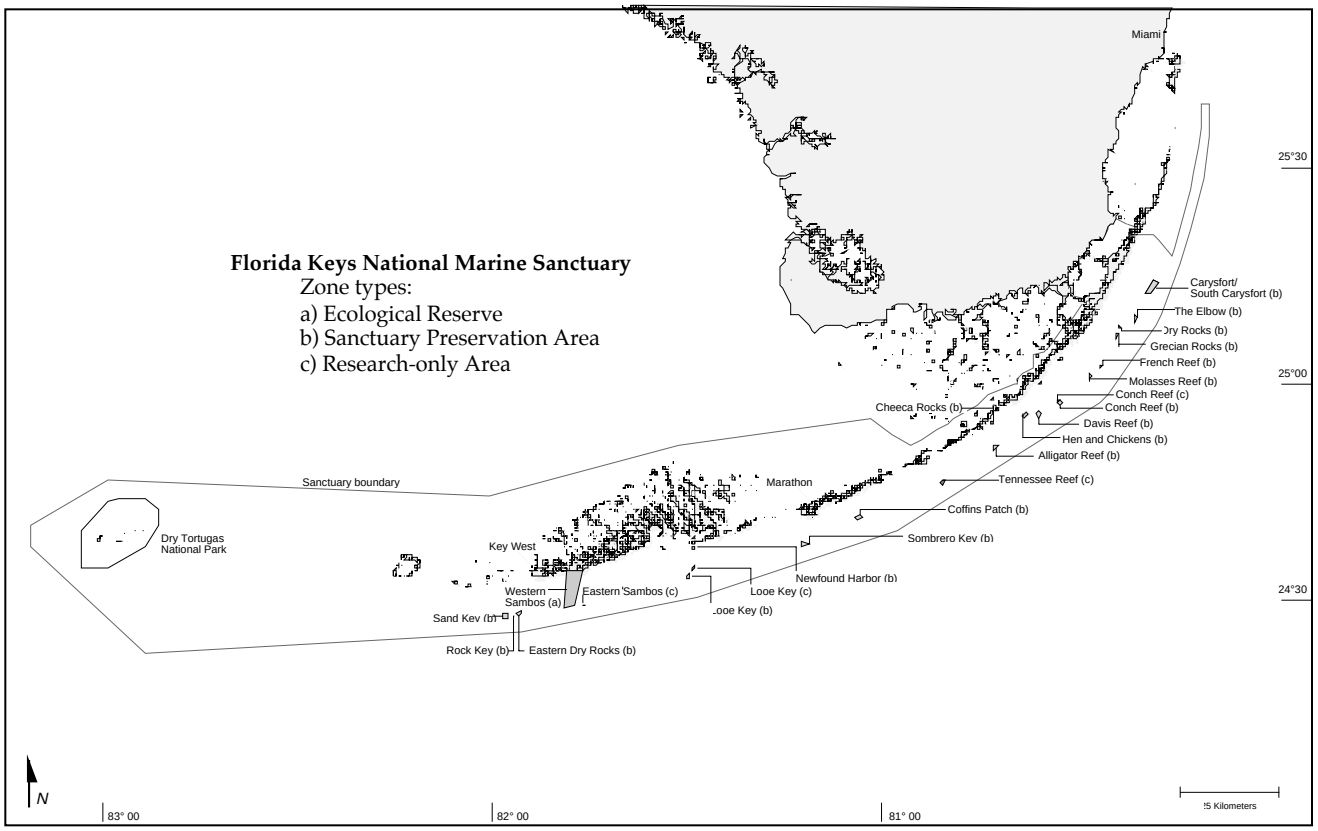
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
FLORIDA KEYS NATIONAL MARINE SANCTUARY
AND
STATE OF FLORIDA

ZONE PERFORMANCE REVIEW

SECOND YEAR REPORT
1999



NATIONAL MARINE SANCTUARIES

FLORIDA

EXECUTIVE SUMMARY

Similar to last year's findings, Year 2 monitoring results indicated that mobile, heavily exploited species such as lobster, snapper and grouper continue to show increases in the Sanctuary's 23 no-take areas. Specifically, legal-sized spiny lobsters were more abundant in Sanctuary Preservation Areas (SPAs) than in reference sites of comparable habitat. The average size of legal lobsters was larger in the no-take zones than in reference sites. Also, catch rates (number of lobsters per trap) were higher within the Western Sambo Ecological Reserve than within two adjacent fished areas during both the closed and open fishing seasons.

Preliminary analysis of reef fish abundance data from one monitoring program showed that mean densities (number of individuals per sample) for three of four exploited fish species are higher in the SPAs than in fished reference sites. Complementing these results, a volunteer-based fish survey showed an overall increase in abundance of four species of snapper (Lutjanidae) and the hogfish (*Lachnolaimus maximus*) at 7 out of 9 no-take zones which have been monitored before and after the establishment of the zones.

As would be expected, the effects of no-take protection on creatures such as conch and urchins that are not directly exploited and on slower-growing, bottom-dwelling species such as hard and soft corals and sponges have not yet become apparent. The queen conch monitoring program found no statistically significant differences in conch aggregation sizes, density, or abundance between no-take zones and reference areas. Two separate teams documented very low abundance of sea urchins, especially the long-spined urchin (*Diadema antillarum).*

Coral monitoring programs indicated no consistent differences in coral recruitment and juvenile mortality rates between the no-take zones and reference sites. Additionally, no significant differences in the percent cover of hard corals and sponges were noted between protected areas and reference sites. Faster growing benthic organisms such as algae and soft corals showed variability in abundance based on season, water depths, and location, with no major differences between protected and unprotected sites noticed at this time. Researchers monitoring these parameters cautioned that the high variability of benthic components over space and time must be taken into account in assessing the effects of no-take regulations on a decadal time scale.

All researchers in the zone monitoring program noted that Year 2 results were heavily influenced by three natural events: coral bleaching in 1997 and 1998, Hurricane Georges in September 1998 and Hurricane Irene in October 1999. These events significantly impacted the Florida Keys coral reef ecosystem, complicating interpretation of the monitoring results. In some study areas, hard corals, soft corals and sponges were completely devastated by one or more of these occurrences.

Continued monitoring inside and outside of the no-take zones is necessary before trends in these areas can be identified. Not until the year 2002 when State and Federal resource managers evaluate the use of zones as a management tool will there be a comprehensive picture of how the zones are performing in light of natural variability.

PREFACE

I am pleased to present the second year report on Zone Performance in the Florida Keys National Marine Sanctuary. This report describes the three-level zone monitoring program and provides second year results. This year's results were heavily influenced by three natural events: coral bleaching in 1997 and 1998, Hurricane Georges in September 1998 and Hurricane Irene in October 1999. These events significantly impacted the Florida Keys coral reef ecosystem. Hurricanes, and possibly bleaching, will likely continue to be a major factor influencing the coral reef community in the coming years which makes long-term monitoring of the zones and the overall ecosystem critical. Not until the year 2002 when State and federal resource managers evaluate the zones will we have a comprehensive picture of how these zones are performing in light of natural variability. While this monitoring program is designed to test primarily the first-order effects of the no-take zones (*e.g.* population structure and abundance), some second-order effects are beginning to manifest themselves, such as changes in animal behavior, fecundity, and reproductive strategies. These are the subtle, long-term changes that are vital to maintaining the integrity of the ecosystem that we hope to investigate in coming years. Please share your observations of changes in the ecosystem with us. Thank you,

Benjamin Haskell
Science Coordinator

INTRODUCTION

On July 1, 1997 after a six year planning process, NOAA and the State of Florida implemented the Nation's first network of no-take zones. Marine zoning is being implemented in the Florida Keys National Marine Sanctuary (FKNMS) to protect the biological diversity and integrity of the marine environment in the Keys. In addition, marine zoning will disperse uses of the resources in such a way as to reduce user conflicts and lessen the concentrated impact to marine organisms on heavily used reefs. As a management tool, marine zoning allows Sanctuary managers to focus the majority of their efforts on a small but important portion of the area while addressing water quality and habitat degradation in the broader unzoned portions of the Sanctuary.

WHY MONITOR THE ZONES?

In the year 2002, State and Federal managers will evaluate the use of zones as a management tool. This evaluation will be based on the actual effects of the zones on biodiversity and on human activities. Long-term monitoring will provide this critical information.

HOW ARE THE ZONES BEING MONITORED?

Researchers are monitoring the abundance and size of organisms as well as other parameters both inside the zones and outside the zones in reference sites of comparable habitat. By comparing the results from inside the zones with results from outside the effect of the zone can be determined. See page 2 and 3 for an overview.

HOW WILL THE ZONES BE EVALUATED?

The primary goal of monitoring is to determine by the year 2002 whether the zones are effective in protecting biodiversity and enhancing human values related to the Sanctuary. Effectiveness will be determined through the following performance measures:

- Coral
  - Coral cover and diversity will differ significantly between the zones and reference sites.
- Algae
  - Macroalgal cover and biomass will differ significantly between the zones and reference sites.
- Fish
  - Average size of exploited fish will be significantly greater inside the zones than in reference sites.
  - Overall abundance of fish will be significantly greater inside the zones than in reference sites.
- Lobster
  - Average size of spiny lobster will be significantly greater inside the zones than in reference sites.
  - Overall abundance of spiny lobster will be significantly greater inside the zones than in reference sites.
- Human values
  - People's perceptions of resource quality will be significantly higher inside the zones than in reference sites.
  - Overall compliance with zone regulations will improve over time.

OVERVIEW OF THE ZONE MONITORING PROGRAM

Goal: To determine by the year 2002 whether the zones are effective in protecting marine biodiversity and enhancing human values related to the Sanctuary. Measures of effectiveness will include the abundance and size of fish, invertebrates, and algae; and economic and aesthetic values of Sanctuary users and their compliance with regulations.

To achieve the goal the following 3-tiered program has been initiated with National Oceanic and Atmospheric Administration / South Florida Restoration funds (except where noted).

LEVEL I: ECOSYSTEM FUNCTIONING

- Objective: Monitor change in ecosystem structure *and* function in the largest zones
- Where: Sambos complex (Ecological Reserve and Research-only Area) and Carysfort Sanctuary Preservation Area
- What: Coral, lobster, fish, algae, seagrasses and ecological processes (predation, recruitment, and herbivory)
- Who:
  - ◊ Dynamics of coral reef benthic communities: Dr. John Ogden (project director), Florida Institute of Oceanography; Dr. Richard Aronson (chief scientist), Univ. of S. Alabama; Dr. Struan Smith (project scientist), Bermuda Biological Lab; and Dr. Margaret Miller (project scientist), NOAA
  - ◊ Fish: Dr. Jim Bohnsack, National Marine Fisheries Service
  - ◊ Lobster: Carrollyn Cox and John Hunt, Florida Marine Research Institute
  - ◊ Seagrass: Dr. Jim Fourqurean, Florida International University

LEVEL II: ECOSYSTEM STRUCTURE AND HUMAN ACTIVITIES

- Objective: Monitor change in ecosystem structure and human use due to closure
- Where: 13 heavily used zones (SPAs and Research-only Areas)
- What: Invertebrates, lobster, conch, fish, coral, seagrass, and water quality
- Who: Interagency monitoring teams and existing monitoring programs

  - ◊ Coral: Research team from Univ. of Georgia, Univ. of Charleston, and the Florida Marine Research Institute (EPA funded)
  - ◊ Fish: Dr. Jim Bohnsack, National Marine Fisheries Service
  - ◊ Seagrasses: Dr. Jim Fourqurean, Florida International University (EPA funded)
  - ◊ Water Quality: Dr. Ron Jones, Florida International University (EPA funded)

Level II Special Programs

- **Rapid Ecological Assessment**
  - Objective: Assess coral community health annually in the zones and reference areas
  - Where: 15 Sanctuary Preservation Areas and reference sites
  - What: Stony Corals, Gorgonians, Sponges, incidence of coral disease
  - Who: Team of marine ecologists organized by National Undersea Research Center/UNCW

- **Socioeconomic Monitoring**
  - Objective: Detect changes in resource utilization patterns and track economic and aesthetic values
  - Where: Subsample of Sanctuary Preservation Areas
  - What: Use characterization, activity distribution, economic and aesthetic values, compliance, attitudes
  - Who: Dr. Bob Leeworthy, NOAA economist

- **Sentinel Fishery Program**
  - Objective: Involve fishermen in the documentation of changes in lobster fishery due to closure of ecological reserve
  - Where: Western Sambo Ecological Reserve
  - What: Spiny lobster
  - Who: Commercial fisherman working under supervision of Monroe County Cooperative Extension agent

LEVEL III: VOLUNTEER MONITORING OF ECOSYSTEM HEALTH

- Objective: Involve local citizens in the monitoring of overall ecosystem health
- Where: All 23 zones and reference sites
- What: Lobster, conch, urchins, fish, substrate cover, trash, coral damage
- Who: Volunteers working through ReefKeeper International, Reef Environmental Education Foundation (R.E.E.F.), and The Nature Conservancy

Level III Special Program

- **Marine Ecosystem Event Response and Assessment (MEERA)**
  - Objective: Investigate and understand causes of episodic events
  - Where: Throughout Sanctuary
  - What: Fish kills, red tide, coral bleaching, coral diseases, etc.
  - Who: Network of local observers and team of experts

Coral Reef Community Dynamics

Project Title: Level I Video Monitoring of Coral Community Dynamics

Researchers: Richard B. Aronson, University of South Alabama Dauphin Island Sea Lab, Dauphin Island, AL and John C. Ogden, Florida Institute of Oceanography, St. Petersburg, FL.

Goal: The goal of this project is to asses the impact of management strategies, particularly protection from fishing, collecting, and diving, within focal sites that are free from various human disturbances compared to reference sites open to managed human use. The program is based on a series of hypotheses covering: (1) coral cover and diversity in no-take areas through time; (2) coral cover and diversity in reference sites through time; (3) composition of coral assemblages; (4) coral recruitment; (5) post settlement mortality of juvenile corals; (6) macroalgal biomass and cover; and, (7) herbivory. The study looks at the health of the reef at two levels: (1) shallow, 6-9 meters; and (2) deep, 14-17 meters.

Methods: For each site/depth studied, 10 haphazardly positioned transects are videotaped. The videotapes are be analyzed by point counts in the laboratory to extract information on live coral cover, coral species diversity (H'), multivariate coral cover, multivariate coral colony counts, live sponge and gorgonian cover, zoanthid cover, sponge and gorgonian colony counts, and possibly colony counts of corallimorphs. In addition, information on algal cover is extracted from the videotapes. The algae is partitioned into three categories for analysis: (1) fleshy macroalgae and thick algal turfs, (2) *Halimeda* and erect coralline algae, and, (3) fine algal turfs, crustose corallines, and bare space.

In 1997, shallow (7.5-10.5 m) and deep (13.5-17.4 m) study sites were established at three no-take sites and three reference sites within the Florida Keys National Marine Sanctuary. Ten haphazardly-positioned transects were videotaped within each of these sites in May 1998 and May 1999 to collect baseline data on components of the benthic communities and to make a preliminary comparison among the two classes of sites (no-take zones versus reference areas).

Findings to Date: Hard corals and sponges showed no consistent site-to-site or depth-related differences in percent cover, nor was there an obvious pattern related to protection status. Gorgonians showed higher cover in 1998 at all sites and depths. The cover of erect macroalgae and algal turfs declined from 1998 to 1999 at all sites at both depths, and, correspondingly, the combined cover of crustose coralline algae, fine algal turfs and bare space increased at all sites and both depths. The greater cover of macroalgae and turfs, as well as gorgonians, in 1998 may have been related to hurricane impacts, although this seems more likely for the gorgonians, given the high growth rates of algae. Another possibility for the macroalgae is the nutrification event(s) (upwelling?) in the early summer of 1998, which also caused short-lived blooms of filamentous algae in several areas of the Florida Keys. The return to normal conditions presumably then reduced macroalgal cover in 1999. Considering these measures of percent cover in aggregate, the video monitoring study provides a picture of the high spatiotemporal variability of benthic components, which must be taken into account in assessing the effects of no-take regulations on a decadal time scale.

Project Title: Level I Monitoring of Benthic Macroalgae and Herbivory

Researcher: Margaret W. Miller, National Marine Fisheries Service, Miami, FL.

Methods: During Year 2 of the Level I Zone Monitoring Program (1998-1999), macroalgae and herbivory sampling was attempted quarterly. However, only three samplings were accomplished at each site due to storms (Floyd, Harvey, etc.) and other weather interruptions. Year 1 algal biomass samples have now been analyzed and a subset of *Dictyota* and *Halimeda* spp. tissue samples have been examined for nutrient content to test for confounding differences between reserve and reference sites.

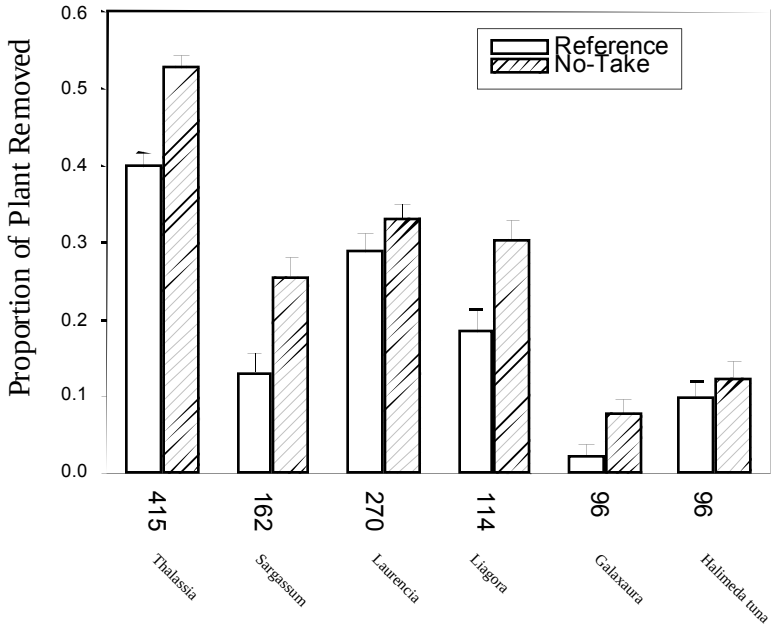
Findings to Date: The first year of algal biomass data shows almost an order of magnitude variation between sites at most sampling dates. The shallow sites showed the expected seasonal pattern (high biomass in summer and low biomass in winter) while the deep sites did not show any clear seasonal pattern. *Halimeda spp.* strongly dominate macroalgal biomass at the deep sites. No clear patterns between reserve and reference sites are evident.

Selected samples (Oct97 and Jan/Feb98) from the shallow South Carysfort/"Maitland" and Western/Middle Sambo pairs were analyzed for %N and %P content. When either nutrient is analyzed as a two-way nested ANOVA [spp * zone(site)], the factors spp and site are significant, but there is no significant difference in tissue nutrient content between reserve (SC and WS) and reference ("Mait" and MS) zones ($p=0.09$ for %P, $p=0.12$ for %N). Thus the null hypothesis of no difference in seaweed nutrient content cannot be rejected. However, the statistical results are marginal and analyses of additional samples are planned to lend greater confidence in this result. Given the consistently high non-*Halimeda* biomass at Pelican Shoal and its closer proximity to reputed nutrient sources via Florida Bay passes, this site will be included in future tissue nutrient analyses.

An overall view of the herbivory assays (seven sample dates, 3 site pairs, n=20-30 each) shows a common trend for higher relative herbivory in the no-take zones compared to reference sites (Fig 1), though isolated sample dates/sites have shown an opposite trend. No clear seasonal patterns in relative herbivory are evident.

Lastly, data on herbivore abundance from the Bohnsack et al. reef fish visual census database are fairly consistent for the Level 1 sites through 1998. The exception is a somewhat lower herbivore abundance at Pelican Shoal, though less data is available. This may help explain the consistently high abundance of fleshy algae at Pelican.

Fig 1. Pooled herbivory assay results for 6 plant types (mean + 1SE). *Thalassia* has been used at every assay site and date, other types at subsets. Open bars represent reference sites while shaded bars represent SPA sites.



***Project Title**:* Coral Recruitment - Level I Monitoring

***Researcher**:* S.R. Smith, Bermuda Biological Station for Research, Inc., Bermuda.

Methods: The juvenile coral populations in permanent photo-quadrats at shallow and deep reef sites in no-take Sanctuary Preservation Areas (SPAs) and reference areas in the upper and lower Keys were re-surveyed and photographed in June 1999. Hurricane storm wave effects on larger corals, soft corals and sponges in the quadrats were also assessed at the shallow and deep sites in the Carysfort SPA and Eastern Sambos Research-only Area.

Findings to Date:
The following patterns of juvenile coral recruitment and mortality since 1998 were observed:

- The lower Keys deep sites exhibited the highest levels of juvenile coral recruitment (8-10 colonies per m^2) compared to the upper Keys deep sites (2-3 colonies per m^2).
- The coral recruitment rates were low and consistent at all shallow sites (2-3 colonies per m^2).
- Five of the six shallow sites displayed unusually high rates of juvenile mortality (35-60%), which may be an effect of the 1998 hurricanes.
- The deep sites in the upper Keys had higher juvenile coral mortality rates (40%) than those sites in the lower Keys (25%).
- No consistent differences in recruitment and juvenile mortality rates were noted between the no-take and reference sites, but this may be due to the hurricane effects.

The effects of hurricanes on large corals, soft corals and sponges in the quadrats were patchy with some quadrats devastated and many unaffected.

- The Eastern Sambos shallow site experienced the greatest losses of hard corals, soft corals and sponges, while the Carysfort shallow site suffered the least damage.
- Nearly 20% of the large corals at three sites were eliminated, with only a 5% loss at the Carysfort shallow site.
- 25% of the soft corals were eliminated at Eastern Sambos shallow, with losses of 15-20% at the other three sites.
- 40% of the sponges at the Eastern Sambos shallow site were eliminated by the hurricanes compared to losses of 10-15% at the other sites.

In conclusion, nearly all photo-quadrats survived intact and were successful in assessing patterns of change in juvenile coral populations. The effects of the 1998 hurricanes precluded an assessment of the success of the SPAs in enhancing the recruitment and survival of juvenile corals. Continued long-term monitoring will be necessary to evaluate the relative effects of natural events versus applied reef management.

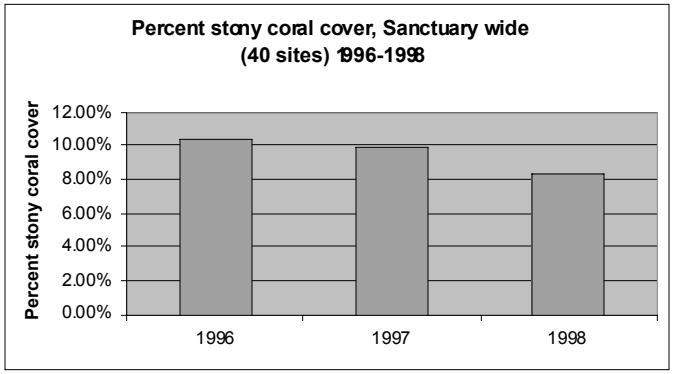
Project Title: FKNMS Coral Reef / Hardbottom Monitoring Project (EPA-funded)

Researchers:
Principle Investigators: Walter Jaap, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, St. Petersburg, FL; James Porter, University of Georgia, Athens, GA; Phillip Dustan, University of Charleston, Charleston, SC.
Project Manager: Jennifer Wheaton, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, St. Petersburg, FL.
Data Manager: Keith Hackett, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, St. Petersburg, FL.

Goals: The goals of this project are to: 1) monitor the status and trends of reef communities in the Florida Keys National Marine Sanctuary at 43 permanent sites, 2) provide estimates of distribution and cover of stony corals, octocorals, sponges, algae, and substrate, and, 3) record the incidence of selected coral diseases and bleaching.

Methods: 1) Station Species Inventory uses paired observers recording the presence/absence of stony coral species during a twenty minute observation swim at each station (four/site); and 2) Videographer films 12 transects at each site (~22m long) from 40 cm above the benthos, video is frame-grabbed and stony coral species or other major benthic functional groups are identified under ten random dots on each image(120 images/transect) using specialized software; analyzed data is QA checked and entered into master database.

Findings to Date: Point Count analysis of underwater video images from all 40 sites reveals that between 1996 and 1998 the mean percent of stony coral cover declined at 34 of 40 sites. In 1996 the mean percent of living stony coral cover was 10.4% which decreased to 8.4% in 1998. (see figure)



Of the 43 sites sampled in the Coral Reef/Hardbottom Monitoring Project, 18 lie within established zones. Of the 45 stony coral species observed by this project, 41 have been recorded within a SPA. It is important to mention that project was not designed to measure the effect of the no-take zones on coral abundance; but is included here as ancillary results.

Future Plans: A subset of the current 43 Coral Reef / Hardbottom Monitoring Project sites will continue to be monitored, based on data analysis (sites with documented change).

Project Title: Volunteer Coral Reef Monitoring

Researcher: Alexander Stone, ReefKeeper International, Miami, FL.

Methods: Between June and September of 1999, ReefKeeper International volunteers surveyed 8 coral reefs in the Florida Keys National Marine Sanctuary (FKNMS) using the ReefCheck monitoring protocol. Seven of the 8 study sites are no-take zones called Sanctuary Preservation Areas (SPAs); only Davis Ledge Reef is a multiple-use site. Several benthic parameters were examined at these data collection sites using point-intercept line transect methods. They included percent bottom cover by hard corals, false corals, algae, abiotics and other biotics. Population densities for certain invertebrates and fishes were also estimated by using belt-transect methods.

Significantly fewer reefs were monitored for ReefCheck 1999 (8) than in 1998 (18). Of these reefs, six of them were monitored both years. When comparing results, only the reefs that were monitored both years are considered. Due to poor weather, volunteers monitored what they could considering the conditions. Boat availability was a factor as well. The result was that all the sites were in the upper Keys, and only one control site was monitored (Davis Ledge).

Findings to Date: The results from this year's ReefCheck are similar to those from last year. However, the low percent hard coral bottom cover which has become representative of the area dropped even lower this year, from an overall 1998 average of 18.7% for all surveyed sites to 13.3% in 1999. Data for percent algal cover resemble that from last year. Percent bottom cover by abiotics also remained similar, but cover by "other biotics" increased significantly. Algae and abiotics continued to dominate many of the reefs with cumulative bottom cover averages of 27.2% and 20.7%, respectively.

Very high numbers of grunts and margates were seen at all the surveyed sites, with an overall average of 75.5 fish noted per transect. The overall average of snappers sighted was only 17.7 animals per transect, while in 1998 it was 77.4 per transect. Groupers and parrotfishes were significantly scarcer, with no groupers noted at several survey sites in 1999. Overall parrotfish numbers decreased by more than half from 1998, and groupers reported were more than six times lower than last year.

Very few mobile invertebrates, such as urchins and lobsters, were noted along the belt transects in 1999. Only four of the reefs showed any occurrence of the target invertebrates, and when they were present it was in limited quantities. Lobsters noted an overall decrease from 1998 (2.3 animals per transect) to 1999 (.57 animals per transect).

Comparing the control site Davis Ledge Reef, where fishing is allowed, against the surveyed no-take SPA sites, Davis Ledge had the lowest percent hard coral cover at 1.3%, and the highest algal cover at 50.3%. At Davis Ledge, there were no mobile invertebrates noted. The highest number of grunts and margates per transect (246.75 fish) were found at Davis Ledge. Davis Ledge was also the location for the highest number of snappers (50.75 fish/transect). A possible explanation for the high occurrence of snappers and grunts and margates at Davis Ledge is the common practice of “fish feeding” that takes place virtually daily at this site.

Several significant events occurred in 1999, which offer some explanation for the degraded condition of the sites surveyed. Two hurricanes combined with one of the worst coral bleaching events experienced by the reefs are presumably main contributors to the poor results. The weather was also a factor in limiting the number of reefs monitored, and therefore limiting the available data.

Project Title: Sea Stewards: A Volunteer Ecological Monitoring Program

Researchers: Brian D. Keller, David R. Bryan, and Mary Enstrom-Warner, The Nature Conservancy, Marathon, FL.

Goal: In 1998, The Nature Conservancy initiated a volunteer program, Sea Stewards, to participate in monitoring the Florida Keys National Marine Sanctuary. The objectives of the program are to: 1) target species and ecological processes that are not being monitored by other studies, 2) contribute useful data to the evaluation of the Sanctuary's zoning program, and 3) engage Keys residents and Sanctuary users in evaluating resource condition and the effectiveness of the management plan.

Methods: The volunteers are organized into 10 teams of divers and boat operators. Each team is assigned a no-take zone and nearby reference area to monitor. A permanent sampling site covering approximately 100 m^2 and centered on a prominent reef feature was located and mapped in coral reef habitat within each of 10 no-take zones and nearby reference areas. The teams monitored selected targets within their sites during the dry and wet season each year; not all of the teams completed data collections during each season. The targets were: 1) all species of reef-dwelling sea urchins (mainly *Diadema antillarum*, *Eucidaris tribuloides*, *Echinometra viridis*, and *E. lucunter*), 2) adult three-spot damselfish (*Stegastes planifrons*), and 3) juvenile and adult yellowtail damselfish (*Microspathodon chrysurus*). These were counted in 20 square-meter quadrats radiating out from the site's central feature in belts of five quadrats. In addition, size categories of sea urchins were recorded. During 1999, volunteers collected preliminary data on fish cleaning stations as a fourth monitoring target for 2000.

Findings to Date: The data so far document a low density of sea urchins overall and no significant difference between no-take zones and reference areas for any of the targets. We lumped all the urchin species together because of their low numbers; most were slate-pencil urchins (*Eucidaris tribuloides*) with a test diameter of 10-30 mm.

Fish cleaning stations also were present; a 30-minute search effort generally located 0-5 active stations and additional inactive ones. The most common cleaner was the neon goby, *Gobiosoma oceanops*; additional fish species were observed, as well as a cleaner shrimp, *Periclimenes pedersoni*. Various species of fish "clients" came to stations to be cleaned, including snappers, groupers, parrotfish, surgeonfish, barracuda, moray eels, snook, and nurse sharks.

Sea Stewards monitoring began approximately one year after implementation of the Sanctuary's zoning plan. Therefore we can only presume that similar densities of sea urchins and damselfish were present in the two types of sites when the management plan took effect in 1997. It is premature to speculate about the similar densities of these species in no-take zones and reference areas after 2.5 years, particularly because severe weather events and other large-scale factors have influenced the ecosystem over the same period. Clearly, continued monitoring will be necessary to detect possible divergences in density of these targets in the future.

Table 1. Mean number of individuals per 20 m^2 (standard error in parentheses) and results of t-tests. W: wet season (May-Oct.); D: dry season (Nov.-Apr.); Ad.: adult; Juv.: juvenile; t: t-value df: degrees of freedom; P: P-value.

Target	Season	Zone	Reference	t	df	P
Sea Urchins	W98	1.0 (1.0)	0.3 (0.3)	0.63	1	0.64
	D98/99	0.2 (0.2)	1.4 (1.4)	0.67	2	0.57
	W99	0.6 (0.6)	0	1.00	4	0.37
Three-spot	W98	2.5 (2.5)	1.7 (0.9)	0.31	1	0.81
	D98/99	0.6 (0.4)	1.3 (1.3)	0.53	2	0.65
	W99	2.2 (0.9)	1.5 (1.2)	0.48	6	0.65
Ad. Yellowtail	W98	1.0 (1.0)	1.0 (1.0)	0.00	3	1.00
	D98/99	1.8 (1.0)	1.0 (0.6)	0.64	7	0.55
	W99	0.4 (0.7)	0.8 (0.8)	0.44	4	0.68
Juv. Yellowtail	W98	0	0.7 (0.7)	1.00	2	0.42
	D98/99	0.3 (0.2)	0	1.54	5	0.19
	W99	0.3 (0.2)	0	1.50	4	0.21

Reef Fish

Project Title: Reef Fish Monitoring in the Florida Keys National Marine Sanctuary

Researchers: James A. Bohnsack, David B. McClellan, Douglas E. Harper, Peter Fischel, National Marine Fisheries Service, Miami, FL.

Goal: On July 1, 1997 the Florida Keys National Marine Sanctuary (FKNMS) established 18 no-take Sanctuary Preservation Areas (SPAs) and one Ecological Reserve in the Western Sambo region of the lower Florida Keys. Extensive field monitoring efforts since then have been directed at documenting changes in no-take areas in comparison to nearby fished reference areas.

Methods: Sampling continued in1999, the second full year of protection, following two hurricanes impacting the lower Keys in the fall of 1998. In a joint effort with Dr. Jerry Ault and Dr. Steven Smith (RSMAS, University of Miami), the sampling design was improved in 1999 to include a habitat-based, stratified random sampling design and expanded into other habitats to more efficiently monitor reef fish populations throughout the Florida Keys and to better assess habitat preferences by different species. This expanded effort added two additional classes of data (random samples of low relief habitat in protected and fished areas) in addition to the high relief protected and fished sites previously sampled. Sampling also was expanded to include approximately 1000 visual point samples from three cruises to the Tortugas region as part of a project to create an ecological reserve in this area. Approximately 492 samples were collected from the rest of the Keys, including 150 samples from high relief habitats in the Sanctuary Preservation Areas (SPAs) and Western Sambo Ecological Reserve and 132 from reference fished areas. An additional 18 samples were randomly obtained from low relief habitats in the SPAs and ER and 192 from additional fished sites. Sample sites included Biscayne National Park (10), upper Keys (37), middle Keys (33),the lower Keys (25). Funding shortages and prolonged adverse weather curtailed sampling at the beginning of September.

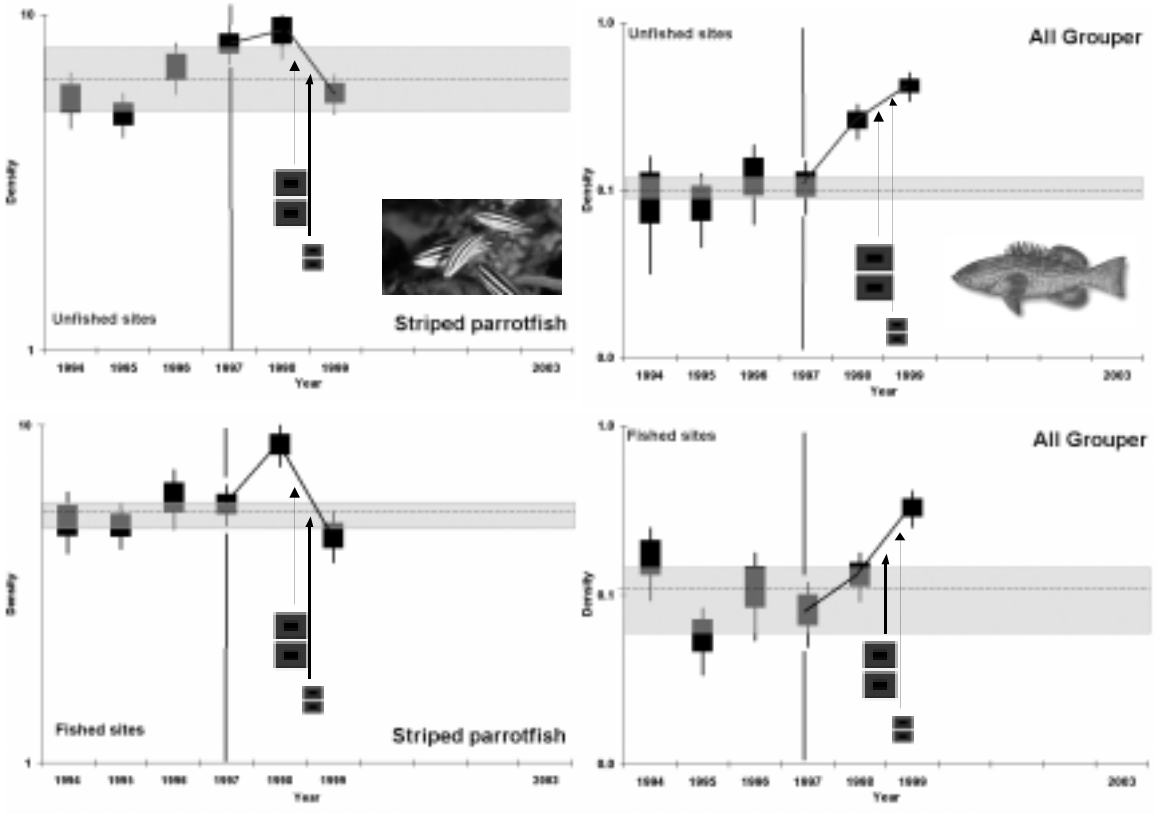
Findings to Date: Preliminary trend analysis of raw data showed that stoplight parrotfish, a large herbivore not targeted by fishing, declined in mean density (number of individuals per sample) in all areas in 1999 to levels well below the long-term performance range. Similar declines in mean density in all zones were also noted for striped parrotfish, a small non-exploited herbivore, and for the economically important gray snapper. Mean density, in each of these cases, however, was higher in no-take zones than in fished reference areas. Among exploited taxa, mean densities were higher in no-take SPAs and the Ecological Reserve than in fished reference areas for gray snapper, combined grouper, and yellowtail snapper, but not for hogfish. Economically important species of grouper continued to be rare and were combined for statistical analysis. Encouragingly, the mean density of combined grouper has increased in both fished reference areas and no-take zones since 1997. Yellowtail snapper mean density declined in fished reference areas to levels below the long-term range but remained at the upper end of the long-term range in no-take zones. In contrast, the mean density of hogfish declined in 1999 in no-take zones but increased in fished sites resulting in significantly higher densities in fished reference areas.

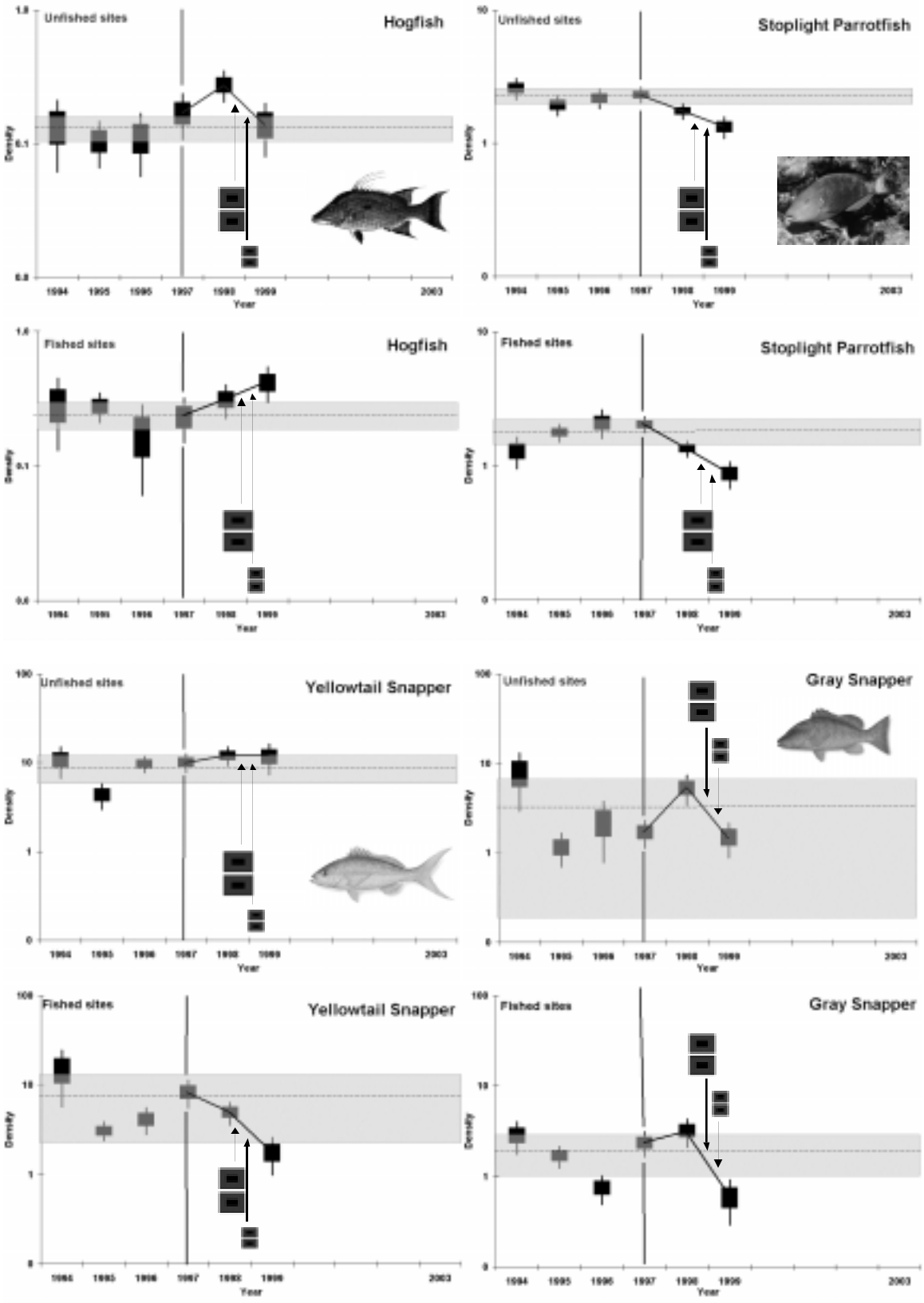
Preliminary spatial analysis was done by habitat and fish size for the first time in 1999. Adult exploitable phased yellowtail snapper CPUE (i.e. density) was significantly higher in no-take protected fore reef zones than in reference fished fore reef zones in the upper, middle, and lower Keys and for reef flat habitats in the upper Keys. Analysis of juvenile yellowtail distributions suggest that one reason for a rapid response by adult yellowtail to no-take-protection is that SPAs tended to include habitat suitable for juveniles. When protected from fishing, the adult population increased rapidly in response to these juveniles becoming adults and facing less fishing mortality. Similar analysis for combined grouper showed no significant spatial habitat trends.

With only two years of data since no-take protection was initiated, it is premature to make any long-term conclusions although some speculations can be offered. The observed declines in mean density at both fished and unfished sites in 1999 for the two non-exploited species and gray snapper are consistent with the possibility that hurricane Georges and Irene may have detrimentally impacted some reef fish populations. Both hurricanes hit the Keys in the fall of 1998 prior to 1999 sampling. The consistently higher abundances of hogfish outside of no-take zones may reflect their preference for low-relief hard-bottom habitat which may be under-represented in SPAs. SPAs tend to have more high-relief habitat which is less preferred by hogfish. The stratified random sampling

design adopted in 1999 provides increased spatial and habitat resolution and increased statistical power for detecting future changes.

Figure Captions: Density trends for striped parrotfish, stoplight parrotfish, gray snapper, combined grouper, hogfish, yellowtail snapper. Combined annual mean density (number of individuals per sample) for species from unfished SPAs (top) and fished reference sites (bottom). Vertical lines show 95% C.I.; boxes show + 1 standard error; the vertical line shows initiation of no-take protection in 1997; the dashed line shows 1994-1997 mean density. The gray band shows the annual trend for 1994-1997 based on 95% confidence intervals and is projected beyond 1997 under the assumption that no changes in abundance occur. Hurricane symbols indicate the occurrence of two hurricanes in the fall of 1998.




Unfished sites
Hogfish
Density
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Stoplight Parrotfish
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Project Title: Volunteer Reef Fish Monitoring

Researchers: Reef Environmental Education Foundation (REEF) staff and the REEF Advanced Assessment Team

Methods: The Roving Diver Technique (RDT) is a non-point visual survey method specifically designed to generate a comprehensive species list along with frequency and abundance estimates for reef fish. During RDT surveys, divers swim freely throughout a dive site and record every observed fish species. At the conclusion of each survey, divers assign each recorded species one of four $\log_{10}$ abundance categories [single (1); few (2-10), many (11-100), and abundant (>100)]. Following the dive, each surveyor records the species data along with survey time, depth, temperature, and other environmental information on a REEF scansheet. The scansheets are returned to REEF, and the data are loaded into the REEF database that is publicly-accessible on the Internet at http://www.reef.org.

This project supports a team of REEF's most experienced surveyors, the Advanced Assessment Team (AAT), to survey 31 sites in the Florida Keys National Marine Sanctuary (FKNMS), including 12 Sanctuary Preservation Areas (SPAs), 3 Research-only Areas, 1 Ecological Reserve, 6 sites in the proposed Tortugas Ecological Reserve area, and 9 comparison or reference sites. A minimum of six RDT surveys are conducted at each site. This is the third year that the AAT has monitored these sites. These data complement REEF's Fish Survey Project RDT surveying by REEF volunteers during their regular diving activities in the Florida Keys.

Findings to Date: During the 1999 field season, 218 RDT surveys were conducted by the REEF AAT documenting 231 fish species. Comparisons among the no-take zones and reference sites using the AAT data were done at the assemblage level using similarity analysis and cluster analysis. These tools are expected, over a longer time scale, to provide a useful indicator of the effect of the no-take zones. Species level comparisons were also done on commercially important species using all REEF data from the FKNMS.

The REEF database as a whole represents a valuable source of baseline and continual data from over 170 Florida Keys sites. To date, a total of 5,228 RDT surveys have been conducted in the FKNMS, and 2,938 of those were prior to July 1, 1997, when the Sanctuary's marine zoning plan was implemented. These data were used to evaluate the change in abundance of four species of snapper (Lutjanidae) and the hogfish (*Lachnolaimus maximus*) at nine of the SPAs and reference sites before and after July 1, 1997. Average estimated abundance of the five species increased after no-take zone implementation at seven of the sites.

Future Plans: The AAT work ensures that annual data collection in the SPAs and reference areas by REEF experts occurs. REEF plans to continue this annual monitoring effort, in addition to enabling all divers to participate in its volunteer Fish Survey Project. Focus on the Dry Tortugas sites will be expanded in order to measure the effect of upcoming harvest restrictions. REEF is also collaborating 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 no-take zones by analyzing shifts in assemblage composition and feeding guilds over time.

Lobster and Conch

Project Title: Monitoring Spiny Lobsters, *Panulirus argus*, in the No-take Zones of the Florida Keys National Marine Sanctuary

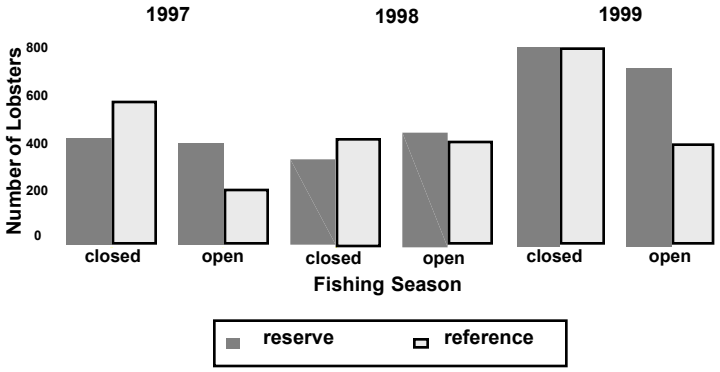
Researchers: Carrollyn Cox and John H. Hunt, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Marathon, FL.

Goal: This project was designed to test the hypothesis that no-take zones would sufficiently protect lobsters so that after their establishment, lobsters in the zones would be larger and more abundant than those in unprotected areas.

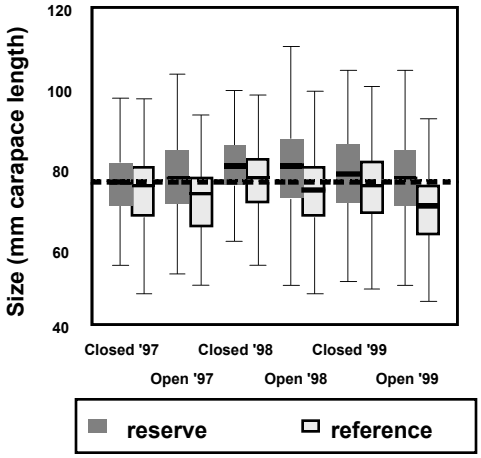
Methods: Abundance and size of spiny lobsters, *Panulirus argus*, were monitored in 15 no-take areas and fished reference areas in the Florida Keys National Marine Sanctuary during the closed and open lobster fishing seasons of 1997, 1998 and 1999. Thirteen of the sampled no-take zones are small (~ 82 ha) Sanctuary Preservation Areas (SPAs) or Research-only Areas, one is a large (515 ha) SPA and one is a 3,000 ha Ecological Reserve (ER). Data from SPAs, the large SPA, and the ER were treated separately and compared with data from their respective unprotected reference areas. Additionally, Looe Key SPA and its reference area were treated separately because Looe Key SPA has prohibited spiny lobster harvest since 1983.

Findings to Date: Lobster abundance varied from year to year, with the greatest abundance in 1999 and the least abundance in 1998. In 1997 and 1999, abundance declined in no-take areas and reference areas during the open fishing season, but the decline was less precipitous in the zones. This decrease in abundance was not observed in the zones during the 1998 open season, presumably resulting from effects of Hurricane Georges. During the closed season each year, lobster abundance was nearly equal in no-take areas and reference areas indicating that redistribution of lobsters along the reef tract is common following the close of the fishing season. There were more legal-sized lobsters (≥ 76 mm carapace length) in SPAs than in reference areas during all three years. In the ER and the large SPA, abundance of legal-sized lobsters was similar in no-take areas and reference areas all three years. In 1999, mean sizes of legal lobsters in SPAs, the ER, and the large SPA were 84.2, 86.0, and 87.0 mm CL, respectively. In all cases, mean size of legal lobsters was larger in zones than in reference areas.

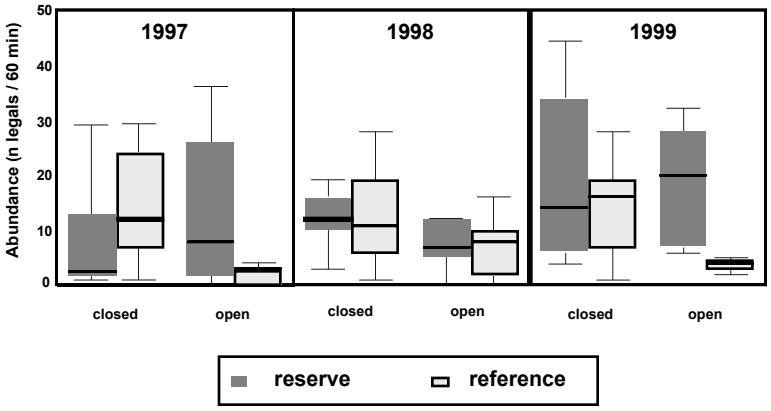
Spiny Lobsters in FKNMS 1997-99



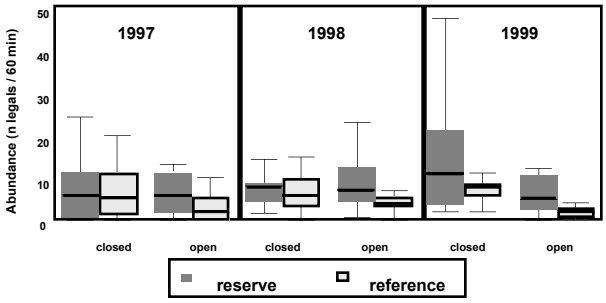
Size of Spiny Lobster in FKNMS 1997-99



Abundance of Legal-Sized Lobsters at Western Sambo ER/Pelican Shoal 1997-1999



Abundance of Legal-Sized Lobsters in SPAs/References 1997-1999



Project Title: Sentinel Lobster Fisheries Project for the Florida Keys National Marine Sanctuary: June 1998 - November 1999.

Researcher: Douglas R. Gregory, Jr., University of Florida/Florida Sea Grant, Monroe County Cooperative Extension Service, Key West, FL.

Goal: The purpose of the sentinel lobster fisheries project is to use commercial fishing gear and techniques to evaluate the long-term effectiveness of the Western Sambo Ecological Reserve as a refuge for spiny lobster and to determine if spillover effects are evident in the adjacent fishing areas. The direct involvement of commercial fishermen in this project is an important factor to make the research results as relevant as possible to the commercial fishing community.

Methods: During 1998 and 1999, 1396 (989 tagged) and 2254 (1022 tagged) lobsters, respectively, were observed in the Reserve and adjacent fished areas (Middle Sambos and Pelican Shoal). Tag returns from the fishery are inadequate for reliable evaluation. Most tag returns were from the study sites or areas nearby, but four long distance returns indicate movement of lobsters as far as the 7-Mile Bridge to the east and the Key West main ship channel to the west.

Findings to Date: Lobsters within the Reserve exhibited significantly larger carapace length sizes and catch rates (number of lobsters per trap (Fig.1) than lobsters within the two adjacent areas during both the closed and open fishing seasons, indicating that lobsters within the Reserve were experiencing reduced mortality relative to lobsters outside the Reserve. Lobster size tended to decrease as the distance from the Reserve increased, however this trend was not statistically significant.

Average size of lobsters in the Reserve declined from 1998 to 1999 during both the closed and open seasons. A similar, but non-significant, decline was also observed in the adjacent non-reserve areas. Catch rates generally increased from 1998 to 1999, however, these increases were not statistically significant (log(CPUE +1)) (Fig. 2). The interannual increase in catch rates included all sizes but were less substantial for legal sized lobsters. The percentage increase in catch rates were greater for the non-Reserve areas. Converse to the size data, the gradation in catch rates relative to distance from the reserve indicated increased catches in the area farthest from the Reserve.

Because of the interannual variability in the weather, continuation of the study is important to provide evidence if the “reserve effect” is permanent and whether spillover is occurring. To date, the weather has been atypical in that the winters have been warmer than normal and the study area experienced a direct hit by a hurricane in the fall of each of the past two years.

Figure 1.

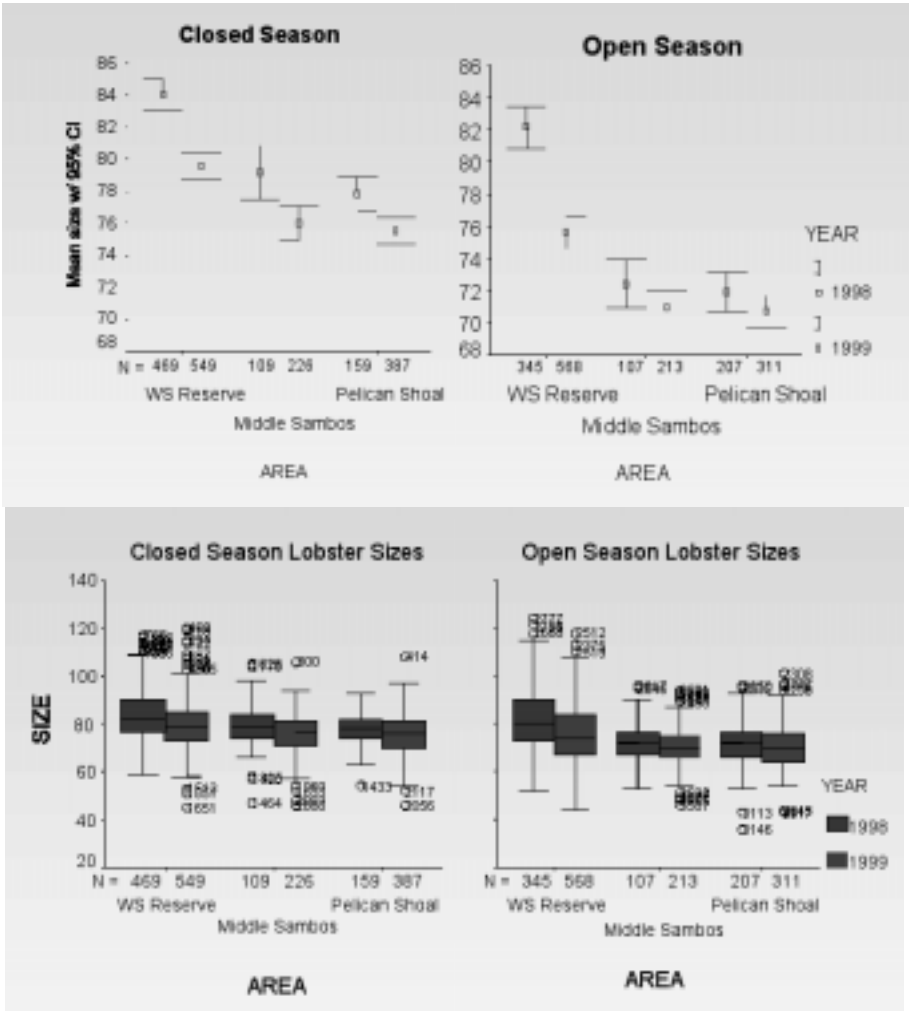
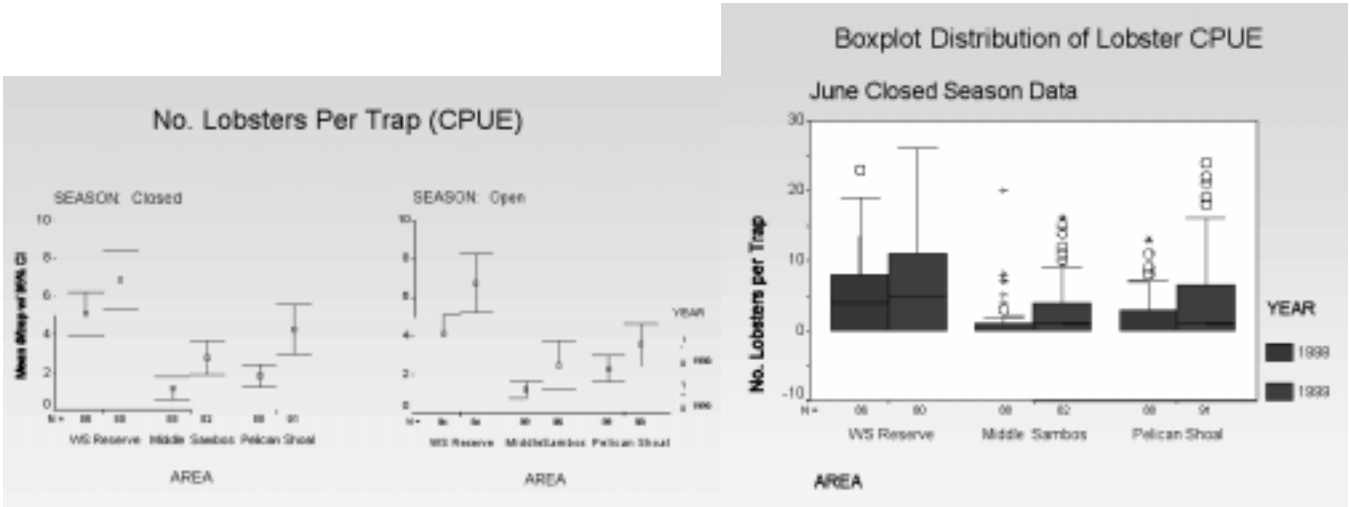


Figure 2.



Project Title: Queen Conch Population Monitoring in the No-take Zones

Researcher: Robert Glazer, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Marathon, FL.

Goal: The goal of this project is to determine the effects of no-take zones on the density, abundance, and area occupied by queen conch in the Florida Keys National Marine Sanctuary.

Methods: Belt-transects were conducted using divers in locations with moderately dense aggregations of conch. Surveys were conducted at both reserves (no-take zones) and adjacent reference areas. We counted all conch within a 1-m swath along each belt and estimated densities based on these counts. Additionally, each aggregation was mapped in order to estimate the area occupied by each aggregation. The density and area estimations were used to determine population abundance. In those areas where conch were sparse, direct counts were made of all individuals present.

Findings to Date: In 1997, the Florida Department of Environmental Protection began monitoring reserves and adjacent reference sites in the Florida Keys National Marine Sanctuary to assess the effects of the reserves on populations of queen conch. We have now completed three annual surveys.

In 1999, we surveyed 10 reserves and 4 reference areas. All surveys were conducted during August. The median area encompassed by the aggregations associated with reserves was 7,911 m^2 compared with 9,512 m^2 for the reference areas. The median adult conch density for aggregations associated with reserves was 0.007 conch per m^2 compared with 0.006 conch per m^2 for those aggregations associated with reference areas. We estimated that the adult abundance of conch in aggregations associated with reserves was 310 conch compared with 252 adult conch associated with reference areas. Juvenile conch density and abundance followed the same pattern. The median juvenile conch density for aggregations associated with reserves was 0.002 conch per m^2. This was the same density as that estimated for aggregations associated with reference areas. We estimated that the median juvenile abundance of conch in aggregations associated with reserves was approximately 20 conch compared with approximately 10 juvenile conch associated with reference areas.

In all of these cases, there were no statistically significant differences between reserves and reference areas. Additionally, there were no statistically significant changes from 1998 to 1999 in either density, abundance or areal extent for conch aggregations associated with either reserves or reference areas. However, there has been a statistically significant decline from the beginning of the study (i.e., 1997) through 1999 in the areas encompassed by aggregations associated with reserves.

Rapid Assessment

Project Title: Rapid Assessment and Monitoring of Hard-bottom Communities

Researchers: Steven L. Miller, Dione W. Swanson and Mark Chiappone, National Undersea Research Center/University of North Carolina at Wilmington, Key Largo, FL.

Goal: A coral reef and hard-bottom monitoring program using rapid assessment techniques was implemented in 1998 to document spatial and temporal variability in benthic community structure and composition in the majority of no-take zones in the Florida Keys National Marine Sanctuary (FKNMS). A specific goal of the rapid assessment program is to determine whether or not management strategies in the no-take zones affect benthic community structure.

Methods: Protocols were modified in 1999 to implement a two-stage, stratified random sampling approach based on hard-bottom habitat distribution maps to document benthic community structure and composition. The modified sampling approach used the existing habitat map of the FKNMS to allocate and randomly select survey blocks within particular depth ranges and habitat types in 17 no-take zones and 46 corresponding reference areas.

In 1999, benthic coverage was surveyed in situ by divers using the linear point-intercept technique along four replicate 25 m long transects in each survey block. Data were recorded at the species or functional group level. Replicate 25 m x 0.4 m transects were sampled for octocoral species richness and abundance, sponge species richness, stony coral size and condition, abundance of selected macro-invertebrates such as anemones and corallimorpharians, and abundance and size of urchins. Juvenile coral abundance and size were surveyed in ten replicate 48 cm x 65 cm quadrats along replicate transects. Digital video surveys of a 0.4 m swath along transects were used to estimate topographic complexity, and as an archival record of each site. Power analysis was conducted to ensure adequate sampling effort to evaluate significant differences among sites and over time, within the limits of resources available to conduct the work.

Eighty blocks were surveyed from August to December 1999: thirty-four blocks were sampled in 17 no-take zones (two blocks per individual zone), and an additional 46 blocks were sampled outside the zones as reference sites. Thirty-nine field days were needed to complete all 80 survey blocks using a team of 3-4 divers per day; team members did not change during the course of the program, which helped ensure quality control in the field. Survey blocks were distributed from Western Dry Rocks (24 26.707 N, 81 55.693 W), southwest of Key West, to north of Carysfort Reef (25 14.901 N, 80 11.703 W). Hard-bottom types surveyed were represented by: low-relief spur and groove, deeper low-relief hard-bottom and fore reef terrace communities at 7.5-10.5 m (25-35 ft.) depth (deeper fore reef); high-relief spur and groove and shallower low-relief hard-bottom at 3-7.5 m (10-25 ft.) depth (shallower fore reef); offshore patch reefs in the lower Keys within and near the Looe Key Research-only Area; and high-relief spur and groove located on the inner reef line from Grecian Rocks to North-North Dry Rocks in the upper Keys. Blocks were marked using differential GPS.

Findings to Date: Linear point-intercept surveys indicated that algae dominated both depth strata. No-take zones in the lower and upper Keys tended to have greater coral cover than reference areas at 8-12 m depth, while sponges exhibited greater coverage in middle Keys no-take zones and reference areas. Species richness of stony corals at 8-12 m depth was generally greater in no-take zones, particularly in the lower and upper Keys. Sponges exhibited an opposite pattern, where species richness was greatest in the middle Keys no-take zones and reference areas. Generally similar patterns were evident in shallower habitats (4-7 m). Octocoral and juvenile coral abundance were highly variable between no-take zones and reference habitats, as well as among regions. Selected invertebrates (anemones, corallimorpharians and spiny lobster) were generally more abundant in the upper Keys, particularly in reference habitats. Urchins were very low in abundance, particularly *Diadema antillarum*; size-distribution data indicated a prevalence of recent recruits.

Future Plans: Plans in 2000 include continued sampling at a reduced number of no-take zones and reference areas (not all sites need to be sampled every year), the addition of several new sites in deeper water (to contrast with results from shallow sites), and extension into Dade and Broward Counties (to better understand how reef communities change at their northern limit of distribution in the sanctuary and throughout the region).

Project Title: Targeted Marine Life Survey

Researcher: Benjamin Richards, Florida Keys National Marine Sanctuary, Marathon, FL.

Goal: To monitor population levels and fluctuations in those levels for a subset of fish and invertebrate species targeted by local marine life collectors. Data collected from this study will be used as an indicator of reserve performance in conserving these smaller and more cryptic species not included in other portions of the Florida Keys National Marine Sanctuary Zone Monitoring Program.

Methods: Population data for seven invertebrate and thirteen fish species will be collected in four of the Sanctuary's no-take areas (Conch Reef SPA, Sombrero Key SPA, Looe Key SPA, and Sand Key SPA) as well as in four associated reference sites (Pickles Reef, Delta Shoal, American Shoals, and Cosgrove Shoal). Abundance data will be collected along ten, twenty five meter transects located haphazardly at each site. Transect placement will be determined through random GPS coordinated generation overlaid with appropriate depth/habitat maps. Data will be collected by dive teams using a visual census technique. Interviews will also be conducted with local marine life collectors to gather anecdotal information on additional or historic population fluctuations in the Florida Keys. At the end of each year, all data will be compared with physical oceanographic data to ensure that any populations level fluctuations found are not due to natural, stochastic environmental patterns.

Findings to date: The Targeted Marine Life Survey was proposed as an addition to the Florida Keys National Marine Sanctuary's Zone Monitoring Program in the fall of 1998. To date, a species list has been created using the 1996 Marine Collected Species landing list compiled by the Florida Department of Environmental Protection. This species list was subsequently modified following interviews with local marine life collectors and Sanctuary staff. Site selection was completed in 1999 with the assignment of random GPS coordinates within each Sanctuary Preservation Area and reference site. Survey data was collected at Sombrero Key and Looe Key SPAs during 1999 for the purposes of methods testing.

Future Plans: In 2000, the survey portion of the Targeted Marine Life Survey will commence with data being collected at the four Sanctuary Preservation Areas and associated reference sites on a quarterly basis. If data collection proceeds smoothly, the addition of Conch Reef Research Only Area and Looe Key Research Only Area will be investigated as a method for ascertaining the impact of divers on targeted marine life populations.

Project Title: Detection and Assessment of Episodic Reef Events

Researcher: Erich Mueller, Mote Marine Laboratory, Summerland Key, FL.

Goal: To obtain early reports and document biological events such as harmful algal blooms, coral bleaching and disease outbreaks. Also, to quantitatively assess the status of coral diseases at permanent monitoring stations along the reef tract in conjunction with an EPA-funded study.

Methods: Reports of biotic events are solicited from a broad base of Sanctuary users (marine observers) including divers, fisherman and environmental professionals. Reports are evaluated to determine whether they constitute an event in progress. Additional responses are conducted, or coordinated with others, to obtain additional information about the biological, geographical and temporal extent of the event.

The coral disease surveys are based on the radial belt transect method and involve the counting of all 20 scleractinian species plus sea fans (>10 cm) within the 113.1 m^2 area. The condition of any diseased corals is noted and counts made. Two to three permanent stations were previously established at seven sites (reefs) from the Lower Keys to Biscayne National Park (additional stations surveyed by the EPA range from Key West to the Dry Tortugas).

Findings to date: The RBAT project was initiated in late 1997 as a pilot project. Several biological events were documented including a Keys-wide algal bloom. The renewal of this project is not just a continuation but a revision that incorporates lessons learned. A full-time staff member was hired in Dec., 1999 and is supported 0.4 FTE by this project to serve as its coordinator. The name was changed to Marine Ecosystem Event Response and Assessment (MEERA) Project to better reflect its mission and reduce confusion with other "ecological rapid assessment" programs. The procedures have been streamlined by eliminating the "Assessment Groups" and new materials prepared for distribution. During late January and early February 2000, the MEERA project has responded to reports of red tide and fish mortality in the area north and west of Key West. Water and fish samples were collected and forwarded to state agencies. Red tide (*Gymnodinium breve*) cell counts were also made on duplicate samples.

Coral surveys in 1998 indicated considerable mortality within the monitoring stations, particularly of *Acropora palmata*, since the prior surveys were in early September 1998. This was particularly noticeable in the Key West area which was affected by Hurricane George in late September 1998 but was also seen within Biscayne National Park which was only moderately impacted by storms. It is also very possible that the mortality was due to the extensive bleaching that occurred in 1998. In general, the incidence of coral bleaching and other coral diseases was generally lower in 1999 than in 1998. Data are still being quantitatively assessed to determine incidence of specific diseases within different regions of the Keys and within different reef zones.

Future Plans: It is anticipated that the MEERA Project will be ongoing beyond the current funding cycle. Immediate plans during this cycle are to re-contact volunteers and agencies to provide updated information about the project. Community outreach will be expanded to include as many people as possible within the observer network. Renewed efforts will be made to integrate the flow of information and samples between various agencies and reduce duplication of effort.

The coral disease surveys are anticipated to continue on an annual basis. Since 1998, surveys were conducted twice per year. Starting in 2000, this will be reduced to a single comprehensive survey taking place in late summer when diseases appear to be most active. There are no plans to increase the number of sites or stations at this time.

Human Activities

Project Title: Aerial Survey for Vessel Usage and Marine Animal Occurrences in the FKNMS, 1992-1999

Researchers: David B. McClellan and James L. Tobias, National Marine Fisheries Service, Miami, FL.

Methods: A cooperative agreement was established between the Miami Laboratory of the National Marine Fisheries Service and the U.S. Coast Guard Miami Air Station to document marine animal occurrence and monitor vessel activity. 131 aerial surveys have been conducted along the southeast Florida coast, from Ft. Pierce to Key West, since September 1992. Through December 1999, 114 surveys of the Atlantic waters of the Florida Keys National Marine Sanctuary (FKNMS) have been completed. The (FKNMS) Management Plan, which became effective on July 1, 1997, closed 18 Sanctuary Preservation Areas (SPAs), 4 Research-only Areas, and one Ecological Reserve (ER) to all extractive use. Preliminary analysis of usage of the Sanctuary Preservation Areas, before and after implementation, by recreational fishermen and divers, commercial fishermen, and lobster trappers, has been completed.

Findings to Date: 20,167 recreational vessels were counted during the surveys. Preliminary findings indicate dive operations occur mainly at the outer reefs during the summer months. Fishing activity occurs primarily in the winter months in the unprotected areas offshore of the reefs. Most of the 2,290 commercial vessels sightings observed were lobster vessels operating during the summer and fall months. Commercial fishing operations occurred throughout the year. Other types of vessels observed include sailboats, research vessels, jet skis, and treasure salvage. Events that have been documented include observations on lobster and fishing vessels fishing the edge of closed areas, on the winter seasons usage of the FKNMS by sailboats, and the approved use of the protected areas by bait fishermen. Little prohibited use of the protected areas has been seen during the surveys, only a few sightings of illegal activity have occurred.

Information on marine turtle and mammal occurrences in the FKNMS has also been documented from opportunistic sightings during the surveys, providing rough estimates of abundance. Bottlenose dolphin sightings indicate year round occurrence with no effect of seasonality. The mean herd size was 6.06 animals (range 1 - 36). Encounter rates were 18.57 per survey (range 0 - 116 animals) with 0.12 animals per nautical mile observed in Florida Keys near shore waters. Species identification (52% unknown) of the 1,740 sea turtles observed during the surveys was not always possible. Of the five species identified, the major species was the loggerhead turtle (37.3%). Turtles were observed all year with a mean number 15.3 (range 0 - 153) per survey. There appears to be a winter aggregation of turtles off of the Florida Keys. Sharks, manatees, schools of manta rays and tunas were some of the other animals seen during the surveys.