Increasing Training and Technique Exchange for Siting MPAs in Remote Coral Reef Environments in the Caribbean

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ABSTRACT

Through the NOAA International Coral Reef Conservation Program it was possible to congregate fifteen people associated with the management of remote coral reef environments which have been declared or are in the process of becoming marine protected areas (MPAs). The first training session was held at the Chinchorro Bank field station, Mexico during two weeks in April, 2005. The training focused on: a) how to collect and interpret fine scale remote sensing imagery from side scan sonar systems in order to generate multi-scale habitat mapping on remote coral reef areas; b) the use of existing coarse scale remote sensing imagery from passive sensors (satellite imagery and aerial photographs); c) the combination of technologies and information on several scales required for increase capacity building in GIS techniques and applications; d) habitat concepts based on biological and ecological criteria, incorporating them into MPA management and designation; and e) increase exchange of experience in planning field work at distant oceanic areas looking at international/ national cooperative alternatives by establishing working networks. As a result of this course a benthic map of coral reef habitats (< 25 m depth) within the recreational diving zone of the Banco Chinchorro Biosphere Reserve was generated. The map will be use to update this MPA's management plan and to illustrate the benefits of a functional network. The success of the course was a result of sharing experiences, expertise and resources from different Caribbean remote MPA practitioners, including those governmental agencies and private enterprises which provided the sonar equipment and the educational materials. The development of this course offers a new model for acquiring technical information needed for MPA management otherwise too expensive to be obtained.

KEY WORDS: Training, MPAs, remote environments

Mejorando el Entrenamiento y Técnicas de Intercambio para Establecer Áreas Marinas Protegidas en Ambientes de Arrecifes de Coral Remotos en el Caribe

A través del programa internacional de conservación de arrecifes de coral de NOAA fue posible reunir a quince personas asociadas con el manejo corales y los Sistemas de Información Geográfica (SIG) en áreas remotas que han sido declaradas o están en el proceso de convertirse en áreas marinas protegidas (AMPs). La sesión del entrenamiento fue llevada a cabo en la estación del campo de la reserva de la biosfera Banco Chinchorro, Quintana Roo, México durante dos semanas en Abril/2005. El entrenamiento se enfocó en: a) cómo adquirir e interpretar escala imágenes de alta resolución del fondo marino utilizando un sistema de sonar de barrido lateral necesarias para generar mapas de hábitat de corales en áreas remotas y en múltiple escalas; b) el uso de las imágenes de menor resolución de sensores pasivos (imágenes satelitales y fotografías aéreas); c) la combinación de tecnologías a diferentes escalas necesaria para mejorar las capacidades del uso de los SIG y sus aplicaciones; d) los conceptos de mapas de hábitat basados en criterios biológicos y ecológicos, incorporándolos en el manejo y diseño de AMPs; e) aumento de intercambio de experiencias en la planeación de trabajo de campo en áreas oceánicas distantes buscando acuerdos cooperativos a nivel nacional/internacional estableciendo redes de trabajo funcionales. Como resultado de este curso un mapa detallado de los corales (desde la superficie hasta 25 m de profundidad) de las diecinueve millas náuticas que constituyen la zona de buceo de Banco Chinchorro fue generado. El mapa será utilizado para actualizar el Programa de Manejo de esta reserva y para ilustrar las ventajas de una red funcional. El éxito del curso se baso en el compartir experiencias, conocimientos y recursos de diversos manejadores y científicos asociados con AMP del Caribe y de Estados Unidos de América, incluyendo aquellas agencias gubernamentales y empresas privadas que permitieron en acceso al sistema del sonar y los materiales educativos utilizados. El desarrollo de este curso se presenta como ejemplo de un nuevo modelo para adquirir la información técnica necesaria para el manejo de AMPs que de otra manera resultaría demasiado costosa de ser obtenida.

PALABRAS CLAVES: Entrenamiento, AMPs, ambientes de arrecifes de coral remotos

STUDY AREA

The training session took place at Chinchorro Bank Biosphere Reserve, which is an elongated atoll located 30.8 km off Mahahual, Quintana Roo and separated from the coastal zone by a 1,000 m depth channel. The reserve was established in 1996, to protect a total of 144,360 ha to include the entire reef system along with a portion of its surroundings oceanic environments. Chinchorro is the largest Caribbean atoll in Mexico and it is included within the Mesoamerican Reef System. The training course was given at the station located at Cayo Centro, the largest of the four permanently emerged cays having a total of 541 ha (SEMARNAP 2000), and included two days of work in Cancun.

METHODOLOGY

The first training session of this project took place during April 11-26, 2005 with the participation of 15 people, including three instructors (Figure 1, Table 1). Previous to travel, participants were informed about the detail course contents, answered a questionnaire, and knew station rules and logistics. SSS methods applied protocol initially tested in Puerto Rico (Appeldoorn *et al.* 2000). In summary, this intense course consisted on seven theory-practical modules as follow:

i) Preparation of equipment and logistics. Included a day of internet work to give access on specific information on equipment tutorials, download processing software and specific GIS routines as well as basic information of marine acoustics. Instructors in collaboration with CONANP personnel required three days in advance to deal with customs and insurance issues. These aspects were conducted in Cancun.

ii) Introduction. Once the group was in Chinchorro, they received classes related with course objectives, general concepts about mapping and habitats (Figure 1). As previously defined, participants were divided in two groups trying to combine people with different expertise and experiences. Group one had seven people while group two had only six, and all of them received the same level of theory and practice.

iii) Work planning. Planning covered two complementary aspects, the preparation of navigation lines and files along the area to be mapped and the installation of the equipment onboard of BIP VIII, the Chinchorro recently acquired research boat. It was decided to map the reserve diving zone, following CONANP suggestions, which is a section located at the leeward side that is 20 km long and a narrow and variable width (90 – 300 m). Lines were defined following depth contours, and separated by 75 m, which will give 25% overlapping, if the SSS imagery is collected at 50 m range using Hypack, a navigational software

from Costalo. On board, instructors and the boat personnel made necessary adjustments to install and test the 300 KHz Marine Sonic Technology Side Scan Sonar (SSS), the davit, the electrical winch, the portable generator, the computer tables and other related equipments. Work planning included DGPS calibration exercises and comparisons.

iv) The SSS data collection and imagery initial processing. Participants had the opportunity to install all the components of the SSS systems on board, and rotate along different positions and responsibilities. At the class room, they were able to review and improve acquired SSS imagery quality (.MST), by selecting appropriate filters and extract additional information such as image measurements and texture and brightness contrasts utilizing PC Review Marine Technology Processing Software.

v) Posterior imagery processing. Single SSS (.MST) was then post-processed to obtain mosaics of the seafloor. The post-processing consisted in image merging and conversion, slant range correction (which eliminated the water column information from the bottom information), the mosaic formation and conversion to a raster format while keeping image geo-reference. SonarWeb from Chesapeak Technology was utilized as the processing software (Figure 1).

vi) Ground truthing. A total of 40 sites having particular SSS habitat type were selected to conduct habitat verification, prior to map delineation. Majority of the stations were sampled by dropping a black and white video-camera connected to a digital video-camera. Video clips images of approx. 3 minutes were recorded as digital files.

vii) Map generation. Habitat maps were digitized utilizing the Habitat Digitizing extension developed by the Biogeography Team at NOAA/NOS and a specific habitat scheme classification using Arc View GIS Vs. 3.2. The map was corrected for digitizing errors, and a preliminary version of the habitat map at scale 1:3000 was printed in a plotter. The final version of the map will be the CONANP responsibility for the project second training session. This work adapted methods described in Prada *et al.* (2004).

In addition to above described activities, the group had the opportunity to utilize a 900 KHz SSS that was loaned by Marine Sonic Technology, Inc. This is a very high resolution transducer which is part of a portable equipment named as The Centurion system which was tested to acquire SSS imagery from an anchor and several canyons from the XVII century wreck. During the course, artisan

fishermen visited the station and they also learn about the activities we were developing at Chinchorro. Each participant talked about their future activities related to the habitat mapping and wrote two-page description about it. There were a special workshop about Station management and a presentation about the ongoing research about conch fishery on the last day.

RESULTS

The development of this training session resulted in the collection of 434 raw SSS images, which with further processes generated a second set of filtered imagery not having electromagnetic interference (Figure 2). The SSS imagery was converted from .MST format to .XTF format, allowing the generation of new files which merged raw data into larger images and facilitating processing. At the end, four habitat mosaics, as defining during the planning phase, were produced. Mosaics were processed at both 1 and 0.25 m resolution and exported as Geotiffs.

There is a total of 51 minutes of underwater video and more than 50 underwater pictures of how different habitat types identified from the SSS imagery looks like. Combining all digital information acquired during this course, we have around 10 G of information.

The habitat classification scheme identified eight habitat types (Figure 3, Table 2), with half of them being various coral patch sizes, because of the map high spatial scale (1:3000). This map was presented to the donor's trip organized at the field station right after the course ended,

as an example of how with an interdisciplinary and collaborative effort, habitat information is now available, accounting for location of previously unknown deep reefs. As mentioned before, the map and the all the information obtained will also be utilized in the process of updating the five-year management plan.

Aside from the work done for Chinchorro, participants defined their projects to contribute with improvement of actual habitat information, applying the knowledge and experience gathered during this course. Table 3 summarizes compromises of participants own projects. All results from this course are available at the web, hosted by CONANP server, at http://www.pyucatan.conanp.gob.mx/sss.html.

The development of this training session was achieved because we had the collaboration of the Fish and Wild Life Service, the Planning and Natural Resources of the USVI who approved the loan of their SSS system. The Marine Sonic Technology, also loan us their Centurion SSS system and a give 12 packages of information including the processing software. Other governmental agencies such as NOAA / NOS / Biogeography Team, along with private companies such as Coastalo, Chesapeake Technology, Inc, Trimble provided 15 cds each containing tutorials, scripts and educational materials which were also given to participants. The University of Quintana Roo and the CONANP provided complementary equipment and supplies to significantly contribute to the success of the course.

Figure 1. Pictures illustrating, A: Scientists and MPA managers participants, B: BIP VII at Magahual being uploaded with equipment and supplies necessary to transport to the Chinchorro field station supported by CONANP, C: Example of fundamental concept classes, D: Participants processing and interpreting SSS imagery.

Table 1. Participants at the first training session of the Project entitled "Increasing Training and Technique Exchange for Siting MPAs in Remote Coral Reef Environments in the Caribbean" held in Chinchorro Bank Biosphere Reserve field station.

Name	Country	Institution	MPA	e-mail
Jorge Carranza	Mexico	CONANP	Nivel Nacional	jcarranza@conanp.gob.mx
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Antonio Iturbe	Mexico	UQROO	Nivel Regional	aiturbe@correo.uqroo.mx
Bárbara Reveles González	Mexico	CONANP	Reserva de la Biosfera Banco Chinchorro	revelesbar@hotmail.com
Felipe Be	Mexico	CONANP	PN Arrecife Alacranes	alacranes@conanp.gob.mx / fbe@conanp.gob.mx
Guilio Cesare Marine	Dominican Republic	Subsecretaria de recursos marinos y costeros	Jaragua and others	giuliomarin@hotmail.com
Rodrigo Lazo	Venezuela	Universidad Simon Bolivar	Los Roques	rlazop@cantv.net
Alejandro Acosta	USA	Florida Wildlife Commission	Florida Keys	Alejandro.Acosta@MyFWC.com
Michelle Sharer	USA	Amigos Amona	Mona Island	mscharer@cima.uprm.edu
Robert Hudgson	Colombia	CORALINA	San Andres Archipelago	bhudgson@yahoo.com
Giovanna Peñaloza	Colombia	CORALINA	San Andres Archipelago	mpaprovidencia@yahoo.com
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Figure 2. Picture illustrating acquisition of SSS images when using the 300 kHz Marine Sonic Technology system.

Figure 3. Example of habitat mapping being digitized from the Geotiff habitat mosaics using the habitat digitizer extension developed by NOAA/NOS/Biogeography Team in Arc View GIS 3.2.

Table 2. Summary of the habitats types and habitat areas mapped within the diving zone of the Chinchorro Bank Biosphere Reserve using the 300 kHz side scan sonar system

Habitat type	Area (ha)
Sand with no structure	280
Sand with Stucture	168
Vegetation	5
Continuous coral	55
Large coral patches	10
Medium coral patches	8
Small coral patches	11
Total area mapped	537

Table 3. Habitat maps participants agree to generate at their sites applying knowledge and experience learn in this Project.

Country	Site	Section	Methods
Mexico	Chinchorro Bank Biosphere Reserve	Diving Section	SSS
	Alacranes Park	South end	Landsat and Spot imagery
	National level		Strategy to extend mapping in Mexico
	Progreso	Progreso	Aerial photographs
Dominican Republic	Jaragua National Park	Bahia Aguilas or Macao-Punta Cana	Update actual maps with recently Landsat imagery
Venezuela	Archipelago Los Roques National Park	Canal entre Dos Mosquises y La Pelona	1949 and 1984 aerial photographs. Potential use of a SSS system.
Colombia	Seaflower Biosphere Reserve	South section of Quitasueño Bank	Aerial photograph and Landsat imagery
Puerto Rico	Mona Island Natural Reserve		Diving to corroborate and complement NOAA/NOS habitat mapping
US	Florida Keys National Park	Sambos Ecological Reserve	SSS

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