6.0 Project Description

6.1 Introduction

a. Situation and Need

Located on the west coast, the Cabo Rojo shelf is the widest section of the Puerto Rico (PR) shelf, comprising a diverse mosaic of benthic habitats including well developed deep reefs, at least three known spawning aggregation (SPAG) sites, three of the six federal U. S. Caribbean MPA's and longstanding and intense fishing activities. During the fish biomass hydroacoustic surveys of 2002 and 2003 (HTI, 2002 and 2004), the west coast of PR had the third highest density values when compared to the rest of the island (Figure 1). Only Mona and Desecheo islands had higher densities. The influence of fresh water discharge from the Yagüez and Guanajibo rivers, as well as industrial and domestic effluents, combined with an important depth gradient greatly limited available habitat mapping generated from NOAA aerial photographs during 1998 (NOAA, 2002, see Figures 2 and 4). As a consequence, extensive areas of the Cabo Rojo shelf lack habitat information, needed to evaluate pattern of habitat change, location and performance of fishery resources, and MPA effectiveness, among others.

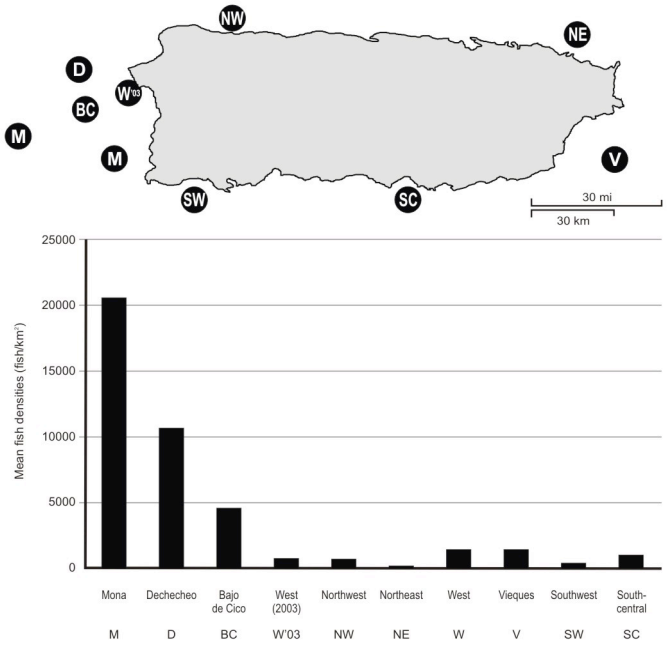


Figure 1. Hydroacoustic biomass fish surveys for 2002-03 of Puerto Rico. Taken from Johnston, *et al,* In Press.

Since 1998, in the U. S. Caribbean, side scan sonar (SSS) mapping initiative of the insular shelf was started under federal and local government funding (Prada, 2002, Appeldoorn, *et al*, 2001). This project will give continuity to those efforts by looking at generation of high resolution habitat mosaics and maps based on SSS technology on the Cabo Rojo shelf. The results obtained will complement information available for La Parguera, Lajas (Prada, 2002), San Juan Bay estuary, and Caño Luis Peña Marine Fishery Reserve, Culebra within PR. The results are also

comparable with recent work done in the U. S. Virgin Islands at the Marine Conservation District (MCD) south of St. Thomas, the National Park Service, St. John's National Coral Monument, Lang Bank and Mutton Snapper closed areas in St. Croix (Geophysics GPR, 2003). Indeed, the proposed work builds on the first two years of CCRI habitat mapping funding of the Cabo Rojo shelf. The final goal is to complete the entire shelf with an extension of 193, 1 nm^2. The results of the proposed work will make PR and the USVI the first Caribbean coral reef dominated shelf having detailed sonar imagery habitat information. Coral reef systems complexity require the high resolution mapping to address multiple scale ecological processes taking place within one of the most complex ecosystems on Earth.

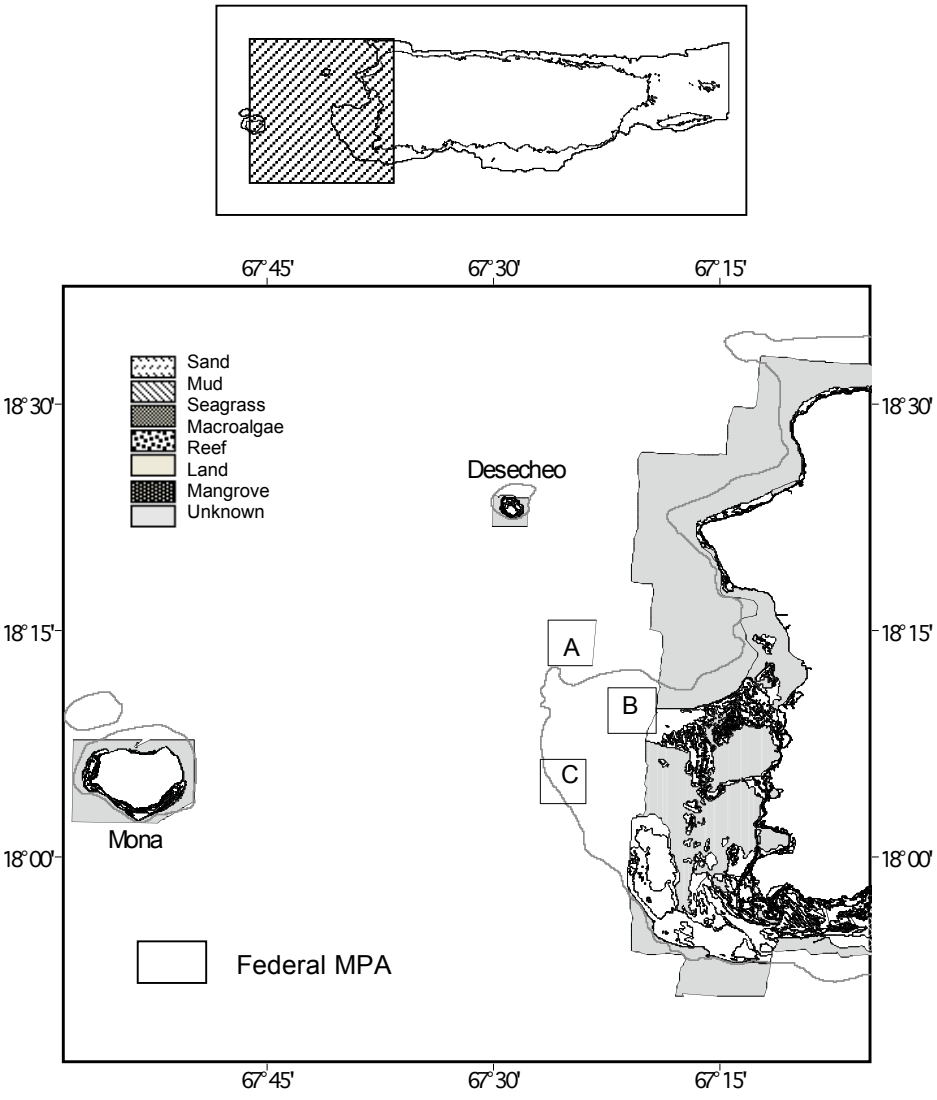


Figure 2. Depiction of the three federal MPA's on the Cabo Rojo shelf. A. Bajo de Cico B. Tourmaline C. Abrir La Sierra. Desecheo and Mona Islands are designated Natural Reserves by the PR Dept. of Natural and Environmental Resources. The shelf brake is represented by the 200m depth line seen between the MPA's. Less than 50% of the benthic habitats of the shelf have been classified from aerial photography at a minimum mapping unit of .5 hectares (NOAA, 2002).

b. Objectives

Specifically, the research objectives will be to:

1) Continue collecting side scan sonar imagery of benthic habitats and make sonar imagery mosaics for the full set of habitats on the Cabo Rojo shelf.

2) Classify, delineate and quantify spatial distribution patterns of benthic habitats on the Cabo Rojo shelf sonar imagery.

3) Provide existing SSS information in digital and paper format needed for scientific and management purposes, allowing comparison within other sections of the PR shelf and among other Caribbean MPA's such as the MCD in St. Thomas or Chinchorro Bank in Mexico.

c. Applications, Benefits and Importance

Results from this project will generate habitat information for another important section of the PR shelf, making possible elucidation of the dynamics functioning at multiple local scales, and in conjunction with existing SSS information it will allow large scale coral reef process studies. Detailed characterization of benthic habitats have been identified as crucial information for ecosystem based management guidelines, sustainable fishery policies and regulations, biodiversity conservation projects, and reduction of socio-economic conflicts. Patterns of habitat spatial composition and distribution as a consequence are considered the basic step in the process of understanding complex and multi-scale functions taking place in coral reef habitats.

d. Significance of the Research

Coral reef and reef fishery studies have historically been handicapped due to the lack of information on the distribution and extent of habitat. The proposed research will provide complete detailed description of coral habitats in digital and paper formats to enable elucidation of the habitat/fish processes at different scales and establish a base line.

Integration of this information into geographic information systems facilitates such type of work, while open unlimited links will help to further research and management applications on a Caribbean basin wide and worldwide reach. This has the potential of converting PR and the USVI in the first Caribbean islands with digital marine resource management and research tasks geographic databases for the entire submerged insular shelf. This capability will provide complete detailed habitat inventories which will allow the design of multiple scale long term resource monitoring and research studies not possible at present.

The detailed habitat information obtained from this study will help provide the data to comply with the essential fish habitat amendments to the Caribbean Fishery Management Council fishery management plans. The information will be available for other federal and local regulatory agencies and the public to help them evaluate habitat alteration for development projects located in coastal and offshore locations.

6.2 Methods and Approach

a. Description of Methods

Side scan sonar imagery will follow techniques first adapted in PR to allow cost-effective methodology including the use of a small vessel, enough imagery overlap, and high precision geographic positioning system (DGPS). With this methodology the entire range of depths in the Cabo Rojo shelf can be sonar scanned therefore bridging the present habitat information gaps.

Once the SSS imagery is collected, processing software (SonarWeb Pro) will be utilized to build 1 nm^2 Geotiff mosaics for later habitat classification, delineation and map generation utilizing an Arc View (3.3) habitat extension developed by Ken Buja, a member of the NOAA Biogeographic Team (Kendall, *et al,* 2002, see Figure 3) while generating the first comprehensive habitat mapping around PR and the USVI. Mosaics interpreted at high spatial scale (1:1,000), will elucidate spatial patterns of habitat composition and distribution. Because of similar procedures, new habitat information can be integrated to existing SSS databases and posted on the web, extending possibilities for future research and management use within PR and other Caribbean locations. In addition, the proposed work will contribute in a better understanding of habitat connectivity and functioning of the PR shelf, as already has happened for other sections of the PR shelf having detailed habitat mapping from SSS imagery.

Due to weather caused sea conditions, equipment maintenance and data processing requirements, sonar data acquisition will be planned for approximately six months each year.

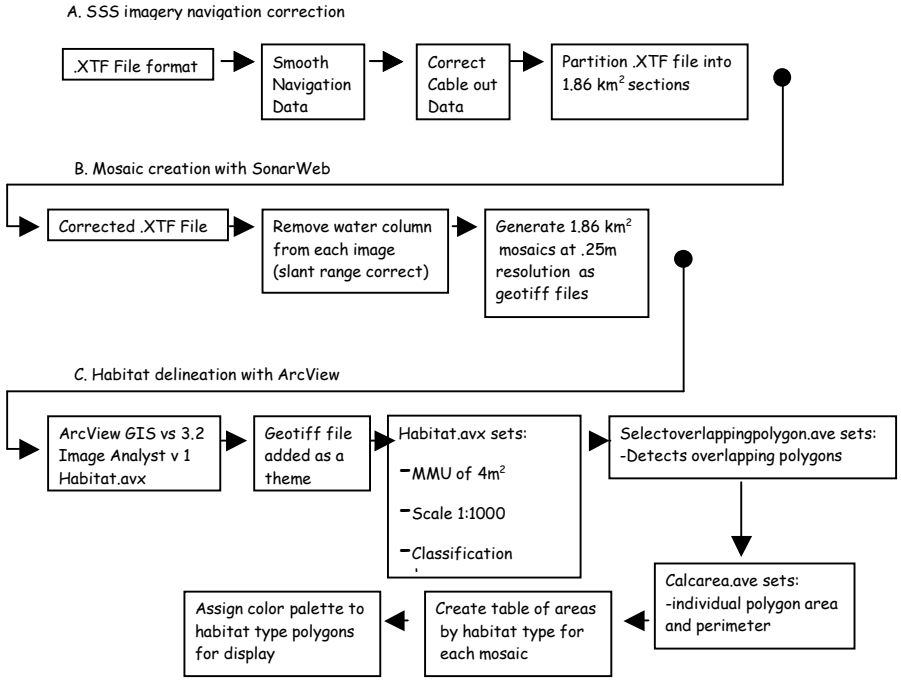


Figure 3. Flow diagram of sonar imagery processing stages. A. SSS imagery navigation correction. B. Mosaic creation with SonarWeb. C. Habitat delineation with ArcView. MMU is defined as minimum mapping unit.

A minimum of ten one nautical square miles of Cabo Rojo submarine shelf to the shelf drop will be surveyed each year. Not to exceed the 30 meter isobath. The shore limits of the survey will coincide with the Municipal borders with Mayaguez and Lajas (Figure 4). The seaward boundaries will follow perpendicular to the shore limits until the 30 meter shelf edge isobath is reached. It is understood that this mapping effort is the continuation of a multiple year effort to map the Cabo Rojo shelf. The mapping effort will consist of two parts:

1. Compile existing side scan sonar imagery for the designated area and process for use in the making of bottom habitat maps.

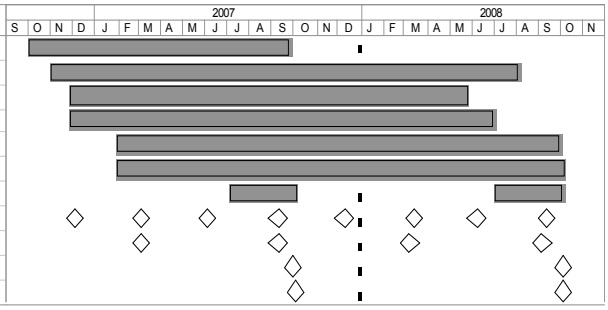
2. Collect new side scan sonar imagery using a minimum frequency of 100- 200 kHz for the designated area for use in the making of bottom habitat maps. Create bottom imagery mosaics from the side scan data in order to use them for delineation of habitat maps. All data collected and processed will be archived in digital format and one copy made available.

Habitat maps will be made following the specifications in Appendix A of section 11.

b. Description of Major Tasks

Table 1. List of project tasks and two year period schedule. Project start date is October, 2006.

ID	Task Name
1	Compilation of existing sonar imagery
2	Collect SSS imagery
3	Delineation of habitat polygons
4	Creation of habitat classification summary table with acreage totals
5	Ground truth and accuracy assessment
6	Edits of habitat polygons based on ground truth input
7	Creation of sonar and habitat maps in paper and digital formats for GIS and Web use
10	PowerPoint presentations at quarterly meetings
19	Semester report
24	Final report
27	Data and Metadata information archived with NOAACORIS



c. Diagram (including map of research area)

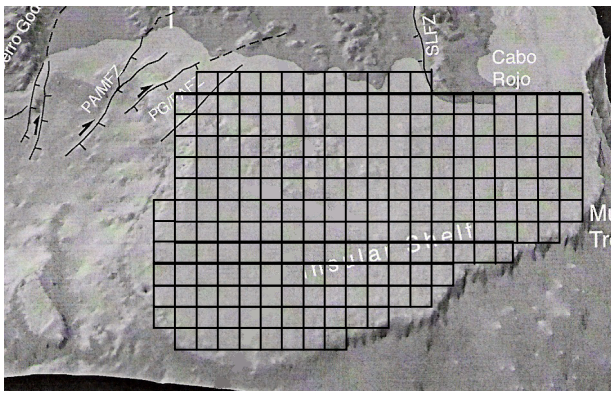


Figure 4. Depiction of the Cabo Rojo shelf, on the southwest coast of Puerto Rico, the proposed area to be mapped with SSS technology. Grid squares are $1nm^2$.

6.3 Alternative Approach (not applicable for CCRI)

6.4 Description of Facilities, Systems and Equipment (not applicable for CCRI)

6.5 Program Management

Project Team

Administration: The PI will be responsible for coordinating all technical issues including field work, data collection and analysis, report and scientific publication writing. The financial administration will be the responsibility of the PUPR and CCRI as in past funded years.

Roles/Assignments and Participation Time: It is estimated that the PI will spend approximately 120 days a year dedicated to this project. Sub-contractors will perform all other project major tasks such as data collection, ground truthing, creation of sonar mosaics and habitat delineation, and final paper and digital map products. It is estimated that sub-contractors will dedicate approximately 180 days a year to the project. A vessel will be chartered to provide the sampling platform for the sonar imagery and the ground truthing. The chartered vessel will have a U.S.C.G. certified vessel operator and a mate to help support project objectives.

Qualifications: The PI is a NAUI Instructor certified diver with 30 years of experience. He has also been trained and certified by the NOAA diving program as a Nitrox Diver, Divemaster, Chamber Operator and Emergency Medical Technician. Sub-contractor technicians will be required to have the necessary diving credentials, but remain to be determined for selection.

The PI acquired hydrographic techniques knowledge as a NOAA Corps Officer aboard charting vessels. Experience was acquired in the use of single beam, multibeam and side scan sonars and survey grade positioning systems (satellite and laser). The PI has attended continuing education courses in sonar and multibeam techniques. When assigned to the NOAA Beaufort Fisheries Laboratory, NC the PI was involved in producing habitat maps of the submerged aquatic vegetation of Back, Bogue and Core Sounds from aerial photos. The PI retired as a LCDR in the NOAA Corps after serving as Commanding Officer of the fisheries research vessel Oregon II.

6.6 Results from Prior CCRI Support

Funds from CCRI have been awarded for FY 2004 and 2005. To date, only FY 2004 have been awarded to PUPR (see attached letter of award in section 11) for a total of $110K. The PUPR is currently in the process of soliciting grant funds from UPRM and it is expected that by October, 2005, these funds will become available to the PI to begin the collection of the first 10 nm^2 of sonar imagery as proposed. Once the FY 2005 funds are awarded, the proposed work can continue to collect the second set of 10 nm^2 sonar imagery. The pace of the sonar imagery data collection and consequently the project productivity will depend primarily on the width of the sonar channel swath of the SSS system available to collect the data. See Table 2 for details.

Table 2. Estimate of the daily sonar imagery productivity collected per day depending on the swath width for the Cabo Rojo shelf.

Swath (m)	nm^2/day	Total days
100	.8	154
200	3	64
300	4.5	43
400	6	32

7.0 Literature Cited

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