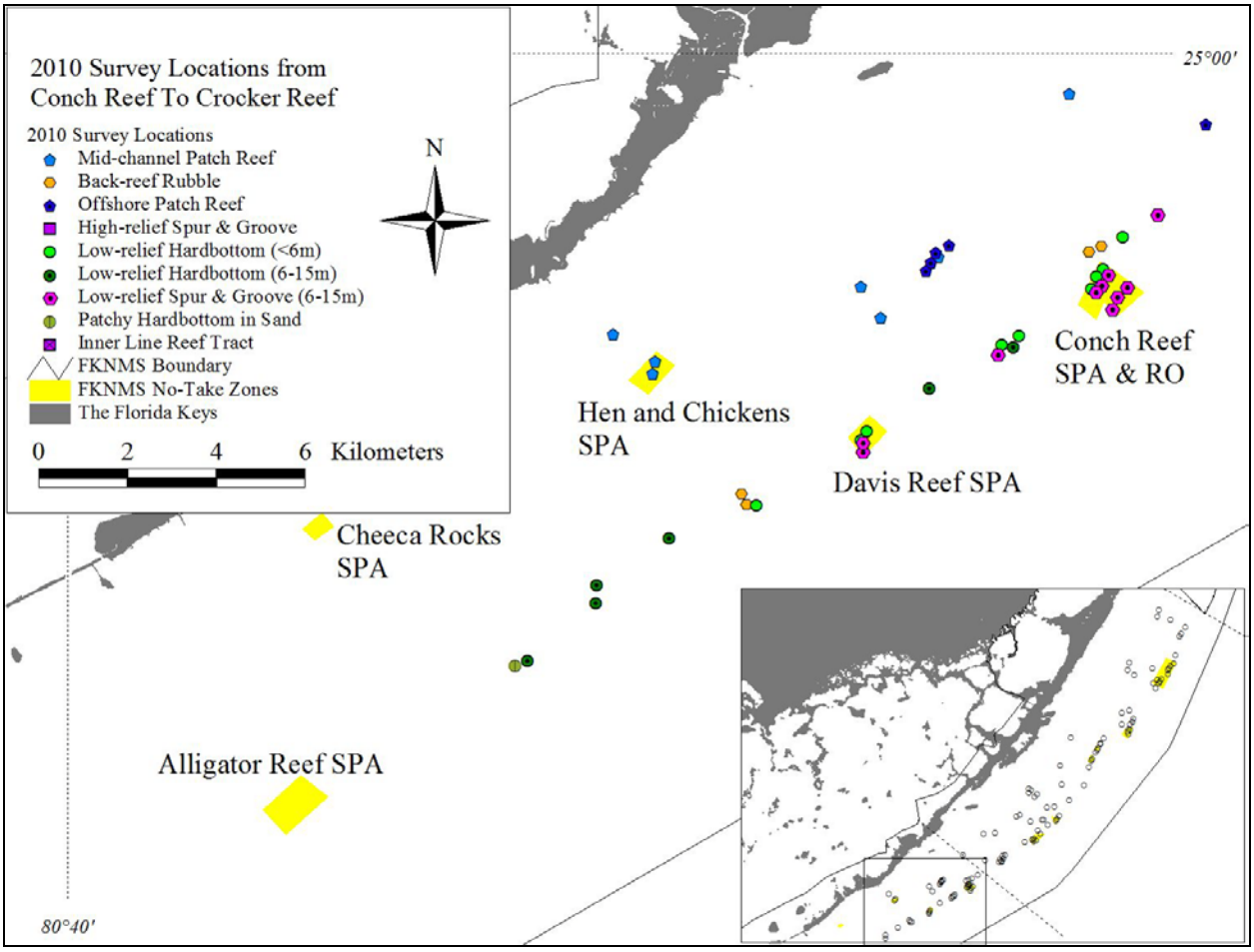


Figure 2-5. Examples of inshore, mid-channel and offshore patch reefs sampled in the upper Florida Keys during 2010.

Inshore patch reef
Site A741, Tavernier Rocks, 2.4-4.6 m
24° 56.594'N, 80° 33.376'W

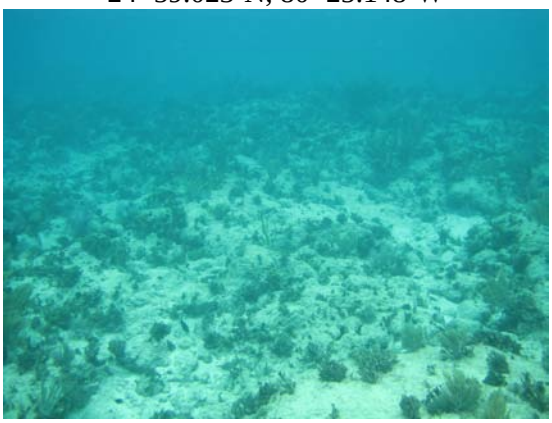
Offshore patch reef
Site B35, West of Elbow Reef, 4.3-6.1 m
25° 09.213'N, 80° 16.074'W

Mid-channel patch reef
Site 637, West of Turtle Rocks, 2.1-3.7 m
25° 17.210'N, 80° 13.425'W

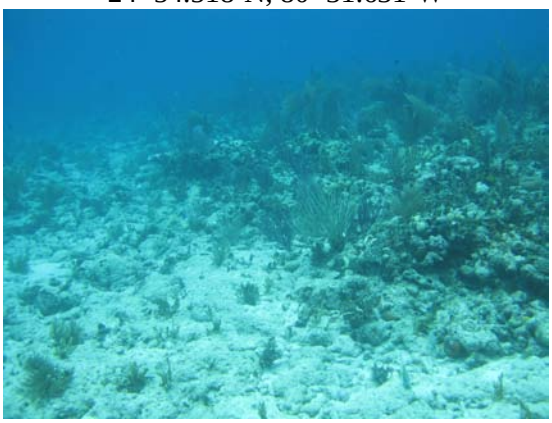
Offshore patch reef
Site A802, Inshore of Conch Reef, 3.7-6.1 m
24° 57.363'N, 80° 29.576'W

Figure 2-6. Examples of shallow (< 6 m) low-relief hard-bottom and high-relief spur and groove reefs sampled in the upper Florida Keys during 2010.

Low-relief hard-bottom
Site 693, Little Pickles Reef, 4.3-5.5 m
24° 59.023'N, 80° 25.148'W



Low-relief hard-bottom
Site A932, Crocker Reef, 3.4-4.3 m
24° 54.518'N, 80° 31.631'W



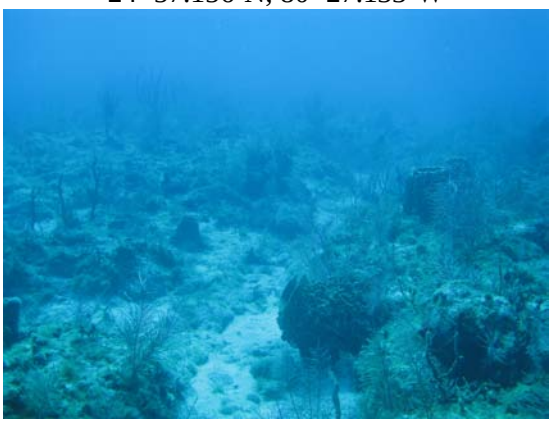
High-relief spur and groove
Site 700, South Carysfort Reef, 1.5-5.2 m
25° 12.566'N, 80° 13.102'W

High-relief spur and groove
Site 711, Sand Island, 3.0-5.2 m
25° 01.089'N, 80° 22.099'W

Figure 2-7. Examples of deeper (6-15 m) fore-reef habitats sampled in the upper Florida Keys during 2010.

Low-relief hard-bottom
Site A94, Little Conch Reef, 8.8-10.1 m
24° 56.428'N, 80° 28.515'W

Low-relief spur and groove
Site 626, Conch Reef, 13.4-14.3 m
24° 57.156'N, 80° 27.133'W



Patchy hard-bottom
Site B57, East of Dry Rocks, 6.4-7.9 m
25° 07.719'N, 80° 17.641'W

Low-relief spur and groove
Site 709, Pickles Reef, 8.5-9.4 m
24° 59.031'N, 80° 24.968'W

Table 2-1. Survey effort for benthic coral reef organisms in the upper Florida Keys National Marine Sanctuary during June-August 2010. 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 (2001) habitat mapping data. Asterisked sites (**) are FKNMS no-take zones represented by 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	15	12.50	706	11.06	2.12
Middle Florida Keys					
Reference sites	4	3.33	165	2.58	2.42
Hen and Chickens SPA**	2	1.67	9	0.14	22.22
MPR Habitat Total	**21**	**17.50**	**880**	**13.78**	**2.39**
Offshore patch reef (OPR)					
Upper Florida Keys					
Reference sites	11	9.17	1,025	16.05	1.07
Carysfort/S. Carysfort SPA**	2	1.67	28	0.44	7.14
Middle Florida Keys					
Reference sites	4	3.33	94	1.47	4.26
OPR Habitat Total	**17**	**14.17**	**1,147**	**17.96**	**1.48**
Back reef rubble (BRR)					
Upper Florida Keys					
Reference sites	4	3.33	61	0.96	6.56
Elbow Reef SPA	2	1.67	9	0.14	22.22
Molasses Reef SPA	2	1.67	6	0.09	33.33
Middle Florida Keys					
Reference sites	4	3.33	158	2.47	2.53
BRR Habitat Total	**12**	**10.00**	**234**	**3.66**	**5.13**
Shallow (< 6 m) hard-bottom (LHB)					
Upper Florida Keys					
Reference sites	3	2.50	775	12.14	0.39
Middle Florida Keys					
Reference sites	4	3.33	176	2.76	2.27
Conch Reef SPA**	3	2.50	5	0.08	60.00
Davis Reef SPA**	2	1.67	2	0.03	100.00
LHBS Habitat Total	**12**	**10.00**	**958**	**15.00**	**1.25**
Inner line spur and groove (IRT)					
Upper Florida Keys					
Reference sites	4	3.33	78	1.22	5.13
Dry Rocks SPA**	2	1.67	4	0.06	50.00
Grecian Rocks SPA**	2	1.67	13	0.20	15.38
IRT Habitat Total	**8**	**6.67**	**95**	**1.49**	**8.42**
High-relief spur and groove (HSG)					
Upper Florida Keys					
Reference sites	6	5.00	34	0.53	17.65
Carysfort/S. Carysfort SPA**	4	3.33	39	0.61	10.26
Elbow Reef SPA**	2	1.67	16	0.25	12.50
French Reef SPA**	2	1.67	12	0.19	16.67
Molasses Reef SPA**	2	1.67	14	0.22	14.29
HSG Habitat Total	**16**	**13.33**	**115**	**1.80**	**13.91**

Habitat type/region/protection	Sites sampled (n)	% of Effort	Sites available (n_{tot})	n_{tot} (%)	n/n_{tot} (%)
Patchy (6-15 m) hard-bottom (PHB)					
Upper Florida Keys					
Reference sites	6	5.00	217	3.40	2.76
Middle Florida Keys					
Reference sites	2	1.67	128	2.00	1.56
PHB Habitat Total	**8**	**6.67**	**345**	**5.40**	**2.32**
Deeper (6-15 m) hard-bottom (LHBD)					
Upper Florida Keys					
Reference sites	3	2.50	662	10.37	0.45
Carysfort/S. Carysfort SPA**	2	1.67	39	0.61	5.13
Middle Florida Keys					
Reference sites	4	3.33	311	4.87	1.29
LHBD Habitat Total	**9**	**7.50**	**1,012**	**15.85**	**0.89**
Low-relief spur and groove (LSG)					
Upper Florida Keys					
Reference sites	5	4.17	709	11.10	0.71
Carysfort/S. Carysfort SPA**	2	1.67	54	0.85	3.70
Middle Florida Keys					
Reference sites	2	1.67	807	12.64	0.25
Conch Reef SPA**	3	2.50	14	0.22	21.43
Conch Reef RO**	3	2.50	6	0.09	50.00
Davis Reef SPA**	2	1.67	9	0.14	22.22
LSG Habitat Total	**17**	**14.17**	**1,599**	**25.04**	**1.06**
Sampling Design Total	**120**	**100.00**	**6,385**	**100.00**	**1.88**

Table 2-2. Chronological list of the 120 sites surveyed for benthic coral reef organisms in the upper Florida Keys National Marine Sanctuary during June-August 2010. 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
631	6/28/2010	Marker 33	25º 08.208	80º 19.871	Mid-channel patch reef
630	6/28/2010	SE of Cannon Patch	25º 06.139	80º 20.630	Mid-channel patch reef
627	6/28/2010	Mosquito Bank	25º 04.451	80º 22.991	Mid-channel patch reef
628	6/28/2010	Mosquito Bank	25º 04.350	80º 22.811	Mid-channel patch reef
643	6/28/2010	White Bank(NW of French)	25º 03.022	80º 21.612	Offshore patch reef
641	6/28/2010	White Bank (West of French)	25º 01.988	80º 22.836	Offshore patch reef
640	6/28/2010	White Bank (West of Molasses)	25º 01.114	80º 25.467	Offshore patch reef
535	6/29/2010	Hen and Chickens Reef	24º 56.262	80º 32.861	Mid-channel patch reef
534	6/29/2010	Hen and Chickens Reef	24º 56.115	80º 32.893	Mid-channel patch reef
533	6/29/2010	West of Conch Reef	24º 56.791	80º 30.129	Mid-channel patch reef
A74	6/29/2010	West of Conch Reef	24º 57.168	80º 30.364	Mid-channel patch reef
A73	6/29/2010	West of Conch Reef	24º 57.529	80º 29.427	Mid-channel patch reef
633	6/30/2010	Basin Hill Shoals	25º 13.250	80º 15.618	Mid-channel patch reef
634	6/30/2010	Basin Hill Shoals	25º 13.772	80º 15.533	Mid-channel patch reef
637	6/30/2010	West of Turtle Rocks	25º 17.210	80º 13.425	Mid-channel patch reef
636	6/30/2010	West of Turtle Rocks	25º 17.713	80º 13.342	Mid-channel patch reef
659	6/30/2010	Turtle Reef	25º 16.976	80º 12.438	Inner line reef tract
649	6/30/2010	West of Carysfort Reef	25º 13.377	80º 13.781	Offshore patch reef
653	6/30/2010	Carysfort Reef	25º 12.501	80º 13.456	Offshore patch reef
648	7/1/2010	East of Basin Hill Shoals	25º 12.895	80º 15.147	Offshore patch reef
715	7/1/2010	North of Carysfort Reef	25º 16.396	80º 11.368	Low-relief spur and groove (6-15 m)
677	7/1/2010	North of Carysfort Reef	25º 15.937	80º 11.659	Low-relief spur and groove (6-15 m)
676	7/1/2010	North of Carysfort Reef	25º 15.740	80º 11.796	Low-relief hard-bottom (6-15 m)
675	7/1/2010	North of Carysfort Reef	25º 14.316	80º 12.084	Low-relief hard-bottom (6-15 m)
701	7/1/2010	Carysfort Reef C5	25º 13.332	80º 12.603	High-relief spur and groove
B67	7/1/2010	Carysfort Reef C2	25º 13.210	80º 12.643	High-relief spur and groove
679	7/2/2010	North Carysfort Reef	25º 13.706	80º 12.224	Low-relief spur and groove (6-15 m)
717	7/2/2010	North Carysfort Reef	25º 13.540	80º 12.437	Low-relief spur and groove (6-15 m)
678	7/2/2010	North Carysfort Reef	25º 12.921	80º 12.669	Low-relief hard-bottom (6-15 m)
716	7/2/2010	South Carysfort Reef	25º 12.245	80º 13.321	Low-relief hard-bottom (6-15 m)
700	7/2/2010	South Carysfort Reef	25º 12.566	80º 13.102	High-relief spur and groove
700A	7/2/2010	South Carysfort Reef	25º 12.412	80º 13.268	High-relief spur and groove
B66	7/2/2010	South of S. Carysfort (Maitland)	25º 11.924	80º 13.531	High-relief spur and groove
B39	7/2/2010	SW Carysfort Reef	25º 12.277	80º 13.727	Offshore patch reef
629A	7/24/2010	Mosquito Bank	25º 04.107	80º 22.986	Mid-channel patch reef
629B	7/24/2010	Mosquito Bank	25º 03.987	80º 22.347	Mid-channel patch reef
629	7/24/2010	Mosquito Bank	25º 03.857	80º 22.555	Mid-channel patch reef
B25A	7/24/2010	Inshore of Molasses Reef	25º 02.463	80º 23.635	Mid-channel patch reef
B25	7/24/2010	Inshore of Molasses Reef	25º 02.342	80º 23.895	Mid-channel patch reef
B25B	7/24/2010	Inshore of Molasses Reef	25º 01.109	80º 26.336	Mid-channel patch reef
638	7/24/2010	Inshore of Pickles Reef	24º 59.513	80º 27.832	Mid-channel patch reef
639	7/24/2010	Inshore of Pickles Reef	24º 59.137	80º 26.178	Offshore patch reef
696	7/25/2010	NE Pickles Reef	24º 59.465	80º 24.748	High-relief spur and groove
695	7/25/2010	Pickles Reef P3	24º 59.244	80º 24.873	High-relief spur and groove
697	7/25/2010	Pickles Reef P1	24º 59.095	80º 24.974	High-relief spur and groove
688A	7/25/2010	Pickles Reef	24º 59.185	80º 25.129	Back reef rubble
688B	7/25/2010	Pickles Reef	24º 59.461	80º 24.949	Back reef rubble
693	7/25/2010	Little Pickles Reef	24º 59.023	80º 25.148	Low-relief hard-bottom (< 6 m)
710	7/25/2010	SW of Molasses Reef SPA	25º 00.453	80º 23.293	Low-relief spur and groove (6-15 m)
706	7/26/2010	Molasses Reef	25º 00.543	80º 22.621	High-relief spur and groove
707	7/26/2010	Molasses Reef	25º 00.617	80º 22.411	High-relief spur and groove
B62	7/26/2010	Molasses Reef	25º 00.664	80º 22.716	Back reef rubble
691	7/26/2010	Molasses Reef	25º 00.738	80º 22.614	Back reef rubble
688	7/26/2010	Sand Island	25º 01.345	80º 22.268	Back reef rubble

Site #	Date	Site location	Latitude (N)	Longitude (W)	Habitat type
711	7/26/2010	Sand Island	25º 01.089	80º 22.099	High-relief spur and groove
712	7/26/2010	SW of French Reef	25º 01.741	80º 21.530	Low-relief hard-bottom (6-15 m)
642	7/26/2010	SE of White Bank Dry Rocks	25º 02.145	80º 21.976	Offshore patch reef
662	7/27/2010	Grecian Rocks	25º 06.532	80º 18.312	Inner line reef tract
663	7/27/2010	Grecian Rocks	25º 06.627	80º 18.236	Inner line reef tract
B42	7/27/2010	Little Grecian Rocks	25º 07.112	80º 18.028	Inner line reef tract
660	7/27/2010	Key Largo Dry Rocks	25º 07.342	80º 17.868	Inner line reef tract
661	7/27/2010	Key Largo Dry Rocks	25º 07.454	80º 17.843	Inner line reef tract
656	7/27/2010	North Dry Rocks	25º 07.803	80º 17.631	Inner line reef tract
657	7/27/2010	North-North Dry Rocks	25º 08.175	80º 17.407	Inner line reef tract
704	7/28/2010	French Reef	25º 02.044	80º 20.944	High-relief spur and groove
705	7/28/2010	French Reef	25º 02.161	80º 20.862	High-relief spur and groove
699	7/28/2010	North of French Reef	25º 02.453	80º 20.703	High-relief spur and groove
664	7/28/2010	North of French Reef	25º 03.128	80º 21.048	Low-relief hard-bottom (< 6 m)
B33	7/28/2010	East of White Bank Dry Rocks	25º 02.122	80º 21.857	Offshore patch reef
689	7/29/2010	Inshore of Dixie Shoal	25º 03.596	80º 19.977	Back reef rubble
665	7/29/2010	Inshore of Dixie Shoal	25º 04.736	80º 20.548	Low-relief hard-bottom (< 6 m)
671	7/29/2010	South of Grecian Rocks	25º 06.045	80º 18.512	Patchy hard-bottom (6-15 m)
702	7/29/2010	Elbow Reef	25º 08.458	80º 15.552	High-relief spur and groove
703	7/29/2010	Elbow Reef	25º 08.752	80º 15.421	High-relief spur and groove
702A	7/29/2010	Elbow Reef	25º 08.811	80º 15.602	Back reef rubble
702B	7/29/2010	Elbow Reef	25º 08.685	80º 15.630	Back reef rubble
B35	7/29/2010	West of Elbow Reef	25º 09.213	80º 16.074	Offshore patch reef
626	7/30/2010	Conch Reef	24º 57.156	80º 27.133	Low-relief spur and groove (6-15 m)
B16	7/30/2010	Conch Reef	24º 57.303	80º 27.361	Low-relief spur and groove (6-15 m)
A86	7/30/2010	Conch Reef C3	24º 57.384	80º 27.421	Low-relief hard-bottom (< 6 m)
555A	7/30/2010	Conch Reef	24º 57.593	80º 27.591	Back reef rubble
555B	7/30/2010	Conch Reef	24º 57.658	80º 27.449	Back reef rubble
625	7/31/2010	Conch Reef	24º 57.031	80º 27.253	Low-relief spur and groove (6-15 m)
610	7/31/2010	Conch Reef	24º 57.169	80º 27.448	Low-relief spur and groove (6-15 m)
555	7/31/2010	Conch Reef C2	24º 57.292	80º 27.504	Low-relief hard-bottom (< 6 m)
708	7/31/2010	NE of Conch Reef	24º 58.028	80º 26.767	Low-relief spur and groove (6-15 m)
B24	8/1/2010	Conch Reef	24º 56.885	80º 27.312	Low-relief spur and groove (6-15 m)
611	8/1/2010	Conch Reef	24º 57.092	80º 27.520	Low-relief spur and groove (6-15 m)
554	8/1/2010	Conch Reef C1	24º 57.139	80º 27.565	Low-relief hard-bottom (< 6 m)
552	8/2/2010	SW of Crocker Reef	24º 52.562	80º 34.563	Patchy hard-bottom (6-15 m)
551	8/2/2010	SW of Crocker Reef	24º 52.621	80º 34.415	Low-relief hard-bottom (6-15 m)
568	8/2/2010	SW of Crocker Reef	24º 53.324	80º 33.581	Low-relief hard-bottom (6-15 m)
569	8/2/2010	SW of Crocker Reef	24º 53.543	80º 33.568	Low-relief hard-bottom (6-15 m)
A931	8/2/2010	SW of Crocker Reef	24º 54.109	80º 32.691	Low-relief hard-bottom (6-15 m)
A932	8/2/2010	Crocker Reef	24º 54.518	80º 31.631	Low-relief hard-bottom (< 6 m)
583	8/2/2010	Crocker Reef	24º 54.519	80º 31.751	Back reef rubble
578	8/2/2010	Crocker Reef	24º 54.650	80º 31.815	Back reef rubble
612	8/4/2010	Davis Reef	24º 55.157	80º 30.349	Low-relief spur and groove (6-15 m)
613	8/4/2010	Davis Reef	24º 55.264	80º 30.349	Low-relief spur and groove (6-15 m)
556	8/4/2010	Davis Reef	24º 55.306	80º 30.367	Low-relief hard-bottom (< 6 m)
A87	8/4/2010	Davis Reef	24º 55.412	80º 30.291	Low-relief hard-bottom (< 6 m)
A84	8/4/2010	Little Conch Reef	24º 56.463	80º 28.657	Low-relief hard-bottom (< 6 m)
A85	8/4/2010	Little Conch Reef	24º 56.568	80º 28.444	Low-relief hard-bottom (< 6 m)
A801	8/4/2010	Inshore of Conch Reef	24º 57.464	80º 29.513	Offshore patch reef
A802	8/4/2010	Inshore of Conch Reef	24º 57.363	80º 29.576	Offshore patch reef
A741	8/26/2010	Tavernier Rocks	24º 56.594	80º 33.376	Mid-channel patch reef
A941	8/26/2010	North of Davis Reef	24º 55.928	80º 29.533	Low-relief hard-bottom (6-15 m)
A942	8/26/2010	Little Conch Reef	24º 56.335	80º 28.709	Low-relief spur and groove (6-15 m)
A94	8/26/2010	Little Conch Reef	24º 56.428	80º 28.515	Low-relief hard-bottom (6-15 m)
579A	8/26/2010	Inshore of Conch Reef	24º 57.586	80º 29.456	Offshore patch reef
579B	8/26/2010	Inshore of Conch Reef	24º 57.673	80º 29.298	Offshore patch reef
579C	8/26/2010	NE of Conch Reef	24º 57.776	80º 27.185	Low-relief hard-bottom (< 6 m)
709	8/27/2010	Pickles Reef	24º 59.031	80º 24.968	Low-relief spur and groove (6-15 m)
B71	8/27/2010	Dixie Shoal	25º 04.670	80º 18.888	Patchy hard-bottom (6-15 m)

Site #	Date	Site location	Latitude (N)	Longitude (W)	Habitat type
B51	8/27/2010	East of Dry Rocks	25º 07.719	80º 17.641	Patchy hard-bottom (6-15 m)
644	8/28/2010	Watson's Reef	25º 10.076	80º 16.062	Offshore patch reef
645	8/28/2010	Watson's Reef	25º 10.249	80º 15.503	Offshore patch reef
B57	8/28/2010	SE of Watson's Reef	25º 09.608	80º 15.180	Patchy hard-bottom (6-15 m)
682	8/28/2010	North of Elbow Reef	25º 09.393	80º 15.255	Patchy hard-bottom (6-15 m)
713	8/28/2010	North of Elbow Reef	25º 09.184	80º 15.447	Patchy hard-bottom (6-15 m)

Table 2-3. Site locations and physical data for benthic surveys in the upper Florida Keys National Marine Sanctuary during June-August 2010. Sites are arranged from southwest to northeast by habitat type. Asterisked sites (**) are Sanctuary Preservation Areas (SPA) or Research Only Areas (RO). Mean ± 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)
Inshore and mid-channel patch reefs				
Middle Florida Keys				
A741 – Tavernier Rocks	24º 56.594	80º 33.376	3.6 ± 0.3	95 ± 17
534 – Hen and Chickens SPA**	24º 56.115	80º 32.893	5.6 ± 0.5	171 ± 25
535 – Hen and Chickens SPA**	24º 56.262	80º 32.861	4.5 ± 0.2	243 ± 25
A74 – West of Conch Reef	24º 57.168	80º 30.364	4.0 ± 0.2	53 ± 7
533 – West of Conch Reef	24º 56.791	80º 30.129	6.0 ± 0.2	78 ± 8
A73 – West of Conch Reef	24º 57.529	80º 29.427	3.5 ± 0.2	27 ± 6
Middle Florida Keys Total (6)			4.5 ± 0.4	111 ± 33
Upper Florida Keys				
638 – Inshore of Pickles Reef	25º 59.513	80º 27.832	3.8 ± 0.1	83 ± 15
B25B – Inshore of Molasses Reef	25º 01.109	80º 26.336	2.7 ± 0.1	61 ± 24
B25 – Inshore of Molasses Reef	25º 02.342	80º 23.895	2.9 ± 0.1	50 ± 11
B25A – Inshore of Molasses Reef	25º 02.463	80º 23.635	2.8 ± 0.1	29 ± 7
627 – Mosquito Bank	25º 04.451	80º 22.991	2.4 ± 0.2	78 ± 12
629A – Mosquito Bank	25º 04.107	80º 22.986	2.1 ± 0.1	74 ± 9
628 – Mosquito Bank	25º 04.350	80º 22.811	2.5 ± 0.3	110 ±11
629 – Mosquito Bank	25º 03.857	80º 22.555	2.8 ± 0.1	44 ± 5
629B – Mosquito Bank	25º 03.987	80º 22.347	2.4 ± 0.1	31 ± 18
630 – SE of Cannon Patch Reef	25º 06.139	80º 20.630	3.5 ± 0.2	62 ± 5
631 – Marker 33	25º 08.208	80º 19.871	4.5 ± 0.4	71 ± 10
633 – Basin Hill Shoals	25º 13.250	80º 15.618	2.3 ± 0.2	61 ± 9
634 – Basin Hill Shoals	25º 13.772	80º 15.533	3.4 ± 0.1	73 ± 13
637 – West of Turtle Rocks	25º 17.210	80º 13.425	3.1 ± 0.3	63 ± 11
636 – West of Turtle Rocks	25º 17.713	80º 13.342	3.3 ± 0.3	116 ± 3
Upper Florida Keys Total (15)			3.0 ± 0.2	67 ± 6
Mid-channel Patch Reef Total (21)			**3.4 ± 0.2**	**80 ± 11**
Offshore patch reefs				
Middle Florida Keys				
A802 – Inshore of Conch Reef	24º 57.363	80º 29.576	4.6 ± 0.2	66 ± 10
A801 – Inshore of Conch Reef	24º 57.464	80º 29.513	4.2 ± 0.0	72 ± 12
579A – Inshore of Conch Reef	24º 57.586	80º 29.456	4.3 ± 0.4	102 ± 12
579B – Inshore of Conch Reef	24º 57.673	80º 29.298	3.9 ± 0.1	43 ± 4
Middle Florida Keys Total (4)			4.2 ± 0.1	71 ± 12
Upper Florida Keys				
639 – Inshore of Pickles Reef	24º 59.137	80º 26.178	7.9 ± 0.1	48 ± 7
640 – White Bank (West of Molasses)	25º 01.114	80º 25.467	3.4 ± 0.2	44 ± 8
641 – White Bank (West of Molasses)	25º 01.988	80º 22.836	4.4 ± 0.2	48 ± 3
642 – SE of White Bank Dry Rocks	25º 02.145	80º 21.976	6.8 ± 0.2	100 ±14
B33 – East of White Bank Dry Rocks	25º 02.122	80º 21.857	5.7 ± 0.2	81 ± 14
643 – White Bank (NW of French)	25º 03.022	80º 21.612	4.5 ± 0.1	22 ± 2
B35 – West of Elbow Reef	25º 09.213	80º 16.074	5.0 ± 0.1	136 ±24
644 – Watson's Reef	25º 10.076	80º 16.062	4.4 ± 0.4	114 ± 37
645 – Watson's Reef	25º 10.249	80º 15.503	5.6 ± 0.1	84 ± 17
648 – East of Basin Hill Shoals	25º 12.895	80º 15.147	2.4 ± 0.1	40 ± 10
649 – West of Carysfort Reef	25º 13.377	80º 13.781	2.7 ± 0.2	38 ± 4
B39 – Carysfort Reef SPA**	25º 12.277	80º 13.727	5.1 ± 0.2	59 ± 8
653 – Carysfort Reef SPA**	25º 12.501	80º 13.456	3.6 ± 0.2	64 ± 7
Upper Florida Keys Total (13)			4.7 ± 0.4	67 ± 9
Offshore Patch Reef Total (17)			**4.6 ± 0.4**	**68 ± 8**

Site number/site location	Latitude (N)	Longitude (W)	Mean depth (m)	Max. vertical relief (cm)
Back reef rubble				
Middle Florida Keys				
578 – Crocker Reef	24º 54.650	80º 31.815	5.1 ± 0.2	15 ± 3
583 – Crocker Reef	24º 54.519	80º 31.751	5.7 ± 0.2	24 ± 5
555A – Conch Reef	24º 57.593	80º 27.591	2.1 ± 0.1	18 ± 3
555B – Conch Reef	24º 57.658	80º 27.449	2.5 ± 0.1	29 ± 5
Middle Florida Keys Total (4)			3.8 ± 0.9	22 ± 1
Upper Florida Keys				
688A – Pickles Reef	24º 59.185	80º 25.129	2.6 ± 0.0	31 ± 2
688B – Pickles Reef	24º 59.461	80º 24.949	2.4 ± 0.0	20 ± 2
B62 – Molasses Reef SPA**	25º 00.664	80º 22.716	3.0 ± 0.2	27 ± 3
691 – Molasses Reef SPA**	25º 00.738	80º 22.614	2.9 ± 0.2	21 ± 3
688 – Sand Island	25º 01.345	80º 22.268	2.5 ± 0.1	19 ± 1
689 – Inshore of Dixie Shoal	25º 03.596	80º 19.977	5.8 ± 0.1	25 ± 3
702B – Elbow Reef SPA**	25º 08.685	80º 15.630	3.8 ± 0.1	19 ± 3
702A – Elbow Reef SPA**	25º 08.811	80º 15.602	4.2 ± 0.0	20 ± 2
Upper Florida Keys Total (8)			3.4 ± 0.4	22 ± 0
Back Reef Rubble Total (12)			**3.5 ± 0.4**	**22 ± 0**
Low-relief hard-bottom (< 6 m)				
Middle Florida Keys				
A932 – Crocker Reef	24º 54.518	80º 31.631	3.8 ± 0.0	51 ± 8
556 – Davis Reef SPA**	24º 55.306	80º 30.367	6.4 ± 0.1	67 ± 8
A87 – Davis Reef SPA**	24º 55.412	80º 30.291	5.6 ± 0.0	60 ± 21
A84 – Little Conch Reef	24º 56.463	80º 28.657	3.9 ± 0.3	52 ± 4
A85 – Little Conch Reef	24º 56.568	80º 28.444	4.5 ± 0.1	42 ± 4
554 – Conch Reef C1**	24º 57.139	80º 27.565	5.0 ± 0.1	67 ± 7
555 – Conch Reef C2**	24º 57.292	80º 27.504	5.0 ± 0.2	55 ± 9
A86 – Conch Reef C3**	24º 57.384	80º 27.421	5.9 ± 0.1	79 ± 12
579C – NE of Conch Reef	24º 57.776	80º 27.185	5.1 ± 0.1	48 ± 4
Middle Florida Keys Total (9)			5.0 ± 0.3	58 ± 4
Upper Florida Keys				
693 – Little Pickles Reef	24º 59.023	80º 25.148	4.8 ± 0.1	35 ± 6
664 – North of French Reef	25º 03.128	80º 21.048	4.7 ± 0.2	89 ± 34
665 – Inshore of Dixie Shoal	25º 04.736	80º 20.548	3.9 ± 0.1	26 ± 2
Upper Florida Keys Total (3)			4.5 ± 0.3	50 ± 20
Shallow Hard-bottom Total (17)			**4.9 ± 0.2**	**56 ± 5**
High-relief spur & groove				
Upper Florida Keys				
697 – Pickles Reef P1	24º 59.095	80º 24.974	4.5 ± 0.1	56 ± 12
695 – Pickles Reef P3	24º 59.244	80º 24.873	4.5 ± 0.2	72 ± 9
696 – NE Pickles Reef	24º 59.465	80º 24.748	4.0 ± 0.1	59 ± 11
706 – Molasses Reef SPA**	25º 00.543	80º 22.621	5.4 ± 0.1	208 ± 32
707 – Molasses Reef SPA**	25º 00.617	80º 22.411	4.4 ± 0.3	86 ± 16
711 – Sand Island	25º 01.089	80º 22.099	4.2 ± 0.2	120 ± 18
704 – French Reef SPA**	25º 02.044	80º 20.944	6.2 ± 0.1	118 ± 19
705 – French Reef SPA**	25º 02.161	80º 20.862	5.8 ± 0.4	83 ± 10
699 – North of French Reef	25º 02.453	80º 20.703	3.3 ± 0.4	50 ± 13
662 – Grecian Rocks SPA**	25º 06.532	80º 18.312	3.5 ± 0.1	120 ± 9
663 – Grecian Rocks SPA**	25º 06.627	80º 18.236	2.8 ± 0.2	101 ± 18
B42 – Little Grecian Rocks	25º 07.112	80º 18.028	4.0 ± 0.1	183 ± 15
660 – Key Largo Dry Rocks**	25º 07.342	80º 17.868	3.1 ± 0.2	159 ± 39
661 – Key Largo Dry Rocks**	25º 07.454	80º 17.843	3.1 ± 0.5	130 ± 30
656 – North Dry Rocks	25º 07.803	80º 17.631	3.3 ± 0.1	133 ± 39
657 – North-North Dry Rocks	25º 08.175	80º 17.407	3.8 ± 0.2	123 ± 13
702 – Elbow Reef SPA**	25º 08.458	80º 15.552	6.4 ± 0.1	109 ± 18
703 – Elbow Reef SPA**	25º 08.752	80º 15.421	6.5 ± 0.1	188 ± 19
B66 – South of S. Carysfort	25º 11.924	80º 13.531	3.7 ± 0.2	63 ± 18

Site number/site location	Latitude (N)	Longitude (W)	Mean depth (m)	Max. vertical relief (cm)
700A – South Carysfort Reef**	25º 12.412	80º 13.268	3.4 ± 0.3	86 ± 21
700 – South Carysfort Reef**	25º 12.566	80º 13.102	4.0 ± 0.4	160 ± 30
B67 – Carysfort Reef C2**	25º 13.210	80º 12.643	3.8 ± 0.2	138 ± 28
701 – Carysfort Reef C5**	25º 13.332	80º 12.603	3.7 ± 0.1	174 ± 42
659 – Turtle Reef	25º 16.976	80º 12.438	3.9 ± 0.2	74 ± 12
Upper Florida Keys Total (24)			4.2 ± 0.2	116 ± 9
High-relief Spur & Groove Total (42)			**4.2 ± 0.2**	**116 ± 9**
Deeper Fore-reef (6-15 m)				
Middle Florida Keys				
552 – SW of Crocker Reef	24º 52.562	80º 34.563	8.0 ± 0.1	45 ± 6
551 – SW of Crocker Reef	24º 52.621	80º 34.415	8.8 ± 0.1	26 ± 3
568 – SW of Crocker Reef	24º 53.324	80º 33.581	9.5 ± 0.2	27 ± 12
569 – SW of Crocker Reef	24º 53.543	80º 33.568	8.2 ± 0.1	16 ± 7
A931 – SW of Crocker Reef	24º 54.109	80º 32.691	7.3 ± 0.1	21 ± 7
612 – Davis Reef SPA**	24º 55.157	80º 30.349	10.3 ± 0.1	31 ± 7
613 – Davis Reef SPA**	24º 55.264	80º 30.349	10.7 ± 0.0	35 ± 3
A941 – North of Davis Reef	24º 55.928	80º 29.533	7.7 ± 0.2	53 ± 13
A942 – Little Conch Reef	24º 56.335	80º 28.709	8.1 ± 0.5	54 ± 16
A94 – Little Conch Reef	24º 56.428	80º 28.515	9.6 ± 0.2	36 ± 8
B24 – Conch Reef RO**	24º 57.092	80º 27.520	14.2 ± 0.1	80 ± 14
625 – Conch Reef RO**	24º 57.169	80º 27.448	13.7 ± 0.1	58 ± 6
611 – Conch Reef SPA**	24º 57.303	80º 27.361	9.4 ± 0.1	47 ± 8
626 – Conch Reef RO**	24º 56.885	80º 27.312	13.9 ± 0.1	49 ± 4
610 – Conch Reef SPA**	24º 57.031	80º 27.253	10.5 ± 0.2	50 ± 4
B16 – Conch Reef SPA**	24º 57.156	80º 27.133	11.7 ± 0.0	29 ± 6
Middle Florida Keys Total (16)			10.1 ± 0.6	41 ± 4
Upper Florida Keys				
708 – NE of Conch Reef	24º 58.028	80º 26.767	9.8 ± 0.1	44 ± 4
709 – Pickles Reef	24º 59.031	80º 24.968	9.1 ± 0.0	35 ± 4
710 – SW of Molasses Reef SPA	25º 00.453	80º 23.293	7.2 ± 0.1	38 ± 6
712 – SW of French Reef	25º 01.741	80º 21.530	8.0 ± 0.0	24 ± 5
B71 – Dixie Shoal	25º 04.670	80º 18.888	7.6 ± 0.2	63 ± 5
671 – South of Grecian Rocks	25º 06.045	80º 18.512	8.0 ± 0.1	64 ± 14
B51 – East of Dry Rocks	25º 07.719	80º 17.641	6.9 ± 0.1	36 ± 4
713 – North of Elbow Reef	25º 09.184	80º 15.447	9.0 ± 0.2	56 ± 10
682 – North of Elbow Reef	25º 09.393	80º 15.255	10.5 ± 0.2	41 ± 10
B57 – SE of Watson's Reef	25º 09.608	80º 15.180	10.2 ± 0.2	53 ± 3
716 – South Carysfort Reef**	25º 12.245	80º 13.321	8.9 ± 0.3	35 ± 3
678 – North Carysfort Reef**	25º 12.921	80º 12.669	7.6 ± 0.1	20 ± 5
717 – North Carysfort Reef**	25º 13.540	80º 12.437	8.3 ± 0.2	33 ± 6
679 – North Carysfort Reef**	25º 13.706	80º 12.224	7.8 ± 0.1	43 ± 6
675 – North of Carysfort Reef	25º 14.316	80º 12.084	8.0 ± 0.2	57 ± 7
676 – North of Carysfort Reef	25º 15.740	80º 11.796	9.9 ± 0.1	48 ± 9
677 – North of Carysfort Reef	25º 15.937	80º 11.659	10.4 ± 0.2	28 ± 2
715 – North of Carysfort Reef	25º 16.396	80º 11.368	9.1 ± 0.1	50 ± 6
Upper Florida Keys Total (18)			8.7 ± 0.3	43 ± 3
Deeper Fore-reef Total (34)			**9.4 ± 0.3**	**42 ± 3**

Table 2-4. SCUBA diving effort for benthic coral reef surveys in the upper Florida Keys National Marine Sanctuary during June-August 2010.

Scientific Diver	Affiliation	No. of dives	Depth range (m)	Bottom time
Mark Chiappone	CMS/UNCW	120	2.4-14.6 m	68 hr 52 min
Leanne Rutten	CMS/UNCW	104	2.7-14.9 m	59 hr 48 min
Thor Dunmire	CMS/UNCW	16	2.4-14.9 m	8 hr 31 min
Total all divers		240	0.5-16.8 m	137 hr 11 min