Volunteer Reef Fish Monitoring in the Florida Keys National Marine Sanctuary 2000 Annual Report – REEF Zone Monitoring

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The Florida Keys National Marine Sanctuary Zoning Plan

On July 1, 1997, a new management plan went into effect in the Florida Keys National Marine Sanctuary (FKNMS) that included a large-scale marine zoning plan with 23 no-take zones. These zones aim to protect the biological diversity and integrity of the marine environment in the Keys. In addition to providing areas that are limited to non-extractive recreation, they are intended to act as replenishment zones where the total abundance of fishes, their average size, and their overall egg production increases.

In the year 2002, State and Federal managers will reevaluate the use of zones as a management tool. Therefore, the FKNMS and NOAA's South Florida Restoration Fund is supporting a wide-scale, three-tiered monitoring program in order to evaluate the effects of the zones on biodiversity and human activities. Monitoring projects include research on coral, algae, fish, lobster, and human values. The three levels are ecosystem focus, human/ecosystem interface, and volunteer monitoring of ecosystem health. It is at this third level that REEF is involved.

REEF and The Florida Keys

REEF has a strong foundation in the Keys. The very first roving dives and REEF field surveys were conducted in Key Largo in 1993. As of April 2001, 6,974 fish surveys have been completed in the Florida Keys by REEF members.

In 1997, the FKNMS contracted REEF to begin Level 3 monitoring at 31 sites as part of the zone monitoring program. REEF formed its Advanced Assessment Team (AAT) in direct response to this contract with FKNMS, inviting their highly trained and active volunteers to become a part of the project. Since then, members of REEF's AAT have annually conducted fish surveys as part of this monitoring program.

REEF's AAT Project and Results

The main purpose of the REEF AAT project in the Florida Keys is to provide baseline and continual data that can be used to evaluate the effect of harvest restrictions on the fish assemblages at specific no-take sites. This project supports a team of REEF's most experienced surveyors, the Advanced Assessment Team (AAT), to annually survey 37 sites in the Florida Keys National Marine Sanctuary (FKNMS), including 12 Sanctuary Preservation Areas, 3 Research Only sites, 1 Ecological Reserve, 10 sites in the proposed Dry Tortugas Ecological Reserve area, and 10 comparison/reference sites (Table 1). A minimum of six surveys are conducted at each site. This is the fourth year that the AAT has monitored most of these sites (in 2000, 4 sites in the Dry Tortugas and 1 new reference site were included in the survey design). These data are collected during a series of cruises in October, and complement REEF's ongoing survey activities in the Florida Keys.

During the 2000 field season, 300 RDT surveys were conducted by the REEF AAT (Table 2) documenting 244 fish species. Several species were documented within the FKNMS for the first time,

including black brotula (*Stygnobrotula* latebricola), wrasse bass (*Liopropoma eukrines*), and belted sandfish (*Serranus subligarius*). During the 1999 AAT survey, 231 species were documented during 218 surveys.

Changes over time in frequency and abundance of harvested species were evaluated using the entire REEF database, including the data collected during the AAT project. The REEF database as a whole represents a valuable source of baseline and continual data from over 223 Florida Keys sites. To date, a total of 6,974 RDT surveys have been conducted in the FKNMS (Figure 1), and 2,938 of those were prior to July 1, 1997, when the marine zoning plan was implemented. These data were used to evaluate the change in average abundance score of three species of snapper (gray, *Lutjanus griseusi;* schoolmaster, *L. apodus*; and yellowtail, *Ocyurus chrysurus*) at sixteen of the SPAs and reference sites before and after July 1, 1997. Survey effort at each site during each time range was between 29 and 332. The general trend among the three species was an increase in average estimated abundance after zone implementation (Figure 2). Two exceptions were Molassess SPA and Middle Sambo. Sighting frequency of black grouper (*Mycteroperca bonaci*) and Nassau grouper (*Epinephelus striatus*) before and after the harvest restrictions went into effect was also evaluated (Figure 3), and a similar trend was found. Sighting frequency was used in the grouper analysis because it is a more sensitive measure of change for species that, when sighted, only one or few individuals are seen.

Another type of analysis looks at the assemblage of species at a given site, rather than just harvested species. This is useful because as harvest restrictions are implemented, one would expect cascading effects, such as decreases in herbivorous damselfishes and other species as a result of increased abundances of targeted species (grouper, snapper, etc.) that are often top predators on a reef. These assemblage-level analyses use the similarity of assemblages (species present and their abundance) among sites as a tool for evaluating change over time. The AAT data are used to produce a similarity index based on a correlation coefficient, such as Spearman's coefficient. This coefficient ranges from 0 to1, where 0 indicates no similarity and 1 is exact similarity. In other words, a Spearman's of 1.0 means that the same species in the same relative abundance were documented at each site. We would expect the similarity between protected and reference sites to initially decrease after protection, but ultimately come back to some equilibrium point. This assumes that the protected area acts as a refuge that increases overall production for an area. This assumption will vary according to the size and location of the sites. For each protected-reference site pair, the Spearman's coefficient is given for 1997,1998, 1999, and 2000, based on AAT data (Table 3).

Cluster analysis is another comparison tool, and is useful in creating a visual picture of similarity in assemblages among sites. The cluster diagram in Figure 4 was developed using the 2000 AAT data. The joint of each cluster corresponds to the x-axis; the smaller the distance the more similar the sites are in fish presence and relative abundance. The ten Dry Tortugas sites formed a distinct cluster. Reefs of similar type, such as patch reefs or bank reefs, also tended to cluster together. In addition to providing a graphical view of the sites, cluster analysis may be useful in detecting shifts in the assemblage that result in changes in cluster affinities.

Both the similarity coefficient comparisons and the cluster analysis are tools that are expected, over a longer time scale, to provide a useful indicator of the effect of the zones.

In addition to the species-specific analyses presented here, the entire REEF FKNMS dataset was the basis of a recent NOAA technical report that evaluated the distribution and sighting frequency patterns of reef fishes within the FKNMS[1]. The data were also used in a multi-species trend analysis method to identify sites of management concern within the FKNMS[2].

The Future

Over the next few years, the FKNMS will use REEF data in concert with fish survey data collected by the National Marine Fisheries Service to evaluate the effectiveness of the zones. In addition to providing monitoring data for the FKNMS, data collected during the AAT project in the Florida Keys is a valuable addition to REEF's growing database. In the coming years, REEF will also continue to focus effort on the Dry Tortugas area in order to measure the effect of upcoming harvest restrictions that will result in the creation of the new Dry Tortugas Ecological Reserve. REEF will also continue its work with NOAA's Biogeography Office to use the REEF database and the FKNMS Benthic Habitat database to investigate fish-habitat interactions, to map species distributions in the FKNMS, and to evaluate the effect of the zones by analyzing shifts in assemblage composition and feeding guilds over time. The success of this AAT project has encouraged REEF to expand the work of its AAT members to other projects. These opportunities will not only assist local conservation and management efforts, but will enable REEF volunteers to be active in those efforts.

[1]Jeffrey, C.F.G., C. Pattengill-Semmens, S. Gittings, and M.E. Monaco. 2001. Distribution and sighting frequency of reef fishes in the Florida Keys National Marine Sanctuary. Marine Sanctuaries Conservation Series MSD-01-1. US Dept. of Commerce, NOAA, Silver Spring, MD. 51 pp.

[2]B.X. Semmens, J.L. Ruesink, and C.V. Pattengill-Semmens. in press. Multi-site multi-species trends: a new tool for coral reef managers. International Coral Reef Symposium, October 2000.

Table 1

REEF Advanced Assessment Team
Volunteer Monitoring of the Florida Keys National Marine Sanctuary
Survey Design and Sites

An Advanced Assessment Team, composed of at least 6 divers, conduct one RDT survey dive at each of the 37 sites. During the 2000 field season, Pelican Shoals and four additional sites on Tortugas Bank were included in the survey design. Eleven additional sites within the Dry Tortugas National Park were also surveyed.

Status	Protected Site	Reference Site
Upper Keys		
SPA	Carysfort Reef	Ball Buoy Reef
SPA	S. Carysfort Reef	Ball Buoy Reef
SPA	Grecian Rocks	Little Grecian
SPA	Molasses Reef	Pickles Reef
SPA	Conch Reef	Pickles Reef
SPA	Hens and Chickens	Cannon Patch
SPA	Cheeca Rocks	Cannon Patch
Rsrch	Tennessee Reef	Delta Shoals
Middle Keys		
SPA	Sombrero Reef	Delta Shoals
SPA	Coffins Patch	Samantha's Ledge
SPA	Newfound Harbor Spa	Newfound Open
Lower Keys		
Rsrch	Looe Key - Research	No Name Reef
SPA	Looe Key - East	No Name Reef
Rsrch	Eastern Sambo	Pelican Shoals
ER	Western Sambo	Middle Sambo
SPA	Sand Key	Western Dry Rocks
Dry Tortugas		
	Texas Rock	
	Pulaski	
	Sherwood Forest	
	G-Spot (near Pinnacles)	
	Wreck Reef (Tortugas Banks)	
	Robins Hood	
	SeaClusive Sanctuary	
	Minefield 5	
	Never See Again	
	Bob's Sanctuary	

Table 2
The number of surveys conducted by the AAT and the survey date for each year of the project.

REEF AAT Florida Keys NMS Zone Monitoring Survey Effort

REEF zone code	Site	Date	1997 N	Date	1998 N	Date	1999 N	Date	2000 N
33020001	Ball Buoy Reef	11/10/97	6	11/22/98	5	9/18/99	6	9/30/00	5
34030004	Grecian Rocks	11/9/97	6	10/22/98	6	9/4/99	8	10/01/00	9
34030006	Carysfort Reef	9/11/97	6	10/22/98	6	9/5/99	8	10/01/00	9
34030009	Molasses Reef	11/9/97	6	10/31/98	6	9/4/99	7	10/02/00	6
34030010	Little Grecian	8/28/97	6	10/22/98	6	9/4/99	7	10/01/00	9
34030012	South Carysfort Reef	9/11/97	6	10/22/98	6	9/5/99	8	10/01/00	9
34030046	Cannon Patch	11/9/97	6	10/31/98	6			10/02/00	6
34030049	Mosquito Bank					9/5/99	8		
34040001	Pickles Reef	11/9/97	6	10/31/98	6	9/4/99	7	10/02/00	6
34040004	Conch Reef	8/5/97	6	9/14/98	6	9/6/99	8	10/03/00	6
34040006	Hens and Chickens	8/5/97	6	9/14/98	6	9/6/99	7	11/20/00	5
34040008	Tennessee Reef	8/7/97	6	9/13/98	6	9/7/99	7	10/04/00	5
34040022	Cheeca Rocks	8/7/97	6	9/14/98	6	9/7/99	7	11/20/00	5
34050001	Sombrero Reef	11/8/97	6	11/1/98	5	9/8/99	7	10/05/00	8
34050002	Samantha's Ledge	11/8/97	6	9/13/98	6	9/8/99	7	10/05/00	8
34050004	Coffins Patch	11/8/97	5	9/13/98	6	9/8/99	7	10/05/00	8
34050005	Looe Key - East	12/1/97	6	10/30/98	6	9/10/99	8	10/07/00	8
34050006	Looe Key - Research	12/1/97	6	10/30/98	6	9/10/99	8	10/07/00	8
34050013	Delta Shoals	11/8/97	6	11/1/98	5	9/8/99	7	10/05/00	8
34050026	Newfound Harbor Spa	12/10/97	6	10/30/98	6	9/9/99	7	10/06/00	8
34050027	Newfound Open	12/10/97	6	10/30/98	6	9/9/99	7	10/06/00	8
34050028	No Name Reef	12/10/97	6	10/30/98	6	9/9/99	7	10/06/00	8
34060002	Adolphus Busch							10/07/00	7
34080001	Western Sambo	12/1/97	6	9/20/98	6	9/11/99	6	10/09/00	13
34080002	Eastern Sambo	9/22/97	6	9/20/98	6	9/11/99	6	10/09/00	10
34080004	Sand Key	9/23/97	6	11/17/98	6	9/12/99	7	10/10/00	11
34080005	Middle Sambo	9/22/97	6	9/20/98	6	9/11/99	6	10/09/00	11
34080006	Pelican Shoals							10/09/00	10
34080018	Western Dry Rocks	9/23/97	6	11/17/98	6	9/12/99	7	10/10/00	11
34100004	Texas Rock	7/25/97	6	11/19/98	6	9/16/99	5	10/11/00	9
34100005	Pulaski	7/27/97	6	11/20/98	6	9/16/99	5	1/14/01	7
34100013	Sherwood Forest	7/25/97	6	11/18/98	6	9/13/99	7	1/12/01	7
34100016	G-Spot	7/26/97	6	11/19/98	6	9/13/99	6	1/13/01	8
34100017	Wreck Reef	7/26/97	6	11/19/98	6	9/16/99	5	1/12/01	8
34100021	Robins Hood			11/20/98	6	9/16/99	5	1/12/01	8
34100041	SeaClusive Sanctuary							1/12/01	8
34100042	Minefield 5							1/13/01	6
34100043	Never See Again							1/13/01	6
34100044	Bob's Sanctuary							1/13/01	8
	Total		185		189		218		300

Table 3

Spearman Correlation Coefficient. Scores are shown for similarity in abundance of fishes for protected-reference site pairs, based on 1997, 1998, 1999, and 2000 REEF AAT data. For example, in 1997, Carysfort Reef and Ball Buoy Reef were 71% similar, but in 1998 the fish assemblages were 53% similar. All things except harvest pressure being equal, we would expect similarity among protected-reference site pairs to initially decrease and then level off at an increased similarity when an equilibrium was reached. These scores can be used to evaluate shifts in fish assemblages over time.

The correlation analysis was performed using the rank of abundance score. In an effort to eliminate the effect of rare species, only species seen in at least 20% of surveys were included in the analysis (91 species).

			protected vs. open		
	1997	**1998**	**1999**	**2000**	
Protected Site					**Reference Site**
Carysfort Reef	0.71	0.53	0.65	0.68	Ball Buoy Reef
S. Carysfort Reef	0.77	0.60	0.68	0.67	Ball Buoy Reef
Grecian Rocks	0.76	0.78	0.72	0.72	Little Grecian
Molasses Reef	0.74	0.88	0.86	0.68	Pickles Reef
Conch Reef	0.61	0.69	0.70	0.68	Pickles Reef
Hens and Chickens	0.66	0.78	0.79*	0.77	Cannon Patch
Cheeca Rocks	0.72	0.71	0.77*	0.79	Cannon Patch
Tennessee Reef	0.63	0.24	0.63	0.41	Delta Shoals
Sombrero Reef	0.82	0.62	0.68	0.77	Delta Shoals
Coffins Patch	0.68	0.67	0.64	0.65	Samantha's Ledge
Newfound Harbor Spa	0.87	0.81	0.84	0.86	Newfound Open
Looe Key - Research	0.42	0.54	0.57	0.57	No Name Reef
Looe Key - East	0.47	0.60	0.50	0.65	No Name Reef
Eastern Sambo	0.89	0.73	0.83	0.76	Middle Sambo
Western Sambo	0.84	0.45	0.79	0.84	Middle Sambo
Sand Key	0.85	0.83	0.87	0.89	Western Dry Rocks

*In 1999, Mosquito Bank was surveyed instead of Cannon Patch.

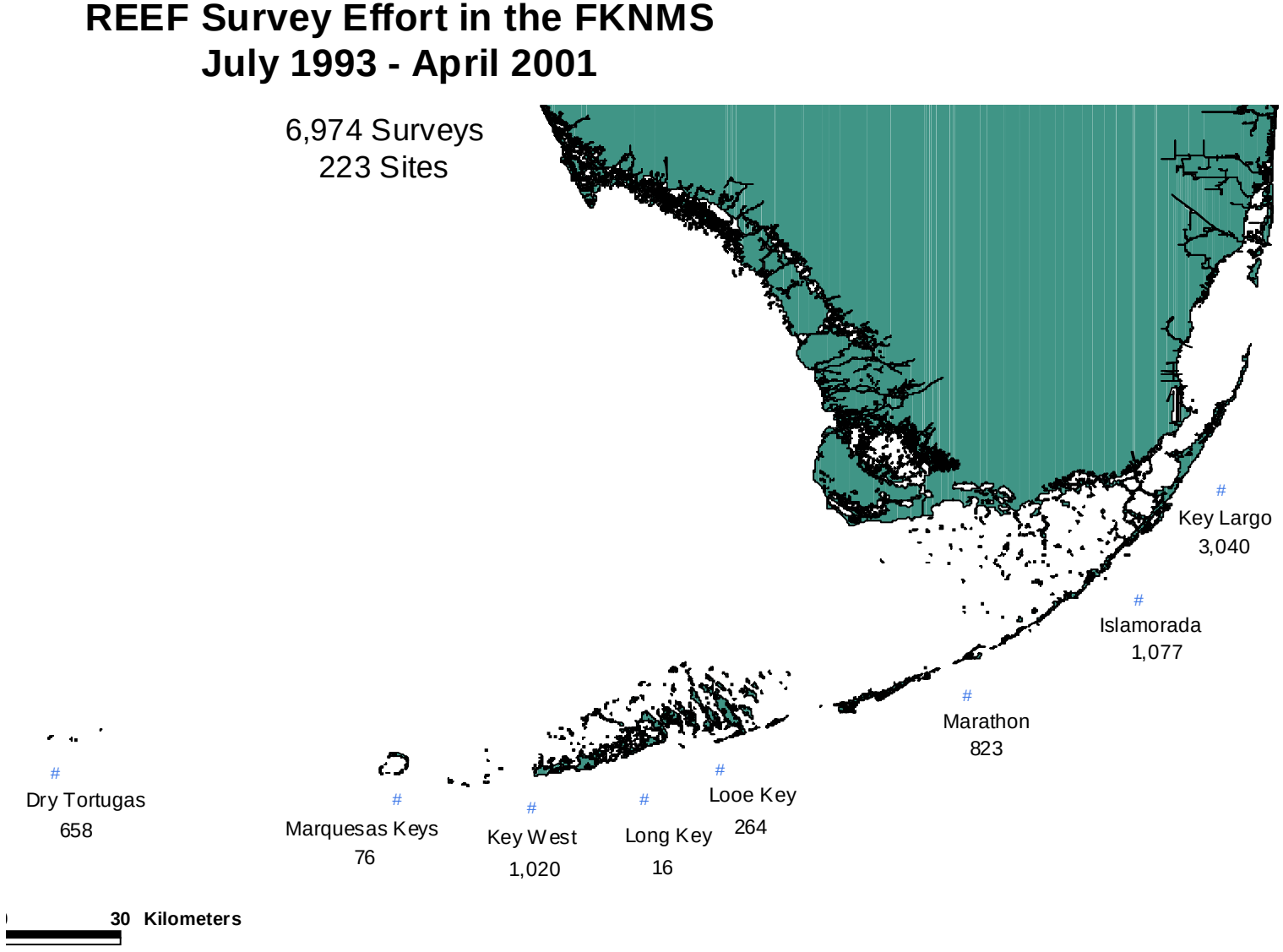
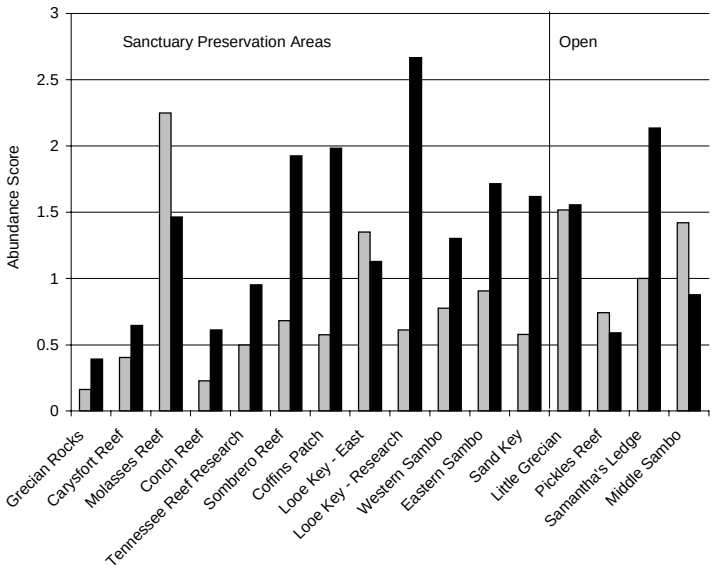
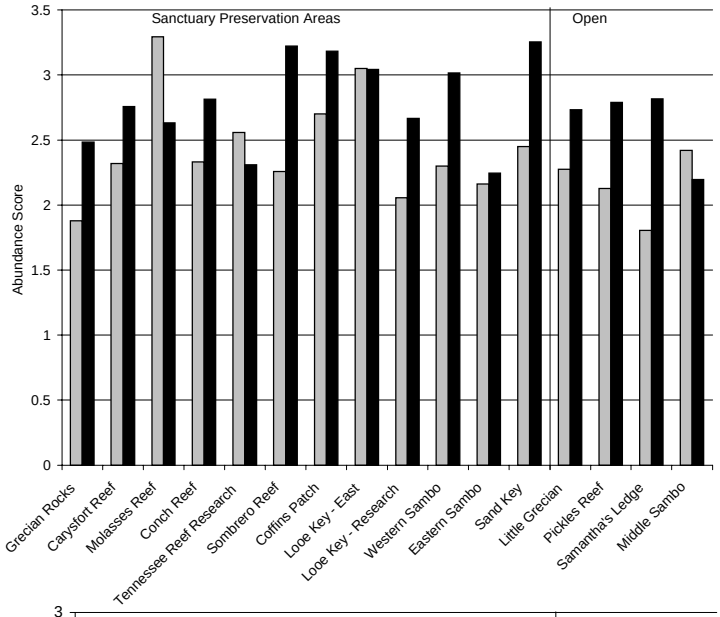


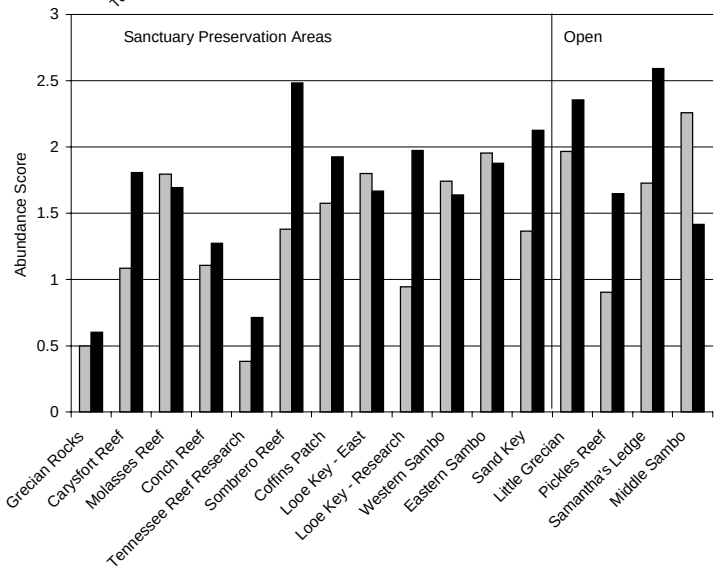
Figure 1
Total number of REEF surveys conducted within eight regions of the Florida Keys National Marine Sanctuary between July 1993 and April 2001.



Gray Snapper



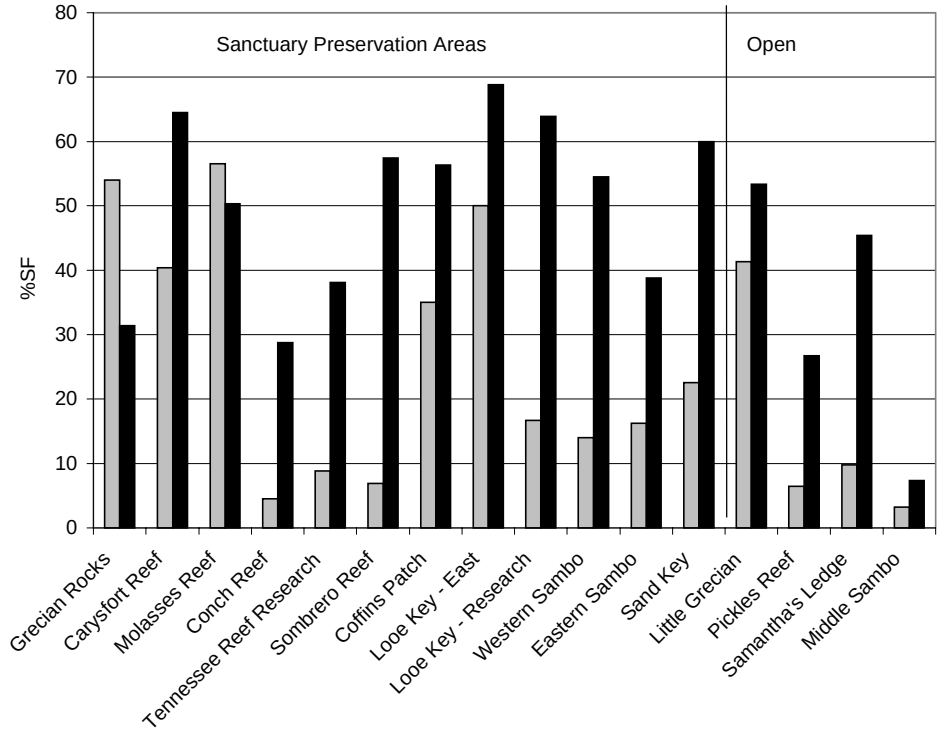
Yellowtail Snapper



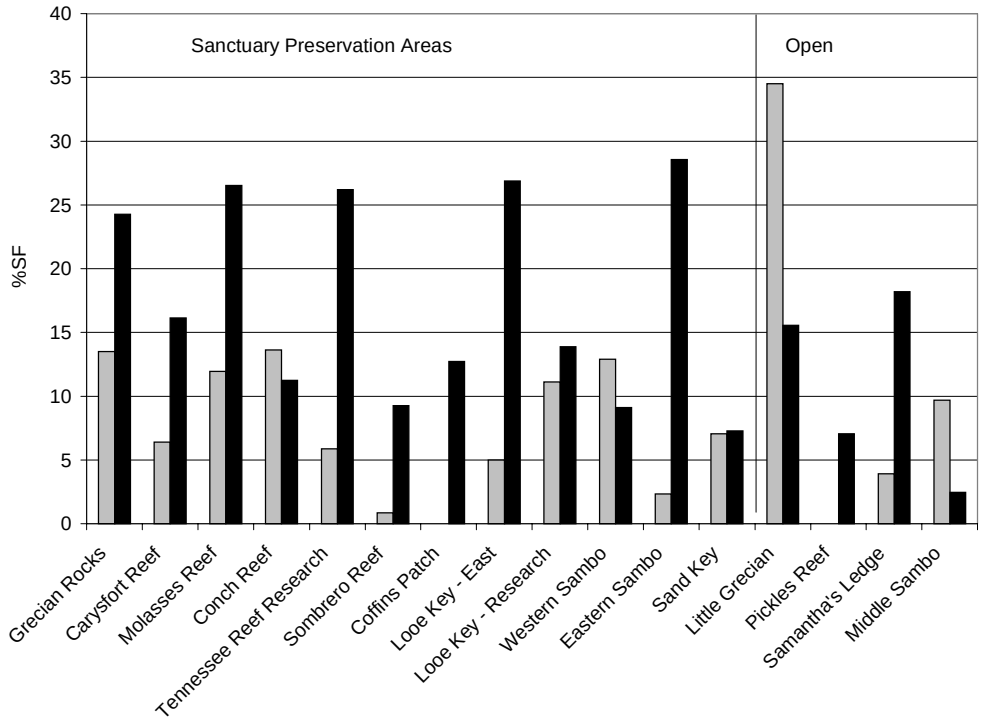
Schoolmaster

Figure 2

Average abundance score for each species is given for 16 sites in the FKNMS, before (July 1, 93 to June 30, 97; gray bars) and after (July 1, 97 to April 31, 01: black bars) harvest restrictions were implemented in the zones. Abundances generally increased or stayed the same at all sites except for Molasses SPA and Middle Sambo.



Black Grouper



Nassau Grouper

Figure 3
The sighting frequency (%SF) of black grouper and Nassau Grouper was compared at eleven sites before (July 1, 93 to June 30, 97; gray bars) and after (July 1, 97 to April 31, 01; black bars) harvest restrictions were implemented in the FKNMS zones. Frequency was used because it is a more sensitive measure of population status than abundance score for species like grouper that, when encountered, only one individual is usually seen. Frequency of sightings increased at most of the sites.

Five of the sites are part of National Marine Sanctuary Existing Management Areas, and have been protected from spearfishing since 1975 (Grecian, Molasses, Little Grecian) and 1981 (Looe Key and Looe Key Research). Groupers are particularly vulnerable to spearfishing, and this long-term protection is likely to confound the effects of comparisons such as this.

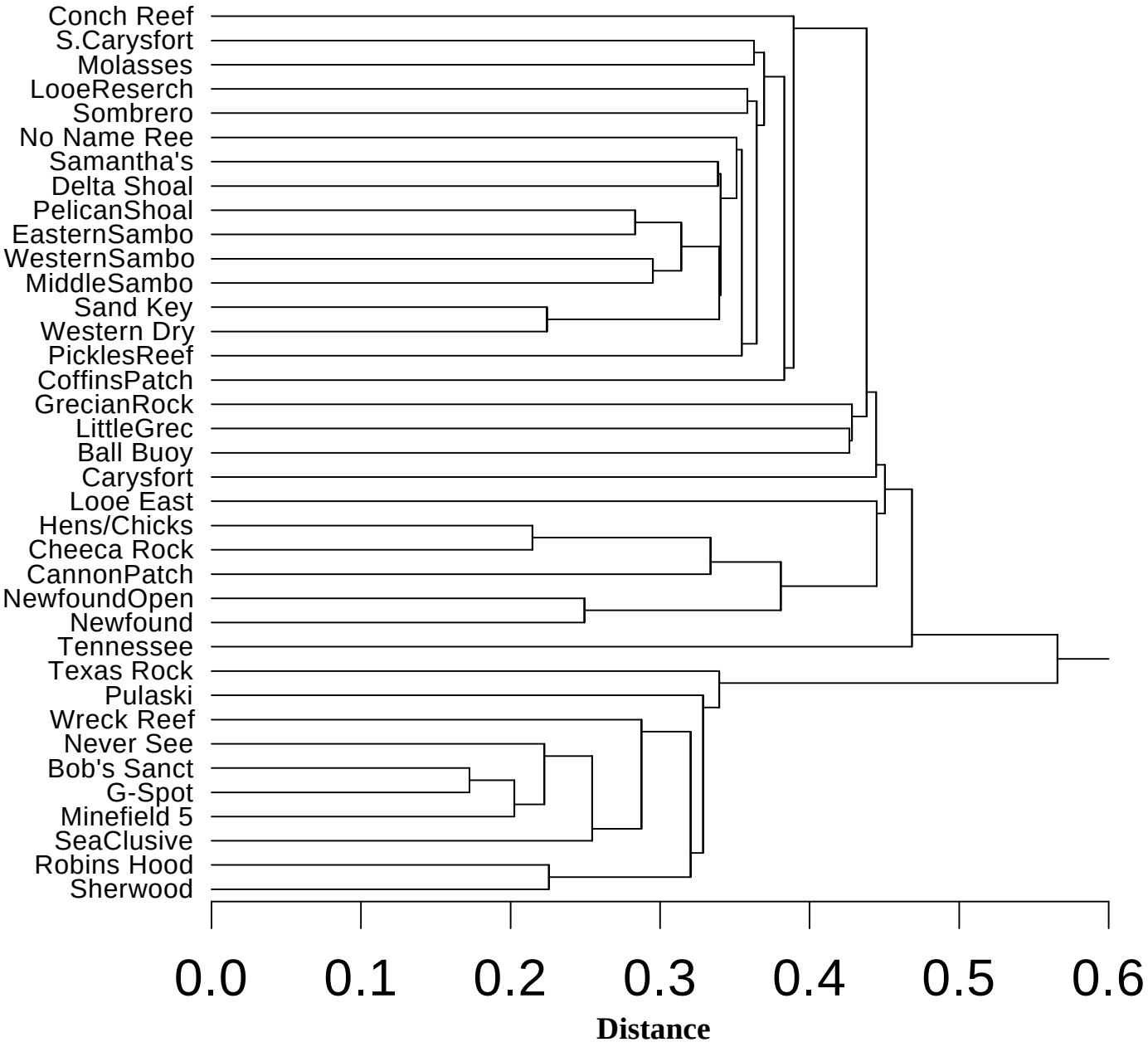


Figure 4

Cluster analysis results. The analysis used REEF's 2000 Advanced Assessment Team data, collected at 37 sites along the Florida Keys and Dry Tortugas. Analysis used rank of the abundance score. Distance of the clusters are 1-Gamma. Only species that were seen with a %SF of at least 20% (91 species) were included in the analysis. The ten Dry Tortugas sites formed a distinct cluster. Patch reefs and bank reefs also tended to cluster together. This type of graphical analysis can be useful in overall site characterization. In addition, shifts in fish assemblages over time due to zone implementation may result in changes in cluster affinities.