

Marine Management Areas Science Abrolhos Node

Habitat Mapping

Final Report

September 2010

Summary of the Activities Developed by:

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HABITAT MAPPING¹

INTRODUCTION:

The Abrolhos Bank is a 200 km enlargement of the Brazilian continental platform and is comprised of a mosaic of marine and coastal ecosystems that encompasses the highest biodiversity in the South Atlantic, the largest reefs in this region, as well as several endemic and red-listed marine species. Covering about 46,000km², the bank includes extensive mangroves, seagrass and algae bottoms, submerged and emergent reefs, and a group of small volcanic islands. Besides holding a representative assemblage of the Brazilian-endemic coral reef fauna, Abrolhos' reefs present unique morphological attributes, growing as mushroom-shaped pinnacles that are locally known as "chapeirões". Despite the region's unique biodiversity, critical knowledge gaps still impede the sustainable use of its natural resources. One of the most key information for advancing in a systematic conservation planning for the region was a comprehensive habitat map in the scale of the Bank. It would be particularly difficult to design a management regime that implicitly includes these areas and accounts for the ecological processes that these habitats provide, without this information. To change this scenario, three main components were designed and implemented:

- **Mid-depth habitat mapping:** Map and describe habitat characteristics of critical sections between 20-70 meters at the scale of the Abrolhos Bank using side-scan sonar surveys and field checking. These areas were largely unknown and the previous available maps did not offer enough information for developing a conservation strategy for the region. Field checking surveys provided a general description of the structures identified by the side scan images, and were developed using direct (scuba dives) and indirect (Remote Operated Vehicles) methods.

¹ This activity was originally called "Inter-reefal Habitats" because we were intending to describe the habitats distributed among the previously known reefs. Meanwhile, as we have discovered large areas of reefs along the implementation of the activity, the name "Habitat Mapping" became more realistic and was adopted in this Final Report.

- **Shallow habitat mapping:** This component refined the existing maps of the shallow (up to 20 meters) coral reefs of the Abrolhos Bank, using high-resolution (sub-meter) satellite images (Quick Bird and IKONOS). Previously available maps were based on Landsat images with a resolution (30-50 meters) that did not show the smaller reefs that are considered key for conservation planning.
- **Database organization and storage:** The GIS database was organized to integrate the geographic information produced by other MMAS Brazil Activities. Information from Social and Economic activities was overlaid with biological and physical data to provide an overall view of the Abrolhos Bank, essential for advancing conservation planning. Data from the long term monitoring programs leaded by CI in Abrolhos will be stored in a professional database, being available for future analysis and planning.

METHODS

Mid-depth habitat mapping:

Side scan sonar surveys were planned to cover a large area in the Abrolhos Bank, providing a general view of the region. The equipment used was a towfish Edgetech 272TD® (100/ 500 kHz), linked by a 200 meter Edgetech Kevlar cable tied to a compact processor Edgetech 560P®, connected to a notebook PC (**Figure 1**). The software EdgeTech Discover® (V.5.12) was used to acquire the field data. The equipment belongs to the *Universidade Federal do Espírito Santo - UFES*, Brazil, that joined MMAS as partner through the direct participation of Professor Alex Bastos, PhD.



Figure 1. Equipment used for the side scan sonar surveys: A) towfish; B) processor; C) laptop and echo sounder.

Parallel west-east transects were planned in a distance of 10 kilometers each, from the depth of 20 meters to the shelf break (nearly 70 meters deep). Areas of special interest were investigated in a more detailed grid, providing a zoom for these areas (**Figure 2**). The position of the boat was obtained using a GPS72MAP® with an external antenna (owned by CI-Brazil), programmed for continuous track data acquisition. The depth was obtained using an analogical echo sounder Skipper 417® (owned by *Universidade Federal da Bahia - UFBA*), printing on thermal paper, and a GPS178MAP Sounder® (owned by CI-Brazil/MMAS) which acquires geographic position associated to digital depth data. A gasoline powered electric generator was used to feed the system (purchased by CI-Brazil/MMAS). A Globalstar® - satellite mobile phone was used for daily position referencing, given to the support team on land, for safety and logistic reasons (owned by CI-Brazil).

Figure 2. Side scan sonar transects covered by field surveys in the Abrolhos Bank.

A 100 kHz frequency was used for the larger transect surveys, covering a swath-width of nearly 300 m along the transect lines. The boat operated at speeds varying between 3 to 5 knots along transects (depending on the waves and winds).

After the surveys the newly acquired data were processed in UFES. The GeoTiff files were transformed into geo-referenced data through the software SonarWis Map4® (V.4.02.0136), Chesapeake Technology. The information was included in an ArcGIS 9.2® project, and classified following the different patterns identified from side scan images. This classification was used for planning the smaller scale transects and field checking surveys focusing on key areas. For this phase, we have used a Remotely Operated Vehicle (ROV - Seabotix LBV150 – owned by University of São Paulo) to produce videos of sample areas from 20 to 100 meters.

Shallow habitat mapping:

The shallow coral reefs of the Abrolhos Bank are reported to cover an area of approximately 300 km², based on Landsat TM estimation (Prates 2002). To refine this database we have obtained high resolution images of all known shallow reefs (up to 20 meters) of the Abrolhos Bank, using two sensors: QuickBird and Ikonos. A total of 09 images were purchased by MMAS/CI.

The 60cm resolution of QuickBird's panchromatic (black and white) images allows objects on the ground to be as small as 60cm to be seen. QuickBird multispectral imagery has resolutions of 2.4 -2.8 m, while IKONOS records multispectral data at 4 meter resolution and panchromatic at 1 meter resolution. Multispectral channels include blue (450nm), green (560-600nm), red (630-690nm), and near-IR (760-900nm). The sharpened resolution of the QuickBird and IKONOS images provides potential information for the identification of fine-scale biophysical characteristics of the sea bottom (e.g. macroalgae, corals, sand, mud), as well as for long term monitoring the growth and deterioration of coral reefs.

A Differential-GPS was used for checking the georeference of three images. As the difference was less than 1 meter from the original files, the original georeference from the files was adopted to all other images. An automatic classification was made considering the size of the reefs, dividing them in two categories: platform, for those formations with

more than 50 meters (maximum diameter) and “chapeirões” (mushroom-shaped reefs), with less than 50 meters. Sand areas were also classified as a distinct category.

Database organization and storage:

Most MMAS Program activities produced associated spatial information, which has been compiled within the same GIS project to provide an overview of the region, and provide sources for integrated analysis. A data base consultant was hired to support us in this activity and is organizing all CI-Brazil Marine Program database.

The questionnaires applied by local assistants during fishing disembarks includes local maps (**Figure 3**) where each fisherman informs the fishing sites they have used. This data is still being processed and digitalized. These maps will give us an idea of the distribution of the fisheries fleet in the Abrolhos Bank throughout the year, help in identifying from where fish target species are coming from, and suggest spawning aggregation sites.

Figure 3. Maps shown to the fishermen for collecting information about fishing areas

Similarly, the Socioeconomic and Governance Monitoring produced geographic data such as the number of fishermen and fishing boats per community, and maps on the distribution of communities along the mangroves. This information will also be compiled within the GIS for integrated analysis together with the biophysical data.

RESULTS

Mid-depth habitat mapping:

A total of 1264 nautical miles were surveyed using side scan sonar, between March 2007 and March 2009. These surveys revealed a great diversity of submerged structures, which were grouped in 06 patterns, as shown in **Figure 4**. These preliminary results indicate that a large portion of unmapped reef structures exists in the areas between 20 and 70 meters.

<i>Pat ter n</i>	Description	<i>Examp le</i>
<i>P1</i>	Isolated reef structures (pinnacles). Distance between structures ≥ 10 m). Strong acoustic reflection and high roughness in a flat bed	
<i>P2</i>	Grouped low relief reef structures. Strong acoustic reflection and high bed roughness.	
<i>P3</i>	Homogeneous, strong acoustic reflection in a flat bed.	
<i>P4</i>	Homogeneous, weak acoustic reflection in flat or low relief beds.	
<i>P5</i>	Heterogeneous weak acoustic reflection in irregular to flat relief beds.	
<i>P6</i>	Heterogeneous strong acoustic reflection in irregular to flat relief beds.	

Figure 4: Habitat patterns observed in the side scan sonar surveys in the Abrolhos Bank.

The geographic distribution of these patterns in the Abrolhos Bank is shown on **Figure 5**. A clear dominance of “P3” can be observed in the map, corresponding to the large calcareous algae bank mapped in the region. Reef formations (“P1” and “P2”) are also commonly observed around the previously mapped reefs, and on the east of the Abrolhos National Park. The southern of the mapped area is dominated by sediments (“P5”).

Figure 5: Geographic distribution of the habitat patterns observed in the side scan sonar surveys in the Abrolhos Bank. The codes are the same described on Figure 4.

Based on this information we have estimated the area of occurrence of mid-depth reefs in the Abrolhos Bank, and presented the results in the XI International Coral Reef Symposium, in Florida on 2008. It represents an increment in the area of new reefs up to seven times the previously known (**Figure 6**). This information has received many attention from the international media, resulting in more than 40 articles worldwide.

Figure 6: Estimated area of the mid-depth reefs described by MMAS efforts in the Abrolhos Bank.

Shallow habitat mapping:

Five QuickBird and four Ikonos images were selected and purchased by MMAS/CI, covering the coastal reefs of Nova Viçosa, Coroa Vermelha, Sebastião Gomes, Pedra de Leste, Parcel das Paredes, Recife de Areia, Recife Timbebas and Parcel dos Abrolhos (in the Abrolhos National Park, and Itacolomis Reefs (in Corumbau Marine Extractive Reserve) (**Figure 7**). The quality of these images is superior, showing almost no cloud cover, clear waters, and little solar reflection.

The maps showing the classification of the images considering the size of the structures are on **Attach 1**. These images show the shallow reefs are distributed for a larger area than previously mapped, and elucidate reef morphology in a very detailed scale. It will be especially important for advancing in a systematic conservation planning for the region.

Database organization and storage:

The Marine Program GIS database was revised and organized to work in an Arc GIS platform. The files are stored in Caravelas office, and a copy of the database will be available for each team member. **Figure 8** illustrates the potential of this tool, by joining the data from the side scan transects, and from other sources to define the main habitat domains in the Abrolhos Bank. These examples were used to convince the Brazilian Government on the importance of expanding the Abrolhos MMA Network.

The long term data from our monitoring programs is also being organized with the support of a consultant specialized on database projects. Data from biological, fisheries and socioeconomic activities will be integrated, allowing a series of comparisons among different themes. This product has being supported by a new donor (Waitt Family Foundation) and will be finalized by January 2011.

Figure 7: Remote sensing images of the shallow habitats of the Abrolhos Bank.
Sensors: QuickBird and Ikonos.

Figure 8: Example of the potential uses of the database produced by MMAS and other sources and integrated in Arc GIS. The figure illustrates the main habitat domains observed in the Abrolhos Bank. Data from MMAS and PROABROLHOS.

NEXT STEPS

By integrating physical, biological, social and economic information generated by MMAS and other sources, we are now advancing in a systematic conservation planning for the Abrolhos Region, in partnership with the Brazilian Government, Academic Partners and NGOs. A consultant was hired by the government and a series of technical workshops are taking place for planning, refining data and generating scenarios for proposals to expand the present Marine Protected Areas Network.

During the last five years, MMAS provided an unprecedented database for the long term planning of the region. The Habitat Mapping was one of the most emblematic of these advances, generating valuable information for planning the future of the region. We strongly acknowledge Gordon and Betty Moore Foundation for investing in such integrated multiple year project. We are confident large conservation achievements will take place in Abrolhos, as a consequence of the Science to Action work initiated by MMAS.