Mission Report

NOAA/NOS/NCCOS/CCMA/Biogeography Branch

August 19 – 30, 2008

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

NOAA
National Ocean Service
National Centers for Coastal Ocean Science
Center for Coastal Monitoring and Assessment
Biogeography Branch
Silver Spring, MD 20910

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

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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 Branch (BB). 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). Most recently, BB data are being incorporated as part of the Southeast Data, Assessment, and Review (SEDAR) conducted by NMFS' Southeast Fisheries Science Center. The purpose of this effort is 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.

Operational Accomplishments:

- Ninety sites were surveyed within the study area (Figure 1), and information on fish distribution, abundance and size (Tables 1 and 2), benthic habitat composition (Table 3), coral bleaching, macroinvertebrate (conch, *Diadema*, lobster) abundance and distribution, and marine debris (Table 4) was collected. The project team consisted of four NOAA scientific divers.

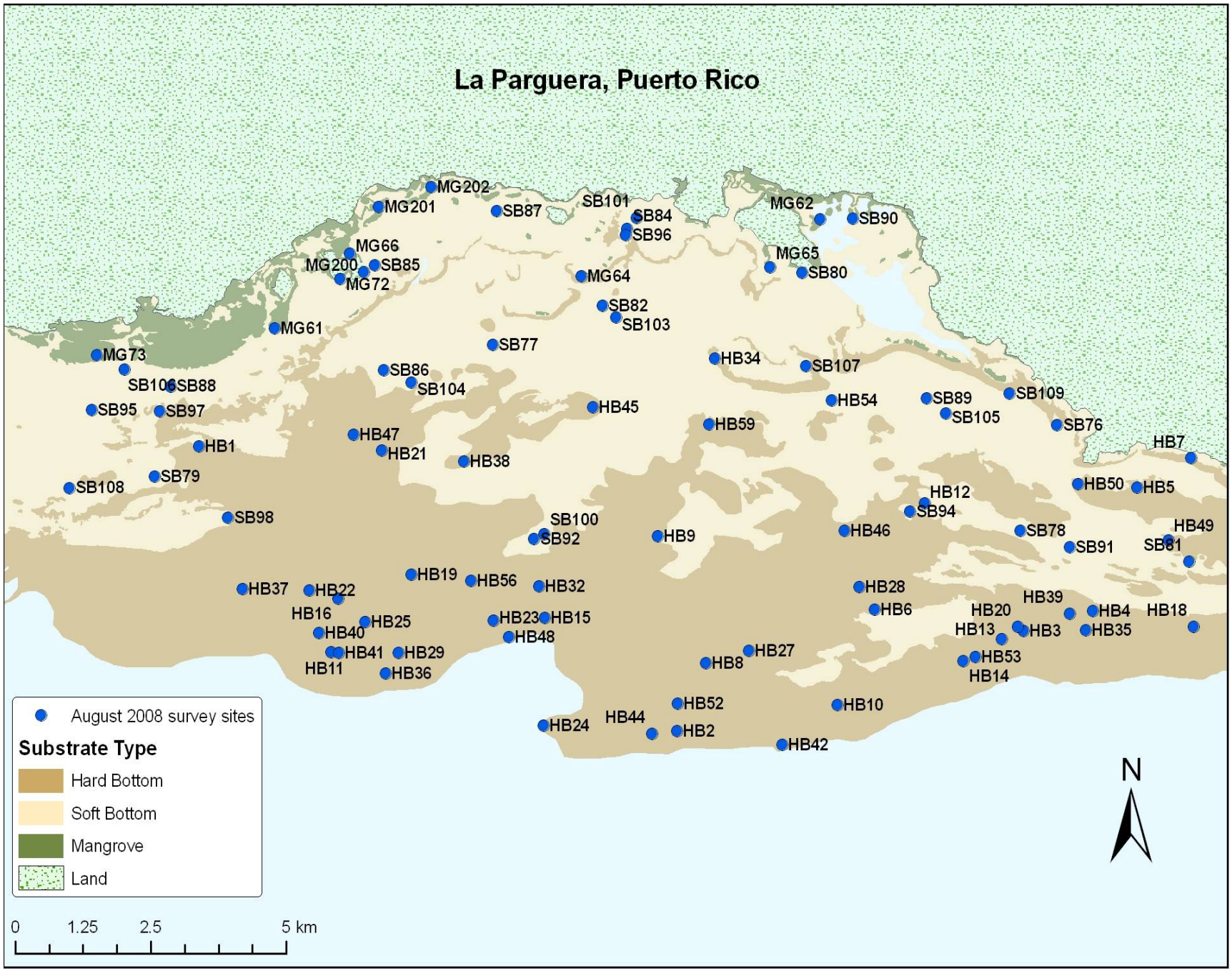


Figure 1. Map of La Parguera, Puerto Rico detailing benthic composition characteristics and selected survey points for August 2008 mission.

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 are weighted based on area sampled and are summarized in Tables 1 and 2. See Appendix A for data calculations.

- The data in Table 2 reflect values where highly abundant baitfish *Atherinomorus* species values (400-100,000 individuals) were removed.

Table 1. Average fish abundance, biomass, richness and diversity. Data are from the August 2008 mission.

Habitat Type	Number of Surveys	# indiv / 100m^2		Biomass (g) /100m^2		# species / 100m^2		Diversity*	
		Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Hard	43	98.0	8.8	3226.1	499.7	18.1	0.9	2.30	0.05
Soft	37	86.0	35.2	681.6	295.0	5.7	0.5	1.09	0.10
Mangrove	10	10367.9	9995.2	5367.5	2571.9	12.2	0.8	1.23	0.23
OVERALL	**90**	**10483.6**	**10007.4**	**9165.68**	**3263.29**	**33.5**	**2.0**	**3.94**	**0.30**

*Shannon Diversity Index

Table 2. Average fish abundance, biomass, richness and diversity where highly abundant *Atherinomorus* sp. values (400-100,000 indiv.) were removed. **All values except diversity reflect removed baitfish values.**

Habitat Type	Number of Surveys	# indiv / 100m^2		Biomass (g) /100m^2		# species / 100m^2		**Diversity***	
		Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
Hard	43	98.0	8.8	3226.1	499.7	18.1	0.9	2.30	0.05
Soft	37	53.6	15.2	673.0	295.4	5.7	0.5	1.09	0.10
Mangrove	10	167.9	46.0	2675.6	575.5	11.8	0.8	1.23	0.23
OVERALL	**90**	**283.4**	**58.2**	**6473.74**	**1266.89**	**33.1**	**2.0**	**3.94**	**0.30**

*Shannon Diversity Index


Hogfish (*Lachnoliamus maximus*)


Spotted moray (*Gymnothorax moringa*)


Tube blenny sp. (*Acanthemblemaria* sp.)


Silverside species (*Atherinomorus* spp.)


Silverside species (*Atherinomorus* spp.)

Habitat

- Benthic composition data were collected at all sites during the August 2008 mission. Hardbottom data are weighted based on area sampled and are summarized in Table 3. Detailed methodology can be found at http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish/protocols.html.

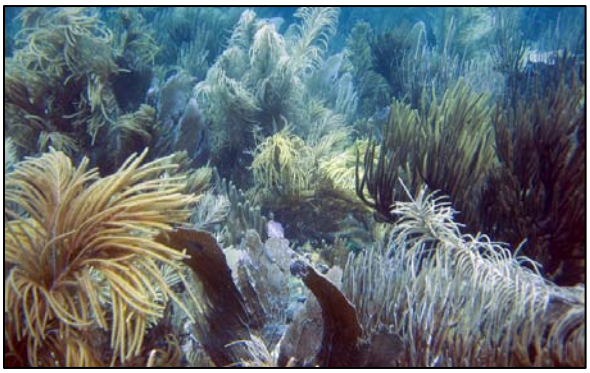
Table 3. Average percent cover of habitat types for 43 hardbottom sites for August 2008 mission.

Number of Surveys	% Coral*		% Algae-Seagrass		% Turf- Crustose		% Gorgonians		% Sponges	
	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)	Mean	(± SE)
43	3.18	0.46	25.93	3.25	38.22	3.62	5.74	1.40	2.23	0.41

* Hydroids (fire coral, etc.) are included in this value

Tunicates, sponges, algae, hydroids and other biota covering mangrove roots

Finger coral (*Porites porites*) in turtle grass (*Thalassia testudinum*) bed



Dense aggregation of sea plumes

Great star coral (*Montastraea cavernosa*) colony

Macroinvertebrates

Conch

- A total of 28 conch, *Strombus gigas*, were observed during transects (n= 90) on this mission. One immature conch was counted at one hardbottom site and 27 conch at three softbottom sites. No mature conch were recorded during this mission.

Lobster

- Six Caribbean spiny lobsters, *Panulirus argus*, were observed during transects (n= 90) on this mission. Five lobsters were enumerated at one mangrove site and one at one hardbottom site.

Sea urchins

- Eight long-spined urchins, *Diadema antillarum*, were observed during transects (n= 90) on this mission. Seven were counted at two hardbottom sites and one *Diadema* recorded at softbottom site.

Marine Debris:

- Marine debris data have been recorded during missions in Puerto Rico since 2007. The marine debris observed within transects during this mission are summarized in Table 4.

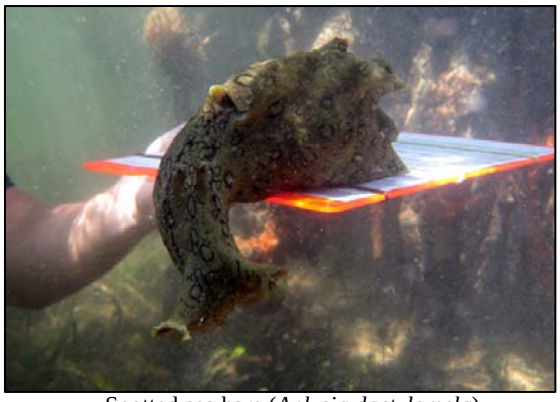
Table 4. The type and size of debris, area affected, and what the debris was colonized by during this mission.

Station	Debris Type	Debris Area (cm^2)	Colonized By	Area Affected (cm^2)
1	7 beer cans	250	filamentous algae	250
	plastic bottle	960	filamentous algae and cyanobacteria	960
	glass beer bottle	350	filamentous algae and crustose algae	350
	large tire	22500	macroalgae	22500
2	plastic oil container	2800	mussels, scallops, tunicates, sponges, algae	2800
3	3 glass bottles	720	turf algae	720
	2 beer cans (medalla)	504	one with turf, one with nothing	504
4	plastic fish reel	1125	cyanobacteria and filamentous algae	1125
	glass beer bottle	686	cyanobacteria and filamentous algae	686
5	11 plastic cups	350	turf algae	350
	rope and buoys	3000	macroalgae and turf algae	3000
	7 beer cans	350	turf algae and cyanobacteria	350
	plastic 1L bottle	1000	cyanobacteria and crustose algae	1225
	plastic cart with wheels	42000	filamentous algae and turf algae	42000
	3 plastic 2L bottles	6000	crustose and turf algae	6000
	3 plastic 6L bottles	18000	crustose and turf algae	18000
6	old fish pot, decayed	5000	algae and cyanobacteria	5000
7	metal can	588	turf algae and a snail	588
	glass bottle	375	turf algae and crustose algae	375
	glass flask	378	turf algae and a snail	378
	aluminum can	400	turf algae and cyanobacteria	400
8	partial plastic cup	150	algae	150
9	plastic bottle	1472	crustose algae and turf algae	1472
	plastic bag	350	turf algae	350
	glass beer bottle	960	turf algae and macroalgae	960
10	thin plastic mostly buried	1795	turf algae, small barnacles	1795
11	beer bottle	735	crustose algae and turf algae	735
12	can	10	algae	10

Boats gathered around a mangrove island for recreation (top); plastic bag wrapped around a mangrove root (left); mangrove roots growing through plastic cups (right)

Events of Note:

- There were no new species recorded on transects during this mission.
- This was the first Puerto Rico mission since collection began in 2000, where no yellow goatfish (*Mulloidichthys martinicus*) were recorded in a transect.
- A large sea hare was observed at a mangrove site and another smaller one at a softbottom site.
- There was an abundance of moon jellys observed during this mission.



Spotted sea hare (*Aplysia dactylomela*)

Moon jelly (*Aurelia aurita*)

Logistics of Note:

- Mission was accomplished with two dive teams.

Mission Participants in Data Collection:

Chris Caldow (NCCOS/CCMA BB)
Chris Jeffrey (NCCOS/CCMA BB)
Matt Kendall (NCCOS/CCMA BB)
Kimberly Woody (NCCOS/CCMA BB)

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,

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

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

$$W_h = \frac{N_h}{\sum_{h=1}^{L} N_h} = \frac{N_h}{N}$$

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 is provided below:

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

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

- 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

$$\text{var}\left[\bar{y}_{st}\right] = \sum_{h=1}^{L} W_h^2 \, \text{var}\left[\bar{y}_h\right]$$

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

References:

Menza, C., J. Ault, J. Beets, J. Bohnsack, C. Caldow, 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.