

Mission Report

NOAA/NOS/NCCOS/CCMA/Biogeography Team

January 16 – January 27, 2007

**Characterization and monitoring of reef fish populations off the coast
of La Parguera, Puerto Rico:**

A cooperative investigation between NOAA and the
University of Puerto Rico

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National Ocean Service
National Centers for Coastal Ocean Science
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Biogeography Team
Silver Spring, MD 20910

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Mission Purpose:

This field mission was carried out as part of the Caribbean Coral Reef Ecosystem Monitoring Project led by CCMA's Biogeography Team (BT). The goals and objectives of this project are: (1) to spatially characterize and monitor the distribution, abundance, and size of both reef fishes and macro-invertebrates (conch, lobsters, and sea urchins); (2) to relate this information to in-situ data collected on associated benthic composition parameters; (3) to use this information to establish the knowledge base necessary for enacting management decisions in a spatial setting; (4) to establish the efficacy of those management decisions; and (5) to work with the National Coral Reef Monitoring Program to develop data collection standards and easily implemented methodologies for transference to other agencies and to work toward standardizing data collection throughout the US and territories.

In addition to serving the goals and objectives above, the data collected thus far have also been utilized by partner agencies for a number of additional projects including stock assessments (U of Miami; NMFS); examination of ornamental fish populations (PRDNR); delineation of Essential Fish Habitat (Caribbean Fishery Management Council); EcoPath modeling (NMFS); and survey design (UPR). BT data are being used also by NMFS' Southeast Fisheries Science Center as part of the SouthEast Data, Assessment, and Review (SEDAR), review process to develop stock assessments and population estimates for yellowfin grouper (*Mycteroperca interstitialis*), mutton snapper (*Lutjanus analis*) and queen conch (*Strombus gigas*) in Puerto Rico at the request of the Caribbean Fishery Management Council.

During the end of this mission, additional sampling was conducted to investigate large-scale and fine-scale variability in the fish community, an altered sample design from what is currently in place. Further discussion on implementation in the field can be found in the "Logistics of Note" section.

Operational Accomplishments:

- ◆ Ninety sites were surveyed within the study area (Figure 1), and information on fish distribution, abundance and size (Table 1); benthic habitat composition (Table 2); bleaching; and conch abundance and distribution was collected. The project team consisted of four NOAA scientific divers and one UPR diver. NOAA and UPR dive logs were maintained.
- ◆ One boat was used each day of the mission, except for one day when mangrove surveys were conducted. During each dive one diver collected data on the fish community while a second diver characterized the habitat and invertebrate community. The third/fourth diver remained on the surface. Rotations were made each dive such that each diver made two consecutive dives then sat out one dive, allowing ample surface intervals for each diver.
- ◆ Nitrox (36 %) was the gas mixture used during of the dives. Air tanks were used on a few shallow sites, and snorkel was used for the shallow mangrove sites.



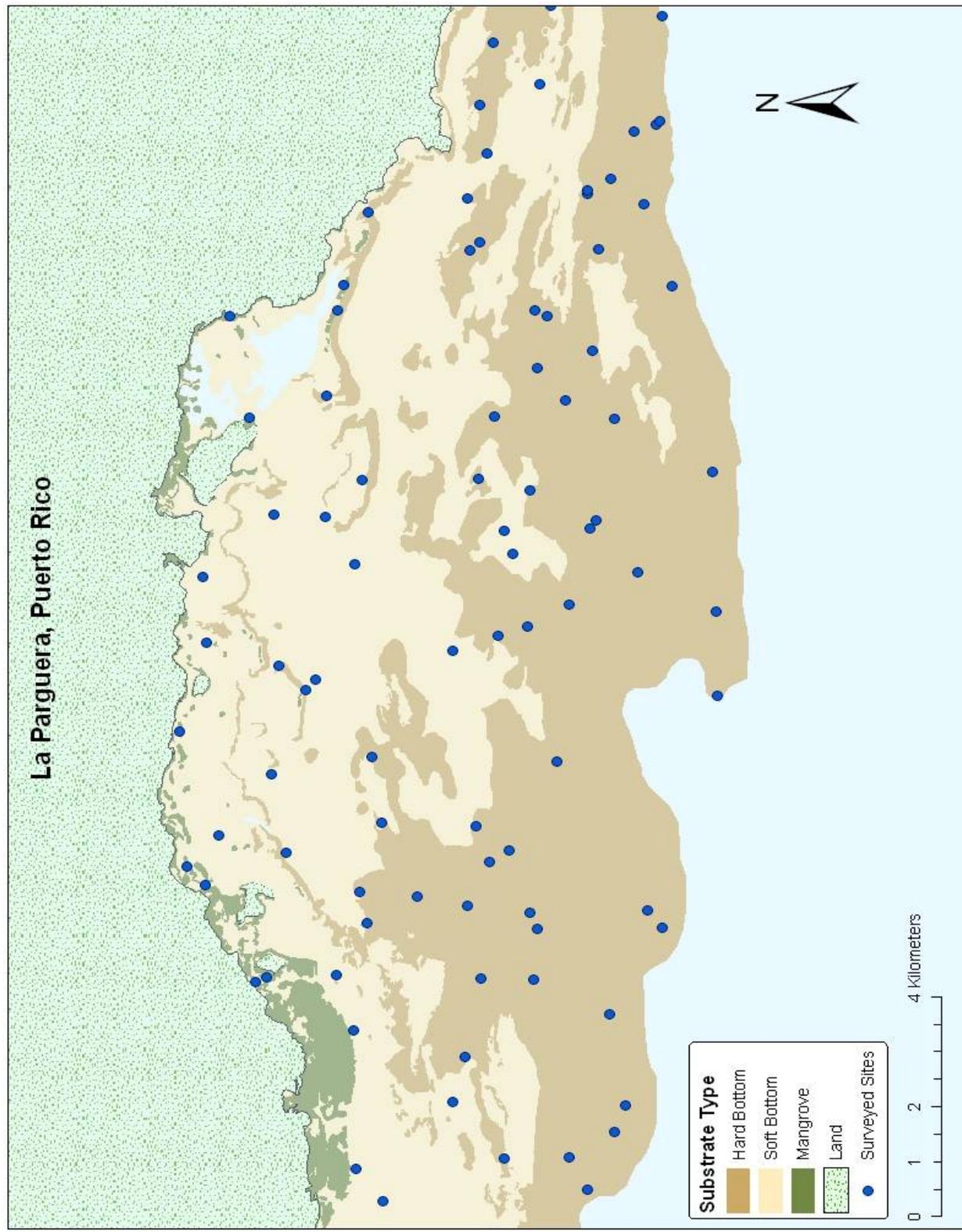


Figure 1. Map of La Parguera, Puerto Rico detailing benthic composition characteristics and selected survey points for January 2007 mission.

Summary of Survey Results:

Fish

- ◆ Fish species abundance, size and distribution were characterized using the belt transect survey method (http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish/protocols.html) at all sites. The data weighted based on area sampled are summarized in Table 1. See Appendix A for data calculations. NOTE: The high variance for number of individuals for softbottom sites is due to a high abundance of grunts and parrotfish at two soft sites.

Table 1. Fish abundance, richness and biomass (all per 100m²). Data are from the January 2007 mission.

Habitat Type	Number of Surveys	# indiv / 100m ²		Biomass* (g) /100m ²		# species / 100m ²		Mean Diversity**	
		Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Hard	50	107.76	10.29	4062.6	554.5	18.64	0.92	2.23	0.05
Soft	30	53.23	30.09	1026.1	456.0	5.30	0.58	1.13	0.09
Mangrove	10	91.50	26.30	1818.9	832.2	9.30	1.99	1.31	0.25
OVERALL	90	218.53	40.54	6602.83	1599.30	31.25	3.26	3.95	0.32

*Biomass values were calculated using $W = \alpha \times L^\beta$; α and β values were obtained from FishBase.

**Shannon Diversity Index



Photo of a Banded butterflyfish, *Chaetodon striatus*



Photo of a large area of live Staghorn coral (*Acropora cervicornis*).

Habitat

- ◆ Benthic composition data were collected at all sites during the January 2007 mission. Detailed methodology can be found at http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish/protocols.html. Hard bottom benthic composition data are summarized in Table 2.

Table 2. Average percent cover of habitat types for 50 hardbottom sites for January 2007 mission.

Number of Surveys	% Coral / 100m ²		% Algae / 100m ²		% Turf- Crustose / 100m ²		% Gorgonians / 100m ²		% Sponges / 100m ²	
	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
50	5.08	0.87	12.33	2.49	32.32	3.98	8.27	1.24	3.03	0.36

Conch

- ◆ A total of four conch, *Strombus gigas*, were observed during transects (n= 90) on this mission, two on softbottom sites (1 immature, 1 mature) and two on hardbottom sites (1 immature, 1 mature).

Events of Note:

- ◆ The Freckled soapfish (*Rypticus bistrispinus*) was recorded on a transect for the first time since surveys began in 2000 in Puerto Rico.
- ◆ During a safety stop after a dive, divers were approached by an inquisitive manatee.

**Logistics of Note:**

- ◆ Additional sampling was conducted at the end of this Puerto Rico mission to determine large-scale and fine-scale variability in the fish community. The rationale behind this investigation was to assess possible implementation of a gridded sampling frame for future Caribbean missions. The details of the sampling are below:
 - Generate a sampling frame over the current survey domain consisting of 50m x 50m sampling units.
 - Select five sampling units over hardbottom substrate and five sampling units over softbottom substrate.
 - Conduct three belt transects from the centroid of each selected sampling unit, such that they radiate from the point like spokes on a tire.
 - Examine the sample size requirements using procedures outlined in Cochran 1977 for a two-stage stratified sampling design.
 - Determine if a single transect is capable of adequately characterizing a 50m x 50m unit when 100+ units are sampled.

**Mission Participants in Data Collection:**

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References:

Menza, C., J. Ault, J. Beets, J. Bohnsack, C. Caldwell, J. Christensen, A. Friedlander, C. Jeffrey, M. Kendall, J. Luo, M. Monaco, S. Smith and K. Woody. 2006. A Guide to Monitoring Reef Fish in the National Park Service's South Florida / Caribbean Network. NOAA Technical Memorandum NOS NCCOS 39. 166 pp.

Appendix A – Equations

- ◆ Overall habitat and fish mean values for each stratum (locations and substrate type) and combined strata were calculated using the following equations (Menza et al., 2006):

Mean density for the stratified survey domain is obtained by summing the weighted averages of sample strata means,

$$\bar{y}_{st} = \sum_{h=1}^L W_h \bar{y}_h \quad (4.6)$$

where L is the number of strata, and strata weighting factors (W_h) are given by

$$W_h = \frac{N_h}{\sum_{h=1}^L N_h} = \frac{N_h}{N} \quad (4.7)$$

where N is the total number of possible sample units in all strata. The weighting factor W_h represents the proportion of the overall survey domain (or sampling frame) contained within stratum h .

An example of calculations are provided below:

- All strata types combined (e.g. Hardbottom, Softbottom, Mangrove),

$$\left(\begin{array}{c} \text{Mean \#} \\ \text{indiv} \\ \text{Hard} \end{array} \times \frac{\text{area Hard}}{\text{Total area}} \right) + \left(\begin{array}{c} \text{mean \#} \\ \text{indiv Soft} \end{array} \times \frac{\text{areaSoft}}{\text{total area}} \right) + \left(\begin{array}{c} \text{mean \#} \\ \text{indiv} \\ \text{Mangrove} \end{array} \times \frac{\text{area Mangrove}}{\text{total area}} \right)$$

- ◆ The overall and combined standard error values for fish and habitat data were calculated using the estimated variance of the mean (Menza et al., 2006). The variance of \bar{y}_{st} is estimated as

$$\text{var}[\bar{y}_{st}] = \sum_{h=1}^L W_h^2 \text{var}[\bar{y}_h] \quad (4.8)$$

For benthic composition calculations, $W_h = 1$ because only mean estimates were only derived for the hardbottom area stratum.