

Assessment and Monitoring
Applications
of a Community-Based Monitoring
Program:
The Reef Environmental Education
Foundation

A poster presented at the National Coral Reef Institute Meeting
April 1999, Ft. Lauderdale

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Introduction

Monitoring in the marine environment can be a challenge. The costs associated with *in situ* activities, coupled with the unreliable nature of marine conditions, make the consistent acquisition of sufficient information for effective monitoring a difficult prospect. The need for information has, in recent years, driven monitoring programs to include community-based data collection. The advantages of such programs are obvious: 1) the costs of assessing the resource are born by the volunteers, not the resource management, and 2) the total time spent by participants collecting data greatly exceeds the amount of time resource agencies would be able to contribute to monitoring efforts. The challenge associated with volunteer data, however, lies in the ability of scientists and managers to make use of the data.

This poster describes the REEF/TNC Fish Survey Project, a volunteer fish monitoring program that was developed by the Reef Environmental Education Foundation (REEF) with support from The Nature Conservancy (TNC). Three monitoring and assessment applications of data generated from the program are described.

REEF

The mission of the Reef Environmental Education Foundation (REEF) is:

“To educate, enlist and enable divers and non-divers alike to become active stewards in the conservation of coral reefs and other marine habitats.”

The REEF/TNC Fish Survey Project, developed in 1993, allows volunteer divers and snorkelers to collect and report information on marine fish populations in the tropical western Atlantic. Volunteers conduct fish surveys during their regular diving or snorkeling activities, and then submit their data on specially designed computer scantron data sheets to REEF. These data sheets are then scanned, and the information is subsequently entered into a database managed by REEF.

The RDT Method

To participate in the Fish Survey Project, volunteer divers use the Roving Diver Technique (RDT) (Schmitt and Sullivan, 1996). During RDT surveys, the diver swims freely through a dive site and records every observed fish species. At the conclusion of each survey, one of four \log_{10} abundance categories (Single[1], Few [2-10], Many [11-100], and Abundant [>100]) is assigned to each species observed. Dive times vary, generally between 30 and 45 minutes, depending on the depth and dive safety time limits.

Data Entry Form

At the conclusion of each dive, the species data, along with survey time, depth, temperature and other environmental information are recorded on preprinted data sheets that are subsequently returned to REEF and optically digitized. In an effort to minimize errors associated with improperly completed data sheets, a series of quality control programs are run on new data prior to their entry into REEF's database. All data entered into the database are referenced by the membership number of the volunteer who submitted the data.

The REEF Database

To date, there have been over 15,000 surveys from 1,414 sites entered into REEF's database (Figs. 1 and 2). The number of REEF surveys submitted by volunteers has increased each year. Based on survey experience and identification ability determined by skill exams, volunteers are classified as either experts or novices in the database. Currently, there are 36 experts.

The data are stored as ASCII files, and custom written Perl scripts are used to query the database and generate data subsets. Data are easily imported into spreadsheets or statistical software. The REEF database can be accessed through the REEF Website (<http://www.reef.org>), where a variety of summary reports can be generated.

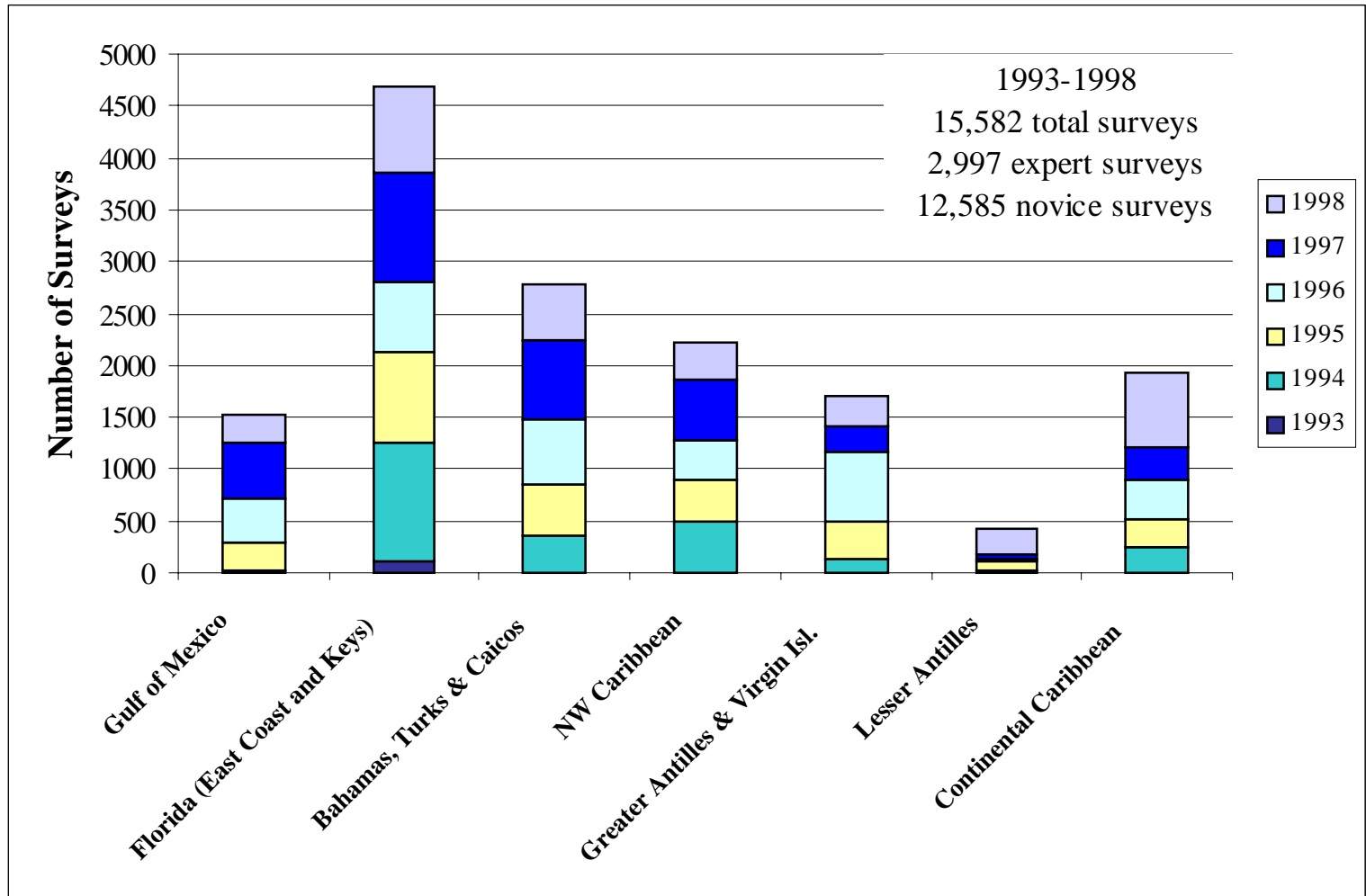


Figure 1. REEF survey effort by region. The REEF Fish Survey Project started in 1993, and to date 15,582 surveys have been conducted by 1858 volunteers of varying skill levels. Survey activities occur throughout the tropical western Atlantic and effort has increased each year.

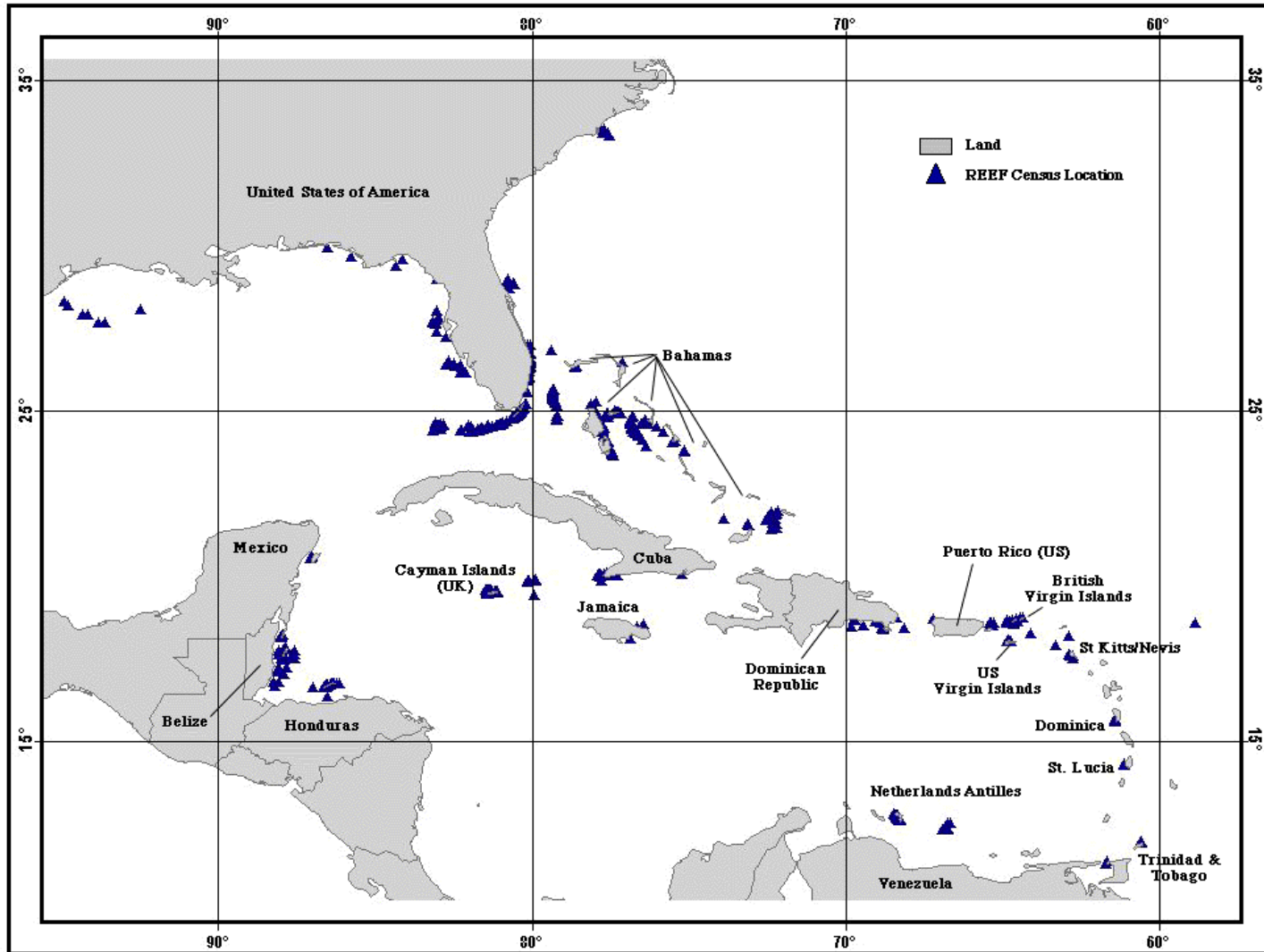


Figure 2. REEF survey locations. REEF fish surveys have been conducted in 1,414 sites. Every site is assigned a unique 8-digit code within a hierarchy based on regions (e.g. Bahamas, Turks & Caicos) and zones (e.g. Bimini).

Power of RDT Data

The goal of monitoring is to detect and quantify change if it occurs. Understanding the statistical power of RDT data, and the limitations of volunteer-generated data is necessary for resource managers and researchers to use them effectively. The utility of data collected by volunteers for use by the Flower Garden Banks National Marine Sanctuary (FGBNMS) was examined in Pattengill and Semmens (in press). REEF volunteers shared ship time on three research cruises to the FGBNMS, enabling a comparison between expert and novice RDT data. Findings included:

- The average overlap in species recorded by the two skill levels based on Jaccard's coefficient was 91.3%. Species seen in only 1 survey, regardless of skill, were excluded from the analysis.
- For many species, statistical power, measured as the ability to detect change in relative abundance, was better for the novice data because of the larger sample size.
- REEF volunteers who had previous REEF survey experience produced considerably more powerful data than other volunteers.
- On average, RDT data for the 30 most frequently sighted species could detect a 17% change in relative abundance.

Three Examples of Monitoring and Assessment Applications of REEF/TNC Fish Survey Project Data

- **Effect of Marine Protected Areas**
- **Species Distribution**
- **General Assessment**

Effect of Marine Protected Areas

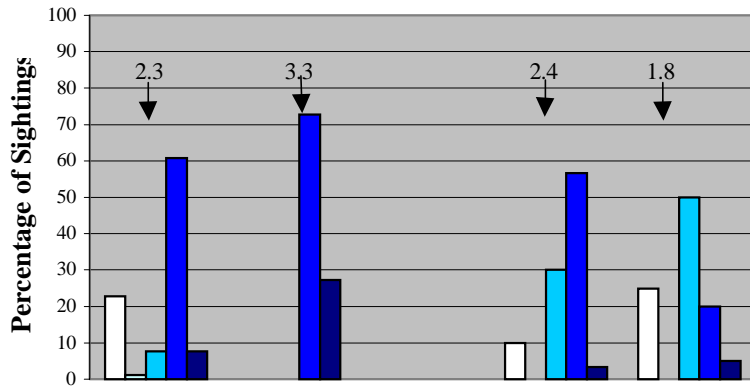
REEF data are being used to evaluate the effect of marine protected areas in the Florida Keys National Marine Sanctuary (FKNMS). On July 1, 1997, a new management plan went into effect in the FKNMS that created 23 no-take zones. The REEF dataset is being used to compare these zones to similar sites, called reference areas, where harvest has not been restricted. The REEF dataset contains a valuable baseline of fish presence and relative abundance information; volunteers conducted 2,949 REEF surveys in the Florida Keys prior to July 1, 1997.

In a preliminary analysis, data for three species of snapper were evaluated before and after the no-take zones were established. The analysis included a comparison of a newly designated no-take site, Western Sambo Ecological Reserve, and a reference site, Middle Sambo (Figure 3). Over the next four 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.

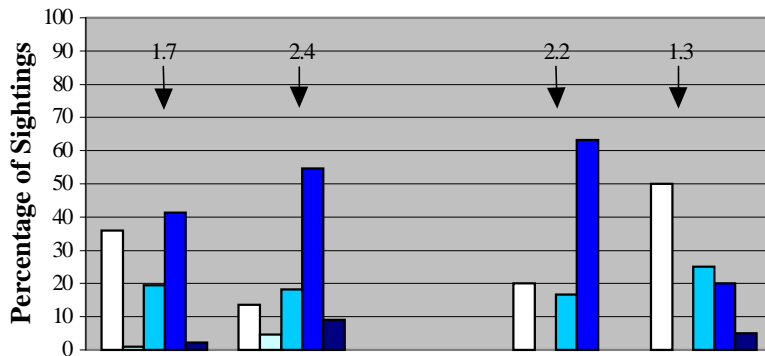
Species Distribution

Presence/absence information on a wide geographic scale is not available for most species. Community-based monitoring programs such as REEF are ideal for generating this type of information because of the large survey effort they generate on a broad spatial and temporal scale. REEF members conduct thousands of surveys at hundreds of sites each year. Data from these surveys can be used to generate species distribution maps useful to managers and scientists for a variety of purposes, including identifying temporal shifts in distribution and GAP analysis for reserve siting. Examples of range maps at regional and local scales are presented in Figures 4 and 4a, using data for gray snapper (*Lutjanus griseus*).

Yellowtail Snapper (*Ocyurus chrysurus*)



Schoolmaster (*Lutjanus apodus*)



Gray Snapper (*Lutjanus griseus*)

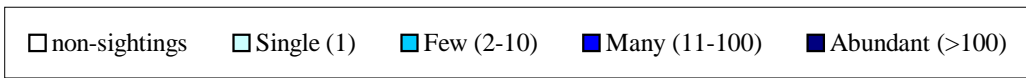
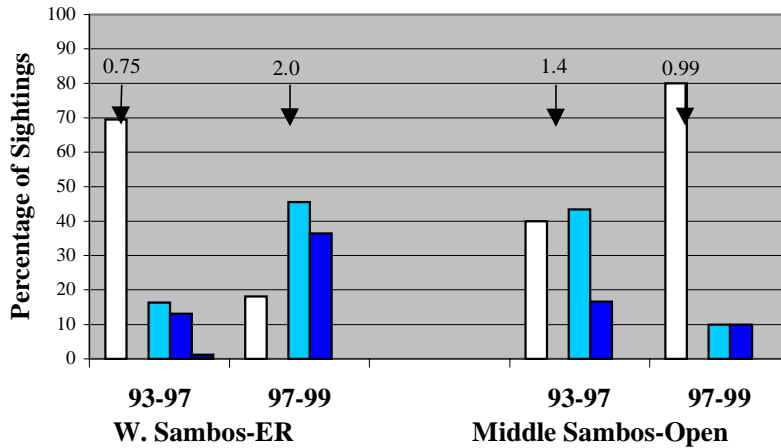


Figure 3. Reporting frequency for three species of snapper. REEF survey data collected before (July 1, 1993 to July 1, 1997) and after (July 2, 1997 to March 1, 1999) the Florida Keys National Marine Sanctuary management plan went into effect was evaluated. For each species, the percent of all surveys where volunteers reported single, few, many, or abundant is reported. The percent of surveys that did not the species is also included. At the Western Sambo no-take site, the average relative abundance score (indicated by the arrow) increased after reserve designation in all three species. Decreases were detected at the Middle Sambo reference site (no restrictions to take).

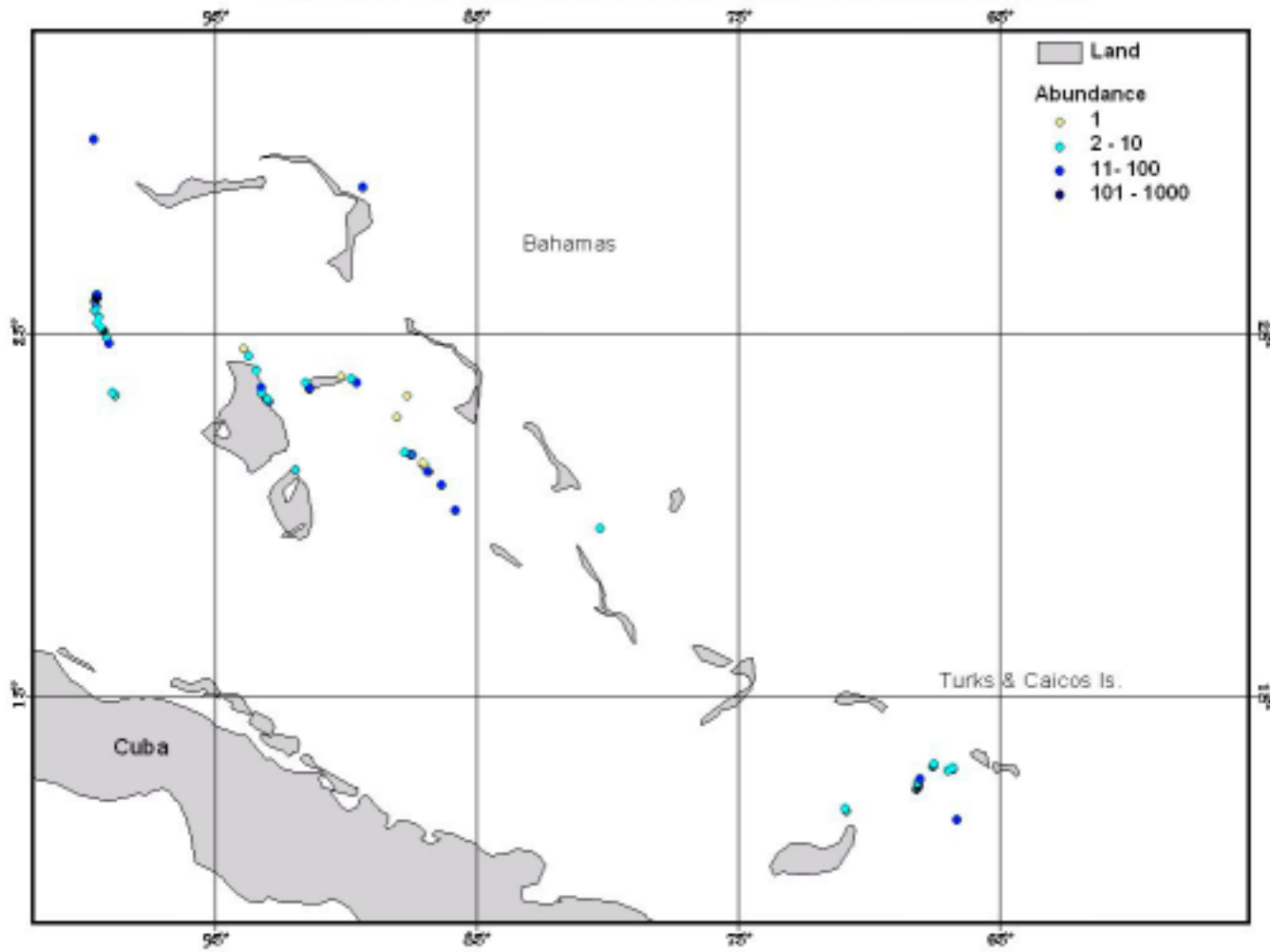


Fig. 4a. Site detail of *L. griseus* for the Bahamas, Turks and Caicos region. Each dot represents a survey site where *L. griseus* was documented, coded by average abundance category.

General Assessment

Use of the non-point Roving Diver Technique (RDT) results in a comprehensive assessment of a site with relatively few samples, and generates a species list that is valuable for both research and management.

- Biological Assessment- The RDT is used in the Flower Garden Banks National Marine Sanctuary (FGBNMS) long-term monitoring program. From 1994 to 1997 a team of six divers conducted surveys biannually to develop a baseline of information on the fish assemblages of the FGBNMS. These data will be used in conjunction with ongoing monitoring programs to indicate community trends. To date, a total of 177 reef fish species have been documented during RDT surveys, 45 of which are new records for the area.
- Rapid Assessment- The RDT was adopted as part of the Atlantic and Gulf Reef Assessment (AGRA) protocol. AGRA was developed to rapidly assess and identify the occurrences of degradation in Atlantic and Gulf reefs using standardized methodology. RDT data are used to assess the entire fish assemblage at each site, and to complement quantitative transect data collected on a sub-set of indicator species.
- Site Characterization- In regions where many RDT surveys have been conducted such as the Florida Keys (N=4,589), data can be used to evaluate spatial community structure using a cluster diagram (Figure 5).

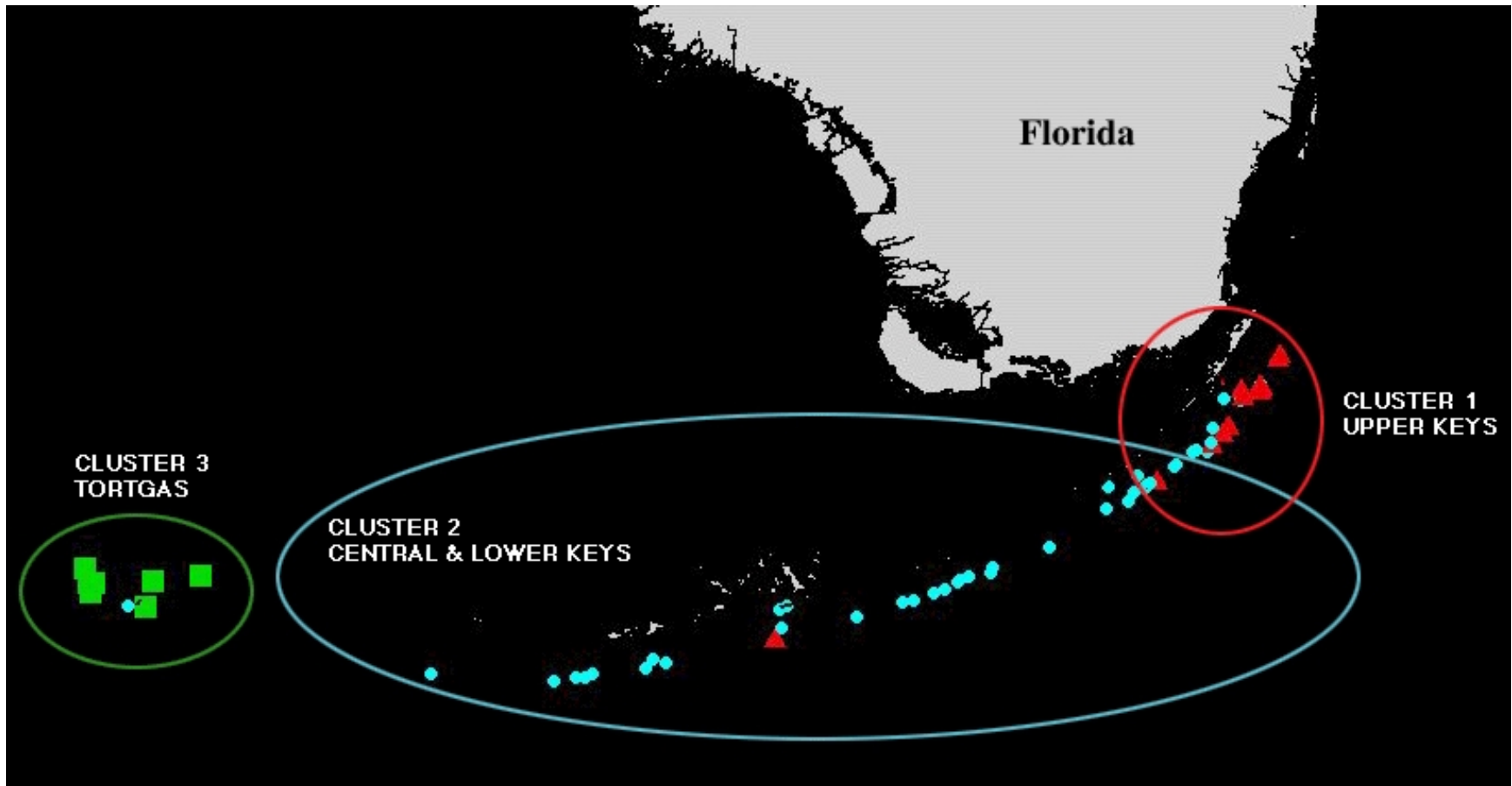


Figure 5. Spatially explicit fish species community clustering. Florida Keys REEF data were used in a hierarchical clustering algorithm (Ward's) to generate a cluster diagram based on species sighting frequency. Three clusters form, with the Tortugas reefs and the upper Keys distinct from the middle and lower Keys.

Conclusions

- Monitoring in the marine environment is often expensive, time intensive, and access-limited. Community-based monitoring programs that utilize volunteers to collect data can augment existing monitoring programs.
- The REEF/TNC Fish Survey Project is an example of a successful volunteer monitoring effort. Members of the non-profit organization REEF have conducted over 15,000 fish surveys in the tropical western Atlantic over the last 6 years.
- Fish Survey Project data are scanned into a database maintained by REEF, and are available to scientists and resource managers.
- These data have been, or have the potential to be used in a number of monitoring and assessment applications by scientists and resource managers. Applications include evaluating the effect of marine protected areas, mapping species distribution, and for general resource assessment.

Literature Cited

- Pattengill, C.V. and B.X. Semmens. in press. Analysis of fish census data generated by non-expert volunteers in the Flower Garden Banks National Marine Sanctuary. *J. Gulf of Mexico Sci.*
- Schmitt, E.F. and K.M. Sullivan. 1996. Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. *Bull. Mar. Sci.* 59: 404-416.

Acknowledgements

All maps produced by Chris Jeffrey, John Christensen, and Matt Kendall- National Oceanic and Atmospheric Administration CCMA Biogeography Program.