Final Report

Implementing Capacity Building in the Mesoamerican Reef MPA Community

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Submitted by:

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Contents

Executive Summary

During the period from October 1 2012 through September 30 2014, the Gulf and Caribbean Fisheries Institute (GCFI) and a group of nine marine protected areas (MPAs) in the Meso-American Reef (MAR) region implemented a cooperative agreement in line with NOAA CRCP's international strategy to work with regional initiatives to develop and implement long-term MPA capacity building programs based on capacity assessments. Two regional workshops and 16 sub-projects were implemented under the cooperative agreement in order to address priority capacity building needs from the Caribbean MPA Management Capacity Assessment (Gombos et al, 2011). The activities implemented successfully increased capacity for effective implementation of MPAs in the MAR region and improved the tiered ranking of capacity in relation to socio-economic monitoring (FFO Obj. 5), the development of alternative livelihoods (FFO Obj. 2), fisheries management (FFO Obj. 2), sustainable financing (FFO Obj. 4) and outreach and education (FFO Obj. 2).

Regional Workshop - Alternative Livelihoods and Sustainable Tourism

Although the Alternative Livelihood workshop was originally planned to take place in the second quarter of 2013, based on advice from the regional SocMon Coordinator and given approval from S. Frew this was moved to 14-17 November 2012 so as to precede and lead in to the SocMon training. The workshop was successfully completed with 15 participants from 7 MPAs, plus guest speakers from UNDP, CARICOM, and local expert organizations. It covered both theory and practice in encouraging the establishment of sustainable alternative livelihoods associated with MPAs.

A variety of case studies on alternative livelihoods such as sea weed cultivation, chicken rearing, pig rearing, tourism, community researchers micro-enterprises, among others were presented by organizations who have implemented these projects in Belize. A presentation on alternative livelihoods in the Eastern Caribbean was presented. Participants believed that the alternatives presented could be replicated and offered to follow up with presenters when necessary. Key lessons learned from engaging in alternatives include:

- ✓ Recipients must be interested in the project and either have capacity to implement or be willing to accept the necessary training to carry it out successfully
- ✓ Feasibility study and business plan are costly, but important to do to ensure viability of project and know of available market/s
- ✓ A clear criteria for selection of project recipients is essential
- ✓ It is vital to follow up closely with recipient/s to offer necessary support and monitor and evaluate projects
- ✓ Usually, resource users want to continue doing what they traditionally did – forever - so it is best to offer a supplemental livelihood opportunity rather than an alternative livelihood

The workshop also included a focus on sustainable tourism, with a tour-guide refresher course, presentations on voluntary standards in marine tourism and discussion between MPA Managers and

tourism operators about the challenges and needs for sustainable tourism in MPAs. Belize Tourism Industry representatives summarized the Sustainable Tourism Master Plan which ignited a number of comments that reinforced the need to ensure that tourism, a revenue earner, does not negatively impact fragile ecosystems that communities depend on for food security.

A presentation on voluntary codes of conduct to minimize negative impacts on reef activities and enhance economic benefits and ecological services that reefs provide, developed by CORAL, sparked a lot of discussion as everyone saw the urgent need to make codes of conduct compulsory for every tour. A presentation on lessons learned in implementing sustainable tourism in Australia, home to the largest barrier reef, was an 'eye opener'. Participants became aware that there is a worldwide effort to implement sustainable tourism.

The tour-guide refresher course and training exchange at the alternative livelihoods workshop was of direct benefit to participating MPA stakeholders who are developing livelihoods as tour guides. This activity promoted both high quality tour guiding and stewardship of marine resources and protected areas. Representatives of tour guide associations who attended the exchange later shared their experience with their associations' membership. Field trips to Chaa Creek Lodge, the San Ignacio Hotel Iguana tour and Chukka Tours, all high quality Belizean nature-based tourism operations, and a series of presentations by the respective tour operators, provided valuable case studies, tourism sustainability reference points and inspiration for the workshop participants.

From discussions on tourism, participants saw the need for MPA managers to promote sustainable tourism to ensure long term benefit to communities who depend on these resources for their livelihood. TIDE followed up with a presentation on voluntary codes of conduct to the Toledo Tour Guide Association. A Honduran tour operator subsequently adapted the voluntary codes of conduct for his tours and committed to ensuring that guides are more familiar with marine reserve regulations.

During the presentations and discussion at the workshop, the participants were prompted to consider how they would most effectively apply microgrant funding available to them under the cooperative agreement so as to learn from the experiences shared and avoid the pitfalls identified. A brainstorming session among participants identified a number of possible microgrants that will be discussed with potential recipients. The alternative livelihoods workshop thus directly informed the set of second year sub-projects for the development and implementation of activities related to alternative livelihoods. It also provided valuable orientation for the subsequent regional SocMon training.

The four-day alternative livelihoods workshop was organized and facilitated by C. Mahung, Executive Director of TIDE Belize, in conjunction with E. Doyle, GCFI Project Manager. Travel logistics for participants and field activities were arranged by TIDE Tours. A copy of the agenda is attached as Appendix I.

Table 1 shows change in the tiered ranking of capacity reported by MPA managers for alternative livelihoods and indicates how capacity was built for effective implementation of MPAs in the MAR region.

Table 1: MPA Management Capacity – Alternative Livelihoods (Tier 1= lowest capacity, Tier 3= highest capacity, see detailed tiers listed below from Gombos et al, 2011)

MPA Management Capacity - Alternative Livelihoods Tier 1: No assessment and no opportunities developed for stakeholders Tier 2: SocMon assessment but no opportunities developed for stakeholders Tier 3: Assessment completed and livelihoods opportunities developed		
	2011	**2014**
Parque Nacional Arrecife Alacranes	1	1
Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	3	3
Parque Nacional Arrecifes de Xcalak	3	3
Half Moon Caye and Blue Hole Natural Monuments	1	3
South Water Caye Marine Reserve	2	2+
Port Honduras Marine Reserve	3	3+
Zona de Protección Especial Sandy Bay-West End, Roatán, Islas de la Bahía	2	3
Turtle Harbour/Rock Harbour, Utila, Islas de la Bahía	1	1
Monumento Natural Marino Archipiélago Cayos Cochinos	3	3

Positive publicity about the workshop was generated via the press note in Appendix II which was shared on MPA practitioner mailing lists, with contributing organizations and by the participants in their home countries. The workshop was also featured in the NOAA in the Caribbean Newsletter (Vol 2 Issue 1, March 2013) alongside a general description of the cooperative agreement.

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International Caribbean

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Fishers taking FADs seriously

Florida Sea Grant is helping Caribbean partners test best management practices for the use of fish aggregation devices (FADs) using input from Dominican fishermen. In December 2012, more than 100 FAD fishers participated in Sea Grant-facilitated meetings in Dominica. By talking to the fishermen about their use of both private and public FADs, researchers learned that managing use is as important as the design, placement and maintenance of FADs. Florida Sea Grant is supporting local efforts to collect information on use, catch effort and economics to evaluate the efficacy of various FAD fishery governance arrangements.■

Florida Sea Grant
Dozimmer@ufl.edu

Fish aggregation device (FAD) fishers meet with researchers in Fond St. Jean, Dominica to discuss options for improving FAD fishing success. Credit: C. Sidman, Florida Sea Grant

NOAA supports coastal zone management in Trinidad and Tobago

The director of the National Ocean Service (NOS) International Programs Office recently participated as the NOAA representative at the first National Steering Committee meeting of the Coastal Zone Management (CZM) Program of Trinidad and Tobago. The meeting was held to develop the program's work plan. NOS has provided staff training, technical advice and help developing the CZM framework. This activity is a collaboration between NOS, the Institute of Marine Affairs in Trinidad and Tobago and the Ministry of the Environment. NOS continues to provide technical advice to the National Steering committee, which meets quarterly. ■

NOS International Programs Office
Clement.Lewsey@noaa.gov

Free lionfish manual released

A manual to assist coastal managers and field workers with local control and research efforts for invasive lionfish is now available for free download. The manual, *Invasive Lionfish: A Guide to Control and Management*, was supported by NOAA NMFS Office of International Affairs, REEF, ICRI, United Nations Environment Programme, Caribbean Environment Programme, SPAW-RAC and over 40 participants of the 2010 Caribbean Regional Lionfish Workshop. The manual is also available in Spanish.■

NCCOS
James.Morris@noaa.gov

Joint study shows success in lionfish control

Lionfish removal efforts in some Mexican MPAs are controlling local populations, according to a collaborative study by NCCOS and Mexico's National Commission of Federally Protected Areas. The two groups monitored lionfish inside two MPAs along the Yucatán Peninsula during the summer of 2012. Preliminary results suggest that lionfish densities are lower and fish are smaller in the parks compared with surrounding reefs, suggesting that control efforts are working.■

NCCOS
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Coral Program building MPA capacity in Mesoamerica

The NOAA Coral Reef Conservation Program established a two-year cooperative agreement with the Gulf and Caribbean Fisheries Institute (GCFI) to build MPA management capacity in the Mesoamerican Reef region. The agreement was initiated by the managers of nine Mesoamerican MPAs, three each from Mexico, Belize and Honduras, in partnership with GCFI. Included are regional training activities to address common MPA capacity building needs, alternative livelihoods and socioeconomic monitoring. Each participating MPA is also receiving support for site-specific priorities identified in a 2011 Caribbean MPA management capacity assessment. These include fisheries management, sustainable financing and outreach/education.■

Gulf and Caribbean Fisheries Institute
Emma.Doyle@gcfi.org

Alternative livelihoods for Mesoamerican MPAs

As part of a two-year cooperative agreement with NOAA Coral Reef Conservation Program, the GCFI and the Toledo Institute for Development and Environment organized a four-day workshop in Belize for Mesoamerican MPA managers to focus on alternative sustainable livelihoods. Managers spoke about their experiences and lessons learned from diversifying local incomes through options such as seaweed cultivation, pig rearing, tour guiding, dive training, and employment in scientific diving, merchandising and micro-enterprise development. Tourism industry representatives also joined the workshop for a special focus on sustainable tourism and MPAs.■

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Caribbean countries support regional planning for queen conch

The CFMC-led working group on queen conch last October concluded with recommendations to the 16th Conference of Parties of CITES, regional fishery bodies and countries in the western central Atlantic. Queen conch is a candidate for listing under the Endangered Species Act and listed in Appendix II of CITES. The meeting was attended by more than 50 fisheries sectors and CITES authority delegates from 23 countries

From NOAA in the Caribbean Newsletter, Vol 2 Issue 1, March 2013 (http://www.regions.noaa.gov/secar/wp-content/uploads/2011/08/NOAA-in-the-caribbean_FINAL_28Mar2013-tagged.pdf)

Regional Workshop - SocMon

A SocMon training workshop was held in Corozal, Belize on February 18-22, 2013. The goal of the socio-economic workshop was to improve the low level of development of socio-economic monitoring activities at most MAR MPAs, as indicated in the MPA Management Capacity Assessment. The Central American SocMon Coordinator, Arie Sanders coordinated the workshop with the assistance of facilitators Alfredo Reyes (University of Zamorano, Honduras) and Sara Bonilla (Centre for Marine Studies, Honduras with co-funding from CEM). SocMon in Central America has an existing agreement with the government agency responsible for protected areas in Honduras (the Instituto Nacional de Conservación Forestal, ICF) and has already commenced efforts with Utila and Roatan. This provided an excellent basis for launching similar efforts with the MPAs in Belize and Mexico. The SocMon-workshop was attended by six organizations: BAS (Belize), Belize Fisheries Department, BICA-Utila (Honduras), BICA-Roatan (Honduras), PN Arrecifes de Xcalak (Mexico), and PN Costa Occidental de Isla Mujeres, Punta Cancun y Punta Nizuc (Mexico). The overall objective of the workshop was to train counterparts at intermediate and field level in the use of SocMon as an instrument for the collecting and analyzing of socioeconomic data. The agenda is attached in Appendix III.

Mid-way through the class-room sessions, on February 20th the participants made a field visit to meet with community members from Copper Bank Village, a fishing community that utilizes Blue Hole and Half Moon Caye Natural Monuments. The facilitators provided guidance on work planning, collecting data and analysis using a range of theoretical techniques that were applied in the field exercise. The participants split into groups and collected data according to appropriate methods and variables to satisfy their objectives. Participants were able to obtain useful knowledge on drafting a site-specific work plan considering all elements such as time management, human and financial resources, community dynamics, stakeholder participation, data analysis, report writing and presentations.

Table 2 shows change in the tiered ranking of capacity reported by MPA managers for socio-economic monitoring and indicates how capacity was built for effective implementation of MPAs in the MAR region.

Table 2: MPA Management Capacity – Socio-economic Monitoring (Tier 1= lowest capacity, Tier 3= highest capacity, see detailed tiers listed below from Gombos et al, 2011)

MPA Management Capacity – Socio-economic Monitoring Tier 1: Little or no socio-economic monitoring Tier 2: Existing socio-economic monitoring program Tier 3: SocMon data evaluated and used in management decisions		
	2011	**2014**
Parque Nacional Arrecife Alacranes	1	1
Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	1	3
Parque Nacional Arrecifes de Xcalak	1	2
Half Moon Caye and Blue Hole Natural Monuments	1	2
South Water Caye Marine Reserve	2	2
Port Honduras Marine Reserve	1	2
Zona de Protección Especial Sandy Bay-West End, Roatán, Islas de la Bahía	1	2
Turtle Harbour/Rock Harbour, Utila, Islas de la Bahía	1	1

Monumento Natural Marino Archipiélago Cayos Cochinos	1	1

Positive publicity about the workshop was generated via the press note in Appendix IV which was shared on MPA practitioner mailing lists, with contributing organizations and by the participants in their home countries. The workshop was also featured in the SocMonitor Newsletter (Issue 11, January 2013).

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The *Geography and You* magazine published a special edition on Lakshadweep and included an article called *Livelihood Dependence on Marine Goods and Services and Changing Social Values in Lakshadweep*. For the full article please visit the link:

http://www.geographyandyou.com/xmag/index.html*

Upcoming SocMon event in Belize, February 2013

The Caribbean Marine Protected Area Management Network and Forum (CaMPAM) and the SocMon initiative for Central America are offering a SocMon workshop in Belize. This workshop forms part of the project, *Implementing Capacity Building in the Mesoamerican Reef MPA Community*. Based on a regional assesment of management capacdity needs at nine sites in the Central America region, CaMPAM identified a shared interest by the local organisations for the topic of socio-economic monitoring. We will offer a four-day workshop tailored to the specific needs of the region, covering three topical areas, including subjects such as participatory research methods, livelihoods strategies linked to SocMon and research planning. The main outcome of the workshop will be the design of SocMon assessments for each of the participating sites. The training is designed to include a follow-up program whereby support will be provided by the partnership to ensure the implementation of the SocMon approach.

From SocMonitor January 2013, Issue 11 http://www.socmon.org/download.ashx?docid=62007

Beach cleanup with school kids

Meetings and workshops

Workshop on Social Economic Monitoring

In January, Giaco travelled to Placencia, Belize to attend a workshop on social economic monitoring (SOCMON) which was organized by the Belize Audubon Society, CaMPAM and NOAA. The aim of the workshop was to develop the tools to approach different stakeholders with the right interview, questionnaires or presentations to understand the community in regards to different cultures and education level and fortify their development. Attendees included representatives from Mexico, Honduras and Belize and we feel that with this new added knowledge, we can develop our own methods of approaching communities and also strengthening ties with other organizations.

Representatives from Belize, Honduras and Mexico meet at a SOCMON workshop

From Roatan Marine Park Newsletter, January-February 2013 http://www.roatanmarinepark.com/wp-content/uploads/2014/05/feb_2013.pdf

Tasks

Task 2, Special projects

Fifteen special projects were developed under the cooperative agreement to address MPA management capacity needs. These projects are listed in Table 3 and the corresponding project numbering is retained throughout this report.

Table 3: Sub-Projects and MPA Management Capacity Building Needs

Country	MPA Site	Financing	Socio-economic monitoring	Fisheries Management	Alternative Livelihoods	Outreach and Education
Belize	Port Honduras Marine Reserve	Project 1 Pay-to-Participate Monitoring		Project 2 Lobster Shades	Project 3 Micro-grants	
	South Water Caye Marine Reserve					Project 7 School Program Project 8 Adult Outreach Program
	Half Moon Caye and Blue Hole Natural Monuments		Project 4 SocMon Assessment		Project 5 Reef Protectors; Project 6 Micro-grants	
Honduras	Zona de Protección Especial Sandy Bay-West End, Roatán, Islas de la Bahía			Project 10 Lobster Shades	Project 9 Micro-grants	
	Turtle Harbour/Rock Harbour, Utila, Islas de la Bahía			Project 12 Fisher Association		
	Monumento Natural Marino Archipiélago Cayos Cochinos			Project 11 Fisheries Assessment		
Mexico	Parque Nacional Arrecife Alacranes			Project 13 Conch Fishery Assessment		

	Parque Nacional Arrecifes de Xcalak			Project 14 Lobster Fishery Assessment		
	Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc		Project 15 SocMon Assessment			

All projects were implemented with the MPA partners and Table 4 shows the change in the tiered ranking of capacity reported by MPA managers for fisheries management, outreach and education and financing. This, together with the results in Tables 1 and 2, indicates how capacity was built through the cooperative agreement for effective implementation of MPAs in the MAR region.

Table 4: Change in Tiered MPA Management Capacity through Targeted Sub-Projects (Tier 1= lowest capacity, Tier 3= highest capacity, see detailed tiers below from Gombos et al, 2011)

	Fisheries Management		Outreach and Education		Sustainable Financing	
	2011	**2014**	**2011**	**2014**	**2011**	**2014**
Parque Nacional Arrecife Alacranes	1	3	-	-	-	-
Parque Nacional Arrecifes de Xcalak	1	3			-	-
Half Moon Caye and Blue Hole Natural Monuments	-	-	2	2+	-	-
South Water Caye Marine Reserve	-	-	1	2+	-	-
Port Honduras Marine Reserve	3	3			2	2+
Zona de Protección Especial Sandy Bay-West End, Roatán, Islas de la Bahía	1	2	3	3		
Turtle Harbour/Rock Harbour, Utila, Islas de la Bahía	1	2	-	-	-	-
Monumento Natural Marino Archipiélago Cayos Cochinos	2	3	-	-	-	-

Fisheries Management	
Tier 1	Site specific fisheries assessment has not been conducted
Tier 2	Site specific fisheries assessment has been conducted but no fisheries management plan is developed
Tier 3	Fisheries management plan is developed
Outreach and Education	
Tier 1	Little or no ongoing outreach and education activities exist
Tier 2	Ongoing outreach and education activities in support of the MPA
Tier 3	Existence of an outreach and education program with various activities and strategies focused on the MPA that helps achieve the MPA's goals and objectives
Financing	
Tier 1	Little or no reliable source of funding identified to support management activities
Tier 2	Existing funding for management activities
Tier 3	Sustainable finance plan being implemented that provides long term sustainable funding mechanisms

From GCFI's perspective as overall project manager for these various special sub-projects, we note the following on project performance:

- Two of the most challenging and innovative sub-projects were also the most successful. Firstly, efforts under Project 1 towards sustainable financing for Port Honduras Marine Reserve through the development of Ridge to Reef Expeditions provided a challenge to the staff of a protected areas management organization with the more usual skills set associated with natural resources management. Nonetheless, TIDE stepped up to the challenge and branched out into business planning and tourism marketing. Development of Ridge to Reef was slower than initially forecast, in part due to the process of organizational learning, and in part reflecting the thoroughness with which TIDE's staff and Board faced this challenge. Implementing the first expedition was a milestone for TIDE. Since completion of the project, TIDE has continued to make great strides to further develop the program and ensure long term sustainability.

  Secondly, the micro-grants program implemented by BAS under Project 6 was a landmark activity for the MPA, tangibly linking the MPA Manager, Community Liaison Office and three communities associated with the MPA to work together on a positive future. The program proved a success for several of the participants and overall generated a new and positive experience for BAS - the Community Liaison Officer gained concrete experience on encouraging alternative sustainable livelihoods, and the MPA Manager benefitted from enhanced community relations with associated benefits for the MPA compliance program. They are already moving ahead to enhance the next edition of the microgrants program.

- The projects that addressed fisheries management for Arrecife Alacranes National Park and Arrecifes de Xcalak National Park were straight-forward to implement and succeeded in answering the pressing questions facing the managers of these MPAs. GCFI's assistance with shaping the call for proposals and in reviewing methodologies and progress played a role in ensuring the credibility of the Arrecife Alacranes conch assessment in order to strengthen management actions based on the findings. In both cases, follow-up activities have been assumed by CONANP through internal funding.

- Sub-projects addressing education/outreach were straight-forward to implement and successful for the MPAs. In the case of South Water Caye Marine Reserve, networking with TIDE and their assistance with outreach to fishers was especially valuable and helped with implementation of the managed access program by Belize Fisheries Department.

- The NOAA grant manager made a valuable contribution to project success as we re-considered the design of two of the sub-projects (the lionfish project by Roatán Marine Park and the seaweed project in Port Honduras Marine Reserve). The flexibility to make changes was particularly important in ensuring the success of the lionfish training project with Roatán Marine Park. This was a timely project as the MPA had sufficient human resources for implementation, a great deal of motivation, and good information and networking with experts through GCFI. With a small amount of funding they were able to undertake significant training and make a large impact locally.

- The capacity of small NGOs to effectively implement sub-projects proved a challenge in two cases. Cayos Cochinos lost its Executive Director during the course of the cooperative agreement which placed an extra burden on the project manager. A high level of staff turnover at BICA-Utila created additional complications for an already challenging sub-project which depended upon achieving a high level and continuous engagement with fishers.

- Two of the projects generated valuable pilot experiences for the MPA managers. Reef Protectors by BAS proved an excellent experience for the participants and the organization, and BAS is seeking internal and/or donor funding for continuation of the program. Although not as successful as hoped, seaweed farming in Port Honduras Marine Reserve proved a useful trial for local fishers. The fishers at least now have firsthand experience of the work involved in seaweed farming and are better able to evaluate the long term suitability of this option for their livelihoods.

Port Honduras Marine Reserve

In the MPA Management Capacity Assessment three priority capacity needs were identified by PHMR: 1) sustainable financing, 2) stakeholder engagement, and 3) alternative livelihoods. The cooperative agreement made it possible for Toledo Institute for Development and Environment (TIDE) to develop and implement an entirely new strategy for sustainable financing of Port Honduras Marine Reserve, to pilot seaweed farming with fishers impacted by small increase of replenishment zones in the marine reserve, and to follow up on the alternative livelihoods workshop with a program of microgrant funding to help promote sustainable livelihoods.

Project 1.Pay-to-Participate Monitoring 'Ridge to Reef Expeditions'

This project sought to build capacity for sustainable MPA financing. From the original idea for a 'Pay-to-Participate' MPA Monitoring Program, TIDE fully developed, marketed and implemented 'Ridge to Reef Expeditions', a program for paying visitors to work alongside TIDE staff and local assistants/stewards to contribute to on-going environmental monitoring, education and conservation activities. Through the cooperative agreement, TIDE developed a business plan, created branding and marketing materials, marketed the program via more than 20 channels, including identifying former TIDE interns to act as sales reps in the UK and Canada. TIDE recruited a dedicated program coordinator/tour leader, developed a detailed science plan, acquired necessary equipment and implemented the first expedition with paying participants. This effort under the cooperative agreement boosted TIDE's management capacity for sustainable financing from Tier 2 in 2011 (existing funding for management activities) to be described as Tier 2+ by TIDE in 2014.

Logo for TIDE's Pay-to-participate monitoring program

A pilot expedition was scheduled for 2013, contingent upon securing the six customers needed to break even. Despite a small number of bookings and a good level of interest in the program, they were unable to get all six bookings needed, and the first expedition was postponed until 2014. This experience also prompted TIDE to come up with a way to accommodate smaller numbers of volunteers and still generate a profit. They see the hosting of small numbers of volunteers and their incorporation into regular program activities as an intermediate stage whilst building the full program. TIDE's business planning confirms that in order to become profitable, they still need to run full-scale expeditions and they continue to work towards this. TIDE's Board requested external review of the Ridge to Reef Expeditions business plan and GCFI assisted TIDE in networking with relevant experts for pro bono review.

Through vigorous marketing of the program led by TIDE's development director and expeditions manager TIDE attracted 6 international volunteers and had a crowdfunding campaign to enable inclusion of a Belizean university student on the team who benefited significantly from the expedition. In July-August 2014 TIDE ran the first 'Pay-to-Participate' MPA Monitoring Program 'Ridge to Reef Expeditions'. This was attended by 6 paying volunteers who participated in an 8-week program of training, field monitoring and project work for Port Honduras Marine Reserve. The participants obtained PADI dive certification and first aid training, learned marine and terrestrial research protocols and assisted our science team with ongoing data collection including habitat mapping, coral reef health monitoring, cetacean monitoring, sea turtle nesting monitoring, lionfish monitoring and culling, and local education and outreach activities in support of the MPA.

Overall the first expedition was a successful event from which the MPA learned valuable lessons. Financial forecasts and planning have been updated and the marketing approach will be adjusted slightly, and TIDE plans to run this program regularly in full format and a shorter version for paying volunteers. We are very pleased with the outcome of the first expedition and internal evaluations and student surveys indicate that volunteers had an educational and fun- filled experience. Some volunteers expressed interest in returning to TIDE to do their internships! We believe that the marketing of our Ridge to Reef expeditions by this first group of paying volunteers will result in a bigger group next year. See videos (TIDE Ridge2Reef-Promo-Sep-2014.mp4 and Our Journey From Ridge to Reef-1080.mp4) based on footage of the first group of paying volunteers.

Lessons learned:

- ✓ Marketing of the program is critical to ensure the optimum number of participants for each expedition
- ✓ There is need for additional logistical support to program coordinator throughout the expedition to avoid delays with field trips
- ✓ Have a plan B for occasions when weather conditions do not permit for outdoor activities
- ✓ Additional time on the teaching of research protocols would be useful
- ✓ TIDE has great potential to offer first class paying volunteer an excellent, educational experience and the team effort at the organization was highly evident!

The program featured prominently in social media as well as in the NOAA in the Caribbean newsletter. A fully-funded place was offered to a local participant (a community researcher) which proved a very successful approach and TIDE anticipates developing this position as an assistant scientist to the program. Many photos and videos are available via the Ridge to Reef Expeditions page on Facebook https://www.facebook.com/RidgeToReefExpeditions.

Participants receive dive instruction prior to participation in MPA monitoring activities

TIDE leveraged NOAA funding through the cooperative agreement to also secure additional counterpart funding to help establish the program. Contributors included the Oak Foundation, National Fish and Wildlife Foundation, and MAR Fund with funding from KfW.

TIDE Rising to Support Sustainable Development in Belize

Fishers' knowledge exchange and sustainable ecotourism ventures

The Toledo Institute for Development and Environment (TIDE) in southern Belize is taking innovative steps to engage the fishing community and grow their network of research volunteers to promote the sustainable use and management of the area's marine resources from ridge to reef.

Participants in the Utila fisher visit to TIDE Belize Photo: A. Quiñonez

TIDE promotes community participation in developing ridge to reef solutions for sustainable resource use across the region known as the Maya Mountain Marine Corridor. The institute supports dedicated rangers, scientists, educators and community stewards to co-manage a large (100,000 acre) marine protected area (MPA) called the Port Honduras Marine Reserve.

In response to local concerns over fishing pressure, the Fisheries Department in partnership with TIDE and the Environmental Defense Fund introduced Managed Access, a fisheries management tool involving fishers who have a history of conducting commercial fishing in the marine reserve.

The program is already showing signs of success, leading to a fisher-knowledge exchange program in August 2013 where five Honduran fishers, as well as representatives from the Honduran Fisheries Division, visited Belize's Port Honduras Marine Reserve to learn more about the MPA and local Fishers Association.

To further support sustainable MPAs in Central America, NOAA's Coral Reef Conservation Fund and the National Fish and Wildlife Foundation awarded TIDE a grant to develop a paying volunteer scientific ecotourism program as a long-term financing mechanism for the Port Honduras Marine Reserve.

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TIDE Rising to Support Sustainable Coastal Development in Belize

(continued from page 2)

Sustainable financing was identified as a priority need in the Caribbean Marine Protected Areas Network management capacity assessment for this location.

The new logo for TIDE's pay-to-participate monitoring program.

Titled the "Ridge to Reef Expeditions" program, volunteers will stay in the local community and assist the Port Honduras Marine Reserve with biodiversity monitoring, applying best practices in line with NOAA science for monitoring status and trends in marine mammals, sea turtles, coral reefs and invasive lionfish. TIDE is now developing science and business plans and acquiring equipment for the program, which is set to begin this year.

This type of support for local capacity building for sustainable marine resource use addresses goals and objectives of NOAA's Coral Reef Conservation Program and NOAA's new Caribbean Strategy.

TIDE and the Bay Islands Conservation Association (Utila) in Honduras are among the 10 MPA partners that are participating in NOAA's FY12-13 Cooperative Agreement with the Gulf and Caribbean Fisheries Institute (GCFI).

For more information on TIDE, visit: http://www.tidebelize.org/. ■

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From NOAA in the Caribbean Newsletter, Vol 2 Issue 3, February 2014
http://www.regions.noaa.gov/secar/wp-content/uploads/2013/06/NOAA-in-the-caribbean_Vol2_Issue3.pdf

First Ridge to Reef Expedition sees sustainable financing in action

Through NOAA's Cooperative Agreement with the GCFI, the Toledo Institute for Development and Environment (TIDE) in Belize is working to become more financially sustainable by establishing a paying volunteer expedition program. The first Ridge to Reef Expedition began on July 1, 2014, with seven paying volunteers from the U.S., U.K. and Belize. Follow the action as it unfolds via the Ridge to Reef Expeditions web site. ■

GCFI
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From NOAA in the Caribbean Newsletter, Vol 3 Issue 1, October 2014
http://www.regions.noaa.gov/secar/wp-content/uploads/2013/06/NOAA-Carib-Newsletter-Volume-3-Issue-1-2014-October.pdf

Project 2. Seaweed Farming

This project sought to build capacity for fisheries management and stakeholder engagement, both of which were priorities identified by Port Honduras Marine Reserve in the MPA Management Capacity Assessment. Under the original proposal, TIDE was to provide microgrants to enable local fishers to make 200 lobster shades, but since fishers indicated that they preferred to substitute the proposed lobster shades project with a pilot seaweed project, TIDE consulted with GCFI and the NOAA Grant Manager to change the scope of the project. With approval granted, TIDE applied for a research permit from the Belize Fisheries Department before piloting the project. At the regional alternative livelihoods workshop held in Year 1 of the cooperative agreement, UNDP had presented the case study of the Placencia Producers Cooperative Society Ltd and their experience since 2005 in producing and selling seaweed. Knowing that the Placencia Cooperative had success with seaweed planting, TIDE asked that they cooperate with identifying a suitable area and to conduct the training for representatives of the ten fishing families and TIDE personnel. There was also commitment from the Placencia Cooperative for the purchasing of seaweed harvested. Additional co-funding was secured from TNC and the New England Biolabs Foundation.

Before the seaweed project began, TIDE contributed some materials from repairs to the ranger station and sourced additional materials for a fisher who made 20 lobster shades for the Port Honduras Marine Reserve. TIDE also used savings from projects to build 30 lobster shades for the conservation zone. The success of this small pilot is being monitored.

To initiate work on the seaweed project, four fishers associated with Port Honduras Marine Reserve (three female and one male) and two TIDE staff (Albert Jacobs, Managed Access coordinator, and Tanya Barona, marine biologist) visited Placencia and received training and field experience in seaweed farming from key staff at the Placencia Producers Cooperative Society Ltd. This visit was featured on TIDE's website

http://www.tidebelize.org/article/mar-2014/seaweed-farming-phmr. The group's technical advisor, Justino Mendez, and lead seaweed farmer 'Japs' then visited Port Honduras Marine Reserve to advise on suitable sites within the reserve for the pilot seaweed farms.

The group then worked together in setting up the seaweed farm and committed to working in smaller groups to check farms regularly and clean debris from ropes. TIDE reports that in the beginning everyone was excited to go out to check on farms; however as the project progressed, there was not full commitment from all group members. Disappointingly, when the seaweed started to grow most of it was stolen by a passerby. When the rest of the seaweed was harvested, it was dried at the TIDE office; however weather conditions did not allow for the number of days needed for drying; therefore this project was not as successful as it could have been.

Lessons learned:

- ✓ Fishers are aware that seaweed can grow in the marine reserve, but they would need to establish a comprehensive monitoring system to secure farms
- ✓ One is unable to generate profits from a small seaweed farm
- ✓ It is essential to measure ecological impact of seaweed farms (before and after)
- ✓ It is difficult to please all users of the marine reserve so measure pros and cons of projects before implementing
- ✓ Project participants need a mentor throughout project cycle
- ✓ Commitment from participants- essential/crucial
- ✓ Supplemental livelihood opportunities need to benefit a large number of users in order to get 'buy' in for a conservation

TIDE's Albert Jacobs and Tanya Barona with four managed access fishers from Punta Gorda at training in Placencia

Seaweed washing and drying underway

Project 3. Small Business Micro-grants

Small business microgrants sought to address the priority of building capacity for the promotion of sustainable alternative livelihoods and the diversification of livelihoods for the fishing communities associated with Port Honduras Marine Reserve. This project was implemented as follow-up to the alternative livelihoods workshop in Year 1 of the cooperative agreement. Together with the Seaweed Farming through Project 2, the efforts under the cooperative agreement took TIDE's management capacity for alternative livelihoods from Tier 3 in 2011 (assessment completed and livelihoods opportunities developed) to be described as Tier 3+ by TIDE in 2014..

TIDE's approach to the small business grants was designed by the TIDE team and approved by GCFI and the NOAA Grant Manager. Rather than making public announcements about the small business grant opportunity, TIDE strategically targeted the grants based on findings of a MAR Fund business planning study, and targeted candidates for microgrants to participants in a recent alternative livelihoods training for local fisherwomen. The Port Honduras Marine Reserve Advisory Council participated in the selection of grantees.

The microgrants were allocated to assist local fishers in diversifying their businesses. Fishers and family members who met the pre-agreed criteria filled out application forms and pledged to attend training session on how to manage their small business. The grants were distributed towards the end of the project cycle so it is difficult to measure impact, but TIDE indicates that since most of these fishers have successfully managed microgrants before and most payments for business ventures were made directly to vendors, they feel assured that the small investment will increase income of fishers or secure a meal on days when fishers do not fish. Table 5 lists the recipients of the microgrants and their small business ventures:

Table 5: Small Business Micro-grants associated with Port Honduras Marine Reserve

Micro-grant Recipient	Use of Funding
Jackie Young	Assistance towards small snack shop
Beverly Castellanos	Purchase of bale of used clothes for sale
Yonardo Cus	1 weed eater (yard cleaning)
Rio Grande Cooperative	Purchase of marine products for adding value to fish products
Mirta Mendez	Art workshop for 10 women
Martin Reyes	Purchase of chicks and feed
Luis Valencio	Purchase of chicks and feed
Francisca Parchue	Fencing for existing chicken coop
Paula Jacobs	Repairs to chicken coop
Fidel Audinette	Repair of boat engine
Suzette Jacobs	Minor repairs to guest house

Lessons learned:

- ✓ Small business planning is essential and knowledge of how to operate a business is critical (regardless of its size)
- ✓ Working together on supplemental livelihoods opportunities also improves communication with MPA managers. Most grant recipients were also willing to become more involved in assisting with natural resource management, thus enhancing stakeholder engagement.
- ✓ Livelihoods projects require capable mentors to work closely with families to implement and monitor progress of projects
- ✓ The concept of alternative sustainable livelihoods functions best as an option for supplemental income, or for economic diversification of fisher family livelihoods. We acknowledge the experimental nature of efforts to stimulate sustainable livelihoods and we feel that the project was successful at permitting local community members to trial new alternatives. We will continue to monitor continuation of business ideas developed.

Half Moon Caye and Blue Hole National Monuments

Half Moon Caye and Blue Hole Natural Monuments indicated priority needs where an injection of special project funding could improve MPA management capacity: socio-economic monitoring and alternative livelihoods.

Project 4. SocMon Assessment

Following up on the SocMon training in Year 1 of the cooperative agreement, Belize Audubon Society (BAS) carried out a SocMon study for the first time to establish a baseline on the economic and skills status within the northern communities of Copper Bank, Chunox, and Belize City and applying lessons learned to efforts in developing supplemental livelihood opportunities for these communities associated with the MPAs. This project took BAS' management capacity for socio-economic monitoring from Tier 1 in 2011 (no socio-economic monitoring) to Tier 2 in 2014 (existing socio-economic monitoring program) with the expectation that they would soon reach Tier 3 as the SocMon data is acted upon.

BAS with the guidance of the SocMon Coordinator Arie Sanders carried out a one week data collection and analysis within two northern communities of Chunox and Copper Bank. BAS leveraged NOAA funding through the cooperative agreement to also secure additional counterpart funding for the SocMon study from Fauna and Flora International, who contributed to field work in Belize City with the participation of students from the University of Belize.

BAS developed a work plan and guidelines for the implementation of the economic and skill assessment within the three communities. This was carried out in conjunction with Arie Sanders, SocMon Coodinator. The team worked in the communities using tools learned from the SocMon workshop held in February of 2013. SocMon survey sheets were designed with listing of seventeen variables ranging from fishermen house hold characteristic to threats and problems. To ensure the application of the SocMon surveys be carried with the best proficiency and accuracy, the SocMon Coordinator was in Belize for seven days to provide technical advice to the enumerators throughout the survey process. The first day was to finalize the surveys. The field work was done in four days: three days in the Northern Communities, and one day in Belize City. The SocMon implementation steps are listed In Table 6.

Table 6: SocMon Implementation Steps with Belize Audubon Society

#	Step	Belizean Audubon Society (BAS)
1	Definition of the goals and objectives	Better understanding of the livelihood strategies of conch and lobster fishermen living in in Chunox, Copper Bank and Belize City
2	Sample frame	About 130 fisherman in the
3	Survey instrument	Use of a questionnaire focused on livelihood assets, fishery activities and perception.
4	Data collection	Fieldwork was done during April 22-29, 2014. SocMon team included staff members BAS and volunteers (students): 10 persons
5	Data analysis	Data digitalized in SPSS, analysis includes descriptive statistics, construction of wealth index (factor analysis) and linear regression to link livelihood outcome (wealth) with fishery activities.
6	Data are written into a report-	Report was written by the Zamorano team and sent to BAS and GCFI. Feedback was given and report was adjusted.
7	Reports provided to the coordinators	Report was presented to the coordinators at the final workshop in Belize
8	Results will be used in adaptive management-	Input will be used for further livelihoods efforts and in the upcoming MPA plan.

A total of 30 fishermen were surveyed in Copper Bank, 45 in Chunox, and 35 in Belize City. The last two days were used to insert data using the SPSS software. Arie Sanders and his team analyzed the data and submitted a report to BAS and GCFI, who provided comments and contributed to practical recommendations for application of the SocMon findings to MPA management. BAS anticipate the SocMon assessment report will provide needed information that can assess changes in the socio-economic condition of the communities associated with Blue Hole and Half Moon Caye Natural Monument. In addition BAS anticipate the SocMon report provides a baseline guide in targeting job development. The full report is attached as Appendix V.

Lessons learned:

- ✓ Realizing that Sarteneja is not a key stakeholder community of either Light House or Turneffe, as well as, the implementation of a similar survey by SACD in that particular community, the SocMon tool was not implemented by BAS in Sarteneja. The sharing of results by both BAS and SACD of their surveys justifies the fact that BAS will continue its conservation work with all three stakeholder communities in Northern Belize.
- ✓ SocMon interviewers need to conduct surveys in accordance with the communities' timing to maximize their participation. For example, when enumerators interviewed Chunox' fishermen they were busily doing repairs on their boats, therefore and appointment was done with them to return to do the surveys at a later hour.
- ✓ Partnering with FFI, UB volunteers, Fisheries Department and other key community stakeholders ensured an effective and efficient implementation of surveys in communities. For example at Copper Bank, Chunox and Belize City key individuals from those communities were asked to take the enumerators to the interviewees.

Project 5. Reef Protector

BAS developed the Reef Protector program to raise awareness and understanding of career options related to marine conservation and protected areas by developing and implementing a conservation-based, out-of-school education program for young people ranging from ages 13-17 from fishing communities associated with the Blue Hole and Half Moon Caye Natural Monements. This was part of BAS' focus on building MPA managemetn capacity for promotion of sustainable alternative livelihoods in order to break the cycle of dependency on consumptive use of marine resources.

A group of 13 high school students (6 boys and 7 girls) from the fishing communities of Chunox, Copper Bank, and Sarteneja participated in the first Reef Protector program which was implemented under the cooperative agreement. The youths actively participated in marine-themed educational activities including a video journalism workshop, field trips to marine protected areas and exposure trips to meet professionals working in the marine conservation field. Four teachers from the two high schools and several parents also participated in the program to assist with mentoring and chaperoning the students.

GCFI shared examples of best regional experiences in MPA education with BAS, providing other examples of kids getting involved in MPAs, and especially projects involving audio-visual products made with and by youth about their MPAs. GCFI shared materials from the Bonaire Junior Rangers program, including a copy of the 'Reconnect' video featuring the Junior Rangers and examples of photo campaigns on the NME STINAPA Facebook page. GCFI also shared the example of the 'Kids with Cameras' program run by Kido Foundation in Carriacou, Grenada, which has links to Sandy Island/Oyster Bed MPA. GCFI also provided assistance to BAS with sourcing sufficient copies of reference materials to share with the Reef Protectors, including the Marine Awareness Guide from the British Virgin Islands, various WIDECAST materials and other marine posters.

The Reef Protector Program was implemented as follows:

Activity 1- Formation of the Reef Protector Program: Selection of participants for the program through a video or written essay competition. After reviewing the entries 13 students were selected for the program.

The successful students were informed in person via a meeting at their school. The objectives and planned activities for the program were also discussed at this first meeting. Each student was issued a letter to take home to their parents. The letter served two purposes, the first was to inform the parents about the reef protector program, and secondly, to give consent for their child to participate.

Activity 2- Video Journalism and conservation Workshop: The group participated in a video journalism workshop including a session to introduce the students to marine conservation. This workshop was designed to teach the participants the basic elements of a creating a good story, while capturing important information for reporting. As future leaders they will need to advocate for the protection of their natural resources as well as speak out on issues affecting their community. Topics covered during the workshop included marine protected areas, basics of video shooting, creating a story and using people and the environment to tell the story. All 13 students and four teachers participated in the workshop. The facilitator was Jose Sanchez, a renowned Belizean journalist and communications specialist.

Activity 3- Field Trip to Half Moon Caye and Blue Hole Natural Monuments: The 13 students, five parents and five teachers were taken on a two-day field trip to Half Moon Caye and Blue Hole Natural Monuments. The purpose of the trip was to build familiarity with local protected areas and to meet professionals working in the field of marine conservation. During the two day trip, the students explored the natural monuments through hands on activities such as snorkeling over coral reefs and sea grasses and walking through the endangered littoral forest on Half Moon Caye. In addition, the students experienced the Red-footed booby birds in their natural habitat and learned about the ecology of marine turtles. The students also interacted with park rangers and BAS' marine biologist, Mr. Eli Romero to get a better understanding about careers in the marine field. The students also practiced their newly acquired video making and journalism skills by interviewing the staff at Half Moon Caye and creating a story on the importance of the protected area. For all participants it was their first visit to Half Moon Caye and the Great Blue Hole. While the natural monuments were aesthetically impressive, the participants were made aware by the staff of the challenges of maintaining the integrity of the site.

Field activities and Reef Protectors filming at Half Moon Caye

Activity 4- Field trip evaluation meeting: Following the field trip the BAS team held a meeting with the reef protectors to evaluate the Half Moon Caye field trip and to critique the short videos produced by the students. The day was well spent with the students sharing their overall experience and some of the interesting information they learned from the field trip. The importance of importance of protected areas for sustaining our quality of life was one of the most resounding feedbacks given by students and teachers. After reviewing the videos, Dirk Francisco, the BAS Publicity Coordinator gave additional tips to the students on how to prepare and shoot a video.

Activity 5- Field trip to meet marine conservation experts: In order to improve support for conservation and to motivate the students to choose career paths in the conservation field, a field trip was organized for the group to visit two important organizations based in San Pedro Town. San Pedro is home to the Hol Chan Marine Reserve one of the most successfully managed marine reserve in the country and to MarAlliance, a newly formed local NGO dedicated to generating and disseminating essential science-based data on threatened marine mega fauna such as sharks, rays, turtles and large finish while promoting sustainable fishing and income diversification. The MarAlliance is headed by renowned shark scientist Dr. Rachel Graham, who attended to our group along with MarAlliance staff member Mr. Hilmar Salazar (a fisherman from Sarteneja who also works as a research assistant). They spent the entire morning passionately working with the Reef Protector students and explaining the role that their organization plays in marine conservation. The MarAlliance team made a particular effort to demonstrate to the students the importance of science-based information for effective marine protected areas management. Many of the

students were amazed to learn about the importance of sharks and rays at the ecosystem level and expressed an interest in learning more (see MAR Alliance on Facebook for photos of the visit https://www.facebook.com/media/set/?set=a.721972754534894.1073741840.638934782838692&type=3. After the visit with the team from MarAlliance, the group moved over to the Hol Chan Marine reserve office where they were met by the marine biologist, Ms. Keira Forman. Ms. Forman welcomed the group and gave an overview of the reserve and her role as a biologist. The students were very attentive and enjoyed the talk given by the biologist. When the formal presentations were done, the group headed off to the Hol Chan Marine Reserve and Shark Ray alley to snorkel and experience the beauty of the Belize Barrier Reef. The staff of Hol Chan facilitated the snorkeling trip and contributed significantly to the educational experience of the group.

Eli Romero, BAS marine biologist talking with Reef Protectors at Half Moon Caye

Activity 6- Field trip to Bacalar Chico Marine Reserve and National Park: To give the students another opportunity to meet conservationists and experience the reef ecosystem, a field trip was organized for the group to visit Bacalar Chico Marine Reserve and National Park and the Corozal Bay Wildlife Sanctuary. Accompanying the group to Bacalar Chio was Mr. Joe Verde, the Executive Director or Sarteneja Alliance for Conservation and Development (SACD) a local NGO based in Sarteneja tasked with managing the Corozal Bay Wildlife Sanctuary (CBWS). The CBWS is a critical estuarine ecosystem and thus its health is directly linked to the health of the Belize Barrier Reef. Mr. Verde's presence was very important because he shared his knowledge of the area, challenges and his personal account of how he converted to conservation work after years of being a fisherman and tour guide. Mr. Verde gave a very inspirational talk to the students about how he has made a career doing conservation work. Mr. Verde proved to be an excellent role model to the students.

At Bacalar Chico, Fisheries Department staff, Mr. Majil and marine biologist Henry Brown who gave the group an orientation and tour of the facilities. The marine biologist also shared with the students his role and responsibilities and his personal passion for the work that he does. Henry also highlighted some of the challenges and the rewarding elements of his job. The group was then escorted to the east side of the reserve where they visited the Blue Ventures research camp. Blue Ventures is a Science led organization that works with coastal communities to develop transformative approaches for nurturing and sustaining locally led marine conservation. Blue Ventures was kind enough to allow the group to use their camp site

as a lunch stop. While at the Blue Ventures camp the researcher coordinator gave the group a short talk on the work they do at Bacalar Chico, which primarily includes monitoring reef health. After lunch the students and teachers were taken to the reef to an area known as Rocky Point to enjoy snorkeling. Of the three sites visited and snorkeled during the program, the site at Bacalar Chico was the most healthy reef ecosystem. There environmental conditions were also ideal, having good visibility and an abundance of different coral species.

Kiera Forman, Hol Chan marine biologist meets with Reef Protectors

The one-day field trip was very successful and left the students with a greater appreciation for marine conservation. As a closing activity each student was asked to share their most memorable experience and identify one important thing that will stay with about the Reef Protector program.

Activity 7- Video making: Each student was given access to a video camera to allow them to acquire an additional skill in video journalism. While not the focus of the program, a secondary objective of the program was to help improve the confidence and communication skills of the students to be effective leaders. The footage was edited and developed into a video highlighting the Reef Protector Program and the role of young people in conservation (due to large file size, this will be sent separately from this report). BAS also has much valuable footage from the Reef Protectors which will provide content for further educational and outreach materials in support of Blue Hole and Half Moon Caye Natural Monuments.

Many online posts at https://www.facebook.com/belizeaudubon featured the activities of Reef Protectors. The video is being shared via Facebook, You tube and other social media. Local radio featured the Reef Protectors to share their experiences and the video is being aired on TV.

Lessons learned:

- ✓ As a new program, several visits and reminders by the BAS Education Officer were required in order to encourage students to apply to the program. Coordinating activities and meetings was challenging due to the distance between the targeted communities (Chunox and Sateneja) and the implementer (BAS), and because the students attended two different schools and lived between three communities. These challenges underline the importance of allocating sufficient funding to

ground transport in order to permit flexibility of the Reef Protector coordinator and to ensure mobility of the group.

- ✓ Since majority of the students in the program lived in Sarteneja but attended school in Chunox Village, meetings were held in Sarteneja Village. The BAS team then transported the students from Chunox and Copper Bank to Sarteneja for the meetings. Due to the logistics and expenses associated with carrying out such as program, in future we recommend targeting the program on one school at a time.

- ✓ The targeted group for the program was senior high school students, however it was challenging to ensure participation of final year students when highest priority is being given to regional examinations and graduation. In future the program could focus efforts on students before they reach their final year.

- ✓ Like other successful MPA education programs in the region, the Reef Protector program was designed to be an out-of-school activity. BAS team met with the students after normal school hours and on weekends. In facing the reality of competing demands on the participants' time, education programs must strive to be dynamic and fun in order to motivate participation. With the combination of field trips and use of technology, the Reef Protector program is well-positioned for future success.

- ✓ For successful video making, support to the students is necessary to assit them in capturing amateur footage.

- ✓ An essential part of the success of the program was the interaction with professionals working in the field of conservation. The personal stories and passion shared by some of Belize's most dedicated professionals served as inspiration to the students. We will seek to involve the passionate conservationist who gave time to speak to the reef protectors, especially: Eli Romero, BAS' marine biologist, Celso Sho, BAS' marine research assistant, Kiera Forman, Hol Chan marine biologist, Henry Brown, Bacalar Chico Marine Reserve and National Park marine biologist, Hilmar Salazar, community field officer for MarAlliance and Dr. Rachel Graham, Executive Director of MarAlliance, and Joel Verde, Executive Director of SACD.

Project 6. Small Business Micro-grants

Small business microgrants sought to address the priority of building capacity for the promotion of sustainable alternative livelihoods in order to reduce pressure on the resources of the Lighthouse Reef Atoll. The cooperative agreement enabled BAS to undertake a pilot experience in developing businesses that promote sustainable use of MPA resources and to assist with start-up costs and necessary equipment for MPA stakeholders, especially fishers and their families associated with Blue Hole and Half Moon Caye Natural Monuments, to diversify alternative livelihoods related to sustainable activities. This project was implemented as follow-up to the alternative livelihoods workshop in Year 1 of the cooperative agreement. Together with the Reef Protector work through Project 5, the efforts under the cooperative agreement took BAS' management capacity for alternative livelihoods from Tier 1 in 2011 (No assessment and no

opportunities developed for stakeholders) to Tier 3 in 2014 (Assessment completed and livelihoods opportunities developed).

BAS' approach to the small business grants via an application process with pre-agreed selection criteria was designed by the BAS and GCFI team and approved by the NOAA Grant Manager. To inform the communities about the microgrants, BAS conducted three meetings, one in each of the three communities. The objective of the meeting was to share information about the microgrants program and the application process. Flyers with all the pertinent information regarding the microgrants program was posted in the three communities and left with villages' leaders to continue spreading the word. A total of 276 applications from persons within the three buffer communities including fishermen and their families were submitted to the BAS office. With GCFI's input, BAS shortlisted applications in terms of creativity, sustainability and other demographic criteria. A criterion was developed to help guide the selection process and after a short listing process, GCFI and the NOAA Grant Manager reviewed the applicants. BAS conducted interviews with short-listed applicants to find out more about their small business plans and to determine whether the applicants were serious in growing their business. After one round of interviews, six successful applicants were selected - four from Sarteneja, one from Chunox and one from Copper Bank. Table 7 below lists the recipients of the microgrants and their small business ventures.

Table 7: Small Business Micro-grants associated with Blue Hole and Half Moon Caye Natural Monuments

Community	Micro-grant Recipient	Micro Grant Funding	Name of Small Business	Use of Funding
Sarteneja	Carlos Aldana	Bicycle Rentals and Tours	Carlos' Sarteneja Tours	Tourism is increasing within Sarteneja Village. Mr. Aldana, a fisherman and a Tour Guide has become creative in expanding his micro business by providing a bicycle rental service to visitors.
Sarteneja	Jose Ardon	Vehicle and Bicycle Tire Repair Business	-	Jose Ardon is currently a fisherman. Mr. Ardon realizes that fishing is no longer as profitable as before, and so he is seeking other means to generate income for his family. He presently has a tire and tube repair shop and applied for the grant to expand his small business.
Sarteneja	Auriol Samos	Boat engine and Small Engine Repair Business	A & S Outboard Engine Repairs	Mr. Samos is a former boat captain looking to expand his engine repair business. He repairs small engines such as lawnmowers, weed-eaters and boat engines. All three northern fishing communities utilize his services for boat engine repairs and servicing.
Sarteneja	Larita Rivero	Pastry Business	Leanne's Cakes and Pastries	Mrs. Rivero is the wife of a fisherman. She is a housewife who plans to expand her pastry business in her community by baking pastry for special events; weddings, birthdays etc. and also selling to local supermarkets within the community.
Chunox	Margaret	Small Food and Snack	Naileny's Fast	Mrs. Sealey is the wife of a fisherman. She plans to set up a small shop to sell cooked

	Sealey	Shop	Food	food and snacks to service her community and commuters' passing through her community on a daily basis.
Copper Bank	Casilda Cobb	Pig Rearing	-	Mrs. Cobb is the wife of a fisherman and has sons who are fishermen. She plans to use the grant to expand her pig farm. She currently has some pigs and wants to buy more and build more pig pens. Her community has a good market for pork so there is potential to expand in her community.

BAS officially announced the recipients of the small business microgrants and held an award ceremony at their office in Belize City. With assistance from the NOAA Grant Manager, a representative of the US Embassy in Belmopan (Mr. Joe Boski, Political Officer) assisted with handing over the awards to the microgrant recipients. Special invitees included potential co-donors such as Fauna and Flora International's representative in Belize (Ms. Chelsea Combeste-Friedman). See Appendix VI for the press note about this milestone in the project.

BAS Micro-grant recipients with US Embassy representative Mr. Joe Boski

The grantees signed an MOU with BAS outlining the terms of the microgrants and the criteria for meeting the second disbursement. The grantees agreed to participate in monitoring visits from BAS and to keeping in regular communication with BAS. The microgrants were issued in two disbursements, with the first disbursement of 80% of the grant. It was agree to by BAS and the grantees to issue the remaining 20% of the grant only if the grantee provides a detailed account of how the first 80% was spent (including receipts) and provide evidence that they were indeed moving towards improving their small business. To verify the grantees' reports, BAS made familiarization visits to each of the small businesses. In total BAS conducted six monitoring visits between October, 2013 to August, 2014. These visits were to determine if the small business had indeed improved due to the small grants received.

After the first three visits to all six small business owners, it was confirmed that only four of the six businesses were holding to their end of the agreement. As a result, the BAS team made a decision to not

disburse the remaining 20% to two of the grantees, Ms. Casilda Cobb (pig rearing) and Mr. Jose Ardon (tire repair shop) and to end the agreement. The two aforementioned grantees failed to 1.) Provide receipts and give an account of how the funds were spent 2.) Showed no interest in improving their business. Those funds were instead re-invested in sign posting and marketing materials to assist the other mirco-grant recipients.

BAS Community Liaison Officer Mr Lucito Ayuos with Ms. Larita Rivero, Sarteneja

The BAS team mentored the recipients throughout the life of the project and continues to provide technical assistance and suggestions to improve their small businesses. BAS and GCFI acknowledge that in addition to being a pilot experience for BAS, efforts related to the promotion of alternative livelihoods are experimental in nature. Accordingly, not all microgrants were expected to be successful. At the close of the cooperative agreement, BAS judges that four of the six grantees can be considered successes to date, and reports as follows on their stories:

Mr. Ariolo Samos boasts that the small grant has helped his A & S outboard engine Repairs business in a *"small but big way*". To improve the caliber of his business, he purchased a tool kit, a sprayer, tester and other tools. This great stride has allowed him to increase his income immensely.

"Carlos Sarteneja Tours" is also a successful story under the Small Grants Program promoted by BAS. Carlos Aldana has made progress through the expansion of his small business. He purchased three bikes through the Small Grants and now he has two additional bikes plus a tri-cycle. Carlos comments that, "*Right now the tourism business is slow but I plan to continue to promote my bicycle rental business. I guess my bikes will do well at the start of the next tourism season since I will be operating through a tour operator."* When asked how the small grants program helped him, Carlos boasted, "*I got my three bikes and have gotten two more through this program."*

Ms Laurita Rivero from the village of Sarteneja, a very innovative and motivated entrepreneur continues to sell cakes and pastries through her small business, “Leanne’s Cakes and Pastries.” She continues to take trainings in marketing and design for her cakes and pastries. Plans are underway for her to acquire a loan from the Sarteneja Credit Union to purchase a freezer to store her products. Currently she intends to market and expand her small business with the schools that are around her neighborhood.

From the village of Chunox, Ms. Margaret Seally operates her small business enterprise under the name "Naileny's Fast Food." Ms Margaret claims that the small grant was a big help to her family since it motivated her to jump start her business. With funds from the small grants she procured the materials need to construct a snack shop. Ms. Margaret opened her snack shop to the public in July 2014. She sells fast foods including local favorites, such as panades, salbutes and garnaches. Her main customers are from her village, however because her business is strategically located at the junction with the Sarteneja road, many commuters are utilizing her business. She plans to expand her fast food business by procuring a loan from the credit union to purchase additional furniture that she needs for her customers.

Lessons learned:

- ✓ Although they provided relatively small amounts of monetary support, the microgrants enabled diversification of local livelihoods and we judge them to have been very useful in helping to reduce local dependence on fisheries, and in turn reducing pressure on the MPA. It is possible that the fishers and/or their families who developed new livelihood options under this project will ultimately leave the fishing business. This appears to be particularly the case for the most motivated microgrant recipients – the boat mechanic and the bike rental businesses. Successful businesses developed by family members of fishers are also an avenue through which fishers might gradually leave the fishing business, as their involvement in a family business becomes more profitable than fishing.
- ✓ Our experience provides a potentially powerful message for others seeking to encourage sustainable alternative livelihoods - the microgrant recipients increased their incomes through their involvement in this project with the MPA. This translated to an improved ability for them to pay for their children's education, pay for medical bills and to attend additional training to improve their business skills. As a stimulus for working with the MPA, the profit motive seen in our success stories can likely help encourage future participation by fishers in alternative livelihoods program, perhaps more so than calls to stop fishing based purely on a conservation message.
- ✓ Alternative livelihoods is a complex topic, dependent upon human behavior and subject to cultural norms. We learned that providing some exposure to ideas for alternative livelihoods prior to the application process would have improved the stakeholders’ ability to develop strong business plans/ideas and improve their access to the microgrants by enhancing their creativity in thinking about and assessing the options available to them. Providing business training throughout the process would also have enhanced the success of the micro-grants.
- ✓ We note that grantees need continuous technical assistance throughout the process in order to help ensure optimal outcomes. This applies from the start of the program, since most of the applicants were below primary or at the primary level of education and many applications were inadequately completed. Ongoing mentoring by the BAS Community Liaison Officer was essential in

ensuring the successful implementation of the program and to help ensure the sustainability of the small business. Proper communications with them was essential in implementing monitoring the program. It is recommended that MPAs allow more time for follow up visits and technical assistance.

- ✓ The use of funds from the grant program to purchase signs and business cards for the small businesses was well-received as tangible added value from BAS.

South Water Caye Marine Reserve

Belize Fisheries Department staff managing South Water Caye Marine Reserve (SWCMR) identified outreach and education as the highest priority capacity building need from the MPA Management Capacity Assessment for assistance under the cooperative agreement. They wished to learn from the expertise of their MPA colleagues TIDE and Belize Audubon in order to design, for the first time, an outreach and education plan for SWCMR. Belize Fisheries Department staff report that the efforts and experiences under Projects 7 and 8 improved management capacity for outreach/education from Tier 1 in 2011 (little or no ongoing outreach and education activities exist) to Tier 2+ in 2014 (ongoing outreach and education activities in support of the MPA), with the expectation that these activities will be shaped into a program that would enable the MPA to reach Tier 3.

Project 7. School Programs

Although funding for this project was a Year 2 activity, upon receiving news of the approval of the cooperative agreement in 2012 the SWCMR MPA Manager put out a call for an environmental education volunteer. Applicant Lisa Mulcahy, an experienced environmental education consultant from the US, was accepted by Belize Fisheries Department to work at SWCMR. She volunteered during November and December 2012 to design an education program for schools about the MPA. She developed supporting outreach and education materials, including presentations and a Reef Keeper Workbook which was adapted from materials developed in the past by the Fisheries Department, and education materials successfully used by TIDE and Belize Audubon Society. She was based at nearby Tobacco Cay and her work included meetings with TIDE and Belize Audubon Society plus coordination with local schools and teachers in the communities associated with SWCMR, especially in Dangriga and Hopkins. Together with the MPA Manager she gave a guest lecture at a school using a newly developed Powerpoint presentation about SWCMR, and then coordinated a field visit to the MPA for pilot groups of students. She remained in contact with the MPA throughout the cooperative agreement. She also led the development of a poster about the project which was presented at the 66th GCFI meeting (see Appendix VII).

In Year 2, SWCMR worked with Hol Chan Marine Reserve and the MPA Manager and Education Officer assisted in the implementation of outreach and education activities for SWCMR under the cooperative agreement. Hol Chan has solid experience in this area and relevant staff to support the SWCMR Manager. Together they implemented a series of guest talks about the SWCMR at schools, with activities and competitions for the participating students. At the primary schools all the standard four to six classes took part, and at the high school the activities included all classes from third to fourth form. In total more than 600 school students were engaged through the education and outreach presentations. Supporting

materials were shared with the students, such as work books about the MPA, and a projector and screen were acquired by SWCMR to enable these activities.

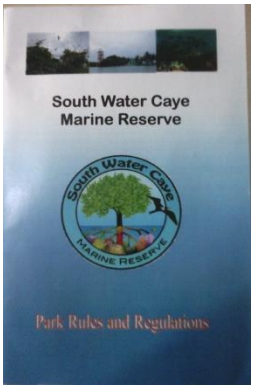
School visits and activities by SWCMR staff

In addition to school visits by MPA staff, follow-up field visits were held for a subset of students from six schools (Sacred Heart Primary School, Zion S.D.A primary school, Epworth Methodist School, Ecumenical High and Jr. College, and Hopkins Primary School). A total of 168 students took part in these field trips, which saw them travel to SWCMR and take part in tours, talks with scientists and activities on-site.


Field visits to SWCMR

Project 8. Adult Outreach Program.

This project saw the creation of a SWCMR booklet with the fisheries regulations (200 copies), the creation of four large signs to place at Dangriga, Hopkins, the local Fisheries base and at SWCMR.



Park Regulations booklet and sign positing for SWCMR

Two focal community activities targeting fishers and the general public were also implemented. The first of these was a meeting with well over a hundred fishers, coordinated by SWCMR with invited guests including Mr Lyndon Rodney from Fisheries Department, Ms Celia Mahung from TIDE and the managed access team from Fisheries Department in Belize City. This provided a new opportunity for community consultation about the marine reserve, with presentations by the invited speakers about the benefits of MPAs, the importance of MPA regulation and the contribution of managed access to sustainable fisheries. The cooperative agreement helped to concrete the successful collaboration between SWCMR and TIDE to strengthen outreach to fishers.

Community meeting with fishers in support of outreach about SWCMR

SWCMR held a community event and live show in Dangriga in support of engaging the general public. This included live entertainment, games and give-aways. Supporting materials included 200 t-shirts to give away to kids during the live show. Building on the activities with local schools and the meeting with fishers, this public event was a significant and successful outreach activity for the MPA.

MPA staff host the SWCMR live show in Danrgiga

Zona de Protección Especial Sandy Bay/West

Project 9. Small Business Microgrants

Small business microgrants sought to address the priority of building capacity for the promotion of sustainable alternative livelihoods and the diversification of livelihoods for the fishing communities associated with Sandy Bay-West End Special Protection Zone. This project was implemented as follow-up to the alternative livelihoods workshop in Year 1 of the cooperative agreement. This project was managed by BICA-Roatán, one of two NGOs that co-manage the MPA. Based on experience with microgrant implementation under the cooperative agreement (especially by BAS), BICA-Roatán designed selection criteria, developed an application form and started to publicize the small grant opportunity locally. A program of consultation meetings with fishers in the three communities of Sandy Bay, West End and Crawfish Rock was developed to discuss the opportunity and to provide assistance with applications where necessary. Subsequently, nine fishers made applications for proposed activities within the context of this

microgrant initiative of which a total of 6 proposals were pre-selected and then approved in consultation with GCFI and NOAA. Table 8 lists the recipients of the microgrants and their small business ventures.

Table 8: Small Business Micro-grants associated with Sandy Bay-West End

Microgrant Recipient	**Micro Grant Funding**	**Use of Funding**
Randy Allen	Tools/materials for making arts and crafts	Mr. Allen is a fisherman who combines fishing with handicrafts making wood & bamboo products that he sells to make ends meet. With the assistance of his wife he wants to expand to carving coconut shell, cow horn, seeds & other types of hard material to take advantage of the growing tourist industry. The grant was used to purchase tools & materials.
Kito Allen Tennyson	Materials for rental apartment repair	Mr. Kito is a fisherman looking for alternatives to fishing. He owns 3 small apartments that he would like to upgrade to increase his current income as fishing has declined over the years. The grant was used to purchase repair materials that he could not otherwise purchase with his current income.
Rufino Lopez	Small food and snack shop	Mr. Rufino established a Mini food & Snack Shop that his wife is managing.
Dean C. Mann	Rental of masks, fins and snorkels	Mr. Mann is a fisherman from West End who purchased 12 sets of snorkeling gear for rental at $5.00 per person. He lives on the main tourist strip in his community and this pilot business is well positioned considering the numerous snorkelers that visit this area.

An award ceremony was held at Carambola Botanical Gardens, Sandy Bay, Roatan, Honduras at which the recipients and BICA signed an agreement about the microgrants. Special guest at the ceremony included Dr. Sotero Medina Castro (Zolitur Technical Unit), Rosa Danelia Hendrix (President Bay Islands Counsil Federation), Ramon Meza (Community Organizer) , Dulce Maria Cruz (Municipality of Roatan) and Don Nestor Vidotto (Coordinator of the Sandy Bay - West End Special Protection Zone Community Council) attended the ceremony. Materials and products based on each proposal where purchased and delivered to the recipients.



Microgrant recipients Rufino, Mann and Kito

BICA provided technical assistance to all fishers during the entire process and actively monitored progress. The microgrants were partially implemented, with microgrants to four fishers successfully awarded but two microgrant recipients that had been identified were not able to act in the timeframe of the project. To date we perceive a willingness on the part of some fishers to supplement their incomes and so start to reduce fishing pressure, but more time is needed to develop individual success stories that can help serve as models for other fishers. BICA indicated that they are commited to provide monitoring and follow up of the activities currently implemented by the fishers beyond the duration of this initiative. Lessons learned will enable them to better implement similar activities with targeted groups within the Sandy Bay – West End Special Marine Protection Zone.

Project 10. Lionfish

Lionfish capture and handling took the place of lobster shades as the local activity sponsored under the cooperative agreement, but similarly sought to build MPA management capacity to apply best practices in fisheries management, to enhance sustainable fishing methods and to improve the livelihoods of fishers displaced by the MPA. The change in this project activity was driven by the launch of the new Bay Islands Marine National Park Management Plan 2013-2018 which prohibits lobster fishing in the MPA. To achieve similar project outcomes, the co-manager of Sandy Bay-West End MPA, Roatán Marine Park (RMP) wished to respond to this change by involving Roatán's local community and fishers in the capture of invasive lionfish. The MPA has been working with selected dive operators to promote controlled lionfish capture and the experience was ripe for replication in Sandy Bay-West End. Efforts under the cooperative agreement complemented other fisheries management approaches by promoting fisher licensing, forging stronger links between local people and the MPA, and enhancing local sustainable livelihoods for fishers. These in turn helped to build support for the MPA's efforts to establish community protected no-take zones.

While spearfishing is illegal within the Bay Islands, RMP has been proactive in the removal of lionfish, and with permission from the Honduran Fisheries Department, been licensing snorkelers and divers to hunt lionfish. Since 2009, the majority of licensed hunters have been tourists and expats who live and work on the island. Through support from the cooperative agreement, RMP promoted lionfish hunting by locals who in the past were unable or unwilling to pay for the license, workshop and equipment.

The project involved outreach to Roatán's local community to raise awareness about the MPA, about the threat of invasive species, about fisheries management and to achieve fisher licensing in lionfish capture and handling. The project enabled Roatán Marine Park to run workshops to train participants in the 'Protect our Pride' program in lionfish capture and handling, and issue them with licenses to capture lionfish in the MPA. Additionally, dive masters/instructors, snorkel guides and local fishers were trained in lionfish capture and handling and licensed to capture lionfish in the MPA. The participants received in-depth training from Roatán Marine Park staff (especially Project Officer Nicholas Bach and Executive Director Giaco Palavicini) in lionfish capture and handling, along with associated MPA information. They were required to sign a waiver and agreement indicating that they understand the risks involved in hunting lionfish and also recognize that it is illegal to spear anything other than lionfish within the Bay Islands. They were then be issued with licenses and equipped with individually numbered pole spears and lionsfish keepers. In total, 73 lionfish hunters were trained and licensed through a series of 8 training workshops. The project included acquisition of a machine to enable the MPA to produce ID cards for the licenses, which must be carried when fishing for lionfish. Licenses were issued to the individuals listed in Table 9.

Table 9: Newly Licensed Lionfish Hunters in Roatan

Maynor Avila	Roger Gonzalez	Nelson Zapata	Osman Gomez	Chayanne Bodden Miller	Jeff Maurick	Balto Pinto
Victor Manuel	Justin McNab	Teddy Dixon Perez	Philip Bodden	Garrick McNab Bodden	Earl Dixon Perez	Dillon Johnson
Orvil Henry	Nicola Arriola	David McCreary	Jermoia Stewart	Cesar Rodas	Alson Heston	Sherwin Green Wood
Luis Santos	John Carter	Timothy Daniel Fisher	Jeff Watson	Douglas Scharringhausen	Janna Parchmont	Nidia Scharringhausen
Alex Mann Romero	Teng-Song Chin	James Arch	Jim Arch	Lori Cassandra Hynds	Oneal Raymond Arch	Tyler Morgan
Christopher Dixon	Allen Wagner	Jesus Rosalez	Leonel Ayala	Oscar Valladaras	Deivis Martinez	Ezra Bush
Jose Santiago Gonzalez	Fermim Hernandez	Carlon Stewart	Brian Cruz	Francisco Salinas Osorto	Antony Webster	Ramon Jesus Raudales
Maynor Amador	Rudith Herrera	Ovilso Paguado	Jorge Miranda	Cesar Abel Cruz	Derick Steven Brooks	Milton Reye Trejo
Denisse Mazv Fuerzalida	Erica Mangia Lara	Edwardo Lenz Elden	Andes Miller	Mario Lagos Rodriguez	Elder Alfonso Fugon Leiva	Roberto Gonzalez Garcia
Edwin Bush	Diana Interiano	Nuwtan Rivers	Patrick Norbert	Ryan Spanier	Marvin Rodriguez	Kristen Walter Thomas
Yvonnay Hyde	Alex Ramirez	Ralston Brooks				

As a tool for teaching about lionfish, Roatán Marine Park designed a bilingual Spanish-English booklet that introduces the MPA, discusses the threats of lionfish, explains how to safely remove them and provides lionfish recipes. These were printed and distributed to fishing communities and to participants in the training workshops.

A part of the project was training local fishers in the construction of lionfish keepers and the provision of necessary materials. These will be sold to dive shops where the Dive Masters or POP candidates work or given to fishermen who will use them while hunting.

Throughout these activities, Roatán Marine Park drew on the many good resources available through GCFI (which are now included in the GCFI lionfish portal) and specialist NGOs such as REEF. The trainers also drew on expertise as helpful from lionfish specialists including Lad Akins, James Morris at NOAA and Ricardo Gomez at CONANP, Mexico.

Lessons learned:

- ✓ One of the most common problems we have encountered during this project is finding suitable candidates who understand that the spear is to be used only to hunt lionfish and can not be used on any other species of fish or lobster. While for those locals involved in the diving industry who hunt while leading groups, this is easily monitored. Local subsistence fishermen on the other hand are harder to supervise as they are on the water each day and may be tempted to spear other fish if they are unable to locate sufficient numbers of lionfish. After in-depth training andlicensing RMP hopes that that incidents of misuse are kept to a minimum, and field enforcement officers will monitor success.
- ✓ One of the additional benefits of the project is that all participants receive a briefing on the RMP so they understand what the orgnization does and the role that projects such as lionfish training play in management of the MPA.

Participants in lionfish project with Roatan Marine Park

Monumento Natural Marino Archipiélago Cayos Cochinos

Project 11. Fishery Management Plan

In the Caribbean MPA Management Capacity Assessment three priority MPA management capacity needs for *Monumento Natural Marino Archipiélago Cayos Cochinos* (Cayos Cochinos MPA) were identified: 1) socio-economic monitoring, 2) fisheries management, and 3) integrated coastal management. The priority area where an injection of special project funding was used is for fisheries management. Project 11 (Fisheries Assessment, monitoring plan and management plan) addresses site priority 2) fisheries management. A special project was developed to assess the status of the lobster population and fishery at Cayos Cochino MPA; provide training to allow the Honduras Coral Reef Fund to maintain a lobster population survey; and make recommendations for the lobster fishery management plan. This project helped to build MPA management capacity for fisheries management from Tier 2 in 2011 (assessment conducted but no plan developed) to Tier 3 in 2014 (fisheries management plan developed).

The goal of rebuilding the lobster population to the level that may maintain the ecological function of lobsters in a tropical ecosystem supports the overall decree of the Cayos Cochinos MPA to preserve representative samples of marine biodiversity. Although not part of the lobster stock assessment and this project, consideration of the local fishing activities and history is a required component of the management plan to balance resource protection objectives with cultural norms in the community. This project included an assessment of fishery management practices with reference to local fishing activities.

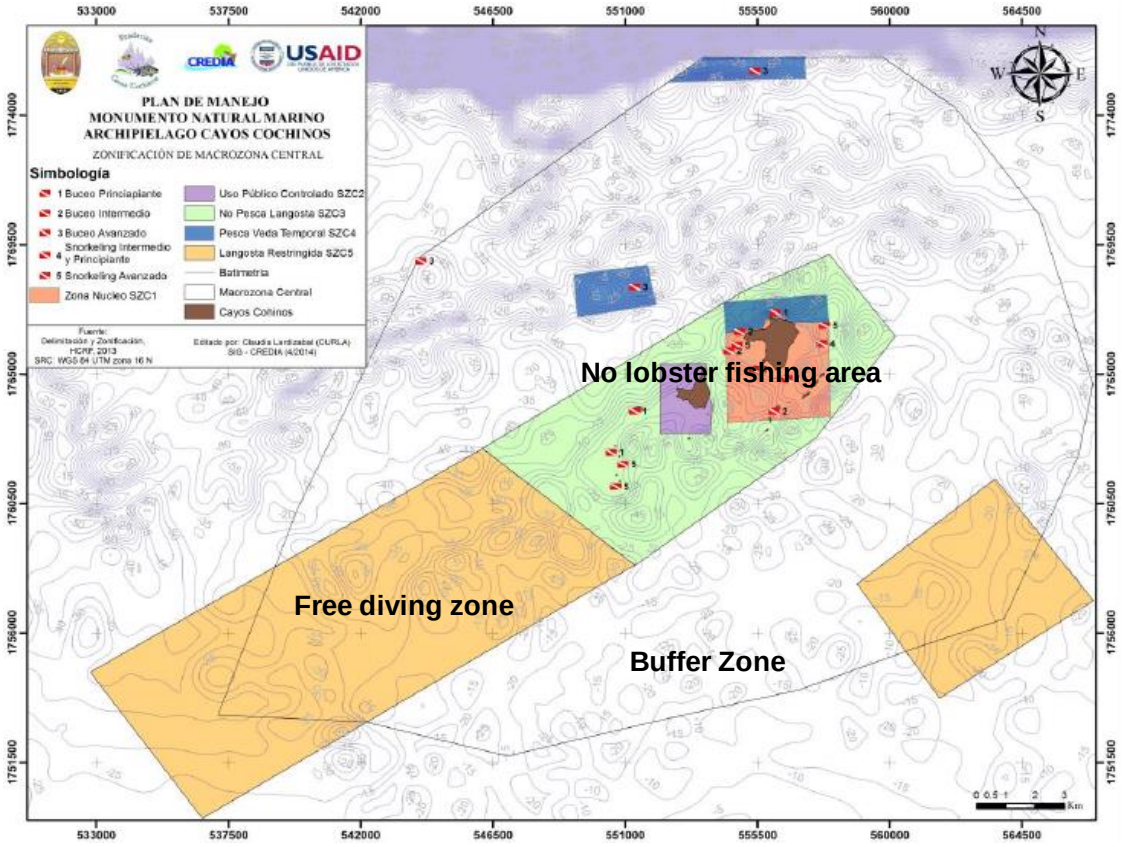
During the course of this project the MPA management plan "Plan de Manejo en el Monumento Natural Marino Archipiélago Cayos Cochinos, Honduras 2014-2025" was completed including the fishery management plan for spiny lobsters. Survey results from year one of the two year survey were available to Cayos Cochinos Foundation staff during management plan development, but a complete review of the lobster population status was not available during the management plan development and an assessment of lobster regulations was not included in the management plan. A review of the current management plan and an assessment of future data and regulatory needs is included herein and will also be published in the Gulf and Caribbean Fishery Institute Proceedings.

Lobsters are a dominant species on coral reefs and fishery activities are recognized as the typical cause for decreased lobster abundance and size. In the 1990s, concerns about overfishing dominated natural resources issues associated with Cayos Cochinos and the area was designated a biological reserve in 1993. At the time, the two recognized deleterious effects of fishing activities were the reduced abundance and size of lobsters; and habitat degradation caused by the shrimp trawling fishery.

The first fishery independent assessment of the lobster population was conducted by Tewfik *et al* (1997). Tewfik *et al* (1997) produced what is now useful as an excellent baseline survey to compare both lobster size and population abundance determined from this project's surveys in 2013 and 2014. Other lobster fishery data is available. A fishery dependent survey of lobster size and catch frequency from traps was conducted in 2008 by Cayos Cochinos MPA personnel. This trap-based data will be very useful to compare lobster size and catch data from potential future trap-based surveys or data collected from interviews of

fishers that utilize traps. The trap-based data was collected with sufficiently different methodologies and from different habitats that comparisons with the current diver-based surveys were not appropriate.

Lobster survey methods were based on those developed by Tewfik *et al* (1998). Tewfik *et al* (1998) methods included completing 57 transect surveys. In that study, a shallow and a deep transect were completed at each site and the transects were 100 m long and 3 m wide, covering a total area of 300 m^2. All surveys were conducted in reef habitat in what is now the *No lobster fishing sub-zone* (SZC3) as shown on the map of marine protected area.



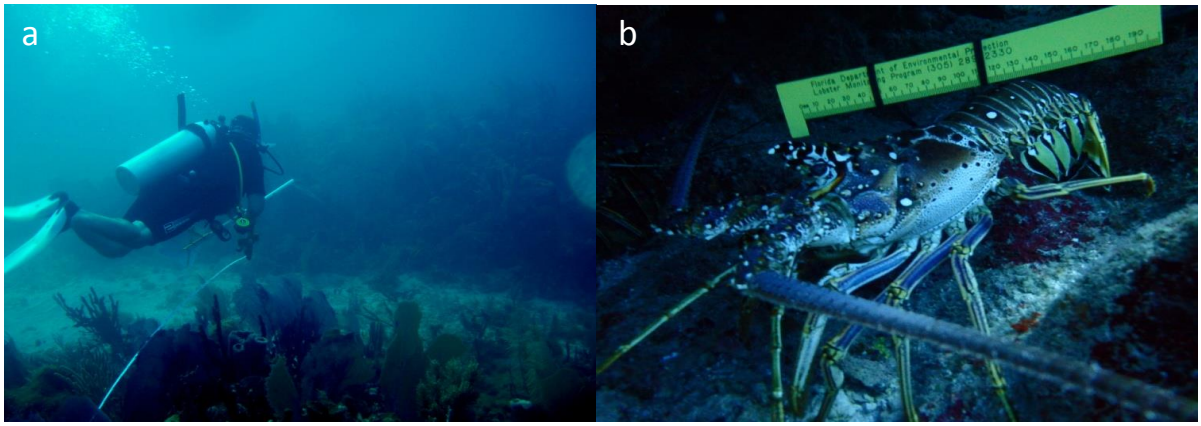
Monumento Natural Marino Archipiélago Cayos Cochinos

Survey design for the current project was modified from Tewfik et al (1998) and included a slightly larger transect area intended to reduce the probability of not encountering any lobsters on the majority of transects, since data with an overabundance of zero counts of lobster can lack homogeneity of variance and have a highly skewed distribution prohibiting some rigorous analyses. Each transect was 50 m long by 10 m wide for a total transect area of 500 m^2. In general, two random-direction transects were completed at each site. Forty-two transects were completed in 2013 and 38 transects were completed in 2014.

As for Tewfik et al (1998), surveys for this project were conducted in coral habitat. Stratifying surveys by habitat type allows for greatly increased efficiency of sampling. One of the few convenient characteristics of lobsters is that they are nearly obligate-daytime residents of reef or other highly structured habitat during daytime. Many of the same sites as Tewfik *et al* (1998) were sampled in the management zone

Subzona de No pesca de Langosta (SZC3- No lobster fishing area), and we also sampled in two additional management zones: *Subzona de pesca de escama y langosta restringida* (SZC5- Free diving area) and *Macrozona de Amortiguamiento* (Buffer zone).

Tewfik *et al* (1998) captured all lobsters encountered and measured several morphometric parameters. This project visually assessed lobster sex, size, and reproductive condition of lobsters while underwater. Assessment of lobster size to the nearest 5 mm carapace length was facilitated with the use of rulers laid along the dorsal surface of each lobster. All divers were trained in this technique and carapace lengths were verified by a second diver until lobster length was estimated consistently.



a) Diver deploying underwater transect tape. b) ruler used to estimate lobster carapace length.

Lobster density was measured in the no-fishing zone in both the Tewfik *et al* (1998) surveys and in this project in 2013 and 2014. It is preferable to measure lobster population parameters in multiple years as lobster populations in fished areas are known to be highly dependent on a single year class as recruitment and can be highly variable. Overall lobster density in 1997, which was essentially prior to implementation of any fishery management, was 19.86 lobsters per ha in coral habitat (Table 10).

Table 10. Lobster density (lobsters per ha) in Cayos Cochinos management zones in each survey year.

	No Fishing Zone	Free Dive Zone	Buffer Zone
1997	19.86	.	.
2013	59.7	20.0	.
2014	50.0	31.3	36.4

This lobster density does not represent the entire no-fishing zone but only coral habitat in that zone. Habitat surveys of the Cayos Cochinos MPA are insufficient to know the total area covered in coral so we cannot calculate the total number of lobsters in the no-fishing zone at this time. However, in the future, if better habitat surveys are forthcoming we will be able to back calculate lobster abundance. Regardless, our surveys in 2013 and 2014 were sufficient to compare the relative change in lobster abundance from 1997.

In 2013 we estimate lobster density was 59.7 lobsters per ha and in 2014 lobster density was 50.0 lobsters per ha.

Implementation of the no-fishing zone at Cayos Cochinos has resulted in a 2.5 to 3-fold increase in lobster abundance. The no-fishing zone has been described as predominantly an area for postlarval lobster settlement and juvenile lobsters. The abundance of lobsters below 60 mm CL observed in both the Tewfik et al (1998) and this survey support that characterization (Table 11).

Table 11. Lobster density (lobsters per ha) by carapace length in Cayos Cochinos no-fishing zone in each survey year.

	<60	60-80	>80
1997	11.68	4.09	4.09
2013/14	36.44	14.41	8.47

The greater than three-fold recovery of lobsters below 60 mm CL and intermediate size lobsters between 60 and 80 mm CL suggests that there has been increased protection for these lobsters that are predominantly below the current legal size 5.5 inch tail length, which is nearly equivalent to 80 mm CL. The lower recovery in abundance of legal-sized lobsters in the no trap zone might be consistent with an area where lobster emigrate upon reaching maturity which can occur near 80 mm CL, but observations of fishing activity and observations of the remains of fished lobsters in the no fishing zone suggest that fishing activity may still be preventing recovery of natural population abundance.

The natural abundance of lobsters is difficult to enumerate. Truly unfished populations of lobsters in areas of appropriate size to retain a lobster during its entire benthic life history are very rare. One of the oldest and largest established lobster no-fishing areas is the Dry Tortugas in Florida. Established in 1975 and encompassing some 26,000 ha, the Dry Tortugas National Park is occupied by predominantly adult lobsters and has a lobster density of 72 lobsters per ha (in coral habitat). Other smaller protected areas in Florida with predominantly adult lobster populations also had larger adult (lobsters over 80 mm CL) populations ranging from 69 to 145 lobsters per ha in Looe Key and the Western Sambos Ecological Reserve (Bertelsen *et al* 2004). Abundance of lobsters in areas dominated by juveniles has been reported at much higher densities, but juvenile density is much more likely to be recruitment dependent, and direct comparisons of density between areas are likely less definitive.

Lobster density in fished areas is often influenced by the number of under-sized lobsters that should be unaffected by the fishery. In the Florida Keys the abundance of lobsters in fished areas was 69 lobsters per ha (Bertelsen *et al* 2004). Lobster density in the free dive zone and buffer zone in Cayos Cochinos MPA were one-third to half that density. This suggests both relatively high fishing pressure on not only legal-sized lobsters but also on undersized lobsters. The size frequency of lobsters in all zones is highly skewed towards smaller lobsters. Very large lobsters were also absent from the surveys in 2013 and 2014. Maximum lobster size in 1997 was 142 mm CL and in 2013 and 2014 maximum lobster size was 115 mm CL. We also did not observe any reproductive activity in 2013 and 2014. The absence of reproductive activity in

Cayos Cochinos MPA is a concern but should likely not be over emphasized given the relatively small number of adult sized lobsters observed.

Lobster density decreased further from the lobster nursery areas surrounding Cayos Cochinos and the number of large lobsters increased (Table 12). There were relatively similar numbers of small, medium, and large lobsters in the free diving zone, but generally there were only larger lobster in the buffer zone which was geographically the furthest from Cayo Cocinos nursery grounds. The relative size distribution of lobsters suggests that there is lobster emigration from the nursery areas in the no fishing zone to the free dive and buffer zones.

Table 12. Lobster density (lobsters per ha) in surveys conducted in 2013 and 2014 by carapace length in each Cayos Cochinos fishing zone.

2013/14	<60	60-80	>80
No Fishing Zone	36.44	14.41	8.47
Free Dive Zone	2.54	5.93	4.24
Buffer Zone	0.85	0.00	5.93

In conclusion, the project indicated that:

- ✓ The implementation of the no-fishing zone has allowed the number of juvenile lobsters to double or triple and resulted in a significant increase in lobster density in the core protected area of the Cayos Cochinos MPA.
- ✓ Lobsters in the no-fishing zone likely emigrate into the fished areas, lessening the effective protection of adult lobsters and egg production in the area, but providing improved fishing opportunity and harvest.
- ✓ Fishing pressure in the free dive and buffer zone has likely increased since 1997 and the management area lacks sufficient large lobsters reducing the egg production in the MPA and putting regional lobster management at greater risk.
- ✓ Local indigenous fishers have likely experienced increased landings in the open fishing areas near the no-fishing zone, but significant illegal fishing in the no-fishing zone and the harvest of under-sized lobsters in the fished areas likely substantially reduces potential yield in the fishery.
- ✓ Fishery regulations and the lobster fishery management plan - the combined use of a closed fishing season, minimum harvest size, no-fishing zone to protect juvenile habitat areas, and escape gaps in traps to prevent the retention of under-sized lobsters are excellent fishery management rules. However, it appears to be relatively common that these regulations are poorly adhered to. Lobster fishers were observed fishing in the no-fishing zone and during the closed fishing season. Traps without escape panels are typical. Although a full stock assessment is not possible, it appears clear that the lobster population is experiencing overfishing and is overfished.
- ✓ Through their participation in this project, staff of the Honduran Coral Reef Fund and local volunteers received training in lobster monitoring and gained experience by taking part in all sampling. They now have field and management capacity to continue with monitoring efforts and work towards implementation of the management plan.

Zona de Protección Especial Marina Turtle Harbour – Rock Harbour

Project 12. Fisher exchange

This project sought to build capacity for fisheries management at the MPA. BICA-Utlia had identified that a challenge to efforts towards improving fisheries management is the lack of any local fishers' association, since local acceptance of a fishery management plan is incumbent on having willing partners in the fishery. Development of a robust fishing organization would provide that key partner. From the original idea for a visit to learn from Roatan fishers, this evolved into an international exchange to Port Honduras Marine Reserve to meet and learn from fishers in Punta Gorda, Belize.

BICA Utila took five fishermen from the cays associated with Turtle Harbour – Rock Harbour MPA, as well as a representative of the Honduran Fisheries Division and a local female candidate for fisher association administrator, on a week-long exchange visit capably hosted by TIDE, the co-managers of Port Honduras Marine Reserve in Belize. Representatives of the Belize Fisheries Department working on catch share agreements in Belize also assisted in hosting the visit.

While in Punta Gorda, the Honduran delegation interacted with representatives of the Rio Grande Cooperative, visited the cooperative to learn of its operation and met with members of the Toledo Fishermen Association who had an opportunity to relate their experiences. Fishers who are engaged in lobster fishing using lobster shades also demonstrated how the shades are constructed and effectively used. Honduran fishers expressed interest in utilizing this method of fishing and learned about the benefits of organization amongst fishers.

The manager of the Port Honduras Marine Reserve made presentations on the management of the reserve, the implementation of Managed Access and ways in which TIDE engages stakeholders in resource management. The visiting fishers expressed admiration for the establishment and management of the Port Honduras Marine Reserve and the stewardship they observed among fishers that they interacted with. They came to better appreciate resource availability in a marine protected area that uses sustainable fishing methods and whose rules are followed in order to provide long term benefits and not short term solutions. A press note about the visit was released by TIDE (see Appendix VIII) and an interview with Project Manager Ana Quinonez from BICA can be viewed at

https://www.youtube.com/watch?v=FHhOSxk_1p0

Upon their return to Utila, BICA continued to work with the fishers and together a new fisher association was established, the 'Asociación de Pescadores Artesanales de Los Cayitos de Utila'. BICA provided support with formalization of the association and lodging of necessary legal documents. BICA also continued to encourage the involvement of key local community members in the operation of the association. As a next step in building capacity for fisheries management, BICA assisted with planning for capacity building efforts for the fishers, including workshops on co-management of areas of responsible fishing, business plan development and administration (including book keeping, internal regulations). Co-funding was secured from and the NGO Coral Reef Alliance, but given changes in key positions within the fisher association these workshops did not take place within the time frame of the cooperative agreement. BICA will continue to

pursue this opportunity for further support to the fisher association, and valuable lessons have been learned by both BICA and the local fishers from this experience of formalizing their organization.

Participants in the Utila fisher exchange visit to TIDE Belize

Parque Nacional Arrecife Alacranes

Project 13.Conch Assessment.

In the MPA Management Capacity Assessment, fisheries management was identified as a top three capacity building need by CONANP staff at Parque Nacional Arrecife Alarances. Of particular importance was an assessment of the conch population (*Strombus gigas*) to support either the continuation of the closed fishery or its re-opening. The cooperative agreement made this assessment possible, and in doing so increased capacity for fisheries management at the MPA from Tier 1 (site specific fisheries assessment has not been conducted) to Tier 3 (fisheries management plan is developed).

GCFI assisted CONANP with the start of this project by preparing a call for proposals in order to secure the best independent and expert advice for the assessment. See Appendix IX for copy of this call. In preparing the call for proposals and evaluating proposals received, E. Doyle, R. Glazer (conch expert) and G. Delgado (conch expert) worked closely with CONANP staff at Parque Nacional Arrecife Alacranes to assist them in assessing proposals from conch researchers. After evaluation of proposals received, EcoSur researcher Dr. Alberto de Jesus Navarrete was selected to implement this project.

Field research consisted of three field trips together with CONANP to Parque Nacional Arrecife Alacranes, each for a period of 5-6 days and made by a team of seven researchers. CONANP's Alacranes field biologist and boat captain took part in the research, receiving training and hands-on experience in conch monitoring. The field work methodology consisted of 20 sample sites selected at varying depths, with sampling of conch along transects of 50m by 2m. Conch were collected, taken to a boat for measurement and to be weighed and were then returned unharmed. Bottom habitat was characterized in terms of vegetation cover and type of sediment. Measurements were also taken of water temperature, salinity and dissolved oxygen. Three periods of field work were conducted - September 2013 (n=152 conch), March 2014 (n=141 conch) and July 2014 (n=159).

Monitoring team at Parque Nacional Arrecife Alacranes and conch in the MPA

Results showed a very low density of conch in the MPA, with higher juvenile abundance. Analysis of the findings and comparison with data from earlier studies and with other sites indicated a clear recommendation to keep the conch fishery closed. Further, a series of recommendations were made for conch recovery, management and on-going monitoring of conch. The final report is attached as Appendix X and the Conch Conservation Plan is attached as Appendix XI. The presentation of these findings at the 2014 annual GCFI meeting is attached as Appendix XII.

Through the cooperative agreement, two staff from PN Arrecife Alacranes attended the GCFI meeting in Corpus Christi in November, 2013 and met with GCFI's Project Manager, Emma Doyle, and with conch experts Mr. Bob Glazer and Mr. Gabe Delgado about project progress and expectations for application of the findings. In conjunction with the third and final field work under the cooperative agreement, Dr. Alberto de Jesus Navarrete visited the CONANP Merida office to meet with the team from PN Arrecife Alacranes and discuss project progress.

Parque Nacional Arrecifes de Xcalak

Project 14. Lobster Assessment

In the MPA Management Capacity Assessment, fisheries management was identified as a top three capacity building need by CONANP staff at Parque Nacional Arrecifes de Xcalak. Of particular importance was an assessment of the Caribbean spiny lobster fishery (*Panulirus argus*) to support management of the fishery. The cooperative agreement made this assessment possible, and in doing so increased capacity for fisheries management at the MPA from Tier 1 (site specific fisheries assessment has not been conducted) to Tier 3 (fisheries management plan is developed).

The objective of the project was to undertake a fishery assessment and develop a fishery management plan to rebuild the lobster population to the level such that it may maintain the ecological function of lobsters in a tropical ecosystem. CONANP staff invited Dr. Eloy Sosa Cordero from EcoSur to submit a proposal to conduct the assessment. The proposal was reviewed by E. Doyle with T. Matthews (lobster expert) and slight modifications were made to the methodology. Upon approval of the proposal, Dr. Eloy Sosa and team

commenced field work with CONANP in Parque Nacional Arrecifes de Xcalak. A team of five researchers from EcoSur worked with CONANP staff and were assisted by undergraduate biology students and a small group of secondary school students from Chetumal. Lobster monitoring consisted of gathering capture data (weight and length of lobster tails, sex, presence of eggs, evidence of recent molt) and catch per unit effort (number of divers and number of hours fished) plus additional observations on lobster health and lionfish sightings.

Complete monitoring of the lobster season was achieved, from July 2013 through February 2014. A total sample size of 7,723 lobsters was achieved and a total of 430 fishing trips by the fishing cooperative operating in the park, Asociación Quintana Roo. Cooperation by fishers was found to be excellent, and the fishers proved patient, flexible and willing to participate in the monitoring which was taken as a good sign of their understanding of the importance of the work. In general the findings indicate that good fishing practices are being implemented in the park, with no alarm signals.

Lobster monitoring in Parque Nacional Arrecifes de Xcalak

Recommendations were made for the sale of live lobster for higher price compared with sale of tails, an accompanying change from use of a hook to use of a lasso for live capture, and potential for certification of the fishery. Dr. Sosa provided calculations of potential income and profit for the cooperative based on these recommendations. Other recommendations were to maintain at least 2 bays with local reproductive populations, with benefits for catch evident in 3-4 years; and the establishment of a maximum catch size within the regulations of the cooperative. The final report is attached as Appendix XIII. The presentation of these findings at the 2014 annual GCFI meeting is attached as Appendix XIV.

Through the cooperative agreement, two staff from PN Arrecifes de Xcalak attended the GCFI meeting in Corpus Christi in November, 2013 and met with GCFI's Project Manager, Emma Doyle, and with lobster expert Dr. Tom Matthews about project progress and implications of the findings for MPA management.

Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc

Project 15. SocMon Assessment

Following up on the SocMon training in Year 1 of the cooperative agreement, the Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc carried out a SocMon study for the first time to establish a baseline on the attitudes and behavior of tour guides in the MPA. This project took the CONANP team's management capacity for socio-economic monitoring from Tier 1 in 2011 (no socio-economic monitoring) to Tier 3 in 2014 (SocMon data evaluated and used in management decisions).

The focus of the SocMon study was tour guides working in the MPA, and an assessment was made of the influence of knowledge and attitudes on the practices of tourist guides working in the marine park with respect to environmental change and health. CONANP with the guidance of the SocMon Coordinator Arie Sanders carried out a one week data collection and analysis amongst tour guides operating in the MPA. Mr. Sanders assisted with data analysis and the findings and recommendations were presented at the end of project meeting in San Pedro, Belize. The final report is attached as Appendix XIV. The SocMon implementation steps are listed in Table 13.

Table 13: SocMon Implementation Steps with CONANP

#	Step	National Commission of Natural Protected Areas (CONANP)
1	Definition of the goals and objectives	Analysis of tour guides perception about the MPA management.
2	Sample frame	138 tour guides
3	Survey instrument	Questionnaire about social capital, knowledge, attitude and practice (KAP).
4	Data collection	Fieldwork June 18th - July 3rd, 2014. Staff of CONANP, including program coordinators and park rangers: 8 persons.
5	Data analysis	Data digitalized in SPSS, analysis includes descriptive statistics, construction of KAP index (factor analysis) and linear regression to explain the knowledge and practice of tourist guides.
6	Data are written into a report-	Report was written by the Zamorano team, there was no feedback from CONANP.
7	Reports provided to the coordinators	Report was presented at the final project meeting in Belize, comments received from GCFI addressed.
8	Results will be used in adaptive management-	Input will be used for targeting training for tour guides.

Positive publicity about the SocMon was generated via the press note in Appendix XV which was shared on MPA practitioner mailing lists, with contributing organizations and was also featured in the SocMonitor Newsletter (Issue 15, January/February 2014).

Assessing tour guide practices and knowledge about Isla Mujeres, Punta Cancun and Punta Nizuc National Marine Park in Mexico

By Arie Sanders

(Extracted from 10 July Press Release)

With more than three million visitors annually, the Cancun area is Mexico's largest tourist destination and most popular beach resort. One of the favourite tourist sites is the National Marine Park, especially Isla Mujeres. Located in the northern part of the Mexican state of Quintana Roo, the park was officially decreed on 19 July 1996, many years after a local grassroots organization and the community of Isla Mujeres began lobbying with the Federal Government for the creation of a protected area in its surrounding waters.

"Because of the high number of tourists in the park, snorkeling, diving and boating can cause direct physical damage to reefs. This damage consists mostly of breaking fragile, branched corals or causing injuries to massive corals. Most divers and snorkelers cause little damage; only a few cause severe or widespread damage, explains the park Director Dr. Jaime Gonzalez

During the period of 22 June to 3 July, 2014 a new SocMon assessment related to the national marine park was carried out to measure attitudes, practices and perceptions. Regional SocMon Coordinator (Central America), Arie Sanders, from Zamorano University in Honduras, commented, "In this assessment we are especially analyzing the influence of knowledge and attitudes on the practices of tourist guides working in the marine park with respect to environmental change and health."

The park is managed locally by the Management Authority, which consists of a group of professionals (mainly marine biologists) and six park guards (local community members) who report to the National Commission of Natural Protected Areas (CONANP). Tourist enterprises need permission of the park authority to operate in the protected area, and tourist guides and dive masters must be certified by CONANP.

"Tourist guides can play an important role in protecting the national park and its coral reefs. The adequate training of tourist guides can greatly help to reduce tourism's negative impacts in the protected area, and our study will help show where and how training should be focused," explained Arie Sanders.

Face-to-face interviews have been held with 150 tourist guides and the results of the study will be available at the end of August 2014.

The training was initiated by the marine national park in partnership with the Gulf and Caribbean Fisheries Institute (GCFI). It is part of a two-year cooperative agreement with NOAA's Coral Reef Conservation Program to build marine protected area management capacity in the Mesoamerican Reef region.

SocMon

For information on the Global SocMon Initiative contact:
Dr. Peter Edwards, Global Socio-economic Monitoring Coordinator (NOAA) peter.edwards@noaa.gov
Visit the SocMon website at www.socmon.org

From SocMonitor July/August 2014, Issue 15 http://www.socmon.org/download.ashx?docid=62065

Project 16. CaMPAM Database

Project 16 (CaMPAM database) was necessary capacity support for several projects. The gap analysis of existing MPA capacity documents revealed a great deal of variation in the purpose, geographic scope, methodology, and nature of capacity information for each MPA that has been collected to date (CMCCA). Basic information on the political and physical parameters of the sites may not be readily accessible. Access to this information is critical for initiating research and management activities. Several fishery assessment and socioeconomic projects proposed herein require additional geographic information. The information

from this project will be incorporated into the existing CaMPAM database of Marine Protected Areas in the Caribbean (http://campam.gcfi.org/CaribbeanMPA/CaribbeanMPA.php). This database contains information on MPA effectiveness as well as other parameters (e.g., governance, physical and natural resources, climate).

Management plan template development: We developed an interface that provided in an MSWord file the output from the database (Appendix XVI). This tool facilitates the easy preparation of management plans for individual MPAs based on information within the database. The template for the management plans was based upon IUCN standards for MPA management plans. We also integrated the records from the MPAs from this project into an application linked to a graphical product which was developed by The Nature Conservancy and the University of Southern Mississippi that spatially illustrates threats to the MPA (e.g., overfishing, land based sources of pollution) based on data provided by the World Resources Institute's Reefs at Risk Revisited assessment. Data entry into the MPA database is an ongoing activity and the database is constantly updated as new information becomes available. The data is also used to populate a management plan template, and the management plan that can be produced this way for each MPA provides a valuable starting point for the MPA that they can edit and use as a basis to develop their own management plan.

Project Wrap-Up Meeting

A project wrap-up meeting was held at which eight of the MPA partners and associated experts presented results of their work under the cooperative agreement. This proved an excellent opportunity for the MPAs to learn from each other's experiences through the project, to discuss findings and weigh in on the practical MPA management implications of the various findings and lessons learned in the course of the cooperative agreement. The program for the meeting is attached as Appendix XVII and the press note that was shared amongst MPA practitioner mailing lists is shown in Appendix XVIII.

APPENDIX I

Appendix I

Toledo Institute for Development and Environment
Alternative Livelihood and Sustainable Tourism Workshop
San Ignacio Hotel and Resort
November 14 – 16, 2012

Day 1: November 14, 2012 - Introduction to Alternative Livelihoods and MPAs		
Time	**Activity**	**Facilitator**
2:00pm – 2:15pm	Welcome to Belize	Mayor John August San Ignacio Town
2:15pm - 3:15pm	Overview of the workshop and discussion on current understanding of alternative livelihood	Celia Mahung Executive Director - TIDE
Coffee Break		
3:30pm - 4:00pm	Steps in planning for alternative livelihoods and livelihood analysis tools	Emma Doyle Project Manager, MPA Support CaMPAM/GCFI
4:00pm – 5:00pm	Case study 1: Example Livelihood Approach – TIDE community researchers	Celia Mahung Executive Director - TIDE
Day 2: November 15, 2012 - Case Studies in Alternative Livelihoods		
8:30am - 9:15 am	Marine protected areas and sustainable alternative livelihoods	Keith Nichols Project Development Specialist, Caricom Climate Change Centre
9:15am-10:30am	Case study 1: Livelihood Approach – Seaweed Cultivation and Pig Rearing	Leonel Requena COMPACT Coordinator
Coffee Break		
10:45am-11:15am	Case study 2: Livelihood Approach – Focus on Tourism	Dwight Neal Independent Consultant
11:15am-12:00pm	Case study 3: Livelihood Approach – Fishing and Tourism as Income Diversification Strategy, Punta Allen	Leonel Requena COMPACT Coordinator, UNDP Belize

12:00pm-12:30pm	Case study 4: Livelihoods and Micro-Enterprise - Plenty Belize	Mark Miller, Executive Director, Plenty Belize
Lunch		
1:30am -2:00pm	Summarizing issues, challenges and possible pitfalls learned from case studies	Lusito Ayuso, Community Relations Officer, Belize Audubon Society
2:00pm - 2:45pm	Case study 5: Lessons Learned from the OECS Alternative Livelihoods Project in Eastern Caribbean	Keith Nichols Project Development Specialist, Caricom Climate Change Centre
Coffee Break		
3:00pm - 6:00pm	Visit to Chaa Creek for MPA managers and MPA tour guides	Tour Guide (San Ignacio Hotel)
7:00pm	Dinner Planning Session on Microgrant Administration (for BAS, BICA-Roatan and TIDE, others also welcome)	Emma Doyle Project Manager, MPA Support CaMPAM & GCFI
Day 3: November 16, 2012 - Sustainable Tourism		
Time	**Activity**	**Facilitator**
8:30am – 9:00am	Sustainable tourism refresher	Terry Wright Sustainable Tourism Project
9:00am – 9:30am	Case Study 1: MPA briefings for tourism operators in Belize	Roberto Carballo, MPA Manager , South Water Caye Marine Reserve
9:30am – 10:00am	Case Study 2: Experience with voluntary standards and codes of conduct for marine tourism	Valentine Rosado, Independent Consultant
Coffee Break		
10:30am-11:00am	Case Study 3: Lessons learned in implementing sustainable tourism in Australian protected areas	Emma Doyle Project Manager, MPA Support CaMPAM/GCFI
11:00am-11:20am	Wrap-up discussion - Concerns of MPA managers and issues faced by tourism operators working in MPAs	Celia Mahung Executive Director - TIDE
11:30am-4:30pm	Field Trip to Jaguar Paw to discuss best practices in sustainable tourism	Jaguar Paw guides
5:00pm	Belize delegation returns home and visiting delegation returns to hotel in San Ignacio	

Workshop Participants:

1. Marta Macpui- Roatan Marine Park, Honduras
2. Marcio Aronne- Cayos Cochinos, Honduras
3. Irma Brady- Executive Director, BICA, Roatan, Honduras
4. Jenny Luque-BICA, Utila, Honduras
5. Erika Hernandez Montenegro- CONANP, Xcalak, Mexico
6. Shane Young- Belize Audubon Society, Belize
7. Lucito Ayuso- Belize Audubon Society, Belize
8. Roberto Carballo, Fisheries Dept. Belize
9. Lisa Mulcahy, Volunteer Education Specialist, South Water Caye Marine Reserve
10. Celia Mahung- Toledo Institute for Development & Environment, Belize
11. James Lord- Toledo Institute for Development & Environment, Belize
12. Oscar Escobar- Tourism Representative, Cayos Cochinos, Honduras
13. Sue Saunders- Tourism Representative, Roatan, Honduras
14. Jose Batun- Tourism Representative, Xcalak, Mexico
15. Emma Doyle- Gulf & Caribbean Fisheries Institute

APPENDIX II

Appendix II

Marine Protected Areas and Benefits for Communities

[San Ignacio] (November 20, 2012) ***Last week a group of marine park managers from Belize, Mexico and Honduras met in Cayo, Belize to share about approaches to bringing greater benefits to local communities from marine conservation.***

An initiative of the Toledo Institute for Development and Environment (TIDE) and the Gulf and Caribbean Fisheries Institute (GCFI), this is the first time that marine park managers in the region have come together to focus on encouraging alternative sustainable livelihood opportunities for the communities associated with their marine protected areas.

"Addressing the needs of communities is a key part of the success of conservation efforts" explains Ms Emma Doyle from the Gulf and Caribbean Fisheries Institute. "We depend on oceans for food, for shoreline protection, climate regulation, and recreational and tourism opportunities. There is tremendous pressure on marine resources."

"Conservation efforts typically seek to prevent over-fishing and to stop illegal fishing in the no-take zones of protected areas. But this cannot be achieved without more sustainable alternative livelihood opportunities for the communities that depend on marine and coastal resources," she adds.

Organised by TIDE, which is acknowledged for its achievements in working side-by-side with the community of Punta Gorda, the workshop featured a number of guest speakers from Belize who detailed their experiences with alternative livelihood activities that can serve to diversify local incomes.

Seaweed cultivation, tour guiding, dive training and employment in scientific diving, pig rearing, merchandising and many forms of micro-enterprise development were among the cases presented. According to TIDE's Executive Director, Ms Celia Mahung, "A common theme in the presentations was how partners work together for the good of marine resources and to benefit the communities that depend on them."

She adds "We have to ensure that alternatives are economically viable, environmentally sound and compatible with local societies. But for the managers of marine protected areas, encouraging the development of alternative livelihoods potentially has positive ramifications for law enforcement and fisheries management."

Part of the workshop focused in detail on sustainable tourism. Tourism development typically brings great expectations of income for coastal communities, as well as for marine protected areas, yet for tourism to be sustainable it must bring economic benefits and at the same time protect the natural resources upon which coastal tourism depends.

Tour industry representatives from Honduras and Mexico joined the workshop to discuss sustainable tourism. Field trips to the Iguana Project at San Ignacio Hotel, to Chaa Creek and to Chukka at Jaguar Paw gave the participants first-hand experience of the high quality of local tour guides, and helped them understand how the guides and tour operators have evolved a strong sense of stewardship of the environment and of local protected areas. They take home with them a new spirit of collaboration to promote sustainable tourism in the region's marine parks.

The workshop is helping to guide follow-up activities for the implementation of alternative livelihoods in communities associated with the participating marine parks, including via microgrants programs. The workshop and its follow-up activities are made possible with support from NOAA's Coral Reef Conservation Program, building capacity building among managers of protected areas to enhance international coral reef conservation.

For more information please contact Emma Doyle at emma.doyle@gcfi.org or Celia Mahung at cmahung@tidebelize.org.

Marine park managers and tourism industry representatives from Belize, Honduras and Mexico visit at Chaa Creek

APPENDIX III

Appendix III

Workshop outline agenda for Belize Workshop: February 18-21, 2013.
GCFI – CAMPAM - EAP Zamorano

Day 1	Sessions	Session leaders/content
08.30 – 08.40	Welcome	Alfredo/Sara / Emma / Amanda
	Introduction	Participants and facilitators
8.40 – 9.00	Fish Game	*Ice-breaker*
9.00 - 9.30	Participants' hopes and concerns	*Individual presentation about names, origins and preferences. Followed by hopes and concerns written on cards and clustered afterwards by team how is socio-economics used in work.*
	Review hopes and concerns (10 mins) Presentation of the workshop objectives.	Presentation (Alfredo)
9.50-10.00	Coffee break	
10.00-10.20		
	Workshop Menu (20 mins) *Schedule* *Introduce teaching style* *Role of trainers* *Role of participants* *Key terms* *Structure (around structure of manual)* *Establish ground rules* Monitoring groups	Presentation (Alfredo)
10.20 11.30	Understanding socio-economic assessments (60 mins).	Collective drawings Group brainstorming (Sara) Concept building. Plenary discussion explanation about participatory monitoring (Sara). Discussion about the implemented tool (Collective drawings).
Lunch		
13.00 – 14.20	What is Socmon (60 min)	SocMon Definition. Elements of SoMon (panel) 7 objectives (What is SocMon used for?) Case study presentation. Plenary discussion Preparative activities
14.20-13.30	Coffee Break	
14.30-15.00	Define objectives, monitoring group and study area (stakeholders)	Progressive panel.
15.00-16.00	Discussion and presentations	Presentation Brainstorming Working group discussions and presentations
16.00 16.30	Reconnaissance Evaluation of the day Instructions for the next day	*3 good points - 3 bad points. Written and handed in.*

Day 2	Sessions	Session leaders/content
8.30 – 8.45	Group presentation	Group 1
8.45 – 9-45	Data collection	Human Graphics (Alfredo)
9.45- 10.00	Coffee Break	
10.30 - 12.00	Tools for data collection (30 minutes for preparation, 10 min per group for the presentations)	Each group receives a tool and prepares a presentation about the tool: *Observation* *Focus groups* *Oral histories* *Interviews* *Surveys* The presentation must include: Definition, purpose, how to use it, pros and cons. Including an example.
Lunch		
13.00- 14.45	Visualization techniques (9 techniques, 20 minutes for preparation, 10 min per group for the presentations)	Each group receives a tool and prepares a presentation about the tool: Maps, transects, timelines, seasonal calendar, historical transects, decision trees, vent diagram, flowcharts and ranking. The presentation must include: Definition, purpose, requirements, pros and cons.
14.45- 15.00	Coffee Break	
15.00 16.00	Dynamic: Conflict analysis Role Play CILP Analysis	5 actors and the rest are observers.
16.00- 16.30	Reconnaissance Evaluation of the day Instructions for the next day	Field work groups / discussions

Day 3	Sessions	Session leaders/content
8.30 – 8.45	Group presentation	Group 2
8.45 – 9.00	Sustainable livelihoods presentation	Plenary discussion (Sara)
9.00- 10.30	Variables introduction (30 minutes for preparation, 10 minutes per group for the presentation) ¡Break included!	Each group receives the frame of the livelihood and indentifies variables for assets, vulnerability, strategies and intuitional structures. (Alfredo)
10.30- 11.30	Fieldwork Preparation (30 minutes for preparations, 10 minutes per group for the presentation)	Each group has to implement two techniques (3 groups), 1 transect technique and 1 visualization technique.
11.30- 13.00	Lunch	
13.00 17.00	Fieldwork	

Day 4	Sessions	Session leaders/content
8.30 – 8.45	Group presentation	Group 3
8.45- 9.45	Variables market	Based on the variables of the guide, each group will choose the variables needed to achieve their objectives.
9.45- 12.00	Working out SocMon plan ¡Break Included!	Plan for each site based on the progressive panel.
Lunch		
13.00 - 14.30	Work plans´ presentations and discussion.	Groups
14.30 - 15.00	Agreements	Emma
15.00 - 15.30	Workshop evaluation	Discussion (Alfredo and Sara)
16.00	Close	

Appendix IV

Appendix IV

Tools for Working with Coastal Communities in the Mesoamerican Reef Region

[Corozal] (February 22, 2013) ***Representatives of eight marine protected areas from Belize, Mexico and Honduras are currently being trained in socio-economic monitoring using the SocMon methodology.***

The training was initiated by marine protected area (MPA) managers in partnership with the Gulf and Caribbean Fisheries Institute (GCFI). It is part of a two-year cooperative agreement with NOAA's Coral Reef Conservation Program to build marine protected area management capacity in the Mesoamerican Reef region.

"The participants all recognise that the development of sustainable alternative livelihoods for local communities is imperative and can enhance conservation efforts at their MPAs" explains the host of the training, Amanda Acosta-Burgos, Executive Director of the Belize Audubon Society.

The training is being held in Corozal, Belize with visiting lecturers from the University of Zamorano in Honduras. Specifically designed to help coastal managers better understand and incorporate the socio-economic context into coastal management, the SocMon approach to socio-economic monitoring is being implemented in many other parts of the Caribbean region as well as globally.

"We seek to promote sustainable livelihood options that will bring economic benefits to the communities surrounding our MPA, Turtle Harbour – Rock Harbour, and this requires an understanding of local skills, interests, concerns and the socio-economic setting," comments Ana Lorena Quinoñez from the Bay Islands Conservation Association in Utila, Honduras.

"Joining together with colleagues from Belize and Mexico for this training means we're sharing ideas and experience about working with fishers, which in turn is helping me plan how best to work with fishing communities at home in relation to sustainable livelihoods," she adds.

Also present from Honduras are representatives of the Natural Marine Monument Archipiélago Cayos Cochinos and the Special Marine Protection Zone Sandy Bay - West End; from Mexico the National Parks Arrecifes de Xcalak, Arrecife Alacranes, and Costa Occidental de Isla Mujeres, Punta Cancún y Punta

Nizuc; and from Belize Half Moon Caye and Blue Hole Natural Monument and South Water Caye Marine Reserve.

Equipped with a new set of research tools, the participants have spent time in the field at Copper Bank, an important fishing community for Half Moon Caye and Blue Hole Natural Monument. Belize Audubon Society's Community Liasion Manager, Lucito Ayuso, coordinated the field visit and described its achievements.

"With a large group of fishers from Copper Bank, we examined the seasonality of fishing income. Women from the community worked with us to rank livelihood options of interest to them according to their existing skills. A special focus on youths from the community highlighted their perception of the opportunities and challenges facing them," he explained.

"As we promote sustainable alternative livelihoods here and in other communities, we'll be undertaking a full SocMon assessment as part of the GCFI project. Our colleagues have given us a head start."

The SocMon training is also serving as a reunion and networking opportunity for MPA colleagues from the Mesoamerican Reef region, some of whom last met at the GCFI-TIDE workshop on alternative livelihoods and sustainable tourism for MPAs in Belize in 2012, whilst others last met at GCFI's workshop on MPA enforcement in the Florida Keys in 2012.

For more information please contact Emma Doyle at emma.doyle@gcfi.org or the regional SocMon Coordinator for Central America, Arie Sanders at asanders@zamorano.edu.

SocMon participant Jorge Gomez with fishers at Copper Bank, Belize (Photo: Dirk Francisco)

APPENDIX V

SocMon Assessment:

Fishery Livelihoods in Copper Bank, Chunox and Belize City

August, 2014

Arie Sanders & Alfredo Reyes
Zamorano University

This Assessment was initiated by Belize Audubon Society with counter funding provided by Fauna & Flora International (FFI) in partnership with the Gulf and Caribbean Fisheries Institute (GCFI). It is part of a two-year cooperative agreement with NOAA's Coral Reef Conservation Program to build marine protected area management capacity in the Mesoamerican Reef region.

Table of Contents

1 Introduction

The Caribbean spiny lobster, *Panulirus argus,* and queen conch, *Strombus gigas* (referred to as lobster and conch, respectively) fisheries are important sources of livelihood for many households in Belize. Commercial fishing of lobster and conch started in the mid to late 1950s, mainly for export to the US (Gongora, 2010). The number of fishers involved has been increasing over time. Between 2004 and 2008, the number of licensed fishers rose from 1,731 to 2,246, representing an overall increase of 30% in four years (Ministry of Agriculture and Fisheries, 2008). In the last nine years the exploitation rate[1] for lobster and conch has increased; in the case of lobster this index has increased from 0.72 in 1999 to reach 0.79 in 2008 (Gongora, 2010). As fishing has increased over time to meet the high demand for lobster and conch from export markets, signals of over-exploitation are also increasing (Huitric, 2005). It is important to note that fish production from offshore areas is determined by, among other factors, the amount and quality of effort that is applied in fishery activity and the availability of stocks. Over the years, the number of people joining the lobster and conch fishery industry has increased, thereby putting considerable pressure on the limited stocks.

In partnership with the Belizean government, the Belize Audubon Society (BAS), a non-governmental membership organization dedicated to the sustainable management of natural resources –through protected areas management. BAS manages seven protected areas, including the Half Moon Caye and Blue Hole Natural Monuments two of which are found in the Lighthouse Reef Atoll two components of the Belize Barrier Reef Reserve – World Heritage Site marine protected areas, which are popular for lobster and conch fishing. Fishermen from different Belizean communities on the mainland use those areas as their main fishing spots. In their conservation strategy for the protected areas, BAS developed a strong focus on community-based natural resource management, where fishery communities take their own responsibility for managing the marine resources: “We (BAS) provide opportunities for stakeholders to participate in the management of their environment, adopt sustainable practices that are compatible with existing values and create alternative livelihoods (BAS, 2012).” The BAS program has a strong environmental education component to encourage fishermen to work cooperatively to protect the area and its resources.

An important group of households from Chunox, Copper Bank and Belize City are significantly dependent on coastal and marine resources for sustenance. As true with many human activities, the fishing industry can have negative impacts on the marine environment which supports these communities. It is therefore critical to have an understanding of not only the biological, but also socioeconomic factors, in order to manage fishery activities in a sustainable and efficient manner. The aim of this assessment is to provide BAS and the communities with basic information that can contribute to improving the effectiveness of decision making, interventions and organization with respect to the management of fisheries and other marine resources. To that end, we conducted a

[1] “Exploitation rate, applied on a fish stock, is the proportion of the numbers or biomass removed by fishing. If the biomass is 1000 tons and the harvest during a year is 200 tons, the annual exploitation rate is 20%.” (United Nations Food and Agriculture Organization, 1997)

livelihood analysis of the fishermen. Belize City was for baseline for the newly established marine protected area Turneffe Reef Atoll.

The document is structured as follows: Section 2 describes the research approach and the instruments used for the data collection and analysis. This is followed by a brief presentation of some critical features of the historical development of the lobster and conch fishery industry in Belize that helps to determine the current challenges for sustainable fishery management and briefly describes the sites where the assessment was conducted. This is followed by Section 3, which presents a summary of village and household-level livelihood characteristics that were encountered during our field work, which focused on the asset status of fishery households, the income-generating activities they engage in and the institutional environment in which livelihood strategies are adopted and adapted. Finally, the household-level findings are linked back to the general level management strategies with a view to identifying weaknesses and gaps in these strategies that need to be addressed if real progress in sustainable fishery management in Lighthouse and Turneffe Atoll is to be achieved.

2 Research approach

2.1 Livelihoods

Based on the sustainable livelihoods framework discussed by Scoones (1998) and Allison and Ellis (2001), we define livelihood strategies as the choices that people make in search of income, security, well-being, and other productive and reproductive goals. These choices are reflected in the way that people use their assets or capital and, as such, are an important part of household behavior, while determining well-being. The concept of livelihood strategies has developed through many years of thought and study on how rural households, including fishery households, construct their lives and income earning activities, the importance of the institutional structures that surround these households and their resulting poverty levels (Dearden *et al.*, 2002). According to Chambers and Conway (1992), a livelihood is sustainable if "[it] can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term."

The sustainable livelihoods conceptual framework represented in Figure 2.1 is a dynamic tool that aims to combine and capture interactions between households, assets and their surrounding institutional environment. Central to the sustainable livelihoods approach is the question of how the poor combine different assets and capabilities to reduce vulnerabilities when facing stresses and shocks (Allison and Ellis, 2001). These assets can be grouped into five categories, namely natural, human, social, physical and financial capital; each plays a significant role in every livelihood strategy adopted to help achieve a particular livelihood outcome (Carney, 1998). The approach acknowledges the different assets, including entitlements, such as fishing rights, that people have in relation to the broader institutions, policies and culture. The sustainable livelihood approach also recognizes the risk and vulnerability of livelihoods to external shocks, trends and

seasonality (Allison and Ellis, 2001). Following this definition, there is substantial evidence to demonstrate that the livelihoods of the coastal fishers in Belize (and other Central American countries) are becoming increasingly *unsustainable*.

Our initial focus was on the conceptualization and quantification of the household's asset portfolio as an input into the explanation of a household's livelihood strategy. Sustainability is one of the essential characteristics of the livelihood focus, and it is key to the theory's success. Sustainability requires risk management in the face of unexpected situations to ensure the availability of resources for future generations. A sustainable system includes a conjugation of the economic, social, environmental and institutional aspects and the management and adaptation to a vulnerability context, such as climate change. In coastal zones, the sustainability of natural capital is the basis for the development of other capitals. In this case, the productivity of the zone is based on the marine resources. The sustainability of the livelihoods may be affected by positive or negative externalities that are presented within the context of vulnerability.

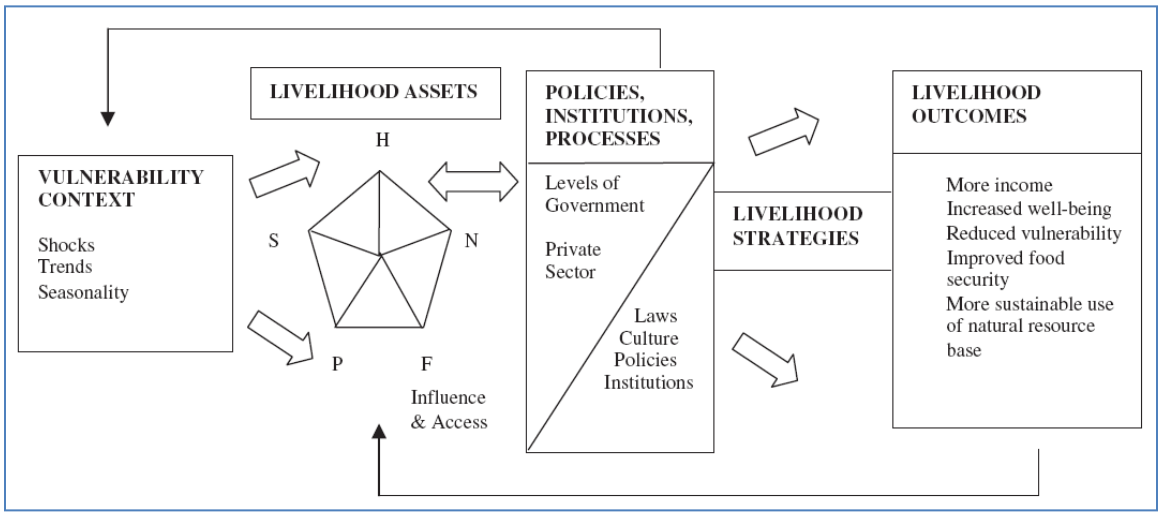


Figure 2.1: Sustainable Livelihoods Framework
Source: Ellis (2000).

The assets determine the strengths and weakness of the households for dealing with external shocks. Better prepared households with more assets are more successful at coping with externalities and are less likely to fall into extreme poverty. Human capital reflects the stock of human skills and knowledge in the household and includes education, fishing skills, knowledge and health. Natural capital reflects the household's endowment of natural resources and includes land, marine resources, mangroves and biodiversity. Financial capital includes savings in cash and kind, credit, and transfers and remittances. Physical capital includes vehicles, boats, engines, fishing gears and methods and technology. Finally, social capital is embodied in human relationships and includes any networks that increase trust, ability to cooperate, access to opportunities and membership in organizations like fishery cooperatives or local credit associations.

2.2 SocMon approach

The SocMon methodology stresses the need to understand the human dimension in the management of coastal and marine resources. It provides simple guidelines and structures for monitoring, which may be adapted to the needs of each study site (Bunce *et al.* 2000; Bunce and Pomeroy, 2003).). SocMon includes three phases for understanding the weaknesses and strengths of the coastal marine resources to permit the creation of action mechanisms that give incentives to improve their conservation and management.

After undertaking preparatory activities that included the elaboration of a proposal and its respective socialization with the included actors, primary and secondary data were collected.

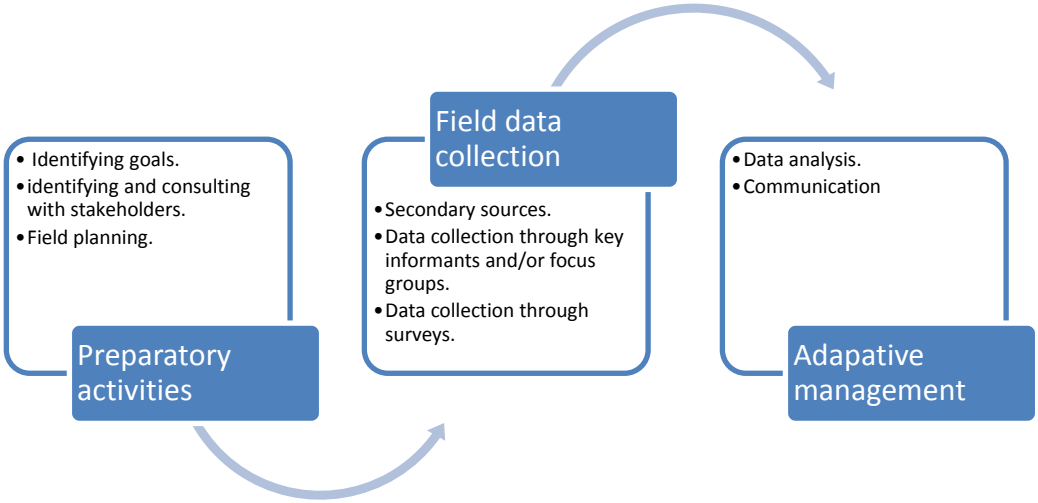


Figure 2.2: SocMon Methodology
Source: Bunce and Pomeroy (2003).

2.3 Data collection

For the analysis, we collected original survey data from fishery households in the district of Corazal (Chunox and Copper Bank) and Belize City. Households were selected from a list that was compiled in collaboration with the Belizean Audubon Society. Face-to-face interviews were conducted at or near the homestead of the household and lasted for approximately 30 minutes. If a selected household was unavailable for the interview, the household was replaced with another household from the list. All interviews were carried out by locally recruited enumerators who were knowledgeable about the area and the activities carried out by fishery households. A standardized questionnaire was used to obtain information on household characteristics based on the asset pentagon. In addition, we asked detailed questions about the fishery, processing and marketing activities.

Given the focus of our assessment, we necessarily adapted and narrowed the broad asset definitions and used the following working definitions of each type of asset:

- *Human capital* is represented by the size and composition of the household with the latter determining the dependency ratio, formal education level of its members and age and gender of the household head.
- *Physical capital* for the fishery activities includes gear, boats and boat engines. We also included questions about the housing conditions (roof, walls and floor) and about small domestic assets (fans, stoves and refrigerators). Such assets determine the wellbeing status of the household.
- *Financial capital* includes transfers (remittances and other cash transfers), credit and savings.
- *Natural capital* is represented by the amount of land (plot and farm size) and the use of marine resources. Because the fishing grounds are not owned by the fishermen, we included questions related to the use of the fishing grounds (fishing calendar, frequency of visiting the fishing grounds).
- *Social capital* includes membership in various types of organizations and programs, including fishing cooperatives and associations and NGO projects.

Data was entered into a statistical program and cleansed. 35 households had to be removed from the data set because of missing data, resulting in a total sample of 102 households for the analysis.

2.4 Data analysis

We employed a wealth index to describe the household welfare situation. A wealth index is based on such durable goods as televisions, radios and transportation means and is considered more reliable than an estimation of household income. In addition, the index requires less intensive data, potentially resulting in a smaller measurement error.

Principal Component Analysis (PCA) was used to assign the indicator weights (Hair, *et al.* 2010) . In addition, the factor analysis process has been used as follows: First, the indicator variables were standardized (normalized); subsequently, the factor loadings were calculated; and finally, for each household, the indicator values were multiplied by the loadings and added up to produce the household's index value. In this process, only the first factor produced was used to represent the wealth index. The households were ranked by score and distributed into three sections (33% for each). Then the household score was recorded into the tercile variable so that each household received a category.

Frequencies and means were used to describe the five types of capital, fishing activities and general perception about fishery of each of the households. Pearson's correlation coefficients were used to examine the association between livelihood patterns and geographic location. The Statistical Package for the Social Sciences was used for all computations.

3 The Context

3.1 Lobster and conch fishery in Belize

The Belizean fishery sector is an important productive component of the country's economy. During 2006, the fishery sector exported 25.6 million pounds of seafood, which represented a total of US$ 53.4 million in revenue. This data includes aquaculture and wild catch fisheries where 95% of the productions and 80% of the revenue was from farmed seafood (Environmental Defense Fund, 2008). Lobster and conch are still the most productive wild catch fisheries; 90% of the lobster, conch and shrimp produced in Belize are exported to the United States.

The Spiny lobster and Queen conch continued to be Belize's principal fishery resources in 2008, and these two commodities are thus responsible for the largest portion of foreign exchange earnings from the wild catch fishery sector. This sector employed 2246 fishermen and 643 fishing vessels and, an estimated 15,000 Belizeans have a direct benefit from the fishing activity (Ministry of Agriculture and Fisheries, 2008).

The number of licensed fishermen has steadily increased from 1,731 in 2004 to 2,246 in 2008, representing an interesting pattern in the levels of fishing effort. In addition, Belizean fishermen depend on national stocks, and they cannot easily relocate if stocks decline.

3.1.1 Lobster

The total value of exported Belizean lobster in 2008 was US$ 7.4 million, resulting from the export of approximately 470,485 pounds of lobster (Ministry of Agriculture and Fisheries, 2008). 90% of spiny lobster caught in Belize is exported. Lobster landings peaked at 750,000 pounds in 1981. Legal methods for catching lobster include traps, free diving and lobster shades. Fishermen have been deploying lobster shades to create aggregation sites. The season is closed from February 15th to June 14th, limiting lobster fishing to eight months (Environmental Defense Fund, 2008).

North of Belize is a major nursery area for lobster; 40% of lobster production comes from the north of Belize City in the surrounding area of Turneffe Atoll. The minimum size for lobsters is a three-inch length between horns and the beginning of the tail and a 4-ounce minimum tail weight.

3.1.2 Conch

In 2008, 614,050 pounds of conch exports amounted to US$ 3.3 million (Ministry of Agriculture and Fisheries, 2008), and conch landings have declined from a peak of 1.2 million pounds in 1972. The only legal form of conch collection is free diving; assisted diving is prohibited. The closed season is from July 1st to September 30th, limiting the conch fishing season to nine months (Environmental Defense Fund, 2008).

By carrying out field studies, the Belize Fisheries Department determines the total allowable catch (TAC) for conch every two years; in 2006 the TAC on conch was set at 620,000 pounds. The Cooperatives are assigned a share of the TAC based on their historical catch, and when they meet their quota, they are required to stop harvesting conch.

3.2 Study sites

The study was conducted in two communities on the Belizean north coast, namely Copper Bank, Chunox and in Belize City. These are important lobster and conch fishing communities where fishermen work mainly in the fishing grounds of Lighthouse and Turneffe Atoll. Each of the communities has its own unique characteristics. Copper Bank is a typical fishing community with a high percentage of households dedicated to commercial lobster and conch fishing. It is situated on the west bank of Laguna Seca, a shallow lagoon that empties into Chetumal Bay just north-east of the community. The local economy is based primarily on fishing for lobster and conch, although tourism is becoming increasingly significant as a source of income. Chunox is a rural community that depends on both fishing and peasant farming. .

The fishermen of Belize City are mainly located in the south-side of the city. Fishermen live in different neighborhoods where people engage in multiple different economic activities. However, for the fishery households, lobster, conch and finfish is the main income source.

3.3 Belize Audubon Society

The Belize Audubon Society (BAS) is a non-profit NGO dedicated to the promotion of the sustainable use and preservation of the country's natural resources in order to maintain a balance between the population and the environment. Since its formation in 1969, the BAS has been Belize's foremost environmental organization, protecting Belize's precious natural resources while educating the public about their value and sustainable use. BAS has grown from an all-volunteer organization with 55 charter members to a Society of over 300 members and a staff of more than 40 dedicated professionals. The Belize Audubon Society cares for public lands in national parks, wildlife sanctuaries and natural monuments, which encompass more than 180 thousand acres.

At the request of the Government of Belize (GOB), the Belize Audubon Society has been instrumental in the financing, development and management of protected areas that have been designated under the National Parks System Act of 1981. Currently BAS manages seven of Belize's protected areas with a well-trained, knowledgeable staff, most of who are from the surrounding buffer communities. BAS works in partnership with government agencies such as the Belize Forest Department and Fisheries Department.

4 Livelihoods

4.1 Profile of the interviewed fishermen

A total of 105 fishermen were interviewed from the three study sites. Almost all respondents were male (97%) with permanent residency in communities in the district of Corozal and Belize City. The average age of the respondents was 37.1 years, and the majority of them were in the 26-45 age group. Most fishermen had completed primary school (63%), and only 4% didn't receive sufficient formal education to achieve an acceptable level of literacy. Over 92% of the respondents identified themselves as full-time fishermen dedicated to harvesting lobster and conch. All the fishermen used Lighthouse or Turneffe Atoll as their main fishing ground. Fishing lobster and conch is mainly

a male activity; no female fishers were sampled or interviewed. The general characteristics of the respondents are shown in Table 4.1.

4.2 Household Capital

In this section we analyze the five different kind livelihood capitals: human, social, natural, physical and financial. Critical features of capital in relation to the ability of households to cope with and adapt to change are the diversity of capital held and whether the nature and diversity of the capital creates a capacity to cope and adapt, thereby reducing vulnerability (Scoone, 1999).

4.2.1 Human Capital

Human capital represents the skills, knowledge, capacity to work and good health that together enable people to pursue different livelihood strategies and achieve their livelihood outcomes (DFID, 1999). In our analysis of human capital, we include the aspect of food security. Household eating patterns are strong indicators of relative poverty and vulnerability.

The results in Table 4.2 confirm findings in other SocMon assessments concerning the role of various demographic variables with respect to low-income households in coastal areas. The average family size of about 4.7 is much higher than the national average of 4.0. However, over the last ten years, average family size has declined in Belize by more than 20%. According to the poverty assessment report (GoB-CDB, 2010), as a result of declining fertility there has been a drastic decrease in the proportion of children aged under 15, from over 40% in 2000 to 34% today.

The dependency ratio is a measure of how much the non-working age population (0-14 years and 65 and over) is dependent on the working age population (15 to 64 years). A higher dependency rate means that more members of a household are not economically active and that the income generated depends from a small number of household members. The average dependency ratio (ratio of non-working members to total household size) in the three sites is about 25%, which is surprisingly low for a rural or coastal area. This means that most of the household members are old enough to be economically active and can have a positive impact on the household's per capita income.

A large number of studies have established that human capital, especially education and skills, is very important for improving livelihood outlooks. Low income and poverty are closely associated with low levels of education and lack of skills. In general, Belizean fishing communities have historically suffered from very low levels of education. However, it appears that the situation is changing for the better. Out of all the household heads, 64% had finished their primary education. Although educational rates in the three communities continue to be below the national average, many people have begun taking an active interest in education and in sending their children to primary school. The enrollment rate for primary education, which is the percentage of the number of children of official school age, was almost 100%. It's obvious that the enrollment for secondary schools is lower than for primary schools. An analysis of all the persons between the age of 18 and 25 showed that only 20% had completed their secondary education. This is far below the national average of 65%. One possible reason for the low rate of young people in the Corozal communities

culminating their secondary school could be the distance to the secondary school; however, we found a same low rate for the households interviewed in Belize City.

Table 4.1: Human Capital

Variables	Community			Total
	Chunox	Copper Bank	Belize City	
Demographic and education				
Gender household head (male =1)	100.0	100.0	100.0	100.0
Age group household head	43.6	32.9	39.1	37.1
< 25 years	4.2%	29.4%	11.1%	18.6%
26- 45 years	50.0%	60.8%	66.7%	59.8%
46 – 65 years	33.3%	7.8%	14.8%	15.7%
> 65 years	12.5%	2.0%	7.4%	5.9%
Education level household head				
< primary	12.5%	13.7%	11.1%	12.7%
Primary complete	54.2%	70.6%	59.3%	63.7%
> primary	33.3%	15.7%	29.6%	23.5%
Family size	5.0	4.4	4.5	4.6
Dependency ratio	0.25	0.25	0.28	0.26
Food security				
Days served during the last week				
Maize	4.3	4.1	2.5	3.8
Rice	5.0	4.3	5.4	4.7
Wheat	6.9	6.5	4.9	6.2
Beef	2.6	1.8	2.1	2.0
Poultry	5.0	5.6	4.9	5.3
Fish	4.0	3.6	5.3	4.2

Source: Questionnaire SocMon-BAS, 2014

By including some aspects of household eating patterns, it is possible to analyze aspects related to food security and household wellbeing. Poorer households tend to consume foods on a less regular basis than wealthier households and may eat lesser quantities per person. Also, poorer households tend to consume more of less costly foods and less of more costly foods. The wealthier households often are more able to purchase staple foods in larger quantities at more favorable per-unit prices.

4.2.2 Social Capital

Social relations between individuals, families and groups play an important role in sustaining household livelihoods. These social relations create trust, collective action and facilitate the access to wider institutions, memberships and the establishment of informal safety nets among the community members. A frequently used benchmark to estimate household social capital is their

membership in social and economic organizations. The majority of the fisher households have affiliation with production-oriented organizations, such as cooperative and local credit groups (92% of all household heads). As explained in the former section, the high incidence of membership in fishery cooperatives has to do with marketing the lobster and conch. Almost all the catch is sold to the national cooperatives. Membership in the local credit branch facilitates access to credit for fishery and non-fishery activities. On average, the household head has been a member of one of the two national fishing cooperatives for almost 13 years.

We found active participation of fishers in the production-related organizations; more than 42% has or has had an appointed leadership position in one of these organizations. Being active as leader involves connectivity that increases peoples' trust and collective movement and expands accessibility to other institutions like NGOs such as BAS.

Table 4.2: Social Capital

Variables	Community			Total
	Chunox	Copper Bank	Belize City	
Fishing cooperative (household head)				
Membership in a cooperative (1=Yes)	100.0	96.1	77.8	92.2
Appointed leadership position in the cooperative (1=Yes)	16.7	52.0	47.6	42.1
Number of years being a registered member (years)	15.1	10.1	17.2	12.9
Local organization (all members)				
Membership in local organization (1=Yes)	16.7	29.4	22.2	24.5
Appointed leadership position in local organization (1=Yes)	0	25.0	33.3	23.1
Number of years being a registered member (years)	6.8	1.5	2.0	2.4

Source: Questionnaire SocMon-BAS, 2014

Except for religious organizations (churches), we did not find involvement in other social and cultural associations. This is possibly because the fishermen are more concerned about work and income-generating activities to fulfill their basic needs.

If we analyze the participation of women in the economically related networks, it seems that at the household level, women have become secondary participants in the economic activities related to fishing. This marginal role of women in the lobster and conch fishery activities undermines not only their status, but also their roles in the households and social networks. The concentration of fishery activities in Belize City and the few available economic activities in the area of Corozal have left women economically marginalized. Because fishermen are out at sea for

long periods of time, care functions are disproportionately allocated to women and create a major barrier to women's full participation in economic market activity.

4.2.3 Physical Capital

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. The lack of particular types of basic infrastructure is considered to be a core dimension of poverty. Without adequate access to services, such as water and energy, the quality of human life deteriorates. Also the opportunity costs associated with poor infrastructure (collecting firewood or drinking water) can preclude education, access to health services and income generation. Insufficient or inappropriate producer goods can also constrain people's productive capacity and therefore the human capital at their disposal. More time and effort are spent on meeting basic needs, production and gaining access to the market (Allison and Ellis, 2001).

To estimate the household welfare situation, we used data on household access to assets, dwelling and basic infrastructure use. According to Filmer and Pritchett (1998), dwelling and basic infrastructure may be a better benchmark for long-run household wealth than per-capita consumption. We assume that households with more access to infrastructure are better off than households with less access to it.

Almost 70% of the households interviewed are house owners; this is in line with national statistics (67%). "The typical Belizean dwelling is an undivided house, owned by its occupants, with walls of concrete or wood and roofed with sheet metal" (GoB-CBD, 2010). This is a very good description of what we found in the households interviewed during our assessment. Most of the houses were in good condition with permanent concrete walls and flushing toilets, piped water, electricity and indoor kitchens. The number of inferior constructions was very low and more prevalent in Belize City.

The distribution of dwellings according to the number of rooms shows that the majority (43%) of them has 2 rooms, 37% has 3 rooms and 17% has 3 or more rooms. The dwelling density measures the number of persons per room. It is considered that an adequately occupied dwelling has less than an average of 1.9 persons per room, and therefore dwellings with more than 2 persons are defined as overcrowded. The distribution of overcrowded dwellings reveals a slightly better situation in the Corozal area (37%) relative to Belize City (41%).

In the second part of Table 4.3, we present the ownership rates for amenities. Ownership of all means of transport is higher in Corozal because of the lack of public transport and its geographic isolation and may be as a result of the need for transportation to the city for selling or buying products. The bicycle seems to be the most popular form of transport, with 78% having at least one; 42% have a car and 6% have a motor bike. Almost as many households own a boat as own a bicycle. Most households are thus likely to have access to some means of transport.

The ownership of indispensable durables like TVs, refrigerators and washing machines is high. The percentage of households possessing refrigerators is on average 90%; this number is lower in Belize City. Given the almost universal ownership of TVs in Belize, we asked about ownership of

flat screen televisions, and an impressive 73% already own one. The use of cable TV was much higher in Belize City.

Table 4.3: Physical Capital

Variables	Community			Total
	Chunox	Copper Bank	Belize City	
Housing				
Ownership (1=owner)	78.3	66.7	66.7	69.3
Number of rooms	2.8	2.6	2.9	*2.7*
Rooms per capita	1.9	1.8	1.6	1.7
Roof (1=improved)	100.0	96.1	88.5	95.0
Floor (1=improved)	100.0	98.0	57.7	88.0
Wall (1=improved)	95.7	90.2	42.3	79.0
Condition of the house (1=good)	87.0	92.2	76.9	87.0
Electricity (1=own connection)	91.3	64.7	92.3	78.0
Cooking fuel (1=gas or electricity)	100.0	96.0	93.0	96.0
Toilet facility (1=flush)	50.0	35.0	81.0	51.0
Amenities				
Cars (1=yes)	52.2	41.2	33.3	41.6
Motorcycles (1=yes)	0.0	7.8	7.4	5.9
Bicycles (1=yes)	73.9	90.2	59.3	78.2
Washing machine (1=yes)	95.7	98.0	70.4	90.1
Refrigerator (1=yes)	95.7	62.7	85.2	76.2
Flat screen (1=yes)	60.9	76.5	77.8	73.3
Mobile phone (1=yes)	100.0	100.0	100.0	100.0
DVD player (1=yes)	43.5	68.6	74.1	64.4
Cable TV (1=yes)	26.1	31.4	85.2	44.6
Fishery equipment				
Sail boat (1=yes)	9.8	20.8	3.7	10.8
Canoe (1=yes)	90.9	98.0	100.0	96.5
Skiff (1=yes)	12.5	2.0	77.8	24.5
Spear (1=yes)	95.0	97.7	91.3	95.4

Source: Questionnaire SocMon-BAS, 2014

With regard to communication services to which households have access, results show that at least one member of every interviewed household owns a mobile phone. This percentage is very high for both areas. At the district levell, only 65% of the households in Corozal and 84% in Belize City possess a mobile phone. This implies that the great majority of households have telephone access.

For fishery activities the ownership of a sail boat, canoe, skiff, motor engine and other fishing equipment is considered as the most important element for the sustainability of the fishery

production system. Social differentiation is based on the ownership of these productive assets because they dictate fishing strategies and influence economic behavior and attitudes. However, in the case of our communities, fishermen do not necessarily need to own these assets, but at least need to have access to them.

Lobster and conch are caught mainly throughout the inner lagoon of the atolls. The fishing vessels used in this activity are constructed of fiberglass or wood and are powered by outboard engines (25-75HP). Wooden boats equipped with cloth sails and outboard engines are also used. These vessels and boats carry nine to twelve divers. The large sailboat is used as the "mother ship" where divers eat, sleep and store all their catch. We found that 97% of the fishermen have at least one canoe, which represents an approximate average investment of US$400 per canoe. About 25% of the fishermen own a skiff with an average value of approximates US$ 12,000 (there are big price differences between the different skiffs, the standard deviation was USD 8,000). We found higher values for the fishermen from the northern communities (USD 15,000 against USD 10,000 in Belize City).

4.2.4 Financial Capital

Financial capital is defined as the financial resources that people use to achieve their livelihood outcomes. These are resources in the form of available stocks (i.e. livestock) and regular inflows of money (salary, remittances and transfers), but also the access to financial services (savings and credit facilities). The role of financial capital is important in explaining fishers' livelihoods. In our case, we will pay attention to the kind of income sources and the access to financial services.

It is important for conservation policies to have a sound understanding of the role that non-fishery activities and income sources can play in rising incomes in coastal areas. This could help to determine, for example, an appropriate way to balance resource use between promoting sustainable fishing on one hand, and providing support and services to non-fishery activities on the other.

Overall, across the sample communities, all the households mentioned that lobster and conch fishing was the main income source. About 81% of the fishers in Chunox and Copperbank are also engaged in subsistence farming while some are engaged in part-time jobs to supplement their incomes. Among these, especially in Belize City, part-time work includes carpentry and construction predominates, although to varying degrees across the study areas. Financial transfers mainly involve remittances from family members living elsewhere and featured very little in the income portfolios of households in these communities.

Belize has a relatively extended network of formal credit suppliers, where credit unions play an important role in providing access to rural and coastal communities. During the last eight years, the Belize Rural Development Project (BRDP) has been supporting the financial sector: "*Empower the rural poor and invest with them to create wealth and eliminate poverty"* (BRDP, 2014). Simultaneously through grant support from Friend of World Heritage, two Community Credit Enterprises were established in Copper Bank and Chunox Villages, providing soft loans and

competitive interest rates to fishermen. In general, low income households have limited access to financial services and are unable to invest in the productive sector to generate income.

Table 4.4: Financial Capital

Variables	Community			Total
	Chunox	Copper Bank	Belize City	
Income Sources				
Fishery as main economic activity (%)	100.0	100.0	100.0	100.0
Other income sources	66.7	64.7	14.8	52.0
Production and sale of commodities (%)	18.8	37.5	0	29.4
Casual labor (%)	43.8	46.9	66.7	47.1
Other (%)	37.5	15.6	33.3	23.5
Financial Services				
Borrowed money during the last 2 years (%)	54.2	41.2	33.3	42.2
Purpose of the loan				
Fishery activities (%)	53.8	47.6	100.0	60.5
Other economic activities (non-fishery) (%)	15.4	4.8	0	7.0
Consumption (%)	30.8	47.6	0	32.5
Credit granted by Credit Union (%)	53.8	71.4	55.6	62.8
Average amount of the loan (B$)	4,568	4,026	2,533	3,779

Source: Questionnaire SocMon-BAS, 2014

However, in the case of the interviewed households, access to credit during the last two years was relatively high. In average, 42% of the households had a cash loan during this period; this figure was higher than expected. One possible explication could be the positive impact of the BRDP project in the area of Corozal. In 2009, under a project title "Community Empowerment for sustainable livelihoods through the promotion of alternative livelihoods such as sustainable tourism for the conservation of Blue Hole and Half Moon Caye" funded by Friends of World Heritage, the Belize Audubon Society guided the establishment of two community credit enterprises (CCEs) within Copper Bank and Chunox Villages. The CCEs are an alternative credit enterprises managed and operated by members of the fishing communities. The CCEs allow fishermen to access soft loans that support development of fisher's capacities and involve them in identifying sustainable development activities towards addressing the requirement of emergent tourism and agriculture sectors. The local village bank, which is linked to the credit union, highlights the important role of the credit union as a loan provider. Loan size averages about USD 2,000 and the funds are mainly used for fishery activity.

4.2.5 Natural Capital

The concept of natural capital refers to the source or supply of resources and services that are derived from nature. In general, user rights and the status of resource ownership are often unclear

in the coastal areas, and much of the coast is common property. In the case of our communities, fishermen are mainly active in the fishing grounds of Lighthouse and Turneffe Atoll. Lighthouse Reef Atoll has two natural monuments that serve as replenishment zones. Turneffe Atoll is newly established marine protected area. Both areas is regulated by the Belize Audubon Society, Turneffe Atoll Sustainable Association (TASA), Fisheries Department and Forest Department; situated relatively far from the communities.

Turneffe Atoll is located 50 km from Belize City and is approximately 48 km long and 16 km wide, making it the largest coral atoll in the MBRS. Turneffe atoll was officially declared a marine reserve in November 2012. Lighthouse Reef Atoll is farther offshore, about 75 km from Belize City and has had some sort of protection since 1982. Access to both areas is only by sea, with vessels originating from the mainland, including Chunox, Copper Bank and Belize City. All vessels and fishermen must be licensed and pay a yearly fixed fee of US$15. In the next table, we present the importance of both areas for each of the communities and the importance of each of the fishing groups.

Table 4.5 describes the use of the fishing grounds and kind of species by community. Conch and lobster fishing is part of a multi species fishery whereby fishers also catch other marine products such as finfish and sea cucumber (Monnereau and Helmsing, 2011). But this by catch is considered by the fishers as less significant and is underreported. The main differences we found was that the fishers of Belize City are travelling less to Lighthouse and the reported absence of conch fishing in Turneffe Atoll because of the lack of conch in this area.[2] According to the Belize Fisheries Department's *Fisheries Statistical Report of 2009, c*ommercial fishing at Turneffe Atoll experienced an alarming decline between 2004 and 2009 with a 70% decline in lobster tail sales to Cooperatives and a 60% decline in conch sales.

Because the vessels are anchored in the city, Chunox and Copper Bank fishers must travel via public transportation to their communities, this result in additional travel costs to fishers. As consequence Chunox and Copper bank fishers are more exclusive in their fishing practices to cover the additional cost. It's important to notice that almost all fishers reported the (by)catch of finfish,. The catch of cucumber was nihil.

[2] Despite the fact that fishermen no reported conch fishing in Turneffe Atoll, there is sufficient evidence that fishers from Belize City are fishing conch in the area.

Table 4.5: Natural Capital				
Variables	**Community**			**Total**
	Chunox	**Copper Bank**	**Belize City**	
Specie				
Lobster	100.0	96.1	100.0	98.0
Conch	95.8	96.1	81.5	92.2
Fishing ground and specie				
Lighthouse - lobster	83.3	67.3	40.7	64.0
Lighthouse - conch	87.5	64.7	29.6	60.8
Turneffe Atoll – lobster	87.5	88.2	88.9	88.2
Turneffe Atoll - conch	0	0	0	0
Source: Questionnaire SocMon-BAS, 2014				

4.3 Fishing lobster and conch

4.3.1 Fishing activities

Lobster and conch fishing takes place during a period of 9 to 10 months of the year. During the closed season, fishers carry out other activities that can earn them income. Most fishers go to the sea for eight to ten days and on average take 2 trips per month. Fishing effort has been measured by the pounds of lobster and conch landed per fisherman per trip. The number of pounds harvested by each fisherman is influenced by a number of factors, including the time spent fishing, diving and/or snorkeling, equipment quality and skills (experience in lobster and conch fishing), the tidal regime and condition of the fishing ground (season). Lobster and conch fishing does not require complicated fishing gear. As mentioned above, for lobster fishing they use a hook stick or spear, while conches are picked by hand from their habitats. On average, 40 pounds of lobster and 158 pounds of conch are landed per fisherman per trip.

4.3.2 Equipment used by fishers

The sea conch and lobster fishers use simple traditional equipment. In order to reach their fishing grounds, the fishers organize trips with other fishers of their community using sailboats. The older fishers and entrepreneurs own the sailboats. The trips are organized with fishermen members of the family or friends. Between April and May (end of conch season and start of lobster season), the sailboats are returned to the community to be repaired with the help of the other fishermen. One sailboat can carry up to twelve fishermen, including their canoes and fishing gear. Once in the fishing ground, each fisherman starts working with his own canoe and fishing gear. Each fisherman has to pay a boat commission of around ten pounds of lobster or 14 pounds of conch per trip, which is around US$110. In Table 4.6 the most used fishing equipment and its cost are shown.

Table 4.6 Commonly used fishing gear for lobster and conch and its costs.			
Item	**Amount**	**Unitary Cost US$**	**Total US$**
Hook sticks (lobster)	2	13	26
Long/hand-line fishing	2	3	6
Free diving (conch) snorkel, masks and fins	2	45	90
Spear fishing (finfish)	2	250	500
Canoe (repair)	1	120	120
Total			**742**
Source: Questionnaire SocMon-BAS, 2014			

Every fisherman owns at least two items of each kind of fishing gear, depending on the season (conch and/or lobster); they always carry both in case one gets broken. Equipment like hooks and long/hand line fishing is bought every season; snorkels, masks, fins and spears last longer and are replaced every two years. The canoes are also repaired at the end of every season.

4.3.3 Fishing costs

We present here the estimated costs per trip for each of the communities studied. The following figures are presented in unitary values and present total cost per season. In the following part, the estimated income is calculated.

Table 4.7: Estimated costs by trip and season for the Communities of Copper Bank and Chunox (amounts in US$).				
Item	**Total cost/trip**	**Unitary cost/trip**	**Average trips/season**	**Total costs/season**
Fuel	250	25	20	500
Packaging (plastic bags)	9	0.90	20	18
Ice	75	7.50	20	150
Food, beverages	350	35	20	700
Boat commission		110	20	2,200
Fishing License		0.75	20	15
Gear		31	20	622
Other costs: Emergency Kit		1	20	20
Total costs		**211.25**		**$4,225.00**
Note: The calculations were made taking into account an average of ten fishers per sailboat and an average of 20 trips in a season for conch or lobster. All costs are presented in US$. Source: Estimations based on SocMon –BAS questionnaire, 2014				

For every trip, the captain of the sailboat is in charge of buying the provisions, fuel, ice and packaging, and then the costs are divided between the fishers on the boat. Fishers can pay either in cash after receiving their payment from the cooperative or in kind with the catch of the day. The cost of fuel includes the transportation on the sailboat from the community to the fishing grounds.

Table 4.8: Estimated costs by trip and season for Belize City.

Item	Total cost/trip (US$)	Unitary cost/trip (US$)	Average trips/ season	Total costs/season (US$)
Fuel	190	19	20	380
Packaging (plastic bags)	9	0.90	20	18
Ice	75	7.50	20	150
Food, beverages	350	35	20	700
Boat commission		110	20	2,200
Fishing License		0.75	20	15
Gear		31.10	20	622
Other costs: Emergency Kit		1	20	20
Total costs		**205.25**		**4,105**

Note: The calculations were made taking into account an average of ten fishers per sailboat and an average of 20 trips in a season for conch or lobster. All costs are presented in US$.
Source: Estimations based on SocMon –BAS questionnaire, 2014

For fishers in Belize City the estimated cost of fuel is less since the travelling distance is shorter. Fuel represents the highest cost during a trip. The average cost of a trip for a fisherman is US$205.25. This cost can be covered in cash or in kind. During a season, the average total cost is US$ 4,015; this represents 27% of the total income. We estimate that the operational costs are probably underestimated.

Table 4.9: Estimated income for lobster and conch for a season (amounts in US$).

Item	Average* landing/trip/fisherman	Average trips/year	Market Price	Operational Costs	Income
Lobster	40	20	7	2,112	3,487
Conch	158	20	3	2,112	7,368
				Total income	**10,855**

Note: *Average presented in pounds.
Source: Estimations based on SocMon –BAS questionnaire, 2014

The total cost per trip was divided between conch and lobster, since fishers do not make specific trips for these species unless one of them is in closed season. The estimated total income for an average fisherman is approximately US$ 10,855 per year. A fisherman harvests an average of 40 pounds of lobster on a ten-day trip. This represents an average of 4 pounds a day. This data is coherent with the results presented by Gongora (2010). The calculation for conch average harvest per fisherman per day is around 15.8 pounds; this data was multiplied by the average number of days/trip to have a catch estimation that was finally multiplied by the average number of trips

during a season. Calculations on economic value are extremely difficult to make, since prices of the two species vary substantially. The price per pound is established by the cooperative. After export and at the end of the season, each fisherman receives a standard extra payment of US$2.5/lb for the total amount of product he delivered.

4.3.4 Fishing market

Belize is strategically located to access North American seafood markets, as well as those in Mexico and Europe. Lobster and conch fishing in Belize is still done in an artisanal manner. Most of the lobster and conch is processed by cooperatives/plants located on Belize City. There are five cooperatives which are the most important link for accessing international markets. The two biggest cooperatives, Northern and National Cooperative, are the only ones authorized to export fish products (Gongora, 2006). The other three fishermen cooperatives (Caribena, Placencia and Rio Grande) sell their collected product to the Northern and the National Cooperatives. In the cooperatives, conch, lobster and finfish are processed, packed and prepared for export. In the case of lobster, 5% of total production has to be sold on the local market pursuant to Belizean law. The fishermen can sell their catch either to the cooperative they are associated with or to another cooperative through another member or directly to restaurants.

In recent years, the cooperatives have created incentives to continue fishing despite declining catches (CZMAI, 2014; Gongora 2010). These incentives include direct subsidies for fishing supplies, such as ice, low-interest loans and indirect subsidies, which create perverse incentives for fishermen including loan abuse and providing landing sites to nonmembers of cooperatives.

Since Belizean offshore waters/fishing areas are shallow, there is no possibility to access the sites with industrial fishing fleets. This has made it difficult for medium-sized and large vessels to navigate there and has thus helped to maintain Belizean conch and lobster fishing activities at an artisanal level. The government has used the geographic condition to its favor by prohibiting fishing methods that could damage or destroy the coral reefs.

In the sea, each fisherman works by himself, going with his canoe and free diving to catch the conch or lobster. In the case of lobster, the product is then brought back to the sailboat, where it is cleaned, put on ice and prepared for delivery. Fishermen deliver only lobster tails to the fishing cooperatives. The conch is cleaned and also put on ice. In addition, small-scale lobster extraction using traps known as “casitas” (little houses) or shades is also a significant activity, and it is mostly carried out by fishermen living close to Belize City.

4.4 Institutions and livelihood strategies

The institutional context is an important set of man-made external factors that influence the range of livelihood options open to different categories of people. They also influence access to assets and vulnerability to shocks (FAO, 2001). A more enabling institutional environment makes it easier for fishermen to gain access to assets they need for their livelihoods. Efforts have been made by the Government of Belize to create opportunities for poor and marginalized coastal communities

to build sustainable livelihoods. One of those projects is "The Sustainable Natural Resource-based Livelihoods Project," which promotes viable and sustainable natural resource-based livelihoods for poor communities in Belize (BEST, 2013). Apart from the government, there are many other organizations and institutions involved in socioeconomic development activities in the coastal areas. At the same time, there is a large group of organizations, governmental and non-governmental, which mediate access to coastal assets and affect coastal livelihood opportunities. Their roles and responsibilities are not always clear and make it difficult to determine who has authority over coastal assets and who can facilitate socioeconomic development. Based on different documentation and articles, we present a short list of general institutional problems that could affect the coastal livelihoods in Belize in general.

1. The Belize Fisheries Department, which is responsible for marine resources, including fishery, does not have the human and material resources to carry out its job effectively, in spite of numerous legislative acts and formal institutions. According to Gillet (2003), "The Government has neither been successful in the sustainable management of fisheries and their resources, nor guarantees the health of the ecosystems upon which the fisheries and the resource depend."
2. Enforcement of existing policies and laws is weak for a variety of reasons. One of the main problems is the unlimited entry into the fishery because there is no limit on the number of licenses issued, and there are no restrictions on how much can be fished (Huitric, 2005). Also there are no limits on gear or the amount of lobster or conch that can be fished.
3. The fishermen cooperatives play an important role in the sector, and their economic impact has been an important driver of the industry. Fishermen can sell their catch to their own cooperative, other cooperatives directly or via another member, or directly to local buyers. However, according to a study of EDF (2008), the cooperatives are reporting a decline in active membership and reduced influence in the fisheries sector. Also they have problems related to their credit schemes; there are difficulties in recovering the loans made to their members.
4. In relation to the former two paragraphs. Fishers who are members of a cooperative are not supposed to sell their catch to intermediaries, but fieldwork shows that a large of fishers does so. Form the intermediaries they get a higher initial price but lose their second payment (cooperatives pay a second payment at the end of the season, depending of their profit). Monnereau and Helmsing (2012) estimate that as many 35-50% of fisher sells occasionally to intermediaries.
5. There is discontinuity of formal institutions. Many coastal activities are project-based and linked to external funding. Setting up and sustaining successful partnerships between the government, NGOs and/or communities has proven to be difficult to realize in practice (CHEC, 2008).

The policy and institutional context largely define the opportunities for fishermen to access and benefit from coastal capital and consequently the livelihood strategies they adopt. Fishermen engage in multiple livelihood activities in each of the communities. However, fishing is still the

predominant activity used for livelihoods. The increase in number of fishermen and boats observed during the last years translates into even higher fishing effort applied to lobster and conch fishing. This increase is unsustainable, especially in the case of the lobster fishery where the production trend shows that the Maximum Sustainable Yield (MSY) has already been reached (Gongoroe, 2014). Livelihood challenges and opportunities will vary between and within the communities.

4.5 Perception about fishery and fishery management

Fishermen were asked about the marine reserve and the potential impact from the activities conducted there. Our questionnaire contained a total of 13 questions using a Likert scale to obtain an individual's opinion about the importance of marine resources and his perception of the current management system of the fishing grounds. First we aggregated the individual preference scores for each of the three communities and then assigned rankings to these scores and used Kendall's Tau rank-order correlation analysis to test if there was correlation among the rankings provided by these groups of respondents. As seen in Table 4.8, the rankings obtained were significantly correlated. This means that the attitudes and perceptions we found are very similar in the three communities, so the results will be presented in their totality in Figure 4.1.

Table 4.10: Kendall's tau rank correlation coefficients between the communities.

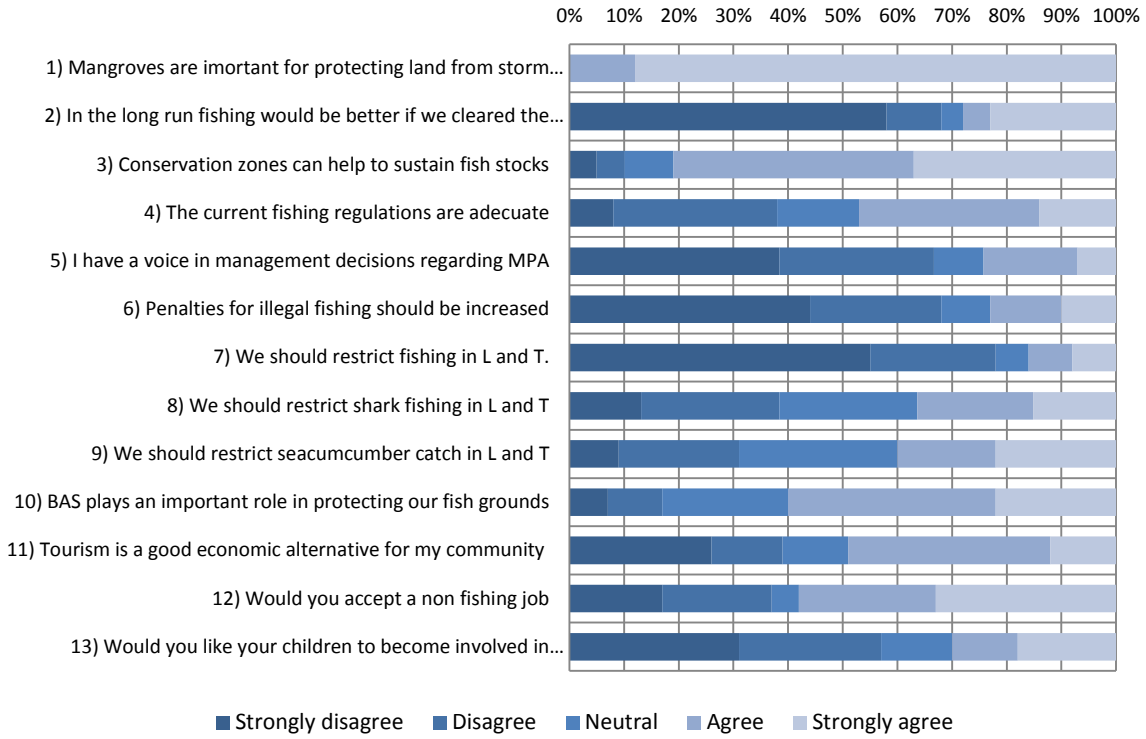
	Copper bank	Chunox	Belize City
Copper Bank	1.000	0.667***	0.571***
Chunox	0.667***	1.000	0.416**
Belize City	0.571***	0.416**	1.000

Significant correlation at: *** p <0.01; ** p < 0.05
Source: Estimations based on SocMon –BAS questionnaire, 2014

Three groups of questions were used to obtain the communities' opinions about the importance and management of marine resources in Lighthouse and Turneffe Atoll. In the first group of questions (Q1-Q3) about the perception of marine resources, fishermen are aware that those resources are important for their own economic activities. More than 80% agreed on the importance of conservation zones for sustaining fish stocks (Q3). However, if we apply this question with regard to specific activities in the Lighthouse and Turneffe Atoll areas (Q7 - Q9), fisherman are becoming less enthusiastic about conservation zones. The application of fishing restrictions is considered as undesirable and short term economic objectives prevail. Shark fishing and sea-cucumber harvesting is a less important source of fisherman income. However, fewer than 40% of the fisherman interviewed agreed to apply restrictions to this activity. While the most important species, lobster and conch, are faraway, the bycatch of finfish and to a lesser extent, sea cucumber, is also important for the fishery households. The bycatch is partly used for subsistence

purposes, but can also help cover the cost of a fishing trip, especially when the catch of lobster and conch is low.

Figure 4.1 Attitudes and Perception



Less than 50% of the fishers approved of the current fishing regulations (Q4). Besides their own economic interest, the level of communication by MPA authorities on the benefits of a protected area could be an important factor in the low approval rating. A relatively low 25% of the fisherman felt that they have influence on the MPA decision-making processes (Q5). Most Belizean fishers did not know of any MPA plans; however, during the interviews some of them expressed their interest in becoming involved in MPA planning procedures. The success of MPAs as a means of management depends largely on the participation of the people involved, including fishers. The BAS approval rate is high; more than 80% considered that their role in protecting the fishing grounds is important.

In the near future the decline of the lobster and conch catch at both fishing grounds will strain coastal communities. Fishers dependent on fisheries for income may find few options for other employment, particularly in northern Belize where the economic development is relatively low compared with the national economy. When prospects for alternative employment are limited, fishing-dependent communities can suffer economic hardships, including unemployment and

outward migration. Alternative livelihoods for fishers may become necessary. As we see in other coastal communities of Belize, dive and snorkel tourism is an option as a livelihood. However, not all the fishers see themselves working as tourist guides (Q11). Although tourist guides earn more than fishers, the work is highly seasonal and requires investment in adequate equipment. Nonetheless, fishers feel optimistic about the possibility of finding work in non-fishing activity (Q12) and also would prefer that their children look for an alternative outside the sector (Q13). At the same time, the success of alternative livelihood programs in coastal areas, designed to encourage fishers to reduce or eliminate fishing activities in pursuit of other income generating opportunities, is often limited. This is particularly the case if fishing remains a more profitable source of income than alternative employment opportunities.

Fishers were also asked to identify the main fishing problems. Almost 45% signaled the increasing number of fishers and illegal fishing. This perception is sustained by the number of licenses supplied by the fishery authorities during the last decade (see section 3). The negative perception of the fishers about the reserves is noteworthy. Only 10% mentioned that there are too many marine protected areas, and that the rules and restrictions are affecting them in their fishing activities and finally in their incomes. This is a positive outcome and demonstrates that the fisher community supports the system of MPAs, but, as mentioned above, is concerned about tools used for fisheries management such as managed access and zonation of MPAs. About a quarter of the fishers mentioned that there are serious problems with enforcement, resulting in illegal and overfishing. Illegal fishing at night, particularly by fishers from Honduras and Guatemala, is a concern, and it seems that there is lack of resources to patrol the areas sufficiently.

4.6 Wealth, capital and perceptions

4.6.1 Wealth index

In this section we evaluate the households' material lifestyle by measuring wealth based on the presence or absence of household possessions. This can be an indicator of relative wealth in a community. To determine this indicator, we used the variables defined in the physical capital section, including items such as a flatscreen television, cable TV, washing machine, type of toilet, home ownership and the type of walls, roof and floor. To get a better portrait of the distribution of material wealth within the communities, scales can be constructed based on the interrelationship between these items. The items were factor analyzed using the principal component method and *varimax* rotation, resulting in two material styles of wealth factors that explained 45% of the variance (Table 4.11). Some items did not have significant loading on either factor and were eliminated from the analysis.

Table 4.11: Principal component analyses of material style of life		
Item	**Wealth index 1**	**Wealth index 2**
Flush toilet	0.588	
Cement walls	-0.342	0.790
Cement floor	-0.445	0.671
Condition house is good	-0.367	0.496
Own electric connection	0.713	
Refrigerator	0.751	0.420
Washing machine		0.320
Eigen value	23.6%	21.8%
Source: Estimations based on SocMon –BAS questionnaire, 2014		

As indicated in Table 4.11, the items that have the highest positive loading on the first component are associated with electricity, flush toilets and refrigerators. Items with high negative loading on the first factor include sanded floors, wooden walls and poor general condition of the house. Thus, index one (subsequently called ‘‘wealth index one’’) is comprised of accessories and having electricity. Items with high positive loading on the second factor include cement walls and floors, good housing condition, refrigerators and washing machines. There was no negative loading on the second index. Items with high positive loading have a stronger contribution than those with low or negative values. Wealth index one scores in the communities range from -2.38 to 1.01. Wealth index two scores range from -2.77 to 0.86. Scores are standardized, having a mean of zero and a standard deviation of one.

Based on the estimated wealth index, a cutoff of 33 percent is used to define the poorest group in the population. This decision is based on the usefulness of categorizing populations into terciles that can be broadly interpreted to represent the lowest, middle and higher ranked groups of households with respect to relative wealth.

4.6.2 Wealth index and the livelihood capitals

The wealth index can be seen as the materialized outcome of the households’ livelihoods. By combining the wealth index with the livelihood variables it is possible to analyze the importance of each of the selected capitals. In the next Table (4.12), we present the three wealth groups based on wealth index one.

The average education level is above the national average, and in families with higher income levels, there is an increasing emphasis on education. Within the sample, 5% of the heads of household in the lowest wealth tercile has no education. Family size decreases consistently from 5.0 members per household in the lowest tercile to 4.2 members in the highest tercile. Also, less wealthy households have a higher dependency ratio than better-off households.

Of the 105 fishers surveyed, almost all were participating in the fishing cooperatives, suggesting that cooperatives are very important to the fishermen. Having a higher wealth index increases the possibility of becoming an appointed member of the cooperative. Less wealthy fishers are more linked to local organizations, which could be an important network for maintaining their

livelihoods. As mentioned before, credit access is relatively high, thanks to the fisher cooperatives, especially for the highest tercile, in which more than 47% of the fishers have access to credit.

A closer look at income sources for fishery households reveals that non- fishery activities can be very important during the closed season when fishers work as part-time laborers, but the participation in these activities is more urgent for less wealthy households. The more successful fishers are more engaged in fishery activities than the fishers with a lower wealth index. Our data confirms that non-fishery activities are inversely related to the implicit fishery income. Similarly, fishers more involved in lobster fishing have a higher wealth index.

Table 4.12: Relationship between wealth index and livelihood capitals

	Wealth groups			
Capitals	**1**	**2**	**3**	**Total**
Human capital				
Age HH (years)	33.8	38.6	38.5	36.9
Household head education level primary education not completed (%)	17.6	13.3	2.8	24.0
Household members	5.0	4.6	4.2	4.6
Dependency rate	0.31	0.26	0.22	0.26
Social capital				
Appointed leadership position in the cooperative (1=Yes)	23.5	43.3	52.8	40.0
Number of years being a registered member (years)	7.9	13.1	14.4	11.8
Membership in local organization (%)	41.2	20.0	13.9	25.0
Financial capital				
Access to credit (%)	38.2	43.3	47.2	43.0
Other income source than fishery	70.6	53.3	36.1	53.0
Natural capital				
Lobster fishing	96.7	97.1	100.0	98.0
Conch fishing	94.1	96.7	88.9	93.0
Physical capital				
Access to electricity (%)	41.2	93.3	100.0	78.0
Location				
Copper Bank (%)	21.7	47.8	30.4	100.0
Chunox (%)	47.1	25.5	27.5	100.0
Belize City (%)	19.2	23.1	57.7	100.0

Source: Estimations based on SocMon –BAS questionnaire, 2014

Our estimates suggest that internal characteristics of the fisher households are very important for wealth accumulation. Nevertheless, nearness to the cooperatives, alternative markets for lobster and conch and lower transport costs could also be an important factor for wealth accumulation. We found wealthier fishers in Belize City than in the two villages of Corazal.

5 Conclusions and policy implications

By using the livelihood approach we tried to address the complexity of the fishers' livelihoods in three coastal communities in Belize. The livelihood approach is used to gain a broader picture of the capital and activity patterns that characterize fisher households in the three communities and the institutional context that either help or obstruct fishers in their search for more secure livelihoods. By better understanding the capacity and strength of the coastal households, it is possible to define the development goals based on what the households already have and can do.

We found that the fishers in the three communities still depend principally on lobster and conch fishing and a growing engagement of other household members in non-fishery self-employment activities. Livelihood diversification is a feature of many fishing households. There is a tendency for projects in coastal areas to lay emphasis on expanding fishing activities as the primary development strategy. What we saw suggests that coastal community development requires a broader starting point than this, especially in the case of Corozal, and has as much to do with awareness raising and mobility as with promoting the fishing sector.

Regarding the topic of costs and income, we found that fishermen in Chunox and Copper Bank have an average operational cost per season of US$4,225 and of US$4,105 in Belize City; this difference is explained by the traveling cost from the communities to the fishing grounds. The average annual income per fisherman in a season was estimated at US$10,855. The average lobster catch was estimated at 800 pounds per fisherman per season and at 3,160 pounds per fisherman per season for conch. It is important to emphasize that interviewees tend to underestimate their operational costs and to overestimate their incomes, creating an illusion that the fisher business is doing a lot better than it really is.

Lobster and conch fishing plays an important role in the current incomes of the households in the study area. If we compare the living standard of the fishers with national data, the fishers are better off than the average Belizean living in the coastal and rural areas. This result is the opposite of what we found in other socioeconomic assessments in the Central American region, where fishery is a typical activity for low income households. Lobster and conch fishing is still an attractive economic activity for the people interviewed. Nevertheless, economic problems in other productive sectors of the Belizean economy are compelling more people to turn to fishing for their livelihoods. Belizean national data also demonstrates that levels of coastal poverty are closely related to the absence of employment opportunities in other economic sectors, which is the case in Corozal and the Toledo District. Development in coastal areas where fishing is important may not be best served by intervention to increase fishing incomes, but rather to support complementary household activities. We do not want people to leave the fishery sector; until now, lobster and conch fishing has been very attractive and generates a stable income for most of the interviewed households. However, encouraging alternative livelihood sources will raise the opportunity for income from fishing and will help to protect the fishing grounds against overfishing.

The main question is whether the current living standard can be maintained by focusing only on lobster and conch fishing. This depends directly on if the current management of the fishing grounds is effective enough to maintain the current stock. If not, fishers have the option to change to other activities or carry out deep sea fishing in other areas. Both alternatives are insecure and would threaten their livelihoods.

The SocMon assessment is BAS's first intent to get a more detailed evaluation of fishers' livelihoods in the communities where they work. Because of the complexity of their livelihoods, this assessment is far from complete, and there are a lot of aspects that have not been included in our study. Topics like gender, climate change and community development are very important and useful for the BAS's current work in the field. In order to understand livelihoods and the factors that are likely to make them sustainable in the face of change, it is necessary to take into account a broad range of factors and influences that may play a role at the different levels of the fishery sector as a whole.

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Appendix VI

Appendix VI

October 25, 2013

PRESS RELEASE

The Belize Audubon Society (BAS) proudly announces the award of small business grants to six residents of the northern communities of Sarteneja, Chunox and Copper Bank in ceremonies held this morning at BAS headquarters.

The small business grants are a component of a project initiated by Belize Audubon Society and other marine protected area partners in Belize, Mexico and Honduras with the Gulf and Caribbean Fisheries Institute (GCFI) and funded by the US National Oceanic and Atmospheric Administration's Coral Reef Conservation Program.

The goal of this collaboration with community members is to promote sustainable livelihood activities within the three above-mentioned northern communities, so as to help reduce pressure on local fishery resources within Lighthouse Reef Atoll.

According to BAS Marine Protected Areas Manager, Mr. Shane Young "the grants will help develop small businesses for marine protected area stakeholders, especially fishermen and their families, thereby providing an alternative source of household financing and helping to ensure the sustainable use of marine resources."

Grant recipients are: Carlos Aldana who will open a bicycle rental service; Margaret Sealey who will set up a small food and snack shop; Jose Ardon who will expand his bicycle and vehicle repair shop; Auriol Samos will develop his boat engine repairing and servicing business; Larita Rivero will extend her baking to include special events; and Casilda Cobb who will expand her pig farming activities. A total of $8,400 will be invested in the small businesses over a four month period. Mr. Joe Boski of the US Embassy in Belmopan presented the small grant awards.

"BAS congratulates the grant recipients and we look forward to continuing to work together with the three communities buffering Blue Hole and Half Moon Caye Natural Monuments", said Mr. Young.

The two year GCFI/NOAA project includes other components in addition to the small business grants to help build sustainable livelihoods. BAS will also engage students from the northern communities in environmental education activities aimed at raising awareness about the conservation of marine resources.

For more information please call Arreini Palacio Morgan, BAS, 670-2924.

Microgrant recipients with US Embassy representative Mr Joe Boski

Appendix VII

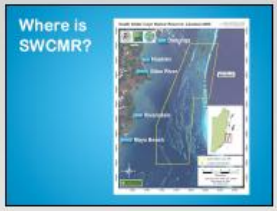
Appendix VII

Using Volunteer Educators to Enhance MPA Outreach: Lessons Learned

Lisa Mulcahy[1], Roberto Carballo[2], Isaias Majil[3], and Emma Doyle[4]

Background

Education and outreach are critical for the protection, stewardship, compliance and enforcement of Marine Protected Areas. MarEPOsa developed an education and outreach program for local primary schools about South Water Caye Marine Reserve (SWCMR) in Belize.[1]



Methods

- Identified 6 primary schools in Dangria, Belize near SWCMR
- Conducted needs assessment
- Created workbook and presentation
- Solicited teacher feedback
- Piloted-tested materials in classroom

Curriculum/Materials

- For Belize Standard 4-6; (U.S. Grade 5-7)
- Focus on stewardship
- Outlines critical habitats within the reserve
- Intended for school settings, field trips, and visiting tourists
- Incorporates Belize social studies and science standards

Materials Development: Workbook

A self-guided workbook for teachers and students who visit the reserve that also can be used in the classroom

Materials Development: Presentation

Example of in-class slide

Results

- An informal pre and post activity assessment showed increased learning
- Increased visibility for the reserve
- Meaningful contact with the local schools
- Materials and activities that can be built upon in the future

Lessons Learned

- Find education experts through professional list serves
- Have clear and attainable goals
- Develop relationships with local people
- Tap into local knowledge
- Link with community liaison to continue education efforts
- Need continued funding or personnel to continue efforts

Volunteer Blog http://blog.mareposa.com

[1]In the NOAA CRCP/CaMPAM Caribbean MPA Management Capacity Assessment, Belize Fisheries Department staff managing South Water Caye Marine Reserve (SWCMR) identified outreach and education as the priority area for capacity building and assistance. Given implementation funding for activities with schools via a GCFI-NOAA Cooperative Agreement, the MPA manager called for an expert volunteer to first help design a new outreach and education plan for SWCMR.

Acknowledgements: MarEPOsa thanks the Belize Ministry of Fisheries and Roberto Carballo for making this opportunity possible, Doreen Castillo-Flores and the staff on Tobacco Caye for their support of the project, and Christ the King School in Dangriga, Belize.

[1] MarEPOsa, Newport, OR, USA; [2,3] Belize Ministry of Fisheries, Belize, Central America; [4] GCFI, Houston, TX

www.mareposa.com MarEPOsa

Appendix VIII

Appendix VIII

TIDE HOSTS FISHERS FROM UTILA, HONDURAS

This past week, the Toledo Institute for Development and Environment (TIDE) hosted a group of fishers, personnel from the Bay Islands Conservation Association and Direction the Pesca in Honduras who were on an exchange visit to Belize.

The purpose of the exchange visit was to promote the formation of fishing associations in Utila, and to learn of alternative ways of fishing, particularly lobster. While in Punta Gorda, the Honduran delegation interacted with representatives of the Rio Grande Cooperative, visited the cooperative to learn of its operation and met with members of the Toledo Fishermen Association who had an opportunity to relate their experiences. Fishers who are engaged in lobster fishing using lobster shades also demonstrated how the shades are constructed and effectively used. Honduran fishers expressed interest in utilizing this method of fishing. The manager of the Port Honduras Marine Reserve, Seleem Chan, made presentations on the management of the reserve and the implementation of Managed Access and ways in which TIDE engages stakeholders in resource management.

The visiting fishers described the exchange as a fruitful one in which they learned a new method of fishing lobster in a sustainable way. The expressed admiration for the establishment and management of the Port Honduras Marine Reserve and the apparent stewardship they observed among fishers that they interacted with. In their messages to Belize Fishers they said, 'Please continue to take care of your fishery…never allow it to collapse! You have a lot more than we do and obviously, you have worked along with your fishing authorities to manage your marine resources…please continue to do so!'

This exchange was made possible with funding from NOAA through GCFI (The Gulf and Carribbean Fisheries Institute).

Appendix IX

Appendix IX

Call for Proposals – Conch Assessment and Management Plan, PN Arrecife Alacranes

Scope of Work

Location: Parque Nacional Arrecife Alacranes, Mexico

Part of the project: "Implementing Capacity Building in the Mesoamerican Reef MPA Community" funded via NOAA CRCP International Coral Reef Conservation Cooperative Agreements, Wider Caribbean Region. Funding Opportunity Number: NOAA-NOS-IPO-2012-2003117.

Project period: October, 2012 to September, 2014 (year 2 pending funding availability)

Focus: Fisheries assessment, monitoring plan and management plan to address the site priority of fisheries management, as identified in the recent assessment by Gombos et al (2011) "A Management Capacity Assessment of Selected Coral Reef Marine Protected Areas in the Caribbean". In this assessment the MPA managers reported the following -

"Fisheries Management **-** Tier 1 (Site specific fisheries assessment has not been conducted). Rationale is that information on Arrecife Alacranes fisheries is limited to academic papers. Most of the research is not useful for management. Of particular importance would be an assessment of the conch population to support either the continuation of the closed fishery or its reopening. Fisheries management was identified as the third most important capacity need for Arrecife Alacranes. This capacity could be built through technical support."

Description: Once comprising a significant conch fishery, Arrecife Alacranes is currently closed to conch harvest but there is interest in possible re-opening the commercial fishery. This project will include 2 years of field surveys and analyses to provide a comprehensive assessment of the current status of the conch population in order to provide the information necessary to support either the continuation of the closed fishery or its re-opening. In this 2-year project we anticipate the following -

Year 1 survey of Alacranes - Year 1 will include an assessment of existing populations including density and abundance, and mapping of reproductive populations in order to provide a picture of the current status of the stock and spatially explicit distribution of the conch. We anticipate that the successful proposal will assess the relationships between habitat at Arrecife Alacranes and conch populations. We also anticipate that a successful proposal will consider the historical, sociological, and economic variables associated with Alacranes that may affect a conch fishery. Funds are available in Year 1. These funds must support fieldwork activities (personnel, supplies, travel) and all activities associated with completing the tasks defined herein.

Year 2 will include a second year of field work to further elucidate the status of the population. Year 2 deliverables will also include the development of a queen conch monitoring and management plan for Alacranes.

With respect to the conch management plan, if the recommendation is to reopen the conch fishery, the plan must define how the conch population will be managed. For example, will there be size limit, gear restrictions (SCUBA/HOOKAH prohibition), closed seasons, no-take zones, quotas, etc. The management

plan should also include rationale behind the development of these restrictions if relevant. If the recommendation is to maintain a closed fishery, the management plan must include a thorough discussion of the rationale behind that decision by providing a thorough interpretation of the results of the surveys and the assessment of the population.

Funds are available in Year 2. These funds should include sufficient resources to complete fieldwork activities (e.g., costs to cover personnel, supplies, travel) and all other activities associated with completing the tasks defined herein including the development of the conch management plan.

Although not required, projects that include match either as in-kind contributions or direct funding will be looked upon favorably.

The maximum length of the proposal is not to exceed 5 pages (not including appendices with tables, maps, letters of support, budget and budget justification).

Send all questions and completed proposals to: alacranes_caracol@gcfi.org

Closing date: January 31, 2013

*Gombos, M., A. Arrivillaga, D. Wusinich-Mendez, B. Glazer, S. Frew, G. Bustamante, E. Doyle, A. Vanzella-Khouri, A. Acosta, and B. Causey. 2011. A Management Capacity Assessment of Selected Coral Reef Marine Protected Areas in the Caribbean. Commissioned by the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP), the Gulf and Caribbean Fisheries Institute (GCFI) and by the UNEP-CEP Caribbean Marine Protected Area Management Network and Forum (CaMPAM). 252 pp. Available at www.gcfi.org

Appendix X

POPULATION EVALUATION OF QUEEN CONCH *(Strombus gigas)*

ALACRANES REEF NATIONAL PARK YUCATAN, MEXICO

Final report

Alberto de Jesus Navarrete

Department of Systematics and Aquatic Ecology

El Colegio de la Frontera Sur Unit Chetumal.

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Rosa María de Jesús-Carrillo

Abel Vargas Espositos

October 2014

POPULATION EVALUATION OF QUEEN CONCH *(Strombus gigas)*

ALACRANES REEF NATIONAL PARK YUCATAN, MEXICO

Introduction

The queen conch *Strombus gigas* (Linnaeus, 1758) is a marine species with high commercial value. It is widely distributed throughout the Caribbean, from Florida (USA) to the north coast of Brazil. It inhabits rocky seabed - vegetated sandy, clean waters, from shallow to depths greater than 40 m. It is a herbivorous browsing species (Warmke and Abbott, 1961), which feeds on epiphytic algae attached to rocks and seagrass (Randall, 1964), as well as blue-green algae covering the sand grains (Jory, 1989). Two types of movement or short scale migration have been recognized, one a process associated with reproduction (Randall, 1964) and the other ontogenetic (Hesse, 1979; Stoner *et al.,* 1988; Stoner, 1989).

The queen conch has been fished and used as subsistence food for a long time in almost every country in the Caribbean, however, the expansion of the commercial fishery began in the last decades due to increased international demand for its meat. The conch resource began to be exploited commercially off the coast of the Yucatan Peninsula from the fifties, and was fished on both coasts of Yucatan and Quintana Roo. However, since 1975, due to overfishing, conch populations have been severely affected and for this reason, the queen conch has been included since 1992 in Appendix II of the Convention on International Trade in Species Endangered Flora and Fauna (CITES) (Stoner and Sandt, 1992, Stoner *et al.* 1996) and in the Red List of Threatened Animals of the International Union for Conservation of Nature and Natural Resources -IUCN 1994 - as a "commercially threatened" species (Gómez-Campos *et al*2010.); totally disappearing in some areas of the Peninsula (Jesus-Navarrete *et al.,* 1992). In Yucatan conch resource has been under a regime of strict management, with fishing banned since 1998 (Official Journal of the Federation, 1988). Although some work done on the conch and fish at Alacranes reef (Rios-Lara *et al.* 2000, Perez

and Aldana, 2003, Aguilar et al. 2007), and on the Yucatan coast (Pérez *et al.* 2000), shows that Conch densities are very low. Perez and Aldana (2003) found a density ranging from 0.003 to 0.035 while ind.m $^{-2}$ Perez et al, (2000) reported density (0.00096 ind .m $^{-2)}$ on the coast.

Lately there have been no studies to determine the status of the conch resource and whether you can open your catch with sustainability criteria.

Consequently, the aim of this work will know the status of the population of *Strombus gigas;* in Arrecife Alacranes reef lagoon of National Marine Park.

Specific objectives

§ Evaluate the density of organisms, whereas juveniles and adults.

§ Determine the size structure of conch *Strombus gigas.*

§ Generate a diagnosis of the state of the population of pink conch crossing information with that obtained in other studies.

2.0 Material and Methods

2.1 Study area: The Arrecife Alacranes is located 135 km north of Puerto Progreso, between 22 ° 21'45 '' and 22 ° 34 'and 89 ° 36'47 55''N' 'and 89 ° 47 '53''W, and measures 26.51 km long by 14.84 km at its widest portion, with an approximate area of 293 km2 (Bello-Pineda 1998) (Fig. 1). Its protected status is National Marine Park since 1994, and currently fishers capture flake, shark, lobster and illegally *S. gigas.* The existence of corals reports: *Montastrea annularis, Acropora palmata, Porites porites, P. astreoides, Diploria* spp., *Manicina areolata,* large tracts of *Thalassia testudinum,* 148 fish species (Hildebrand *et al.* 1964), several commercially important such as grouper *(Epinephelus morio).*

The collection of information was carried out in three periods: September 2013, March 2014 and July 2014, for which he had the support of the authorities of the CONANP.

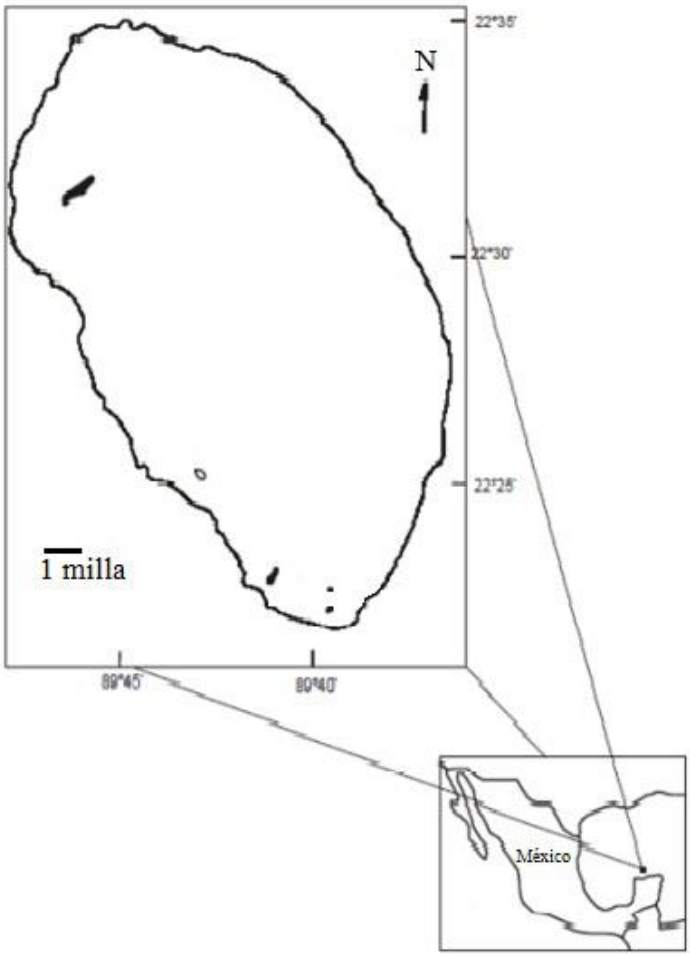

Fig. 1. Location of the study area.

2.2 Evaluation density of organisms, considering the youth and adults.

To determine the density of conch, twenty sampling stations considering the depth and stratum were located. By using a map of the National Park, overcame a satellite image of Google Earth, to check the depth of the area. 20 points were randomly selected with depths ranging from 0-20 meters in four classes: 0-5, 5.1 to 10, 10.1-15 and from 15.1 to 20 m (Table 1).

Table 1. Distribution of sampling sites, coordinates and depth in each area.

ID	X_UTM	Y_UTM	Depth (m)	Area
Ala_1	219260.63	2495856.94	-2	North
Ala_2	221896.02	2493392.70	-2	North
Ala_3	224032.24	2495630.71	-8	North
Ala_4	213657.59	2493489.08	-7	North

Ala_5	227555.92	2492760.98	-13	North
Ala_6	222247.41	2497275.96	-18	North
Ala_7	218700.70	2498897.43	-17	North
Ala_8	223153.62	2489945.05	-2	Center
Ala_9	220586.86	2485494.76	-1	Center
Ala_10	214477.32	2490853.13	-7	Center
Ala_11	227987.77	2490326.75	-9	Center
Ala_12	215781.33	2487357.16	-12	Center
Ala_13	230444.48	2484059.78	-13	Center
Ala_14	230738.02	2487529.93	-18	Center
Ala_15	224160.61	2482733.16	-2	South
Ala_16	227711.98	2479946.83	-6	South
Ala_17	228216.01	2476958.89	-10	South
Ala_18	220696.61	2481213.51	-11	South
Ala_19	228605.37	2478318.03	-16	South
Ala_20	230048.90	2480912.33	-19	South

At each site three transects were established of 100 m length and 2 wide, with the first transect drawn randomly. The next transect was placed at the end, and the end of it was placed the third perpendicular transect, in a "Z" shape. After making each transect, all organisms found within 2 m wide were sampled, taken the boat where siphonal length was measured with a vernier to the nearest mm, weighed with an electronic scale 0, 05 g precision. Conch were identified as juveniles and adults following the criterion lip width (5 mm) of Stoner *et al.* (2012).

2.3 Determination of the size structure of conch *Strombus gigas.*

With the information on frequency of sizes, a histogram was made of organisms collected in each sampling period. All data gathered was ultimately combined to determine the general structure of the population.

3.0 Results

3.1 Density of organisms

In September 2013, 152 conch were collected in total, which means a very low number of agencies around the National Park. In various sampling stations, the presence of

organisms was nil, and densities ranged from 0 to 0.06 conch.m $^{-2,}$ as shown in Figure 2. Only three sites (A16, A14 and A7) showed a higher density conch.m 0.04 $^{-2}$ in the remaining sites density was lower than 0.04 $^{-2}$ conch.m, (Fig.2).

When the density of conch per hectare expressed apparently agencies densities are higher, but remember that the distribution of conch is not uniform, so that extrapolation could be misleading. Figure 3 shows the density of conch in the National Park expressed in hectares. The sites marked in red, with 50 conch per hectare or less and could present problems of reproductive meetings in the future.

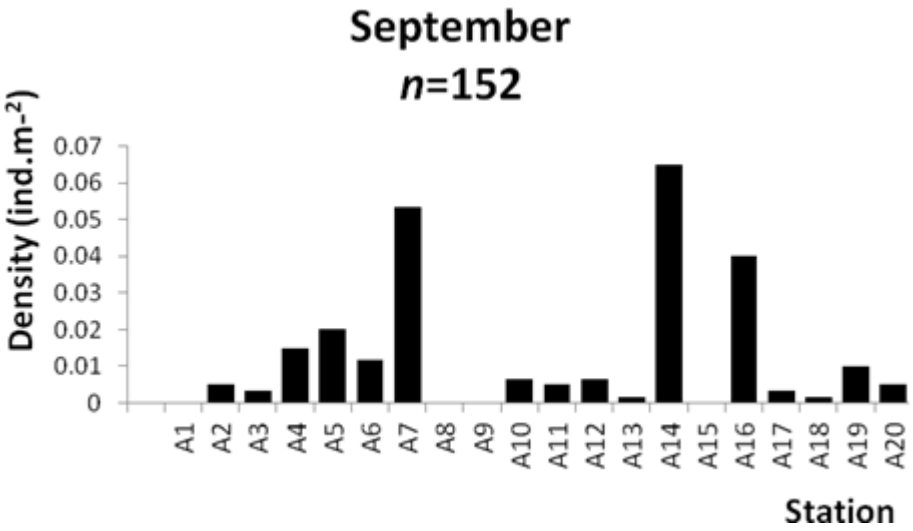

Fig.2.Density of conch (ind.m $^{-2)}$ at the sampling sites

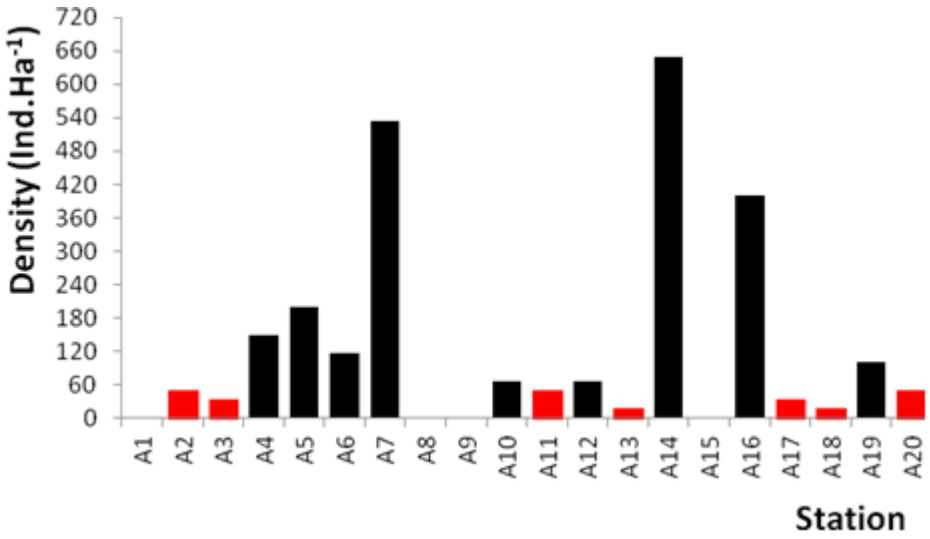

Fig 3. Density of conch per hectare in the sampling sites.; September.

Considering the abundance of conch separated into two categories: "adult" and "juvenile" and taking into account the criterion of greater than 5 mm lip, found that 102 of organisms collected were juveniles, while there were only 50 adult conch. The abundance site shown in Figure 4.

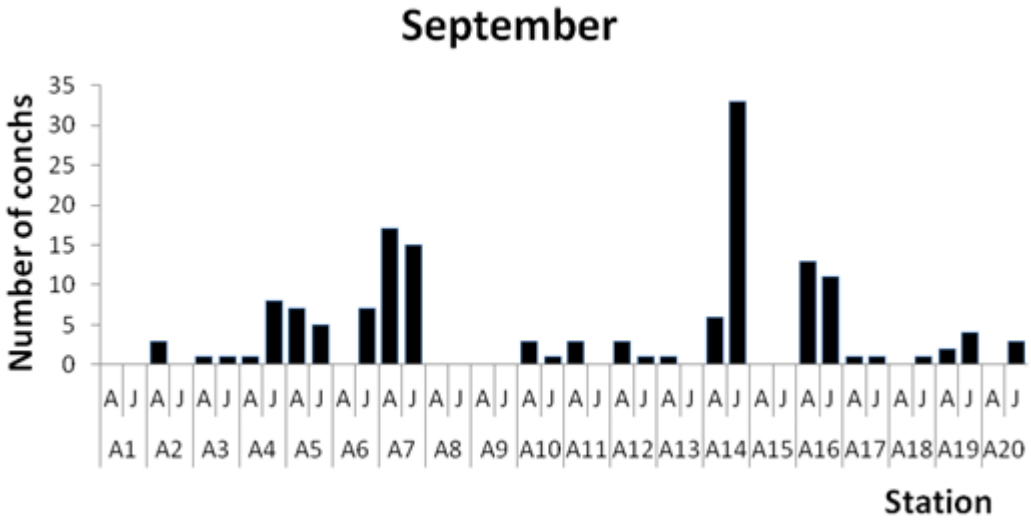

Fig. 4. Abundance of conch in the sampling sites, A = adults J = Youth.

In March 2014 141 conch distributed in the sampling area were found, and the densities ranged from 0 to 0.06 conch.m- ^{2,} as shown in Figure 5. Only two sites showed a higher density of 0.04 conch.m $^{-2,}$ the A17 (0056 conch.m- $^{2),}$ and A18 stations, in other sites density was lower than 0.04 $^{-2}$ conch.m, (Fig.5).

Figure 6 shows the density of conch per hectare can be seen that the stations A2, A3, A9, and A13 have a less than 50 conch.ha $^{-1}$ density value that has been designated as the threshold for them to be the meetings reproductive success. This is consistent with what was observed in the first sampling in the National Park.

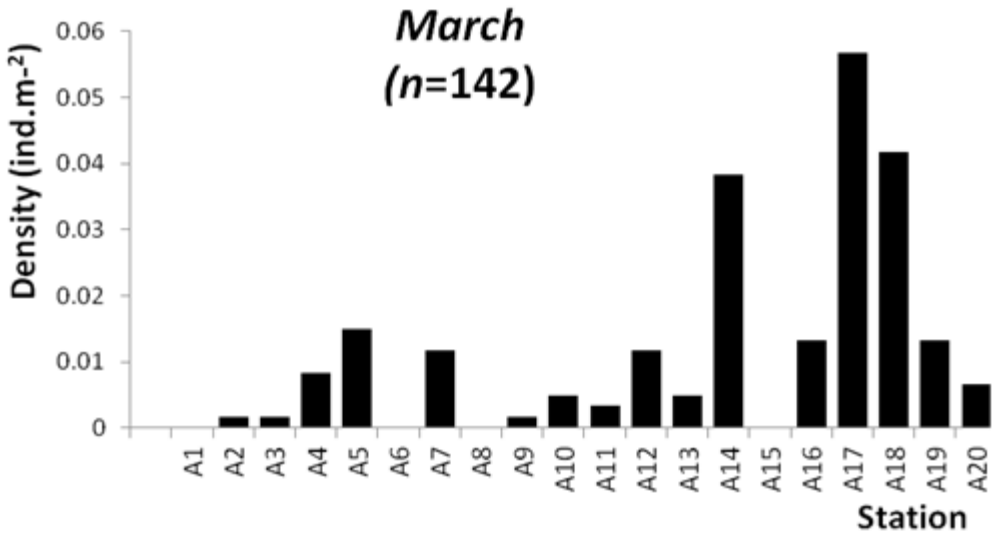

Fig.5. Conch density (ind.m $^{-2)}$ at sampling sites in March.

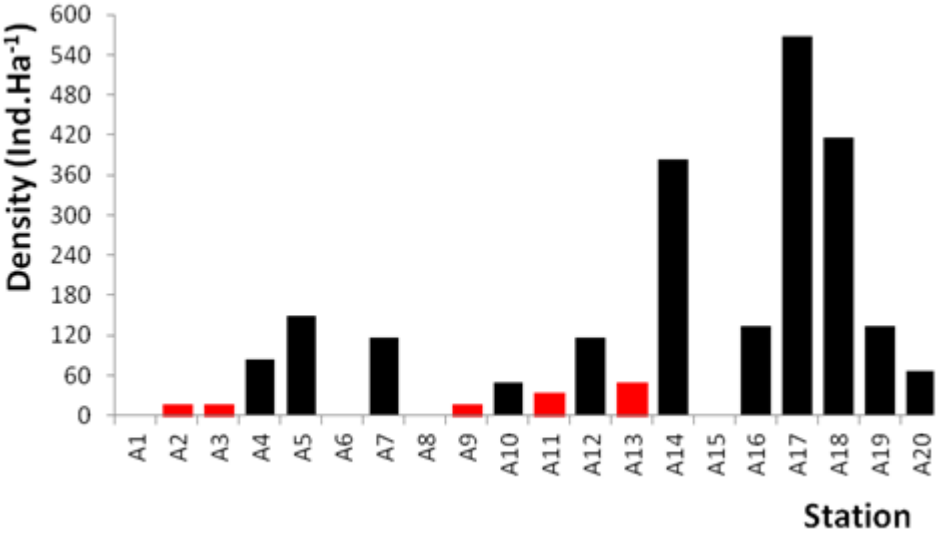

Fig. 6 conch per hectare density (ind. Ha $^{-1)}$ in March.

Considering the abundance separated by "adult" conch and "juvenile" and taking into account the criterion of greater than 5 mm lip, found that 85 of the organisms collected were juveniles, while there were only 56 adult conch. The abundance is shown in Figure 7.

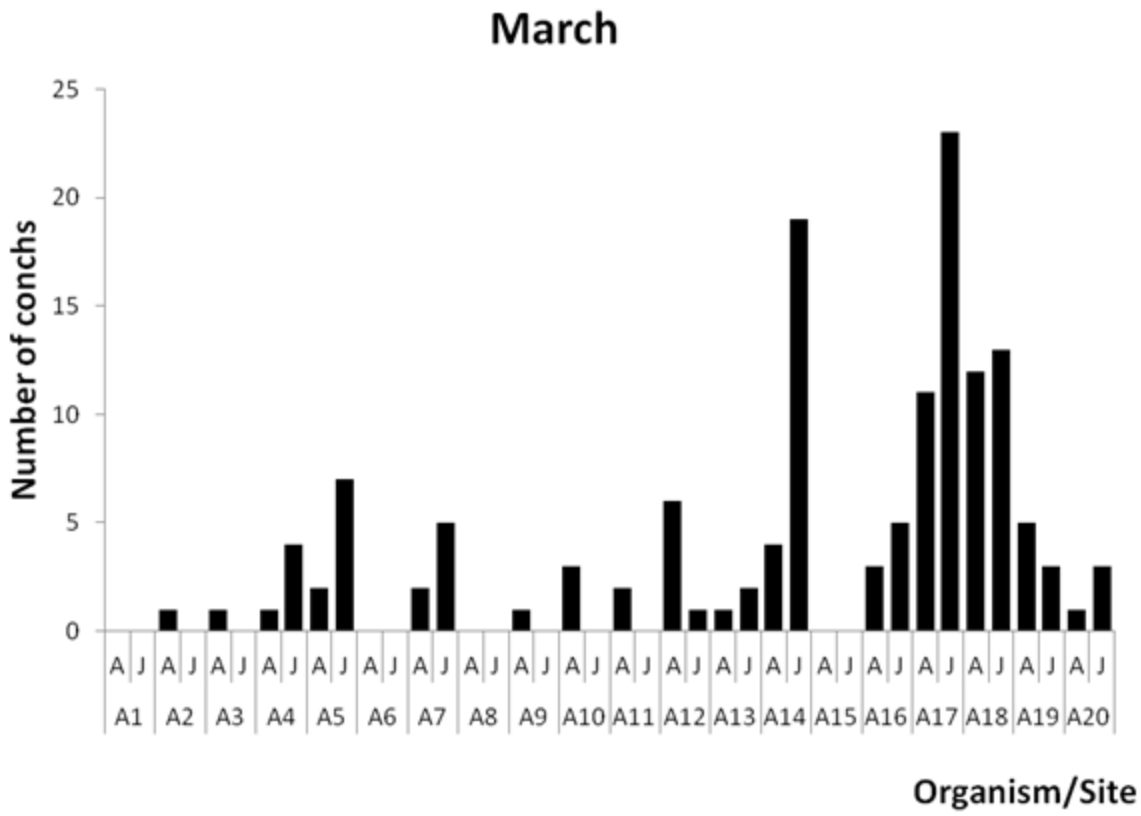

Fig. 7. Abundance of juvenile and adult conch in March.

In July, the behavior of plenty followed the same pattern as in the first and second sampling, only 159 conch distributed throughout the park were found. The densities ranged from 0 (A1 Station) conch.m- ^{2} 0.06 (A5 station), other stations were 0.03 conch.m- near ^{2} (Stations A7, A14, A16, and A17) values in the remaining stations the density was lower than 0.02 $^{-2}$conch.m, (Fig.8).

9 shows conch density per hectare is observed that except for the A4, A14 stations, and A16 all other conch are less than 50 per hectare.

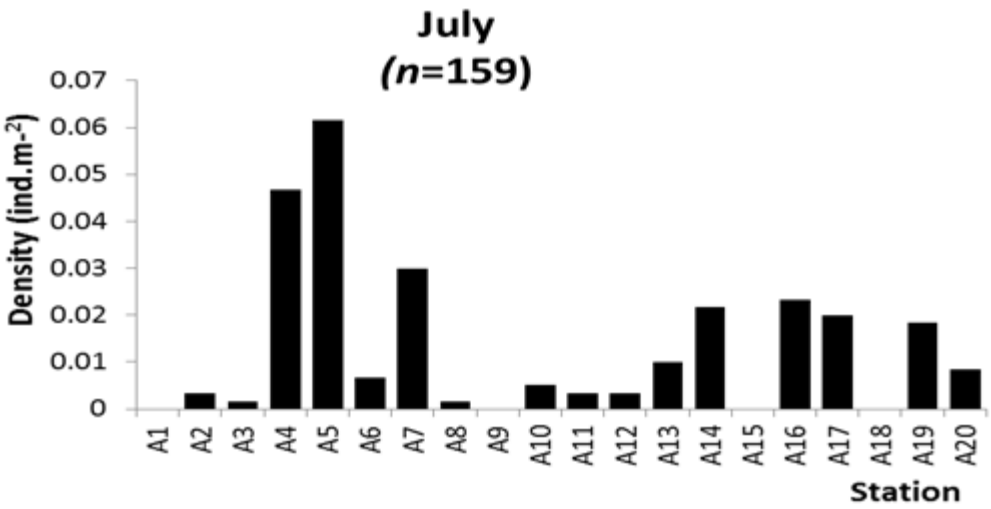

Fig.8. Conch density sampling sites in July 2014.

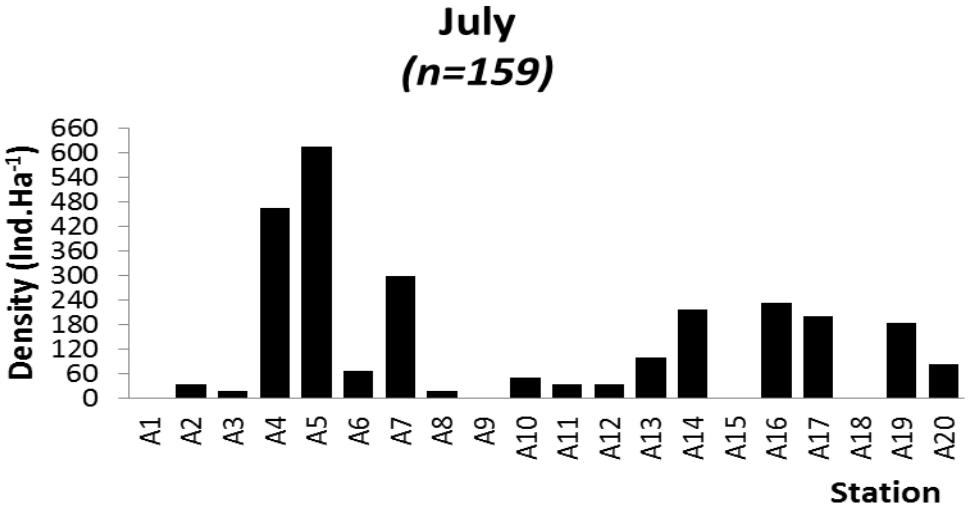

Fig. 9. Density of conch per hectare in the sampling sites

Considering the abundance separated by "adults" conch and "youth" in this sample were found to A4, A16 and A17 stations have a higher density of organisms to 100 conch per hectare. Adults abundance site shown in Figure 10.

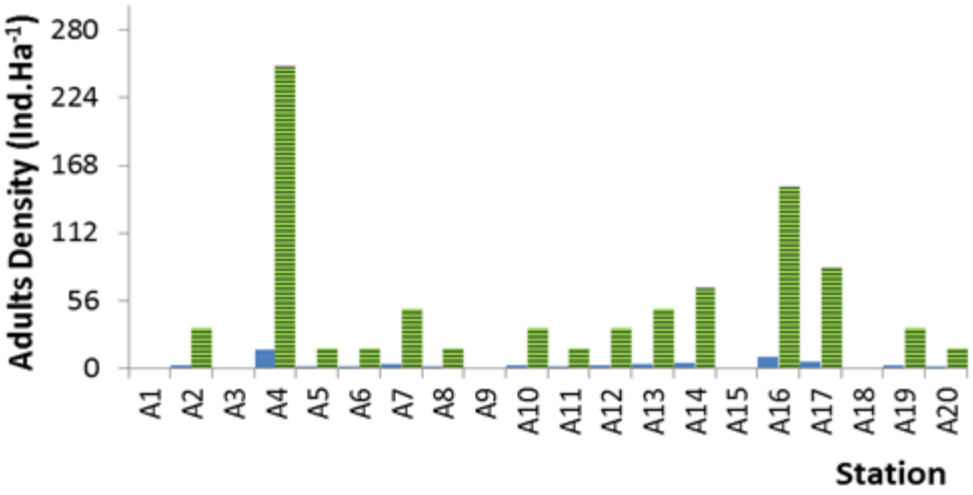

Fig. 10. Abundance of adult conch in sampling sites in July.

3.2 Size distribution

In September sizes of conch ranged from 40-275 mm shell length. The proportion of conch larger than 200 mm in Mexico corresponds to the minimum catch size (SAGARPA, 2000), was also low (33%) as shown in Figure 11. In the figure one can see three peaks of abundance, a very small in size 40 mm, the second peak and the largest of the three, in size of 100 mm and one more in the size of 220 mm, this could be natural variations in the life cycle of conch.

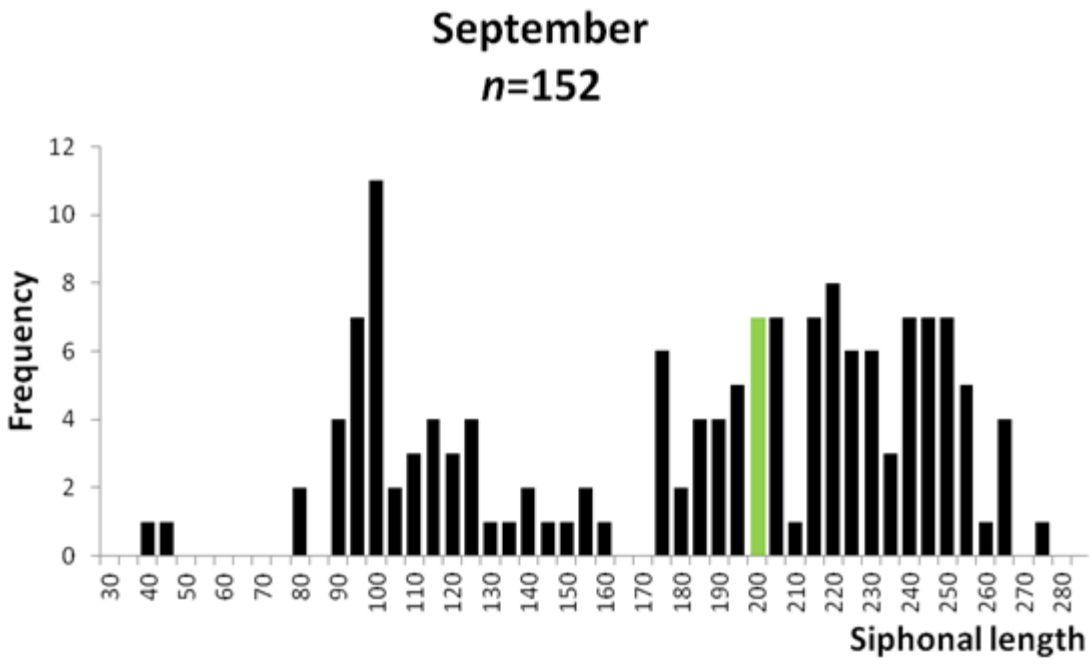

Fig. 11. Frequency distribution of S. gigas shell carvings. Green bar corresponds to legal catch size in Mexico.

In March, the sizes of conch ranged from 115-295 mm shell length, as already mentioned abundance was low as in the first month of sampling. The proportion of juveniles and, based on the presence and adults lip width was: 85 young conch are considered and only 56 are adult organisms throughout the protected area, this is shown in Figure 5. In Figure 12 they can be see two peaks of abundance, one very small in size 115 mm, the second peak and the larger of the two, at the height of 225 mm. The maximum size of the conch corresponded to 295 mm, but with a low frequency.

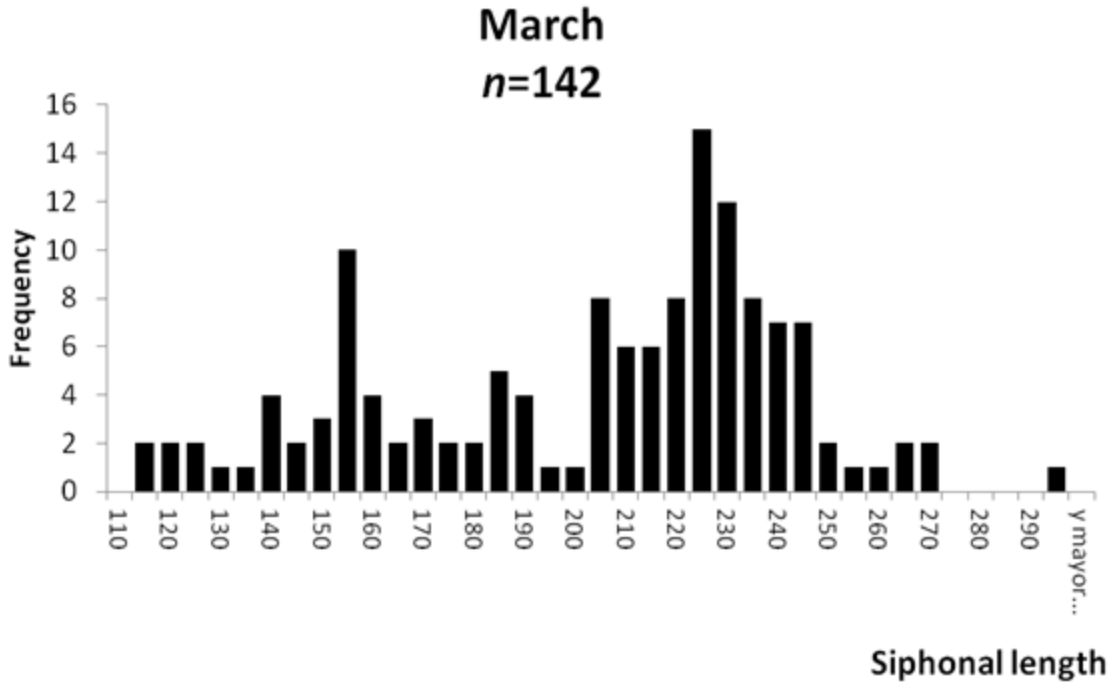

Fig. 12. Frequency distribution of conch size *S. gigas.*

In July, the size distribution was bimodal, with mean values of 175 mm and 230 mm shell length, respectively (Fig. 13). It could be considered that there is a high portion of organisms distributed between 175 and 300 mm which was the largest recorded size, the fact is that very few organisms in the sample (159 conch). This time the smaller size corresponded to 75 mm of siphonal length.

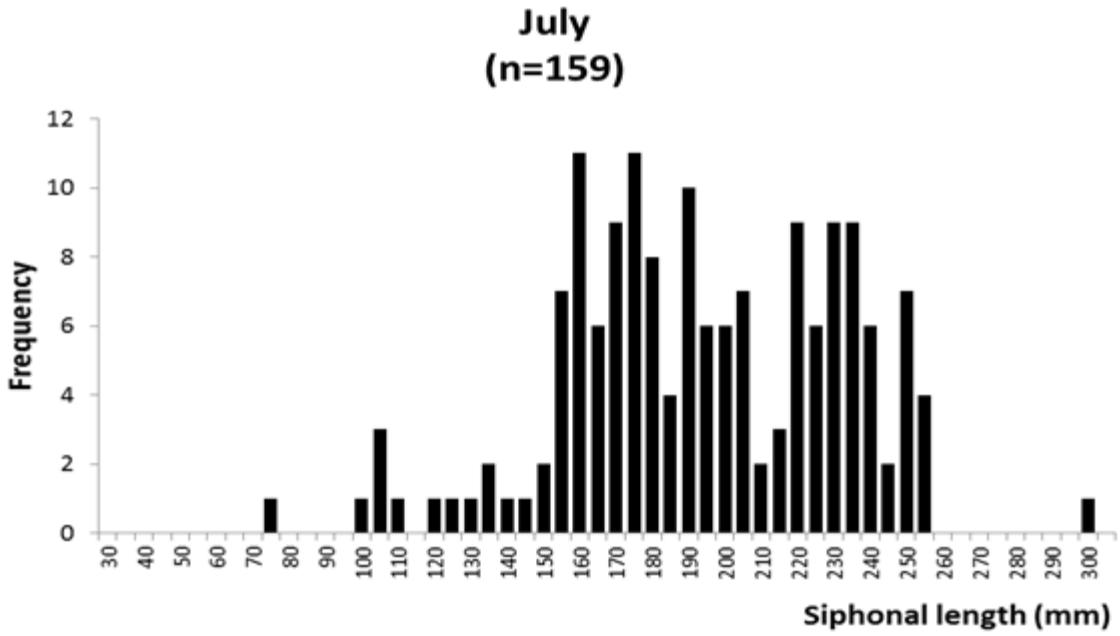

Fig. 13. Frequency distribution of conch size *S. gigas* July.

3.3 Physicochemical parameters

At each site the environmental parameters of the water column were measured. The results are consistent with other work in this area. Temperature was normal with values above 29 degrees Celsius, as was the salinity with values above 36 UPS and very little variation. The values of other parameters are shown in Figure 14.

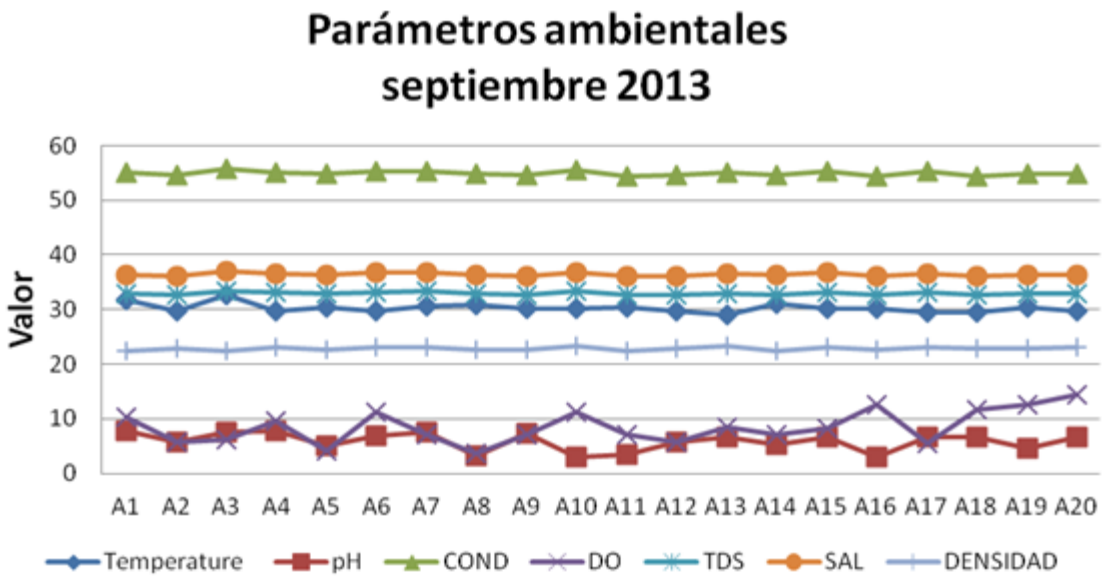

Fig. 14 environmental parameters in the study area, September.

No drastic changes in the parameters are within normal values in the region, with temperatures between 28-30 ° C and salinities of 36-37 UPS are observed. It is noteworthy low pH (2.9-5) at some stations such as A10 and A16.

In March, the behavior of the parameters was similar, with normal seawater for the region values, and very similar to those obtained in September. The conductivity was between 50 and 55 µmohos, the temperature between 28 and 30 ° C and salinity UPS between 34 and 35, as shown in Figure 15.

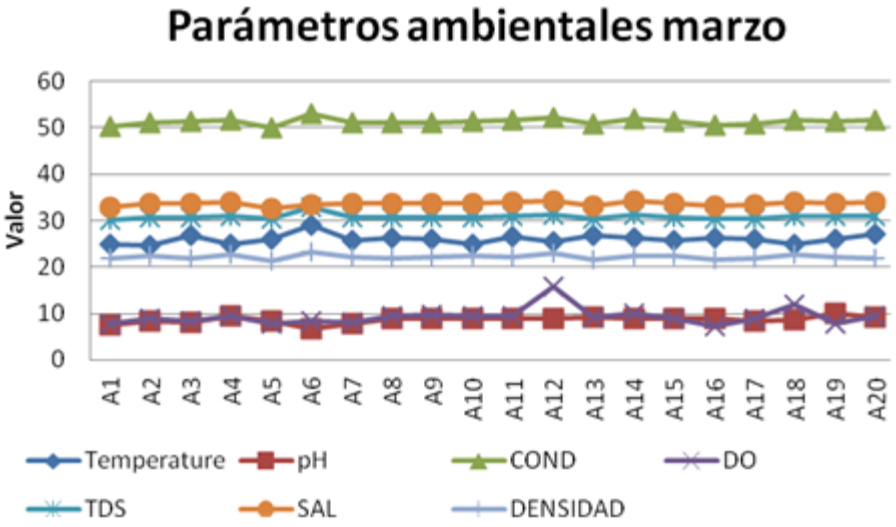

Fig. 15. Environmental parameters in the study area, March.

In July, the behavior was similar with temperature varying between 28 and 31 ° C, salinity between 32 and 33 UPS and conductivities between 49.9 and 50.4, which are considered completely normal in a marine environment such as Arrecife Alacranes. These and other data are shown in Figure 16.

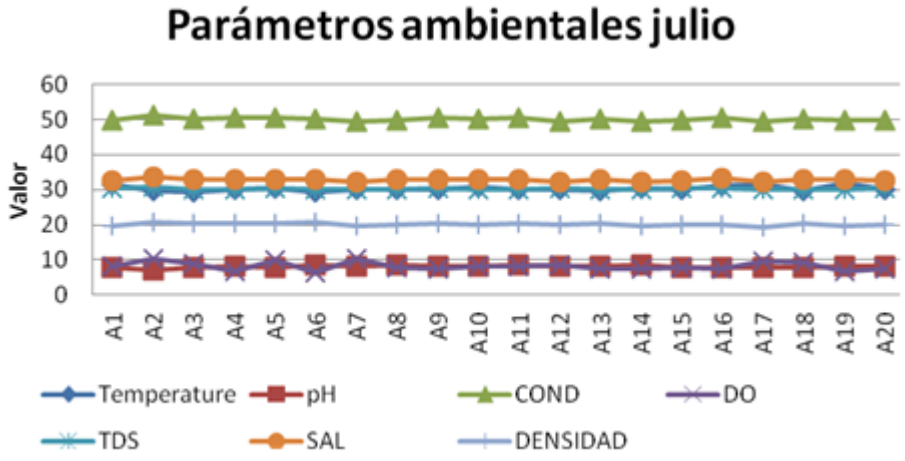

Fig. 16. Environmental parameters in the study area, July.

The results of Pearson correlations and density of conch, were not significant ($p > 0.05$) in any of the months of sampling.

4.0 Discussion and conclusions

When a natural resource is exploited without sustainability criteria, changes occur in the structure of the population (Harmelin *et al.,* 1995). Within these changes, the most conspicuous are a low density of organisms, and a decrease in sizes that comprise the population (Pauly & Palomares, 2005), and this appears to be happening at Alacranes reef.

Table 2 shows changes in the density of the conch *S. gigas,* in the Mexican Caribbean.

Table 2. Changes in density (ind.m $^{-2)}$ spiral *S. gigas* in the Mexican Caribbean.

Author / Year	1984	1988	1990	1998	2003	2012	2014
De la Torre	Three						
Quijano		0.03					
Chavez			One				
Basurto				0.08			
Peel and Aldana,						0.17	
River-Lara				0.00047			
Perez and Aldana					0.018		
This study							0.013

Data from De la Torre, and Quijano, are the oldest and correspond to density values in southern Quintana Roo in the eighties, Chavez and Basurto collected information on Banco Chinchorro and how we see indicates a decrease in density few years. Peel *et al.* (2008) found that the inlet of Xel-Ha, a protected area for tourist use, there is a density of 0.16 conch.m $^{-2,}$ with the presence of all sizes.

In the Alacranes reef, the oldest date density assessment was conducted by Rios-Lara et al (2000) and found that the density of conch was 0.00047 conch.m $^{-2.}$ On the other hand, Perez and Aldana (2003) reported an average density of 0.018 $^{-2}$ conch.m three collection sites, but with a variation of 0004-0035 conch.m $^{-2.}$ In our study, we found a very similar average density (0.013 conch.m $^{-2),}$ which compared with the year of the ban (1998) could mean an improvement, but in fisheries and resource management terms, means a density very low to support the fishery.

This situation of low density of organisms is shared by other sites in the Caribbean, Wood and Olsen (1981) reported a density of 0.0009 conch.m $^{-2}$ in the Virgin Islands, while Berg *et al.,*(1992) in Florida found a density of 0.00076 conch.m $^{-2.}$ and in The Bahamas, Stoner and Ray (1996) reported a density of 0.002 conch.m $^{-2.}$

Another negative effect of fishing is reflected in the average size of the organisms. Data appear to show that conch at Alacranes reef include large organisms, however, the size distribution graphs indicate that the percentage of adults is low. For Alacranes reef, Aldana and Pérez reported in 2003 that the average size was 220 mm shell and we found a mean length of 184.22 mm for the entire area of the reef and the entire sampling period.

No other studies refer to the length of conch shell at Alacranes reef, but a similar decrease was observed in Banco Chinchorro, where an average size of 229.30 mm in 1994 which decreased to 128.30 mm in 1997 (of Jesus was found Navarrete, *et al.,* 2003).

Environmental parameters were within the range considered normal for the area. Aldana and Perez (2007) found that the temperature range at Alacranes reef ranged from 24.2 to 30.2 ° C, while salinity ranged from 36.4 to 37.2 UPS, which coincides with our data because they are within the same range, while dissolved oxygen

ranged from 5.2 to 6.5 mg / l, which means that there is less oxygen in the water column than we found in our study, but that may be due to the specific oceanographic conditions such as strong winds, or maybe Once a problem of calibration.

One of the main problems for recovery of conch populations in the Caribbean is undoubtedly the existence of illegal fishing, due to a lack of enforcement personnel in the government sector, either Fisheries or staff of protected areas, which has no authority to make arrests or seizures.

In conclusion, the diagnosis of the state of the population of queen conch *S. gigas* at Alacranes reef is that densities are very low, and in some places, the presence of the mollusc is zero. Considering the low density per hectare (56 conch.ha $^{-1)}$ we can say that 45% of the sampling sites are in a critical situation, since under this density, the probability of reproductive encounters declines. The sizes of conch present in the reef correspond mostly to juvenile classes that have not yet reached sexual maturity, according to the relative size and width of the lip (Aldana and Frenquiel, 2000) and therefore a quick recovery of the resource is not likely.

Further studies are needed related to the biology of the conch, and distribution and abundance of larvae, juvenile growth habits, juvenile recruitment sites and occurrence of reproductive events, to establish management measures and resource conservation. Examination of these elements is essential to make a proposal for comprehensive management of the species.

5.0 Acknowledgements

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Appendix XI

PROPOSAL FOR CONSERVATION OF QUEEN CONCH *(Strombus gigas)* IN THE ALACRANES REEF.

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El Colegio de la Frontera Sur-Unit Chetumal.

November 2014

Introduction

Coral reefs are highly complex and high diversity systems that are distributed in tropical and subtropical areas of the Planet (Ault *et al.,* 2005). From the economic point of view, are highly productive in terms of tourism and production of fishery resources, and other supplies for human consumption.

One of the fishery resources reefs Mexico is the queen conch *(Strombus gigas* L.) that is widely distributed from the Mexican Caribbean to the Gulf of Mexico in the state of Veracruz, but is currently limited to some reefs of the Gulf of Mexico and Caribbean sea (Baqueiro, *et al.* 1999).

This conch represented the second fishery resource, surpassed only by the spiny lobster *(Panulirus argus)* (Jesus-Navarrete et al., 1992). Despite the different management strategies that include catch quotas, bans reproductive, and protected natural areas, as the Alacranes reef itself, resource recovery in Mexico and elsewhere in the Caribbean, has not been visible (Stone r *al.* 2012).

Importance of the Conservation Plan

The dynamics of the fishery in Alacranes reef was the same as in the Caribbean, with a maximum growth around the seventies and a drastic decline from the eighties, which led to the closure of the fishery in the Yucatan coast in 1988 (Official Journal of the Federation 1988), which later became a permanent ban from 1994 (Official Gazette, March 16, 1994).

The remoteness of the reef and perhaps the lack of enforcement were the two main problems for resource recovery.

After a lengthy ban (20 years) there are no signs of recovery queen conch in Alacranes reef, since the work to assess the density of organisms on the reef show no significant change. E n 1998, Perez et al., r eportaron a density of 0.0084 organismos.m $^{-2,}$ during the summer of 2002 the same authors sampled the resource again, finding a density of 0.0043 organismos.m $^{-2,}$ including juveniles and adults, while De Jesus et al. (2014)

reported a density (0.013 organisms.m $^{-2)}$ with less than 38% of adults, so as you can see, there are no signs of recovery conch population.

This is complicated by the oceanographic conditions, possibly indicating that there is a significant flow of larvae from s the Caribbean Sea, (Pérez and Aldana, 2003), as on sampling within the reef, the larvae collected corresponded with agencies sizes between 520 and 990 microns, indicating develop within the reef lagoon, and therefore the conch population Alacranes depends on its own production of larvae. U n similar result was found by Paris et al. (2008) and the dynamics of the larvae, showed low larval connectivity to the Caribbean. E n consequence conch population in Alacranes, depends on a minimum density of adults, because the reproduction is not performed if the density is less than 0.0056 organisms.m $^{-2}$ and spawning will not be submitted if the density is less than 0.0048 organisms.m $^{-2}$ (Stoner and Ray, 2000).

While the status of the conch is considered commercially threatened, there is no risk of extinction of the species, since genetic diversity found in the reefs of the Mexican Caribbean is moderate to high, suggesting that there would be no threat to the species (Perez-Enriquez *et al.,* 2011).

Therefore conservation criteria conch in Alacranes reef should consider all stages and all the variables that affect their distribution and abundance, in order to achieve effective resource recovery in the medium term.

Fishery Problems

The take of queen conch in the Caribbean has followed international demand with catch peaks in the seventies and a gradual and sometimes drastic decrease in the fishery in several locations or countries (Bermuda, Cuba, Florida, Venezuela Virgin Islands US) Tewfik *et al.* (2003).

Despite the various measures of regulation and management, there are no signs of substantial recovery of the population (Stoner *et a l.,* 2012).

History of the fishery in Yucatan

In Yucatan, fishing conch was performed in Alacranes reef, located 120 km from the coast, this situation did not allow an adequate and constant vigilance so quickly recourse showed signs of deterioration. So a catch m aximum of 333 tons in 1971, a gradual drop to 54 tonnes was recorded in 1975, causing a cancellation of fishing licenses (INP, 1976) (Fig.1).

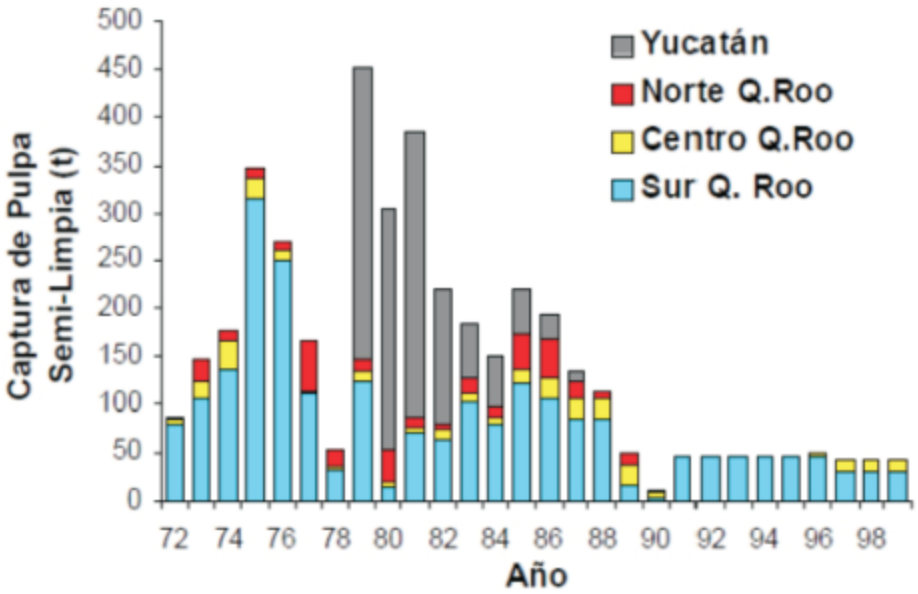

Figure 1. Evolution of catches staircase in the Yucatan Peninsula (Source: INAPESCA).

In 1979 the catch was started in the Yucatan coast, with species such as white conch *(Strombus costatus)* the lancet conch *(Strombus pugilis),* the punch *(Busycon sp)* and tomburro *(Xancus angulatus)* and major ports of landing jurisdiction n Celestun, Sisal, Rio Lagartos and Progress. Although the fishery remained fairly stable in the end showed signs of over-exploitation in 1987 (Fig. 2).

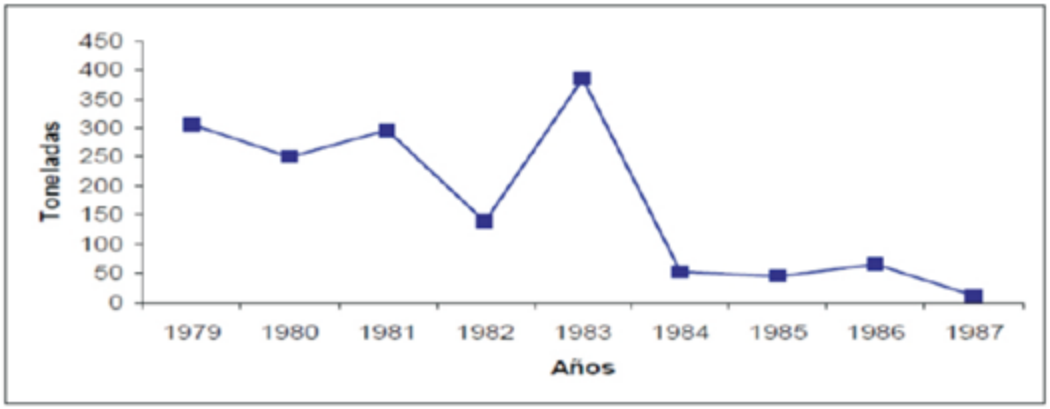

Fig. 2. Capture l conch *Strombus gigas* in Yucatan, (Source: SEPESCA, 1989).

This caused a permanent ban from 1988 and the cancellation of permits granted for inshore fishing establishment and Alacranes reef (DOF, July 25, 1988, Yañez-Arancibia, 1994, DOF, February 13, 2009).

The last assessment in Alacranes reef showed that densities remain low, and in some places the reef not h ubo presence of the conch, as shown dela mollusk spatial distribution in the different months of collection. In September 2013, the sites A1, A8, A9, A15, conch were not present, while sites A2, A11 and A20 is less than 50 conch / ha), (Fig. 3).

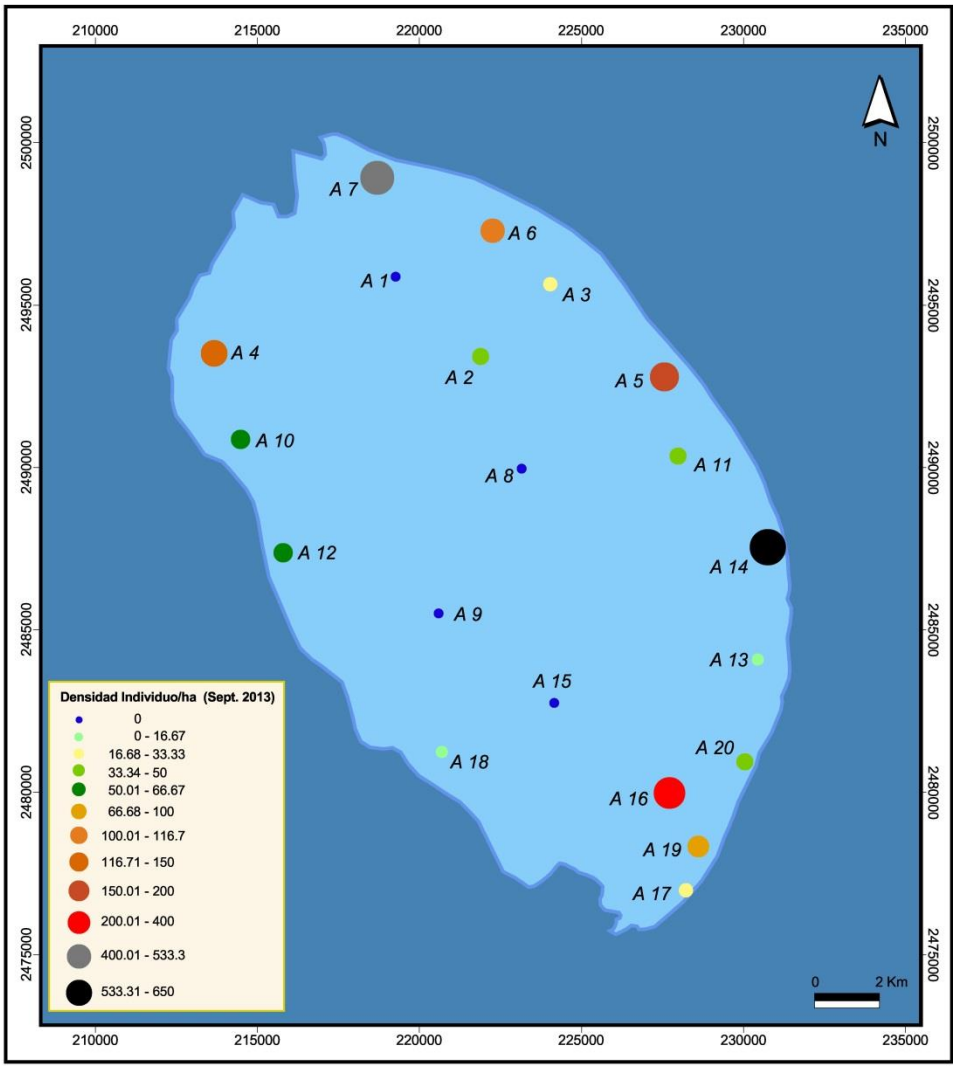

Fig. 3. Spatial distribution of conch at Alacranes reef, September 2013.

The rest of the sites showed densities above 50 conch / ha, and may not have problems with reproductive encounters.

In March 2014, the behavior of the spatial distribution of the conch was similar (Fig. 4).

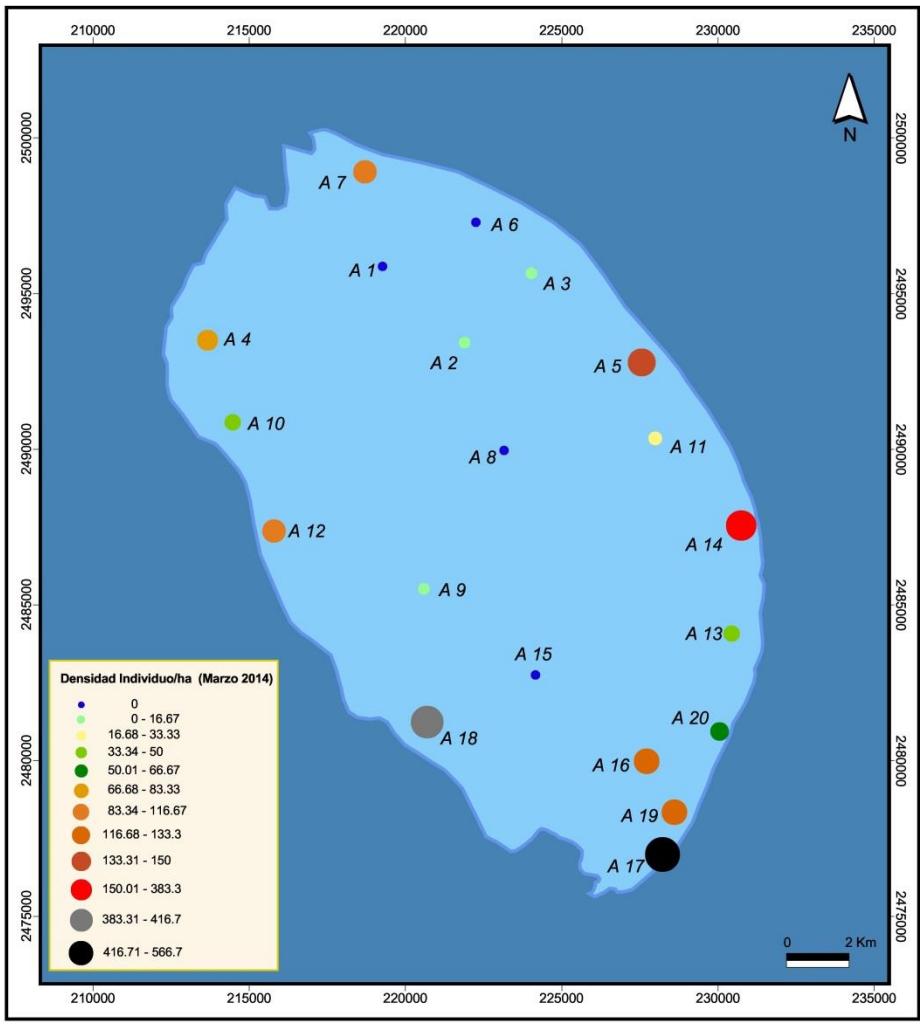

Figure 4. Spatial distribution of the density of conch in March 2014.

Sites A1, A6, A8 and A15 had no presence of organisms, while sites: A9, A10 and A13 had a density less than 50 conch / ha. The remaining sites showed greater than 50 to 586 conch densities and / ha. In particular the site A17, close to Isla Perez, had the highest density and is possibly one of the sites conducive to move to larger conch, places without the presence of organisms.

In July, a similar pattern to previous months was found, in Figure 5 we can see the spatial distribution of conch in Alacranes reef, and in September 2013 and March 2014 or densities ranged from 616 conch / ha.

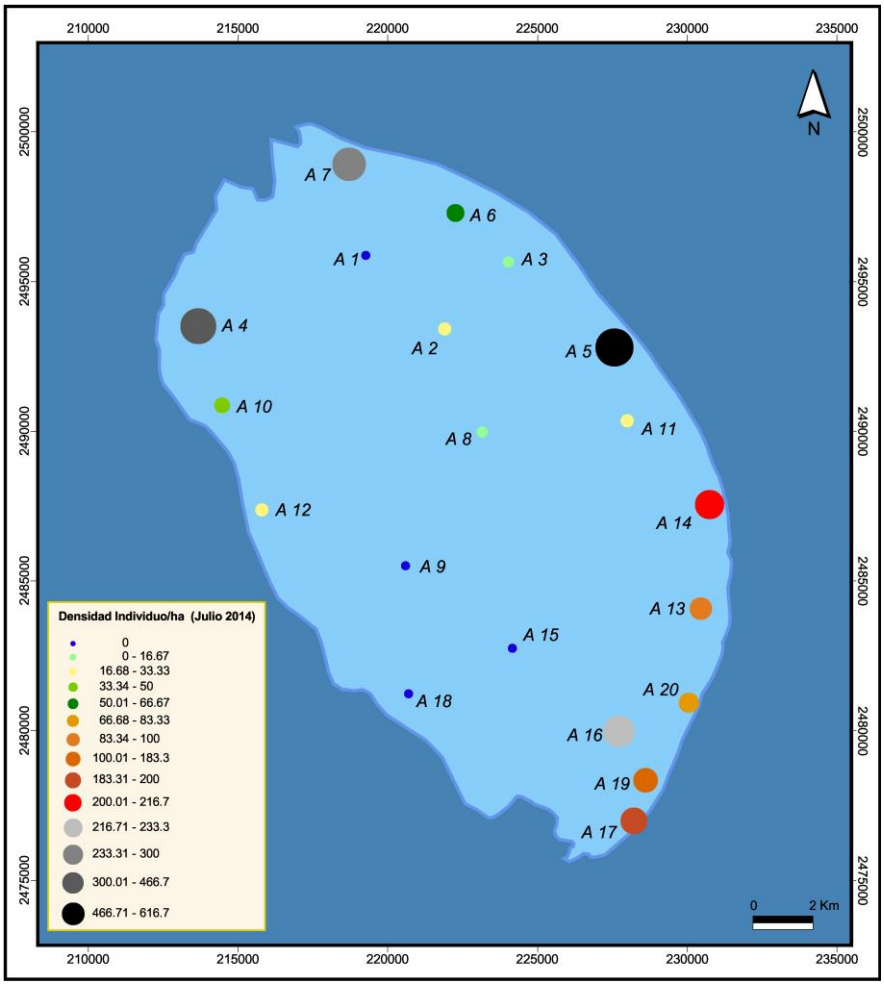

Figure 5. Spatial distribution of the density of conch in July 2014.

Again the A1, A9, A15 and A18 sites had no presence of conch. The A2, A8 and A10, sites had less than 50 conch / ha. The remaining sites showed densities greater than 50 conch / ha, highlighting A4, A5 and A7 sites had a density of more than 300 conch / ha. Should be noted that in all cases we are talking about a density which includes juveniles and adults, so that high values could be misleading.

Legal Framework

The Law of Fisheries and Aquaculture sustainable (LGPAS) states in its article 8 that the regulation, promotion and management of fishery resources accruing to the Secretariat of Agriculture, Livestock, Fishing and Food (SAGARPA), through the National Commission Aquaculture and Fisheries (CONAPESCA).

The conch fishery in Mexico is regulated by NOM-013 PESC-1994, which establishes the conditions and procedures for the operation of conch species in the waters of Federal jurisdiction, this standard complements the NOM-009-PESC-1993 establishing procedures for determining the times and closed areas, to catch the action, establishes the minimum legal size for the capture of species: for *Strombus gigas* (200 mm shell length), capturing procedures dictate, which is semi-autonomous and autonomous (lung and SCUBA) diving, and is determined to catch quotas are established in accordance with the monitoring carried out by the National Fisheries Institute.

These fishery management strategies have not been effective because: 1) the closure established from March to November each year does not correspond to all the months in which females are reproducing, as it has been shown that there is not a correlation between the closure and reproductive capacity because egg laying females have been observed throughout the year in the Mexican Caribbean (Corral and Ogawa, 1985).

The legal minimum size of 200 mm shell length is another measure that has been established, but it is not an effective tool because it has been shown that at that size, many conch have not yet formed a lip, or there is no correlation between shell length and gonadal maturity, as Aldana and Frenquiel, (1998) have shown for different sites in the Caribbean.

Based on this concern, it has recently been proposed to use the thickness of the lip as management criteria to separate sexually mature adults from juveniles (Stoner *et al.,* (2012), however, this academic proposal has not been incorporated by the countries that share the resource, so from a legal point of view there are no substantial changes in local populations.

As most problematic resource mentioned has to do with the lack of monitoring in the coastal area in general and particularly in marine protected areas as park rangers have no authority to stop or punish the offenders, so that there is a loophole.

Due to the low densities of conch found at Alacranes reef (Average = 0.013 ind.m $^{-2)}$ it is not appropriate to speak about restoring the fishery, or generate or propose management strategies, but rather it is more appropriate to establish conservation measures that restore the conditions required for the viability of the species, to promote a greater number of reproductive encounters and management of organisms to increase their density. Therefore the following measures are proposed:

1) Translocate conch from deep to shallow waters area.

   At Alacranes, the reef management authority, using the fishing sector and coordinated by academics, should implement this strategy, which would improve the number of adults and induce reproductive meetings. To do that, first determine the sites of "origin" that match similar genetic characteristics between conch and second, establish the areas where the conch, having the biological conditions of shelter and food to sustain the biomass of organisms to be introduced. Naturally, consideration should also be given to sites where increased surveillance will be possible. This measure has already been implemented elsewhere (Delgado *et al.,* 200 4) and has demonstrated that transplants can improve density and reproductive encounters. Having a conch control through tagging can help determine their activities and home range of the species. Some studies have previously been performed to determine the characteristics of habitats or micro-habitats for conch translocation, for example to ensure enough food. Within this measure, and perhaps on a larger scale, studies could be conducted to determine genetic "distances" or genetic similarities among different populations and move only those that exhibit high affinity (Landines, et al., 2011).

2) Assess the reproductive activities of adults. It is important to know if there have been changes in reproductive activities of conch resulting from the low density of organisms. In the latest stock assessment (Jesus-Navarrete et al. 2014), no

reproductive activities of conch were observed in all of the Alacranes reef lagoon. Perez and Aldana (2003) reported that reproductive activities such as coupling, occurred from January to October, that spawning was related to water temperature and were more common from February to September, and apparently do not stop when cooler northerly weather systems are affecting in the area. Egg masses were visible in April and May. Although we did not find that there are any significant differences in densities between our study (average 0.013 ind.m $^{-2)}$) and those of Perez and Aldana, 2003, they observed a greater number of reproductive activities, despite have lower densities (0.004, 0.003, and 0.035 ind.m $^{-2)}$.

3) Determine the abundance of larvae and locate recruitment sites of juveniles.

It is necessary to know the abundance of veligers, their size distribution and periods of maximum abundance and to relate to reproductive activities of adults. The larval abundance should correlate with the abundance of juveniles in the benthos, for which we must conduct studies to meet the settlements of juveniles, since this way you can also protect through increased surveillance and promote further growth of organisms. It has been established that there are "biological keys" for the recruitment of conch (Davis, 1994) and there is an ontogenetic separation between the organisms with juveniles, associated mainly with seagrass beds, where they find shelter and food (Stoner et al. 1996) and in areas of coral where they frequently form aggregations (Dany lchuck *et al.,* 2003). Once these sites are identified, they could be proposed as the core area or dedicated solely to research, where fishing is prohibited.

4) Local captive breeding of conch larvae and juveniles to seed recovery sites in Alacranes reef. It is important to consider which institutions could provide necessary human resources and infrastructure for captive breeding and out-planting of individuals raised this way. This aspect would have to be designed to

generate juveniles 3-4 cm in length that can be tagged and out-planted in the Alacranes reef, which will allow observations of growth rates, juvenile behavior and the association with different micro-environments on the reef.

In conclusion, densities of *Strombus gigas* appear to have increased slightly since 1988 (0.00048 individuos.m $^{-2)}$ to the present day (0.013 individuals. M $^{-2).}$) but this density is mainly composed of juveniles and few adults, so it is not possible to re-establish fishing activities. It is necessary to establish scientific committees, or take advantage of the members of the Scientific Council of the Park, to discuss the most feasible options for the conservation and recovery proposals and to obtain national and international funding for the activities proposed.

Acknowledgements

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Appendix XII

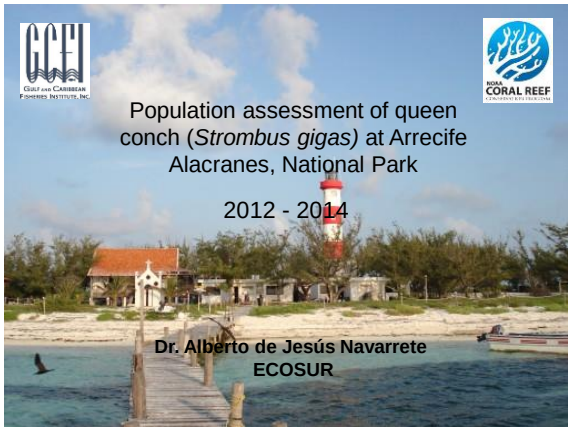
ARRECIFE ALACRANES NATIONAL PARK

Ing. Yrvin Ramírez Hernández
Subdirector

SEMARNAT
SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES

CONANP
COMISIÓN NACIONAL DE ÁREAS NATURALES PROTEGIDAS

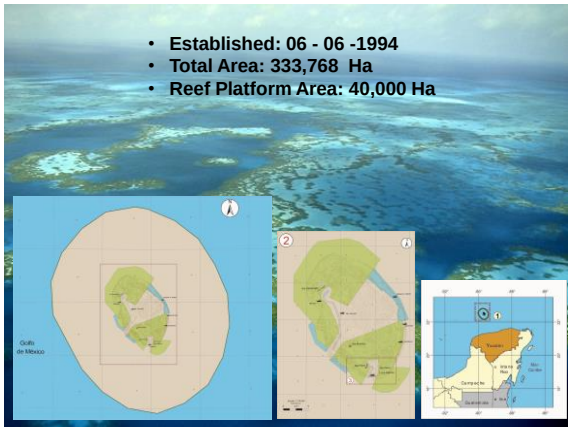
Arrecife Alacranes parque nacional



Population assessment of queen conch (*Strombus gigas)* at Arrecife Alacranes, National Park

2012 - 2014

Dr. Alberto de Jesús Navarrete
ECOSUR

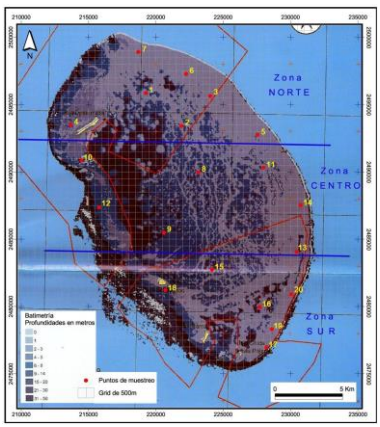


- **Established: 06 - 06 -1994**
- **Total Area: 333,768 Ha**
- **Reef Platform Area: 40,000 Ha**

METHOD

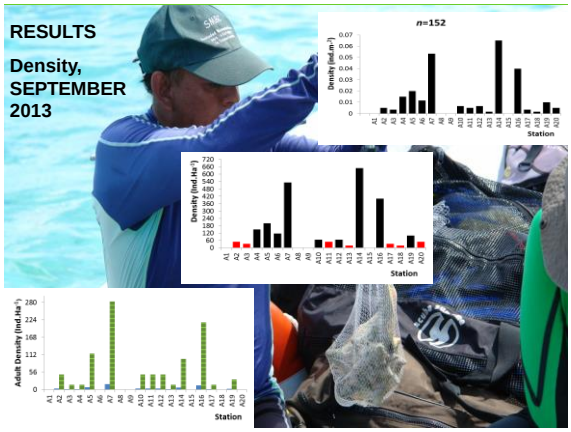
- **Location: Alacranes Reef**
- **Timing: September 2013, March 2014, July 2014**
- **Surveying: 20 random sites**
- **Per site: 3 transects 100 x 2 m long each, in "Z" pattern**
- **Measurements: Siphonal length and weight**
- **Analysis: Density and size frequency**

Survey sites



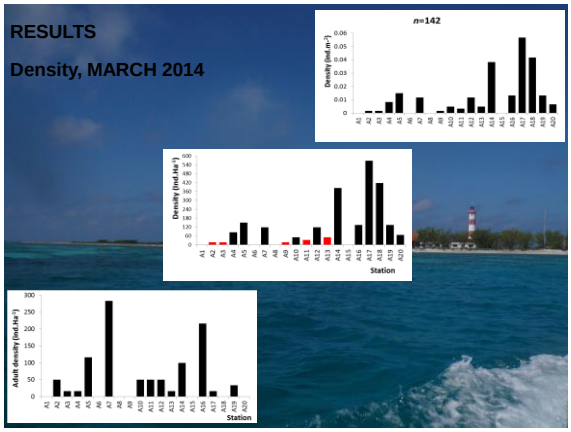
RESULTS

Density, SEPTEMBER 2013



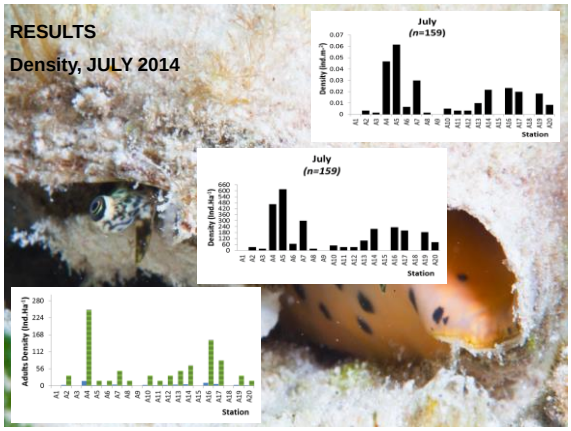
RESULTS

Density, MARCH 2014



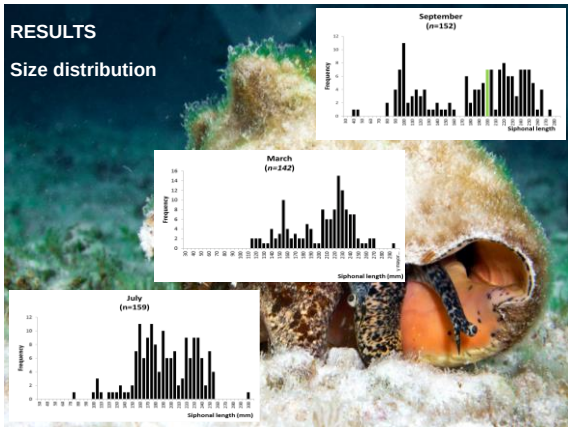
RESULTS

Density, JULY 2014



RESULTS

Size distribution



DISCUSSION

- Juveniles are the most abundant size class of conch at Alacranes Reef
- Densities of conch at Alacranes Reef are very low compared with other MPAs
- Densities of conch are also low compared with past studies at Alacranes Reef

Author/Year	1998	2003	2014
Rios - Lara	0.00047		
Perez and Aldana		0.018	
This study			0.013

RECOMENDATIONS

- Continue the closure of the conch fishery at Alacranes Reef
- Enhance enforcement of fisheries regulations
- Conduct education and outreach campaigns to increase compliance with fisheries regulations
- Implement a conch recovery program:
  1. Translocate conch from deep to shallow zones
  2. Captive raise conch larvae and juveniles in order to seed recuperation sites
- Further research:
  1. Evaluate whether conch are reproducing within the MPA
  2. Determine the abundance of conch larvae and locate recruitment sites


THANK YOU
© Jesse Cancelmo

APPENDIX XIII

Project: Implementation of capacity building in
the Mesoamerican Reef MPA community.

Sub-project: The lobster fishery *Panulirus argus* in
Arrecifes de Xcalak National Park.

Joint implementation ECOSUR- Arrecifes de Xcalak National Park - CONANP

Final report.
Monitoring and evaluation of the lobster resource in the Arrecifes de Xcalak National Park, based on information collected during the 2013-2014 fishing season.

Produced by: Eloy Sosa-Cordero[1]
Contributors: Beatriz Hernández Millán[2], Severo Díaz Larios[2]; Angelica Ramírez González[1]; Jorge Gómez M.en C. Poot[3]

1) El Colegio de la Frontera Sur (ECOSUR) - Unit Chetumal;
2) Fellows supported by the GCFI-NOAA cooperative agreement;
3) Arrecifes de Xcalak National Park-CONANP

Chetumal, Quintana Roo, Mexico
2014

Summary

The project on the lobster fishery *Panulirus argus* in Arrecifes de Xcalak National Park (PNAX) included two main activities: *i)* monitoring of the fishery during the 2013-2014 season; and *ii)* the analysis and modeling of data collected. This report contains the results of both activities. Monitoring of the fishery was comprehensive and detailed, and generated a database of catch-effort *(n* = 432 fishing trips) and lobster size structure *(n* = 7,223 lobster tails) from fishing areas in PNAX. Monitoring of a complete season allowed modelling of fishing impact using data on total catch and catch per unit effort (CPUE) at two scales: day and month. The results are encouraging. Capture had a greater impact on adult lobsters, fully recruited. There is little presence of sub-legal sized lobsters in the fishery (3.7%), one of the lowest among the towns of Quintana Roo. The presence of lionfish had no negative effects on the relative abundance of lobsters of exploitable size. The study achieved one of the first records of total catch of lobster in areas of PNAX, with volume 2917.5 Kg tail, and worth pesos MN $ 1,033,440, equivalent to USD $ 76,589. The estimate of fishing mortality, *F* (year $^{-1}$)= 0.92 was high, but should be considered with caution as several factors suggest that it may be an overestimation. There is a need to obtain estimates of the rate of fishing mortality based on data from several seasons. Another priority is the change in the marketing of whole lobster tails. In the 2013-2104 season, fishers missed out on pesos MN $ 516,705, that is USD $ 38,274 [exchange rate pesos MN $ 13.5 = USD $ 1]. They must change from using a hook to a loop for lobster fishing. This will enable the extension of MSC certification from Banco Chinchorro RB to also include PNAX. At the end of the report we set out conclusions and recommendations. Based on the information collected and the analyses performed to date, no evidence of red flags or warning signs were found in relation to the sustainability of the lobster fishery. However, we must admit to limitations based on working with data from a single fishing season. This work provides the basis for further analyses using a database of several seasons. Data from a longer time series is required to implement more sophisticated analytical tools and more powerful methods to the evaluation of the PNAX lobster resource. This is just the beginning of tasks in the medium and long term.

Acknowledgments. To partners and directors of the cooperative "Andrés Quintana Roo" (AQR) for their patience in doing interviews after fishing. The president of the AQR, Gerardo Arreola ("Yayo") who facilitated access to data and files from the cooperative. To the management of PNAX - CONANP Maricarmen Garcia C. R. and Jorge Gómez P, for management and logistical support; and to CONANP staff who assisted with sampling, thanks to Ma. Ericka Montenegro, Ing Pesq. Felipe Fonseca Peralta, among others. Thanks to ECOSUR for institutional support. The project was made possible by funding from GFCI, and management of Emma Doyle.

Final report. Monitoring and evaluation of the lobster resource in PNAX, based on information collected during the 2013-2014 fishing season.

1. Introduction

The lobster fishery *Panulirus argus* in Arrecifes de Xcalak National Park (PNAX) has the characteristics of a small-scale artisanal fishery. It shares with similar fisheries the need to reassess the importance of local contribution to poverty alleviation and-indirect contribution to

food security. Another common trait with similar fisheries is the lack of data and analysis to guide management. Accordingly, this report shares the results of a project which included monitoring during the 2013-2014 season and resource assessment based on analysis of data collected. Sampling was carried out in Xcalak, where lobster fishers and members of the cooperative "Andrés Quintana Roo" (AQR) reside.

This paper takes a comprehensive approach to the description of the main aspects of the lobster fishery in the PNAX, and in this regard the fishery is considered a fishing system (Charles 2001). This concept of fishing system evolved in recent years, the socio-ecological system that explicitly recognizes the weight of social and economic issues in isheries; especially in the craft.

Fishing operation and organization. The lobster catch in the PNAX takes place by means of free diving (apnea) with hook, a hook attached to the end of a stick or long handle. The hook brings fatal injuries to lobsters, which means the fishery consists of lobster tails, preserved in ice. Since the mid-1960s (Solis-Ramirez 1966, Miller 1982), Banco Chinchorro became the main fishing area of AQR cooperative. As a result, studies on lobster in the southern Mexican Caribbean have been limited to Banco Chinchorro. However, at present the members of the cooperative are fishing for lobster in areas adjacent to Xcalak, located in the PNAX. A first group consists of veteran fishers who prefer to fish lobster in Xcalak; another group alternates fishing in Xcalak with trips to Chinchorro. A third group of fishers, a fraction of whom do not live in Xcalak, are the "boyeros". This last group makes free diving trips along the coast, checking patch reefs, ridges and rocks in search of fish and lobsters. They gather their catch in a bag attached to buoys that lighten the load, hence the name “boyeros”. For years, they were considered fishers who lacked organizational and were sometimes linked to illegal fishing. This increases the importance of them being recognized by the cooperative. This first step out of the informal sector opens the possibility that future some ‘boyeros” join the cooperative; which would complete their regularization. Following the implicit recognition by the cooperative, the catch of “boyeros” are duly recorded, something unthinkable until recently.

Marketing. The lobster fishery PNAX depends entirely on the sale of tails. For every kg of tails sold, the lost income compared with sale of whole live lobsters is $ 150.00 pesos MN . Despite this, only the PNAX tails are marketed. In July 2013, the sale of 1,043 Kg of tails reduced the income of fishers in $ 156,450 pesos MN, a considerable sum equivalent to $11,719 USD [exchange $ 1 USD = $ 13.35 pesos MN]. Therefore, to increase the income of partners operating in Xcalak AQR requires marketing of whole / live lobster. This requires changing fishing method from the hook to the loop for free diving, a change made a few years ago in Banco Chinchorro. This would likely extend to PNAX the MSC certification of the lobster fishery that now includes Banco Chinchorro Biosphere Reserve and the bays of the Sian Ka'an Biosphere Reserve.

Climatic factors In the 2013-2014 season anomalous weather conditions prevailed in the frequency and magnitude of rainfall; strong winds (SE and north wind) caused waves and turbidity in coastal waters where lobster fishing occurs. These weather conditions caused frequent interruptions in the lobster fishery, but no reports were received of a negative impact on fishing activity or the resource in PNAX.

This report describes the fishing activity through the main indicators of catch-effort and size structure of the lobsters, broken down by sex of the lobsters. It takes the results of

comprehensive monitoring of the fishery in the 2013-2014 season, analyzes data collected and makes a first assessment of its operational status. The information on the fishery is current and detailed, and valuable for further analysis. The structure of this report is simple. The section headings or sub-section are self-explanatory. Tables and figures are accompanied by text that emphasizes the main results and a brief discussion. Finally some conclusions and recommendations are presented from the results, with reference to next steps or actions.

2. Results

2.1 Monthly monitoring of the fishery, July 2013-February 2014.

The working group in charge of monitoring the fishery was formed by the P. Biol. Beatriz Hernández Millán and P. Biol. Severo Díaz Larios, students studying Biology Technological Institute of Chetumal. He also collaborated staff PN Xcalak- CONANP residing in Xcalak station. In each month of the 2013-2014 season there were two sampling periods of ten days each. The monitoring group had close coordination with the Ocean. Angélica González Ramírez and Eloy Sosa Cordero, ECOSUR, who had under his responsibility the organization and review of the database; plus analysis of data, descriptive aspects and modeling.

Monitoring objectives were met. Monthly sampling was completed in eight months of the 2013-2014 season (Table 1). Sampling effort brought together samples applied decent size, with large number of interviews and many lobsters measures (Table 1). In total were interviewed n = 432 travel-boat, the number of interviews per month ranged from seven in December to 122 in July (Table 1).

In virtually all fishing trips n = 432, data size composition, weight and sex of lobsters caught were collected. Data sample sizes large, n = 7,223 (Table 1) was obtained. In Xcalak only lobster tails are marketed; therefore, measurements of height were abdominal or tail length (LA), to the nearest 0.1 mm. Less frequently wet weight measurements or abdominal weight tail were taken in grams; because it takes longer to make data size and the advent of digital scales was delayed. Sometimes the product delivery was so quick maneuver that prevented record individual weight data.

Table 2 contains a summary of the different variables collected in the monthly monitoring. Of each variable minimum, maximum, median, average, first and third quartiles (Table 2) are reported. The term NA (yellow) denotes missing values, which for some reason were not collected, fired with wrong values or it was impossible to recover or traced in field formats.

Table 1. Summary of results of monitoring of the lobster fishery in the PNAX during the 2013-2014 season. There operates the cooperative "Andrés Quintana Roo".

Months	Interviews, catch-effort (trips, *n*)	Sizes lobster (number measured, *n*)
July	122	2,467
August	66	950
September	71	1,047
October	40	619
November	40	517
December	7	414
January	42	162
February	44	811
PNAX	**432**	**7,223**

2.1 Descriptive analysis of catch-effort.

From interviews with captains, managers and crew *n* = 432 fishing trips, catch, effort and economic variables of each fishing trip were obtained. Presented below is a selection of the main results of the interviews during the monthly sampling of July 2013 to February 2014. The analysis includes the main descriptive statistics that summarize the data, obtained by applying simple tools of descriptive statistics.

Table 2. Summary of the variables collected through interviews catch-effort for *n* = 432 fishing trips in Xcalak. NA refer to lost or unrecorded data.

```
LOCALE        FECHA           YEAR           MES             CWG_LANG
 PNAX:432   02/07/2013: 16   Min.   :2013   Min.   : 7.000   Min.   :  300
            01/07/2013: 15   1st Qu.:2013   1st Qu.: 7.000   1st Qu.: 1800
            28/08/2013: 15   Median :2013   Median : 9.000   Median : 3000
            17/07/2013: 12   Mean   :2014   Mean   : 9.507   Mean   : 3742
            08/07/2013: 10   3rd Qu.:2013   3rd Qu.:11.000   3rd Qu.: 4525
            03/07/2013:  9   Max.   :2103   Max.   :14.000   Max.   :27400
            (Other)   :355

  WMN_G          PROF.M         TRIPULANTES      HRS.PESCA       ARTE_PESCA
 Mode:logical   Min.   : 1.000   Min.   :1.00   Min.   :0.500   GANCHO:432
 NA's:432       1st Qu.: 2.000   1st Qu.:1.00   1st Qu.:3.500
                Median : 4.000   Median :2.00   Median :4.500
                Mean   : 5.547   Mean   :2.13   Mean   :4.368
                3rd Qu.: 8.000   3rd Qu.:3.00   3rd Qu.:5.000
```

```
                Max.   :25.000   Max.   :4.00   Max.   :8.000
                NA's   :2        NA's   :1      NA's   :2
```

```
  GAS.L             ACEITE.L                PEZLEON     LANG_ENFERMA   COOP
Min.   : 0.000   Min.   :0.0000   ABUNDANTE  : 97   Mode:logical   AQR:432
1st Qu.: 5.000   1st Qu.:0.1000   AUSENTE    :164   NA's:432
Median :10.000   Median :0.2000   MUYABUNDANTE: 67
Mean   : 8.114   Mean   :0.1713   RARO         :101
3rd Qu.:10.000   3rd Qu.:0.2000   NA's         :  3
Max.   :25.000   Max.   :3.0000
NA's   :2        NA's   :2
```

```
   FISHER                 LANCHA              BOYERO                BYCATCH_1
JESUS_TOLENTINO : 33   ANI      : 39   CARLOS       :  8   BOQUINETE: 33
ROSALINO        : 28   EMPELA   : 35   RICARDO      :  8   PARGO    : 30
GILBERTO_BELTRAN: 25   CARMEN   : 32   JUAN_CARLOS  :  6   PICUDA   : 11
CRUZ_BELTRAN    : 18   TINTORERA: 28   ERBEY_CORDOBA:  4   MERO     :  9
GEOVANI_HDEZ    : 14   FINA     : 24   HILARIO      :  4   ABADEJO  :  8
(Other)         :231   (Other)  :191   (Other)      : 53   (Other)  : 45
NA's            : 83   NA's     : 83   NA's         :349   NA's     :296
```

```
 BYCATCH_2        BYCATCH_3          AREA_PESCA          OBSERVS
BOQUINETE: 12   ABADEJO  :  2   PORTILLAS  : 86   BOQUINETE_1_KG  :  4
CHACCHI  :  7   BOQUINETE:  2   P_GAVILAN  : 58   BOQUINETE_2_KG  :  4
PARGO    :  7   MERO     :  2   SIETE_COCOS: 39   XCOCHIN_2_KG    :  3
XCOCHIN  :  5   BARRACUDA:  1   RIO        : 37   BOQUINETE_1.5_KG:  2
COJINUDA :  4   CABRILLA :  1   FTE_XCALAK : 20   BOQUINETE_4_KG  :  2
(Other)  : 19   (Other)  :  4   (Other)    :189   (Other)         : 78
NA's     :378   NA's     :420   NA's       :  3   NA's            :339
```

2.1.1 Trends in catch-effort Monthly, July 2013-January 2014.

A key indicator of fishing activity is the monthly average catch of lobster fishing trip in number or kg of lobster fishing trip -Specify whole or tails (Fig. 1). In general, as a first approximation, the average monthly catch per unit effort (CPUE) are considered indices of relative abundance of lobster resource in fishing areas under study.

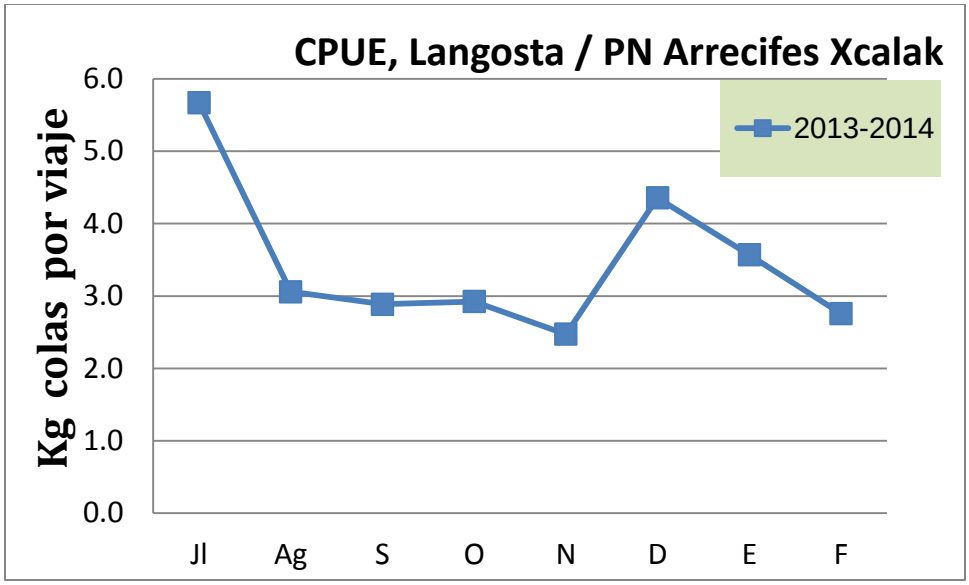


Figure 1. Average values of catching lobster fishing trip (CPUE) in Kg tail trip (KgCv $^{-1)}$ throughout the months of the 2013-2014 season.

Monthly averages CPUE index had a seasonal pattern (Fig. 1) with high values to start the season, averaging 5.67 kg in July tail per trip (KgCv $^{-1),}$ although individual dispersion values presented above and below average (Fig. 2). Then, the average CPUE decreased to 3.06 in August and a minimum of 2.47 KgCv $^{-1}$ in November (Fig. 1). Came after a recovery of CPUE, averaging 4.36 KgCv $^{-1}$ in December; was followed by a second downward trend since February was recorded on average 2.78 kg per trip tail (Fig. 1). This seasonal pattern characterized by decreasing abundance (CPUE) as the season progresses have been reported previously in the lobster fishery in the bays of RB Sian Ka'an (Lozano-Alvarez et al 1991;. Sosa-Cordero et al 999) in Banco Chinchorro (Sosa Cordero 2003).; and recently in Belize (Babcock et al. 2014).

The following chart includes the individual values of CPUE in kg of tails per fishing trip (KgCv $^{-1),}$ which is great variability (Fig. 2) warns. In Figure 2, the larger the scale of the y-axis, ordinate, was achieved include very high recorded in July individual values, but this very difficult to appreciate the trends of average monthly CPUE, such as presented above (Fig . 1).

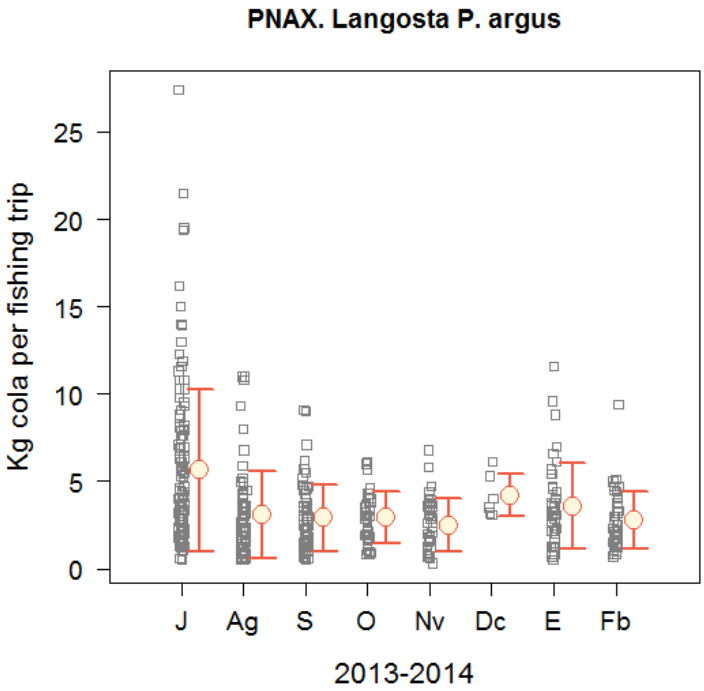


Figure 2. Individual values of the capture rate of lobster fishing trip (empty boxes) in kg of lobster tails, during the 2013-2014 season. Monthly averages (open circles) and associated standard deviation are included.

2.1.2 Comparison of catch rates per unit of effort.

With intensive monitoring of the fishery detailed information on each fishing trip, hours of diving () and number of divers () was achieved. The product of both, It is the total hours of diving trip, another measure of fishing effort. With this alternative CPUE index that reflects more accurately the variation of fishing effort between trips was calculated. In the 2013-2014 season CPUE values were obtained in Kg per hour tail diving (KgChr $^{-1)}$ for each fishing trip in the sample *(n* = 432). Thus, for each fishing trip there were two values CPUE, two indices of relative abundance whose monthly averages were compared (Fig. 3). Both indices had similar behavior (Fig. 3); only differed in two consecutive months, October and November. In October grew CPUE in KgCv $^{-1}$ while it decreased in KgChr $^{-1}$ (Fig. 3). The opposite occurred in November when he dropped the CPUE in KgCv but increased KgChr $^{-1\,-1}$ (Fig. 3). It is remarkable similarity of the pattern followed by two indices in the season, with occasional variations in two months. Although it is preferable CPUE in total hours of diving trip, as this index requires intensive monitoring requires more resources; in conditions of scarce funds is sufficient to have the CPUE in kg of lobster fishing trip, obtaining more economically. This was reported earlier in the lobster fishery of Banco Chinchorro (Sosa Cordero et al. 1999).

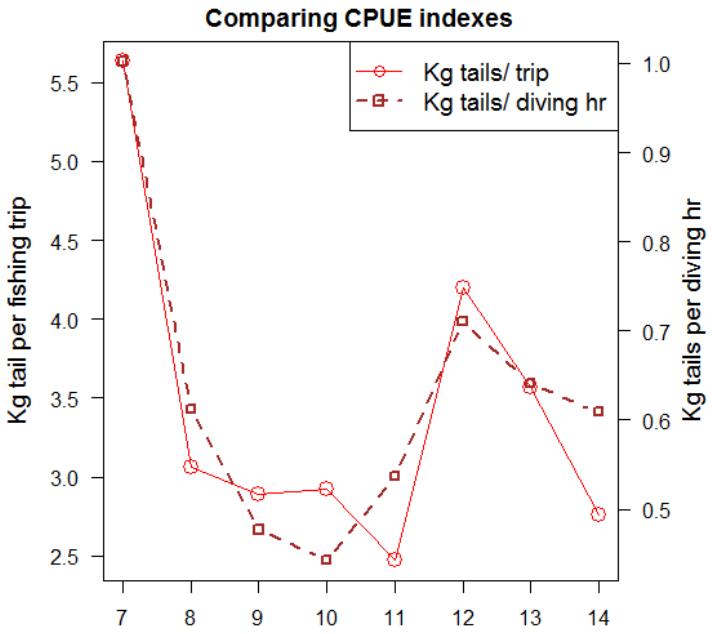


Figure 3. Monthly variation of two indices of catch per unit effort (CPUE), monthly averages tail Kg per trip (open circles, solid line) and Kg per hour tail diving (empty squares, dotted line). The first index in the y-axis on the left side, the second in the y-axis on the right. On the horizontal axis, the months of July (7) February (14) of the 2013-2014 season.

2.1.3 Modeling of catch-effort day in July 2013.

Dynamic resource in PNAX: 1 to July 25, 2013. With the approach of Medley & Ninnes (1997), the resource dynamics *Panulirus argus* was performed in the first 25 days of July 2013 using two versions of a model of depletion. Such models were adjusted to daily data capture in Kg tail, fishing effort in number of fishing trips and catch per unit effort (CPUE) -index of relative abundance in kg per fishing trip tail (Figs . 2 and 3). This period includes the start of the fishing season, after four months of closure (March 1 to June 30), when fishing took a break. During the closure key processes occur: *a)* redistribution of resources from natural habitats, empty holes are occupied by lobster and recruits who survived past seasons; and *b)* a pulse of recruitment from May to June, with the addition of new lobsters.

Model of the population, expressed by:

$$B_{t+1} = (B_t - C_t) \cdot e^{-m''} \qquad \text{Model 1}$$

$$B_{t+1} = (B_t - C_t) \cdot e^{-m''} + B_0 \cdot \left(1 - e^{-m'}\right) \qquad \text{Model 2}$$

Where,

B_t is biomass or population size lobster tail in kg at the beginning of the time interval t, in this case from day t;

C_t *is* the total catch of lobster tail in Kg, day t. Observation or data files recorded in the cooperative "Andrés Quintana Roo" therefore is the result of a census of fishing activity in the study area.

m' *is* the total loss per day, includes daily rate of natural mortality, *m* (day $^{-1)}$ together with the emigration of lobsters from shallow areas where fishing is by free diving (apnea). A fraction of lobster leaving the fishing area and moves into deeper waters; that is, at depths greater than 18-20 m.

B_0 is size of the lobster population in the area just before the start of the fishing season; ie is biomass lobster tail in Kg, 30 June 2013. This is a model parameter of the population, which is estimated by adjusting the data (observations) of relative *abundance* $CPUE_{obs,t}$..

The model of the observations establishes the relationship between the model predictions and observations of CPUE data or index; ie between $CPUE_{modelo,t}$ and $CPUE_{obs,t}$

Model of observations, expressed as:

$CPUE_{obs,t} = q \cdot B_{t+0.5} + \varepsilon_t \quad \varepsilon_t \sim N(0, \sigma^2)$ Model of observations

$CPUE_{obs,t}$ is observation of the relative abundance index on day t, expressed by the catch per unit effort in Kg tail by fishing trip,

q is catchability coefficient, the constant of proportionality between the observation *of day t and the mean abundance predicted by the model* $CPUE_{modelo,t}$ given by the product $CPUE_{modelo,t}$= $q \cdot B_{t+0.5}$;

$B_{t+0.5}$ is average biomass of the stock on day t; lobster biomass being half the unit time interval. Thus, half of day t, biomass is given by the *approximation* $B_{t+0.5} \approx B_t - \frac{C_t}{2}$.

Model 2 is the depletion model used by Medley & Ninnes (1997); they report that in some years it was not satisfactory to adjust daily catch-effort data from the first month of the fishing season. It is worth noting that they adjusted the model to the data daily catch (C_t). In our case, Model 2 was adjusted to CPUE data or relative abundance ($CPUE_{obs,t}$). The same data were adjusted in Model 1; an alternative, simpler version of the depletion model.

In this paper, the standard setting was the least squares method which assumes that the data (CPUE) follow the Normal distribution. This first set of models postpones the use of more sophisticated criteria such as maximum likelihood method, which supports assume that the data (CPUE) follow a lognormal distribution or Gamma. Table 3 contains results of fitting both models 1 and 2; for several scenarios depending on the rate of total *losses, expressed in multiples of natural mortality M* (year $^{-1)}$ carried scale of days. Table 3 indicates the scenario considered most likely to reflect the reality -based on experience. In subsequent analyzes such decision will be formalized, with arguments that give stronger support.

Table 3. Results of modeling of biomass Lobster PNAX in July 2013. Initial estimates of biomass *in* g *K* tail catchability coefficient (Travel $^{-1)}$ and sum of squared residuals (SRC) under different scenarios of natural mortality*M.* The most likely scenario results are indicated in bold.

Models Parameters		**Scenarios according to the magnitude of total losses M (external value)**				
	***M* (year $^{-1)}$**	***M* = 0.36** [1]	**2 * *M* = 0.72**	**6 * *M* = 2.16**	**10 * *M* = 3.6**	**15 * *M* = 7.2**
	(Day $^{-1)}$	**0.001**	**0.002**	**0.006**	**0.01**	**0.02**
Model 1	B_0 , Tail kg	2263	2350	2779	**3410**	Model unstable, unreliable
	q , Travel $^{-1}$	0.002964	0.00285	0.002393	**0.001936**	
	SRC	31.4658	31.4627	31.4586	**31.4679**	

						results.
Model 2	B_0 , Tail kg	2385	2629	4505	Model unstable, unreliable results.	
	q , Travel $^{-1}$	0.002803	0.002529	0.001444		
	SRC	31.4537	31.4477	31.5214		

Note: 1) The value of *M* as experts in regional workshops lobster FAO-WECAF 1997-2006.

Below the graphs of fit-1 with the total fixed losses in 10 * *M* (= 3.6 / year), equivalent to a rate of total losses = *0.01 (day* $^{-1)}$ is the most likely scenario that reflects the actual situation, a pragmatic approach based on experience. According to the model results, just before the season started in June 30, 2013, the lobster population in areas of PNAX had a total biomass of 3,410 kg of tails (Table 3, Fig. 4). At the end of the period, July 25, 2013, because of the removal by successive captures and total losses, had a biomass of 1.820 kg of tails (Fig. 4). So, in 25 days the local lobster population was reduced by 1,590 kg tail; that is, 46.6% of initial biomass (Fig. 4).

The daily rate of fishing mortality *F* (day $^{-1)}$ defined *as* $F_t = -LN\left(1 - {}^{C_t}/_{B_{t+0.5}}\right)$ *by (Haddon* 2011), showed wide variation (Fig. 5), with a minimum value of 0 in the absence of fishing days and a maximum of 0.041 (day $^{-1}$); and 0.017 average (day $^{-1)}$ This translates into a cumulative value of 0.41 in the first 25 days of July, a very high monthly rate of fishing mortality, given by *F* (month $^{-1)}$ = 0.50. It is noteworthy that the estimates presented above are provisional result of fitting models to data from a single fishing season. The daily data files come from the cooperative "Andrés Quintana Roo". As stated before, this model still requires more work to refine details of fit to the data available.

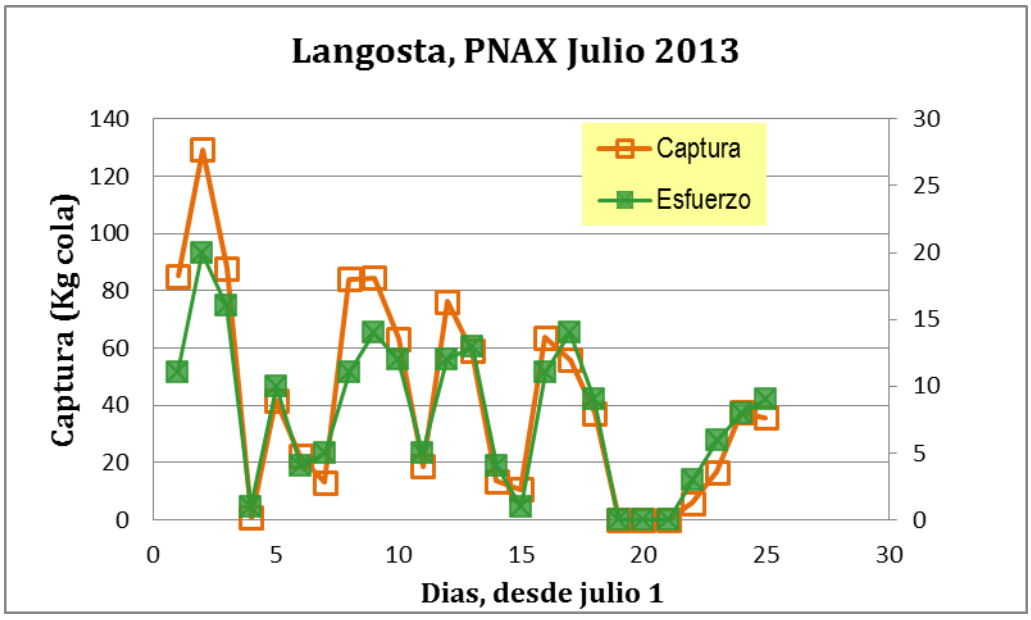


Figure 2. Variation July 1-25, 2013, the daily catch in kg of tails, and fishing effort in fishing trips in the lobster fishery PNAX. Data from files of the cooperative "Andrés Quintana Roo".

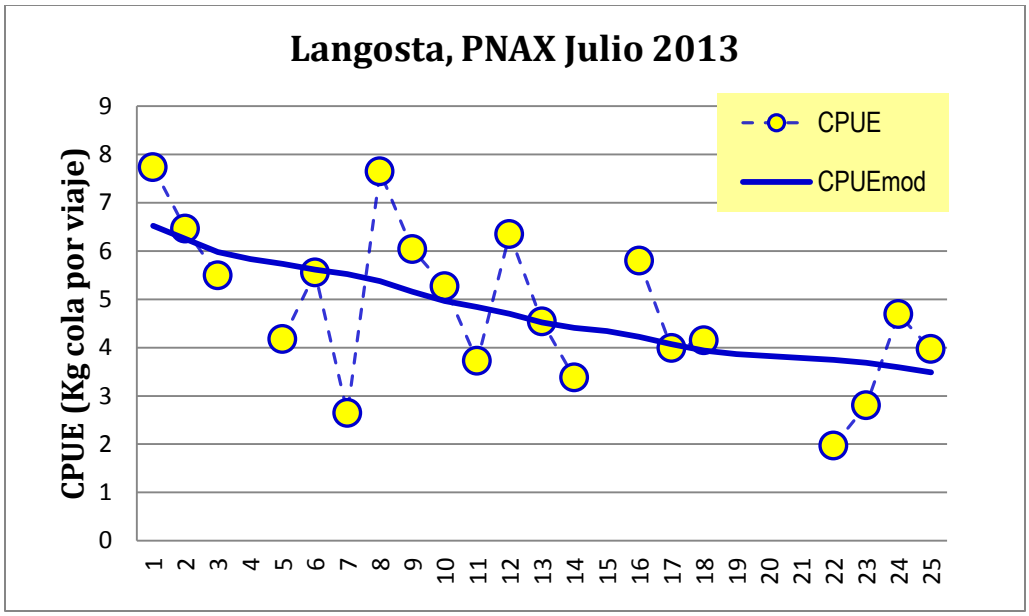


Figure 3. Daily values of catch per unit effort CPUE in kg $^{-1}$ tail trip, observations (circles, dashed line) and model predictions 1 depletion (solid line), adjusted least squares. In the lobster fishery PNAX, 1 to July 25, 2013.

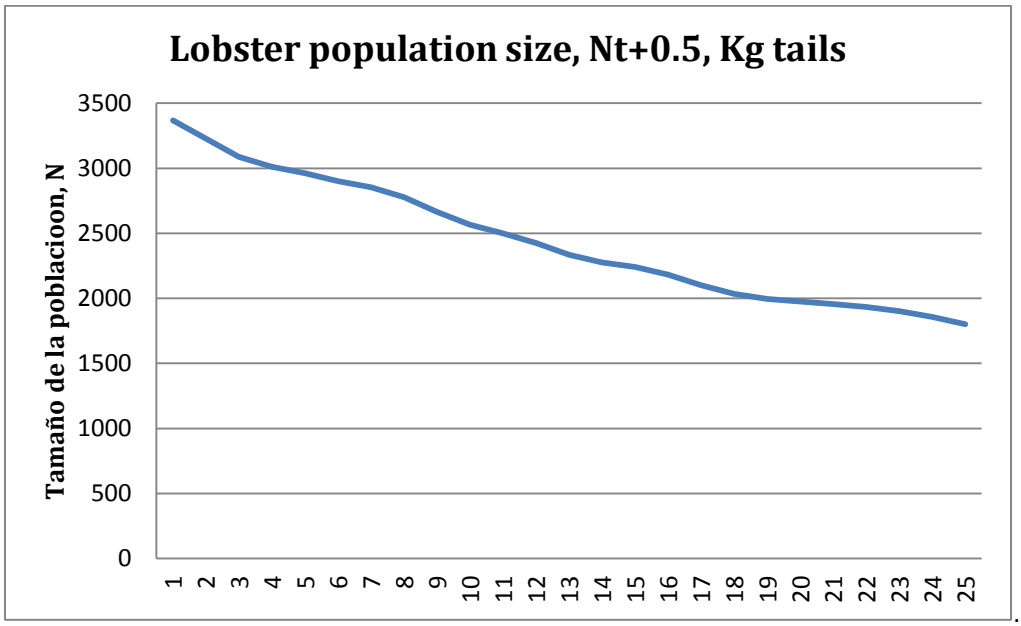


Figure 4. Biomass local lobster population in PNAX, 1 to July 25. Daily values in kg tail, the model predicts 1 depletion, adjusted data by least squares.

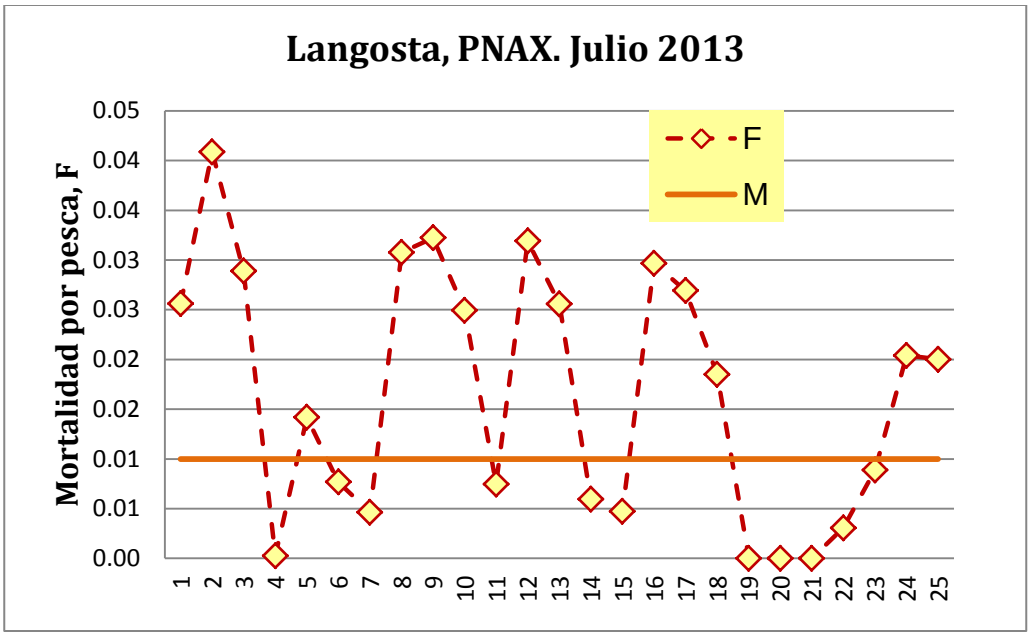


Figure 5. fishing mortality rate *F* (day $^{-1)}$ in lobster PNAX, from 1 to July 25 (diamonds and dotted line). Estimates from model 1 and daily catch. The total rate of losses, natural mortality and emigration = *0.01 (day* $^{-1),}$ given as external value (horizontal solid line) is shown.

2.1.4 CPUE lobster fishing depth and type of fisher.

In areas PNAX fishing, snorkeling lobster (apnea) is captured. Therefore, it is of interest is the relationship between diving depth and abundance of lobster (CPUE). In considering the depth data on fishing sites, note that fishers cooperative AQR apply the regular operation on boats or motor boats, diving at depths at which fish the "Cattle" (Fig. 6). Recall that “boyeros” do not use boat (see introduction). This affects the catch per unit effort (CPUE) in kg of tails per trip (KgCv $^{-1),}$ the average fishers operating regularly, 4.23 ± 3.35 KgCv $^{-1}$ with *n* = 349, CPUE exceeded much to the average of the drovers, *n* = 83, worth 1.68 ± 1.12 KgCv $^{-1}$ (Fig. 7).

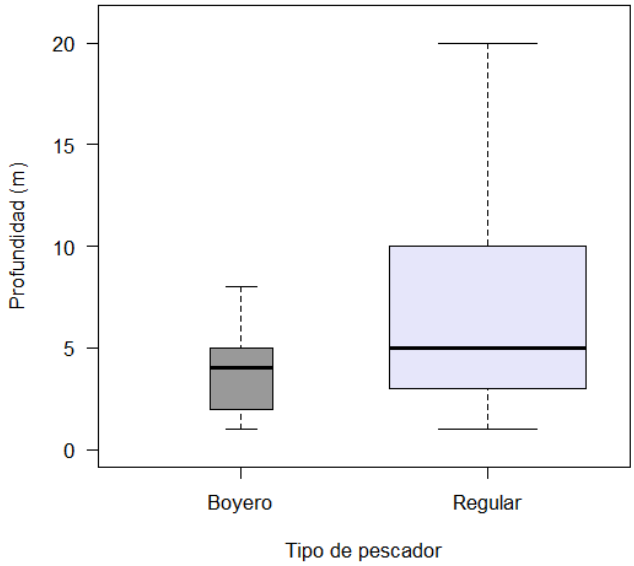


Figure 6. Depth dive, in meters, lobster fishing in PNAX during the 2013-2014 season. For separated values fishers made regular operation *(n* = 349) and Cattle *(n* = 83) which ignore the launch.

The depth of diving fishing trip *(n* = 432) had wide variation and followed a polymodal distribution (Fig. 8). The thickness of the depth values was less than 15 m (Fig. 8); two main trends within 5 m, and a third high fashion, centered 10 m (Fig. 8). The average depth was 5.6 m and the third quartile was 8 m (Fig. 8). A weak relationship between the depth of diving and the relative abundance of lobster tails CPUE in kg per trip is noted. This corroborates that is a nonlinear complex relationship (Fig. 9). The scatterplot of CPUE -their values (Fig. 9) included smoothing curve that results from applying a regression technique resistant, locally weighted (Maindonald and Braun 2010). This technique produces a curve that follows the trend of the data without setting or explicitly define a particular equation or model.

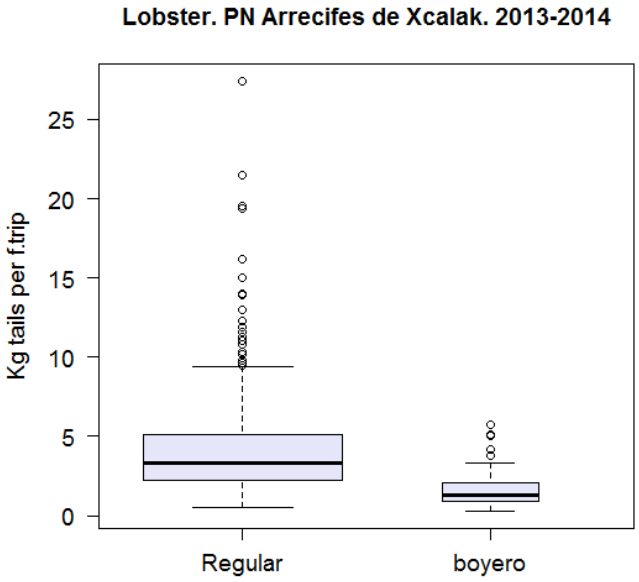


Figure 7. Catch per unit effort (CPUE) in kg tail fishing trip in the PNAX during the 2013-2014 season. Separately for fishers operating regularly *(n* = 349) and for Cattle *(n* = 83) which ignore the launch.

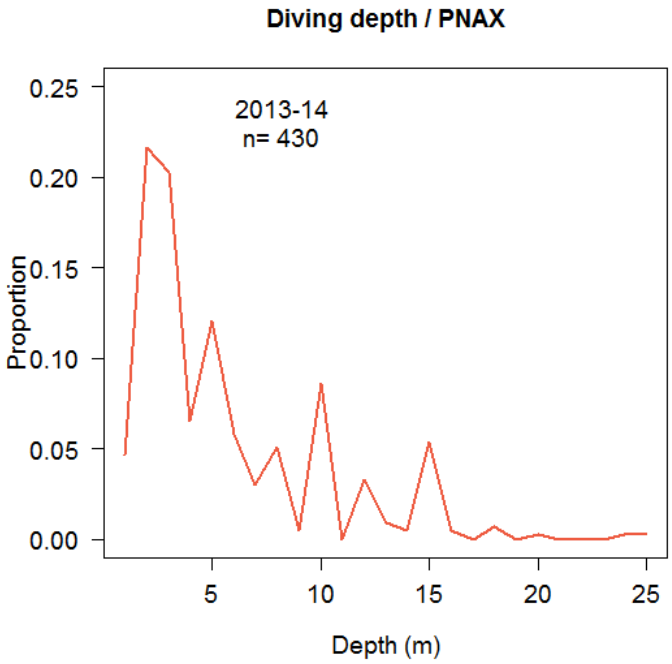


Figure 8. Distribution of the values of diving depth in meters, in the lobster fishery PNAX, during the 2013-2014 season.

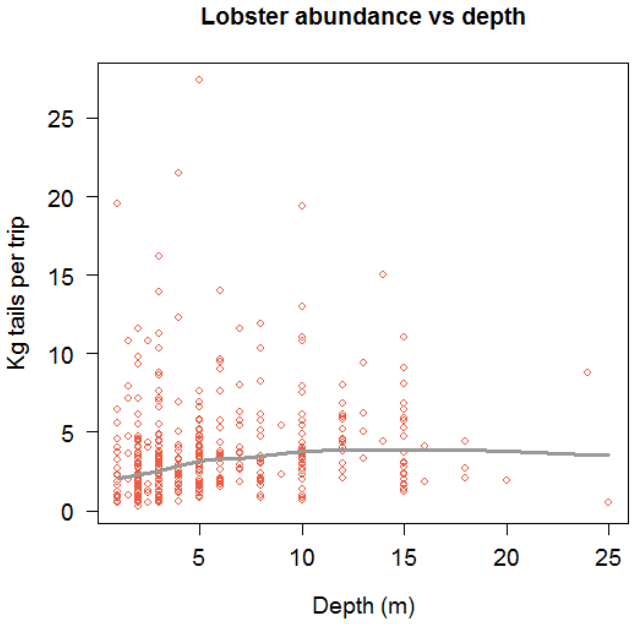


Figure 9. Dispersion of point values of relative abundance, CPUE in kg per trip, with respect to depth in m; in the lobster fishery PNAX. Smoothing the curve derived from a regression resistant, includes weighting locally.

2.1.4 Abundance of lionfish in fishing sites and spiny lobster.

The presence of lionfish *Pterois volitans* , invasive species in the Mexican Caribbean, in the areas of lobster is a new factor and concern among fishers. For the first time monitoring of the fishery in Quintana Roo locations even the polygon PNAX, the format of survey included a new question: What was the abundance of lionfish in the fishing site? The answer admitted four options (levels) of abundance: i) absent, 0; ii) rare 1-4 fish; iii) abundant, 5-12; and iv) very abundant, more than 12 fish. However, some fishers reported often the exact number of lionfish that found in fishing sites.

According to the results of *n* = 385 interviews, a large fraction of lobster fishing trips in the PNAX went to places where lionfish was absent (23.4%) or rarely (37.4%); both levels adding 60.8% (Fig. 10). In contrast, 39.2% of sites abundant presence (16.1%) or very abundant (23.1%) of lionfish (Fig. 10) was reported. Therefore, dominated the low abundance values lionfish, according to this index based on the valuation of fishers. This initial assessment of relative abundance of lionfish in lobster fishing areas in the PNAX, with data provided by fishers can be seen as the baseline method. It is important to follow in subsequent seasons to detect trends between seasons.

This index of relative abundance of lionfish (Fig. 10) allows to examine its relationship with the corresponding values of relative abundance of lobster (CPUE) in number of lobsters per trip. The results of such a relationship is shown in Figure 11. From the data collected in the PNAX during the 2013-2014 season, it shows that the CPUE in kg of tails per trip, an index of relative abundance of lobster, remained stable without significant changes between sites with different relative abundance of lionfish (Fig. 11). This relationship between abundance of lobster and different levels of relative abundance of lionfish, is clearly an issue that requires more

attention in future monitoring programs for the lobster fishery in fishing villages in the Mexican Caribbean.

2.2 Preliminary analysis of the size composition, weight and sex.

The size structure of captured lobsters is presented, based on data collected in eight months of the 2013-2014 season, from July 2013 to February 2014, in the PNAX. Is advanced-but unfinished, review and clearance of individual data tail weight in grams. If required, the tail lengths can be converted to carapace lengths differentiated by sex, with separate sexes equations previously reported (Cobá Cetina 1990). These equations were obtained from lobsters collected in Ascension Bay during 1987-1989. In females, the equation is expressed as LC = 0.56 * THE -1.23; and males equation is given by: LA-LC * 9.11 = 0.65 (Cobá Cetina 1990).

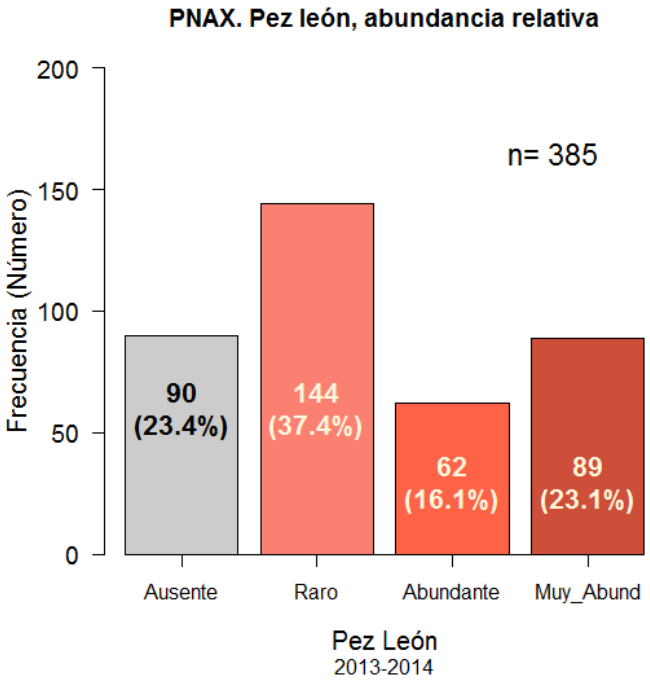


Figure 10. Relative abundance of lionfish in lobster fishing areas in the polygon PNAX, using four levels of abundance reported by fishers.

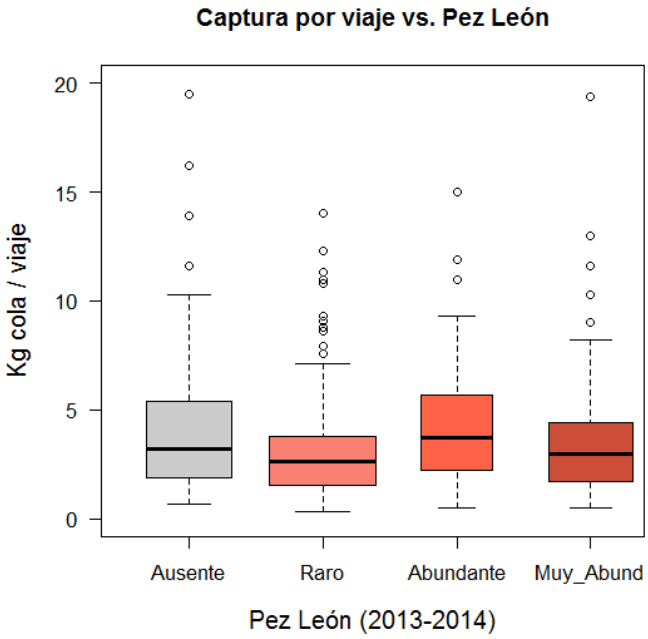


Figure 11. Relative abundance of lobster (CPUE) tail Kg per trip, fishing sites with different levels of abundance of lionfish, according to fishers operating in the estate of PNAX.
In subsequent analyzes, more elaborate, you need to apply a weighting to each monthly sample sizes, to expand or increase the size structure of the sample to the structure of the total catch. It is therefore essential to know the total catch per month in Xcalak. Hence, the values of total catch per month are obtained from catch records deposited in the AQR files cooperative.

2.2.1 Size structure both sexes combined, July 2013-January 2014.

2013-2014 season in a sample was collected, of large size, lobster Size, *n* = 7.223 (Table 1). This large sample is the sum monthly samples whose size ranged from 162 lobsters in January to 2,467 in July (Table 1). In this sample, the tail length (LA) had a minimum of 36.9 mm and maximum of 259 mm (Table 4). With average of 156.1 ± 14.9 mm LA $\bar{x} \pm de$,, and median of 155.0 mm LA (Table 4).

Table 4. Basic descriptors LA tail length, in millimeters, of both sexes lobster fishing areas PNAX during the 2013-2014 season.

```
summary (LA.mm) ## Length of tail or abdominal LA (mm)
Mean Median Min 1st Q 3rd Q Max.
36.9 145.0 155.0 156.1 165.0 259.0
sd (LA.mm, na.rm = T) [1] 14.9171 ## Standard deviation of LA (mm)
var (LA.mm) [1] 222.5199 variance of ## (mm)
```

2.2.2 Size structure, separated by sex, July 2013-January 2014.

In all lobsters measures, *n* = 7,223, were determined sex; total there were 3,946 (54.6%) females and 3,277 (45.4%) males. The tail length (LA) in males was 155.1 ± 14.59 average mm ($\bar{x} \pm de$) , slightly smaller than the average size in females, 157.0 ± 15.14 mm LA (Table 5). In the relative frequency polygon size for both sexes and separate sexes very similar behavior of the size structure between female and male lobsters (Fig. 12) shows.

Table 5. Descriptors LA tail length in mm, females (F) and males (M) lobster fishing areas PNAX, during the 2013-2014 season.

```
## LENGTH OF TAIL, LA ## mm // By sex /
tapply (LA.mm, gender2, range , na.rm = T)
H [1] 117 254 ;; $ M [1] 36.9 259.0
tapply (LA.mm, gender2, mean , na.rm = T) ## average, LA mm
HM
157.0153 155.1027
tapply (LA.mm, gender2, sd , na.rm = T) ## mm standard deviation LA
HM
15.13572 14.58569

summary (LA.mm [gender2 == "H"]) # FEMALES Tail Length, LA mm
Min. 1st Qu. Median Mean 3rd Qu. Max. NA's
117 146 155 157 166 254 1

summary (LA.mm [gender2 == "M"]) # MACHOS     Tail Length, LA mm
Min. 1st Qu. Median Mean 3rd Qu. Max. NA's
36.9 144.0 154.0 155.1 163.0 259.0 1
```

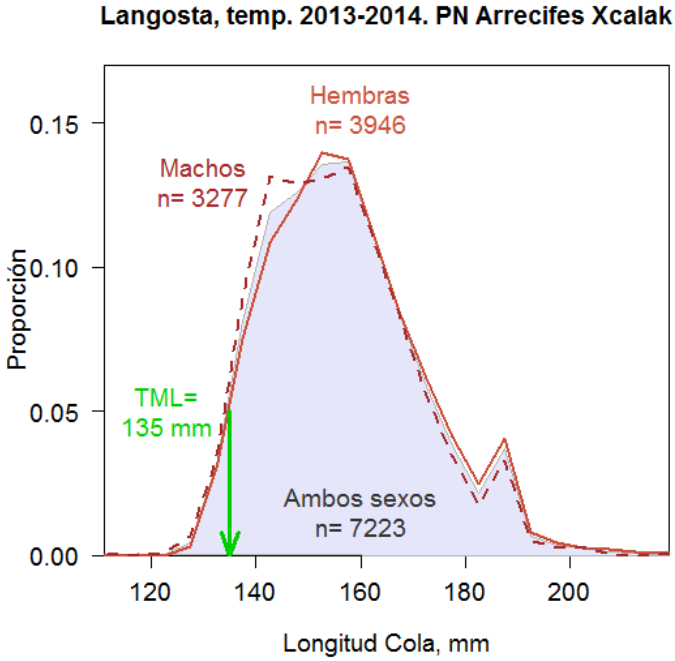


Figure 12. Distribution of tail length, in mm, in the sample of lobsters collected in areas of PNAX during the 2013-2014 season. The distribution of females (solid line), male (dotted line) and both sexes (shaded gray) are indicated.

The size distribution of lobster caught in fishing areas PNAX during 2013-2014 (Fig. 12) season, dominated the adult lobster, fully recruited sizes. There was even a secondary fashion centered 190 mm LA (Fig. 12). This has some similarity with sizes of lobsters caught in Banco Chinchorro (Lozano-Alvarez et al. 1991, Sosa-Cordero et al. 1999, Sosa-Cordero 2003). The lower incidence of juveniles or thresholders in catching lobsters in the PNAX (Fig. 12) is a clear sign

that fishing there has greater impact on adult lobster medium to large (Fig. 12). This seems a contradictory result, since lobster fishing by free diving (apnea) is performed at a depth of 18-20 m (Fig. 8); however, at such depths fishing sites usually correspond to coral reef habitats occupied by adult lobster.

2.2.3 Percentage of sub-legal lobster catch

Related to the previous section, since the snorkeling fishing is restricted to shallow waters and coral reef habitats, it becomes important to avoid capture and handling of lobsters of sub-legal size, smaller size to the minimum legal size (TML) of 135 mm tail [~ 74.5 mm carapace length LC]. In the sample of lobsters caught in the PNAX in the 2013-2014 season there were few examples of sub-legal size (Fig. 12). Of *n* = 7,223 lobsters measures in total, there were 267 sub-legal lobsters size; ie 3.7% of the sample (Fig. 12). In the sample of the catch of fishers who made regular operation, *n* = 6,610, only 241 (3.6%) were sub-legal; while sample from boyeros, *n* = 614, there were 24 (3.9%) of sub-legal lobster size. Therefore, it is valid to say that handling and capture (mortality) of sub-legal is not a problem that afflicts the lobster fishery PNAX.

2.2.4 Size of lobster after the fishing operation.

By comparing the sizes of lobsters caught by mode of fishing operation; ie between fishers cooperative applying regular operation, motorboat, and drovers, no boat, no differences in size (Fig. 13) are appreciated. It is noted that the average size of lobsters caught by the regular operation, 156.1 ± 14.8 mm LA, is similar to the average size of lobsters caught “boyeros”, 157.2 ± 16.2 mm LA (Fig. 13). However, the size of the sample size is larger for fishers in regular operation, *n* = 6,610, which for Cattle, *n* = 614.

This indicates that catches delivered to the cooperative for “boyeros” meet the standards established by the legal minimum catch size. In the past, a lack of data on the size composition of lobsters caught by type of fishing operation, it was suspected that “boyeros” tended to capture individuals of sub-legal size. Now, the size data collected in the 2013-2014 season lasts provide information about the general compliance with the minimum legal size by all fishers operating in the fishing areas located at the site of PNAX (Figs. 12 and 13).

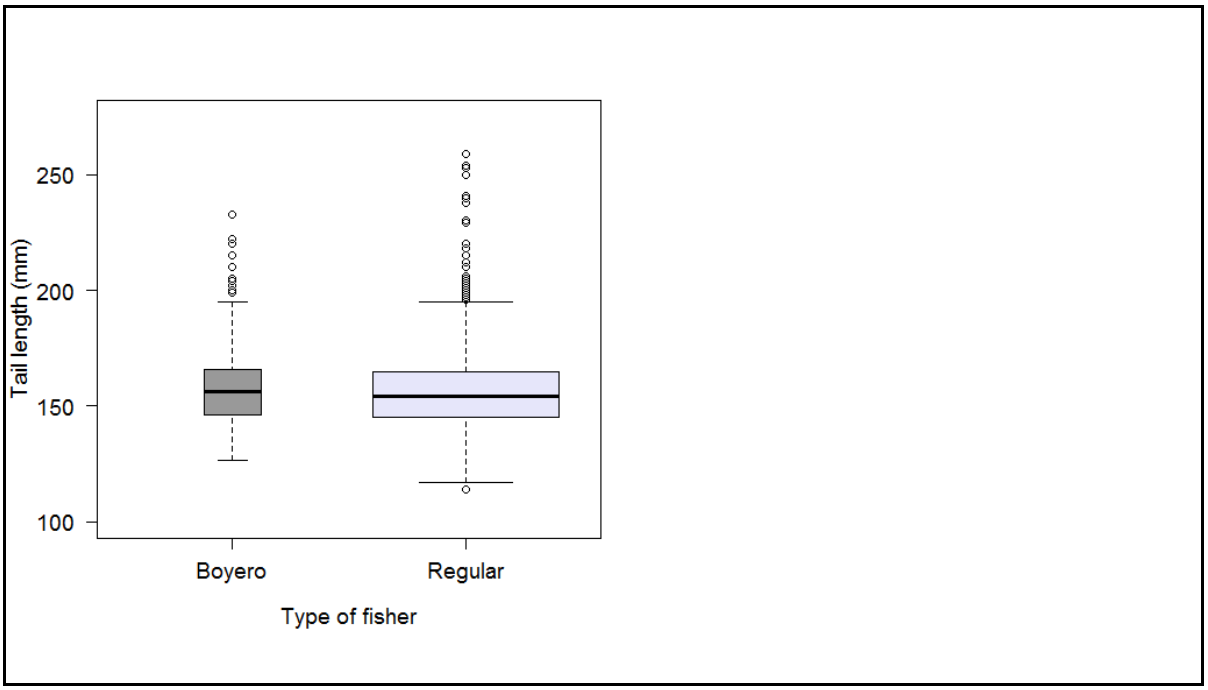


Figure 13. Comparison of the abdominal or tail length (LA), in mm, lobster PNAX captured during the 2013-2014 season. Data separately for fishers with regular operation and “boyeros”.

2.2.5 Total catch lobster in the PNAX, season 2013-2014.

The total catch of a locality or region is one of the essential basic data in the analysis and evaluation of fisheries. It is assumed that the data on catches and landings are collected *by default* by any government agency. This is not always true, especially in small-scale fisheries, as illustrated by the lobster fishery in the PNAX . The fishery does not have a process for regularly and systematically collect data on catches of lobster from the estate of PNAX. For years, the cooperative AQR put emphasis on the reporting of landings of lobster product fishing activities carried out in Banco Chinchorro. Instead, catching lobster fishing areas located in the PNAX , for many reasons it is not reported separately or is not reported at all. This is the cause of the lack of official statistics on total catch of lobster in the PNAX .

In the last three decades, the AQR cooperative has reported monthly catches of lobster tail Kg in offices Fisheries sub -SAGARPA CONAPESCA located in Chetumal. In these reports is implicit that such figures are catching lobster from Banco Chinchorro. However, it has recently increased interest in quantifying the volume of lobster which originates in the areas of PNAX separately from Banco Chinchorro. Thus, the need for information on catches of lobster in the PNAX was a problem detected since the beginning of the project, to which he invested extra effort.

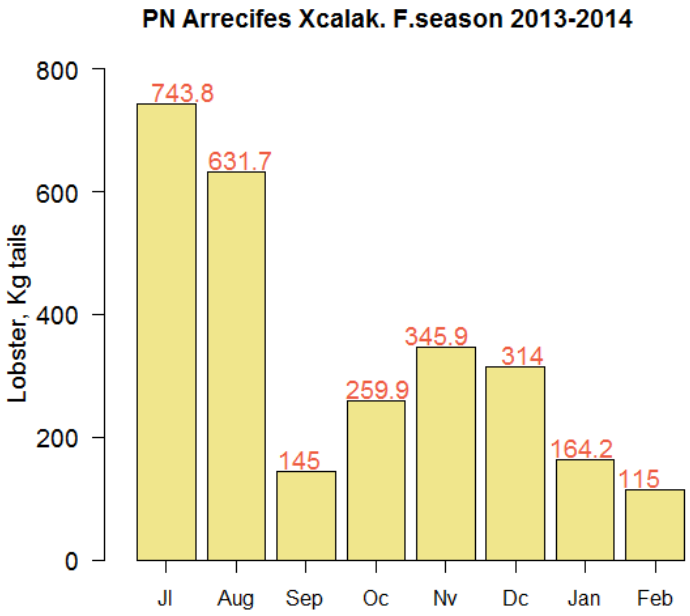


Figure 14. Monthly catches of lobster tails in Kg, from catches in fishing areas PNAX, during the 2013-2014 season.

Using files maintained by the AQR cooperative, data was gathered on lobster catch. The monthly catch ranged from a minimum of 115 kg of tails in February 2014 to a high of 743.8 kg in July-2013 (Fig. 14). The sum of monthly catch-July 2013 to February 2014, reached 2719.5 Kg tail; This is the total catch of lobster in the PNAX during the 2013-2014 season. A price of $ 380 per kg of tails, such capture represented $ 1,033,410 pesos MN [USD $ 76.549, rate of change of $ 13.5 pesos MX = $ 1 USD]. This is one of the first records of total catch of lobster in PNAX.

From the monthly catch in Kg of tails, and the weight of monthly samples, an estimate was obtained of the monthly catch in numbers of lobsters, whose sum is the total catch in the 2013-2014 season. These values are presented in Table 6. The capture seasonal pattern lobster number (Table 6) was similar to the capture tail kg (Fig. 14) behavior. The monthly catch ranged from a low of 644 individuals recorded in February, up to 3,948 lobsters in July. The total catch of the 2013-2014 season was about 14.972 lobsters (Table 6).

Table 6. Monthly lobster catch in number of individuals, from PNAX during the 2013-2014 season. Values estimated from the sample.

Months	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	2013-2014
Catch (number)	3,948	3,727	778	1,398	1,800	1,746	931	644	14.972

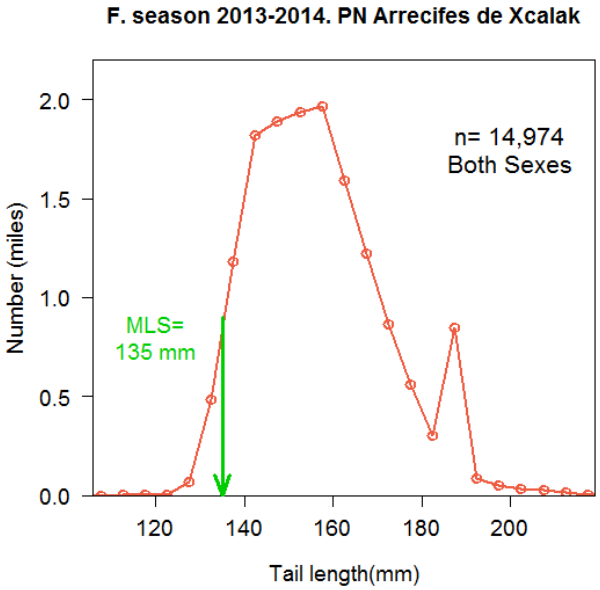


Figure 15. Size distribution summary, LA tail length in mm, corresponding to the total catch of lobster fishing areas PNAX during the 2013-2014 season.

2.2.6 Size distribution of lobster in the 2013-2014 season.

From the monthly catch in Kg of tails, together with the weight of monthly samples, obtained using weight-length relationship, calculated separately for each sex, it was possible to determine a monthly expansion factor required to raise the size composition of each monthly sample size composition of the total catch. With the latter, the summary size distribution for lobsters caught in the PNAX during the 2013-2014 season (Fig. 15) was calculated. This is the sum of the eight months for each of the size ranges (Fig. 15), which is only correct after having expanded each monthly size sample.

2.2.7 Modeling of monthly catch-effort in 2013-2014 season.

The dynamics of resource lobster *Panulirus argus* in PNAX during the 2013-2014 season was represented by a model of depletion (Medley & Ninnes 1997, Sosa Cordero 2003, Babcock et al. 2014). The model was fitted to monthly values of total catch in Kg tail, and monthly averages of catch per unit effort (CPUE) -index of relative abundance in Kg per hour tail diving (Figs. 16 and 17). Resource modeling gave just after finishing the closure period, after four months without fishing beginning. It is considered that during the closure key processes occur: *a)* redistribution of resources from natural habitats, empty holes are occupied by the recruits lobsters and survivors of the previous season; and *b)* a pulse of recruitment from May to June, with the addition of new lobsters.

Model of the population, expressed by:

$B_{t+1} = (B_t - C_t) \cdot e^{-m''}$ Model of depletion (Dpm)

Where,

B_t is biomass or population size lobster tail kg at the beginning of the time interval t, in this case from day t;

C_t; *is the total catch of lobster tail kg of* month t. It is an observation or data files recorded in the cooperative "Andrés Quintana Roo" therefore is a census of fishing activity in the study area.

m'*is* the natural mortality rate, here set at = *0.03 (= 0.36 / 12). Est* and external value *M* = 0.36 (year $^{-1}$) was taken from the literature (de Leon and Arce 2001, Medley & Ninnes 1997, Sosa Cordero 2003). *M* is one of the most difficult parameters to estimate. To some extent includes the rate of permanent emigration of lobster from shallow areas where fishing is by free diving. A fraction of lobster leaving the fishing area and goes into deeper waters, at depths greater than 18-20 m.

B_0 is initial size of the lobster population in the area just before the fishing season; ie is biomass lobster tail in Kg, 30 June 2013. This model parameter estimation of the population to fit the data (observations) of relative abundance is obtained $CPUE_{obs,t}$.

Recruitment in the season. According to the equation in the model, there is no recruitment during the lobster season. This assumption of "zero" recruitment was reconsidered in view of the rise of CPUE , relative abundance index in December 2013 and the reduction in the average weight of captured lobsters (Fig. 16). The solution *ad hoc* was to assume that in December 2013 they were recruited , with $R_{in-season}$, con $R_{in-season}= {B_0}/{3}$.=. *A*rbitrarily fixing the recruitment season at a third of the initial biomass avoids estimating an additional parameter. This is not necessary if the number of monthly data It is longer, and can include a greater number of recruitment parameters $R_{in-season}$, to estimate the process model fit to the data. No history of models that postulate recruitment during the season, in the bays of RB Sian Ka'an (Sosa Cordero 2005); and in towns of Belize (Babcock et al. 2014).

The model of the observations establishes the relationship between the model predictions and data and observations of CPUE; ie between entre $CPUE_{modelo,t}$ and $CPUE_{obs,t}$

Model of observaciones, expressed as:

$CPUE_{obs,t} = q \cdot B_{t+0.5} + \varepsilon_t \qquad \varepsilon_t \sim N(0, \sigma^2)$ Model of observations

$CPUE_{obs,t}$ is observing the relative abundance index in month t, expressed by the catch per unit effort in Kg tail for hours of diving,

q is catchability coefficient, a constant of proportionality between the observation $CPUE_{obs,t}$ in month t and the mean abundance predicted by the model *given by the product* $CPUE_{modelo,t}= q \cdot B_{t+0.5}$;

$B_{t+0.5}$ is average biomass of the stock in month t; lobster biomass being half the unit time interval. In the middle of the month t, biomass is given by the approximation: $B_{t+0.5} \approx B_t - \frac{C_t}{2}$.

The adjustment criterion applied in this section was the least squares method which assumes that the data (CPUE) follow the Normal distribution. The use of a more sophisticated approach is postponed: the maximum likelihood method, which suggests that the data (CPUE) follow a lognormal distribution or Gamma.

Below the graphs of model fit are shown with the natural mortality rate fixed at *M* = 0.36 (year $^{-1}$). Table 7 contains the results of the model fit. Visually, it seems a reasonable accommodation

because overall the model predictions follow the trend of the data (Fig. 17). According to the model results, just before opening the season (30 June 2013), the lobster population in PNAX had total biomass of 4,474 kg of tails (Table 7, Fig. 18). At the end of the season, in February 2014 due to the elimination by successive captures and natural mortality had a biomass of 2,670 kg of tails (Fig. 18). Thus, in eight months the lobster population was reduced by 1,804 Kg tail; that is, 46.6% of initial biomass (Fig. 18).

The monthly rate of fishing mortality *F* (mes^{-1}), given as $F_t = -LN\left(1 - {C_t}/{B_{t+0.5}}\right)$ *F* (month $^{-1}$), by (Haddon 2011), showed wide variation (Fig. 19), with minimum of 0.04 in February 2014 and up to 0.21 (mm $^{-1}$) in August 2013; with geometric mean of 0.11 (mm $^{-1}$). The rate of fishing mortality *F* (month $^{-1}$) had a cumulative value of 0.98 in the eight months of the 2013-2014 season; equivalent to a high annual rate of fishing mortality, *F* (year $^{-1}$) = 0.98. It must be said that this first estimate of *F* in the areas of fishing PNAX was the result of fitting the model to data in a single season. It is also known that depletion models tend to overestimate fishing mortality. Finally, the data of relative abundance (CPUE) in Xcalak fishery underestimate the abundance of the resource by not including in the correct proportion the size of the population living at depths greater than 18-20 m. In short, it is likely that the actual abundance of the resource exceeds the predictions of the model; similarly, the real value of fishing mortality *F* , is likely to be lower than estimated in this first resource modeling exercise in the PNAX.

Given the above, it is important to emphasize the need to continue efforts of comprehensive monitoring of the fishery, so that current evidence of changes and meets annually increase the number of catch-effort and size composition. The latter will allow a significant improvement in the estimates, on a more reliable basis. Also, with increasing database of the fishery will be possible to apply more sophisticated models and analytical techniques.

Table 7. Results of modeling the lobster resource in PNAX during the 2013-2014 season. With estimates of initial biomass *in K* g tail catchability coefficient (hr diving $^{-1}$) and sum of squared residuals (SRC). The rate of natural mortality *M* = 0.36 (year $^{-1}$) was given as external value taken from the literature [1].

Model parameters	Estimates (units)	Comments
B_0	4,474 (Kg tail)	Initial biomass lobster, just before the season.
q	0.0002050 (diving hr $^{-1}$)	
$R_{in-season}$	1.491 (Kg tail)	Estimate derived from an arbitrary postulate, =
SRC	0.1184	

Note: 1) value of *M* as experts in regional workshops lobster FAO-WECAF 1997-2006.

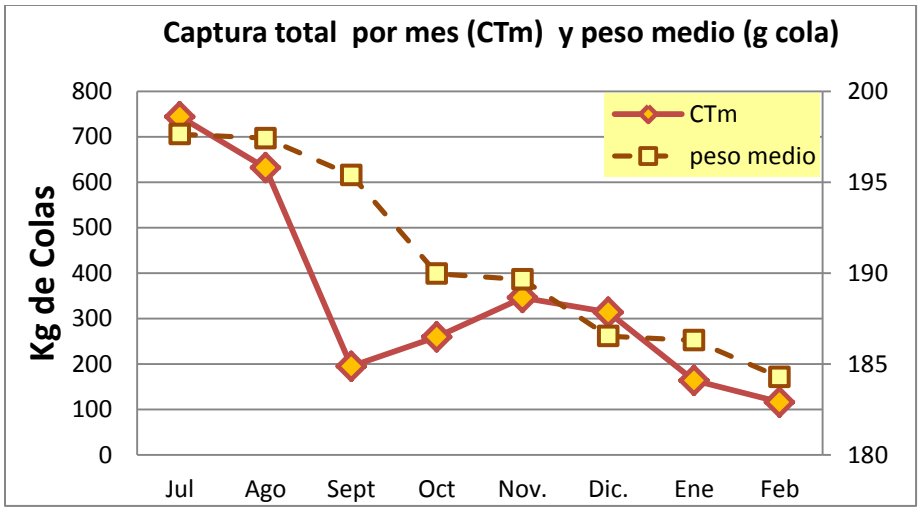


Figure 16. Total catches per month, Kg tail and average individual weight, in grams, of lobsters caught in the PNAX during the 2013-2014 season.

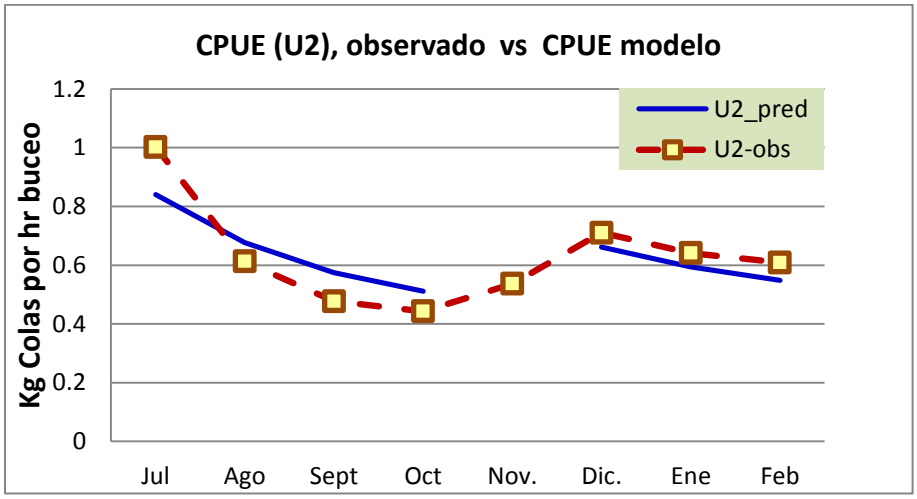


Figure 17. Average monthly catch per unit effort CPUE in kg hr diving tail $^{-1}$, observations (squares, dotted line) and model predictions (solid line), adjusted least squares. Lobster fishery PNAX in the 2013-2014 season.

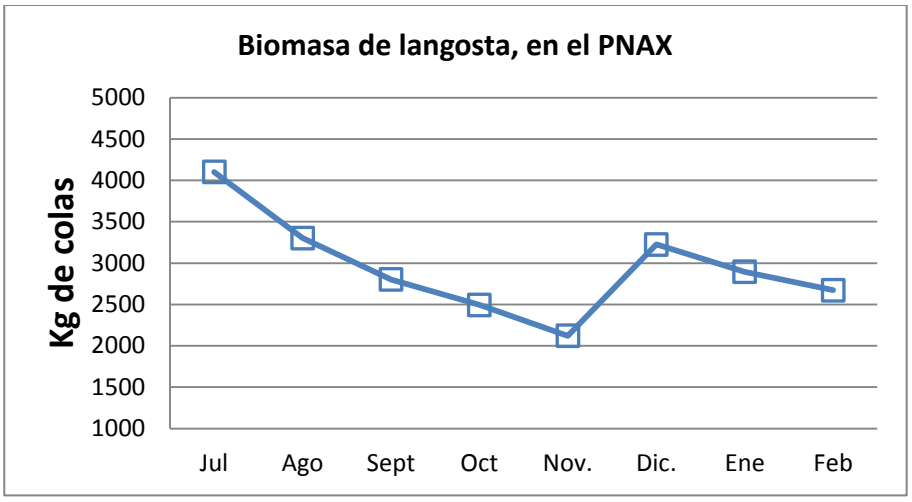


Figure 18. Biomass in Kg tail, local lobster population in PNAX during the 2013-2014 season. Monthly values predicted by the model (open squares) fitted to the data by least squares.

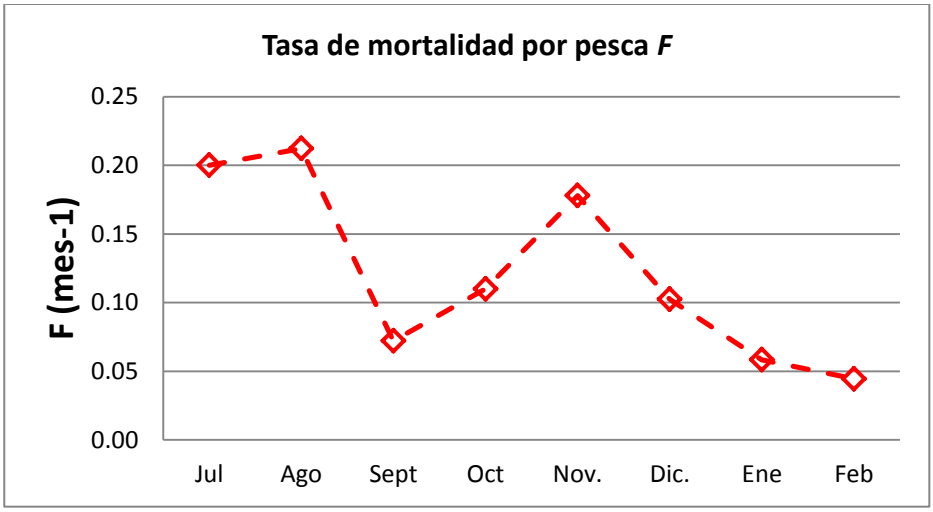


Figure 19. Rate of fishing mortality *F* (month $^{-1}$) in lobster PNAX during the 2013-2014 season (diamonds and dotted line). Monthly estimates of *F* from the model and the total catch per month.

3. General conclusions and recommendations

Based on the results of monitoring of the lobster fishery in the fishing areas of PNAX during the 2013-2014 season, and from the outputs of a series of descriptive analysis and modeling exercises first, it is possible to draw the following conclusions:

- The objectives of monthly monitoring of the lobster fishery, which included every eight months, from July 2013 to February 2014 were met; in the fishing areas of PNAX.
- A sample of considerable size was obtained for catch-effort data with n = 432 fishing trips; size structure (n = 7,223), weight (n = 6,353) and sex in Xcalak, locality where the fishing cooperative "Andrés Quintana Roo" operates.
- The results of monitoring results provide the basis for subsequent, more elaborate analysis aimed at assessing the current state of the lobster resource in PNAX. It is a priority to provide continuity and stability to the monitoring of the lobster fishery in PNAX.

- In the fishing areas of PNAX, the relative abundance index of lobster (CPUE) in two versions, CPUE 1 in kg of lobster tails per trip, and CPUE 2 in kg of lobster tails per hour of diving, followed a seasonal pattern, with highest values at the beginning of the season (July), followed by a gradual and steady decline until December, when a minimum was recorded. A similar pattern has been observed at other locations in Quintana Roo.
- A first assessment was made of the relative abundance of lionfish in lobster fishing areas of PNAX. Based on information from *n* = 385 interviews with fishers, a large proportion of the fishing trips were to places where lionfish was absent (23.4%) or rarely seen (37.4%); intotal 60.8%. In contrast, at 39.2% of sites lionfish were reported to be abundant (16.1%) or very abundant (23.1%). Low abundance of lionfish was the main finding. This first assessment of relative abundance of lobster lionfish in PNAX fishing areas provides a baseline and it is important to gather data in subsequent seasons to detect trends.
- The relative abundance or lobster CPUE was consistent between sites with different levels of relative abundance of lionfish. It is encouraging news that the presence of lionfish has no harmful effects on the relative abundance of commercial size lobsters. This topics warrants further research.
- A large sample of lobster tails was obtained (*n* = 7,223). The minimum tail length was 36.9 mm, and maximum 259.0 mm. The average was 156.1 mm LA and median 155.0 mm.
- The sex of lobsters was determined for all 7,223lobsters measured. 3,946 (54.6%) were females and 3,277 (45.4%) males. Tail length of the males was on average 155.1 ± 14.59 mm, slightly less than the average among females, 157.0 ± 15.4 mm.
- The data indicate that lobster fishing in fishing areas of PNAX targets adults of medium-large size. This is despite the fact that fishing is based on free diving which limits fishing to shallow waters less than 18 meters.
- We encountered a low percentage of lobsters of sub-legal size in the sample caught in the PNAX during the 2013-2014 season. Of the *n* = 7,223 lobsters measured in total, there were only 267 (3.7%) of sub-legal size less than 135 mm tail length. The percentage sub-legal size lobster in PNAX is the lowest in Quintana Roo. We conclude that fishers operating in PNAX generally comply with the regulations on minimum legal size.
- The catch of sub-legal size lobsters is a source of mortality in fisheries using a hook, as is the case in PNAX. This issue requires constant attention and efforts to improve compliance with this current statute.
- For the first time a reliable record has been obtained for the total catch of lobster in the lobster fishing areas located in PNAX. In the 2013-2014 season the total catch of lobster in PNAX was 2719.5 kg of tails, representing about 14,972 individual lobsters. Based on a price of $ 380 pesos MN per kg of tails, the total catch of lobster in the PNAX during the 2013-2014 season represented an income of $ 1,033,410 Mexican pesos equivalent to $ USD $ 76,589.
- Modeling of the lobster resource in PNAX generated an estimate of biomass of 4,470 kg of tails, a coefficient of catchability 0.000250 (hr diving $^{-1}$) and an estimate of recruitment during the season of 1,491 kg of tails. According to the model, and taking into account the effect of losses from successive catches and natural mortality, the lobster biomass in PNAX is estimated at 2,670 kg of tails.

- For every kg of tails sold by a fisher, there is lost income of between $ 150 and 210 pesos MN. Changing from marketing of tails to whole/live lobster is identified as a priority initiative. With a total catch of 2719.5 kg of tails, the AQR cooperative partners collectively missed out on $ 516.705 pesos MN [USD $ 38,274.40; exchange rate pesos $ 13.5MN = USD $ 1.00]. This is a considerable amount, which could be used to cover different needs of partners and the collective organization.
- An additional benefit of changing to marketing of whole/live lobster instead of tails, lies in changing fishing gear from hook to loop. The use of the loop is more lobster-friendly, without allowing the release of gravid females and sub-legal lobsters without lethal harm. A few years ago, this change was achieved with relative ease in Banco Chinchorro Biosphere Reserve. Achieving this in PNAX could also help extend MSC certification of the lobster fishery to PNAX, an advantageous distinction that is already in force in Banco Chinchorro.
- Based on the progress achieved in this project, especially in terms of building an up-to-date database, the groundwork has been set for the next stages of development of research on the lobster resource in PNAX. In particular, research to strengthen and guide management of this valuable resource locally. The assessment of the lobster resource in PNAX will permit the eventual certification of the lobster fishery.

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APPENDIX I

Table I.1.Comparison of lobster catch volumes, prices and income for the fisher in two cases, in kg of tail and in kg of whole/live lobster. This is based on the capture and sale of lobster tails and conversion of tail weight to whole weight (whole weight = 3 * weight tail). Prices are as on the beach. Exchange rate pesos MN $ 13.5 = US $ 1 was used as valid during the 2013-2014 season.

General case, per unit volume and unit price				**PNAX, total catch 2013-2014**		
	Volume, kg	Price $ MN	Total $ MN	Volume, kg	Total Price $ MN	Total Price $ USD
Tails	One	$ 380.00	380.00	2719.5	1'033,410	76.589
Whole / Live	Three	$ 190.00	570.00	8158.5	1'550,115	114.823
Difference			**190.00** (pesos MN)		**$ 516.705** (pesos MN)	**$ 38.274** (USD)

APPENDIX XIV

Monitoring and evaluation of the lobster fishery in Arrecifes de Xcalak National Park

Project supported by GCFI-NOAA CRCP; implemented by ECOSUR –CONANP.

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Beatriz Hernández Millán, Severo Díaz Larios.

ECOSUR CONANP

Barbados 2014

SUMMARY

- Monitoring and evaluation of lobster in Arrecifes de Xcalak National Park
- Principal results achieved
---> Catch effort in the lobster fishery
---> Size composition, sex and observations (eg. lobster health, presence of lionfish)
- Recommendations for management
- Next steps and additional considerations

Form 1: Catch effort, size and sex per fishing trip

PPD /Integradora de Pescadores SA de CV/ RB Sian Ka´an-CONANP
Monitoreo de la Pesqueria de Langosta *Panulirus argus* /**Bahía de la Ascensión**

Formato 1: Captura-esfuerzo y tallas-sexo, por viaje de pesca (1/2)

Colectores:

#	Longitud Carapacho (mm)	Peso Total (g)	Sexo (M/H)	Observaciones*	#	Longitud Carapacho (mm)	Peso Total (g)	Sexo (M/H)	Observaciones*
01					31				
02					32				
03					33				
04					34				
05					35				
06					36				
07					37				
08					38				
09					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				

Collectors:
* Indicate: Other species, female with eggs (HO), tail size (length, abdominal mm), recent moult (S)

Form 2: Catch effort, size and sex per fishing trip

Ingresos del viaje de pesca:
Captura de langosta_____# o Kg ☐ entera ☐ colas Precio_____ $/kg Subtotal $_____

Especies incidentales	Kg	$/Kg	Subtotal $
1.			
2.			
3.			
4.			

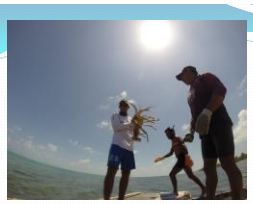
Datos del esfuerzo de pesca:
Lugar_____ Nombre de la embarcación/pescador_____ **Fecha**_____
Método de pesca: ☐buceo a pulmón ☐Hábitat natural ☐Casitas
Arte de pesca: ☐gancho ☐jamo ☐lazo
Area de pesca_____ Posición (GPS)_____ _____ Profundidad_____brazas
Tripulantes_____ Hora de salida_____ Hora regreso_____ Casitas revisadas_____

Costos del viaje de pesca de la embarcación
Gasolina _____ l precio, gasolina _____$/l Aceite ____l precio, aceite _____/l Alimento $___ Hielo $___
Colectores:

New questions added:
-- Relative abundance of lionfish at fishing sites
-- Lobster health

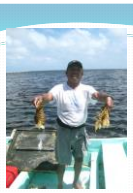
MONITORING: KEY VARIABLES

- Catch - number or weight
- By-catch
- Other questions about lionfish and lobster health
- Fishing effort - time of departure and return, number of divers, fishing area/site
- Costs – fuel, oil, food, ice, bait etc











2013-2014 MONITORING ARRECIFES DE XCALAK

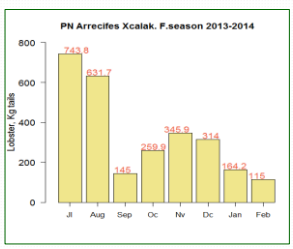
Meses	Entrevistas, captura-esfuerzo (viajes, n)	Tallas de langosta (mediciones, n)
Julio	122	2,467
Agosto	66	950
Septiembre	71	1,047
Octubre	40	619
Noviembre	40	517
Diciembre	7	414
Enero	42	162
Febrero	44	811
PN Arrecifes de Xcalak	432	7,223

Sampling

- ❑ Every month
- ❑ Large sample sizes

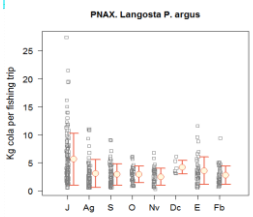
COOP ANDRÉS QUINTANA ROO/ MONTHLY CATCH

Total Catch 2013-2014: **2,719.5** **kg of tails**
14,974 **number of lobster**



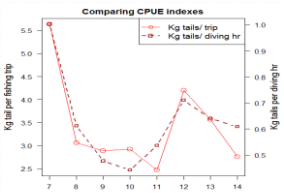
Month	Number
Jul	3,978
Ago	3,727
Sept	778
Oct	1,398
Nov	1,800
Dic	1,746
Ene	931
Feb	644
Total	**14,974**

CPUE: KG OF TAILS PER TRIP / 2013-2014 LOBSTER SEASON

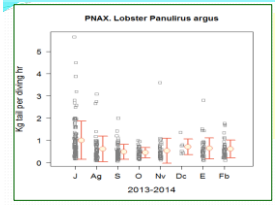


- Sampling during 8 months, **n= 430** fishing trips
- Monthly CPUE mensual, relative **abundance index,** productivity of site

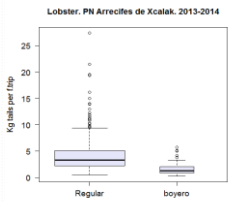
- Seasonal pattern typical of the central coast and south of Quintana Roo, with greatest catch at the start of the season
- Average CPUE in the park is highest at the start of the season, with 5.6 kg of tails per trip, and gradually reduces to 2.5 kg in November.



CPUE: Kg of tails per hour of diving / 2013-2014 Season

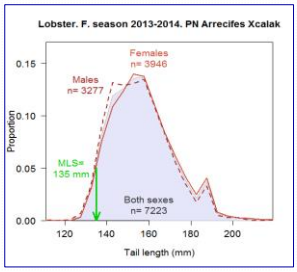


- Second index, based upon dive time and number of divers per vessel
- Monthly CPUE is preferable index of relative abundance
- Typical seasonal pattern increses for both indices of CPUE. Decae Jul-Nov; Dic*



- Sampling during 8 months, **n= 430** fishing trips
- Monthly CPUE mensual, relative **abundance index,** productivity of site

Lobster size, total and by sex / 2013-2014 Season

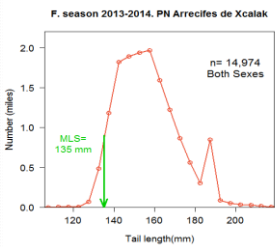


Total samples

Sampling during 8 months **n= 7,723** lobster

- **45.4%** male and **54.6%** female
- Similar male and female size distribution by size intervals
- Few illegal lobster **(3.7%)**. Minimum size: **13.5 cm tail and 74.5 mm de carapace.**

Coop Andrés Quintana Roo / size frequency



Of the total catch of **14,974** lobster; **3.7 %** de langostas sub-legales (=559)

Moderate-high presence of large lobster of 160 to 190 mm.

The presence of lobster larger than 160 mm indicates the existence of a **local population of large reproducing lobster**.

DISCUSSION

- Monitoring of the lobster fishery was completed from July 2013 to February 2014; and included all months. There was complete monitoring of the season.
- A large sample size was achieved for catch effort (***n***= 430) and size (***n***= 7,723).
- In general, the findings can be considered to reflect the successful application of best fishing practices. There is no reason for alarm.

RECOMMENDATIONS

- The total production of lobster in Arrecifes de Xcalak National Park was **2,719.5 kg of tails in 2013-2014, or** approx.**14,974** langostas. Their sale generated around **$1,000,000 pesos** MN. If they had been sold whole, they would have generated **$1,468,000 pesos**. This represents a potential profit to the cooperative of $**468,000 pesos** (USD $ 34,600).
- It is important to continue this high level of contact between fishers, authorities (including CONANP) and researchers.
- The continuation of monitoring permits not just the evaluation of the resource, but facilitates close relations with fishers.
- The introduction of casitas cubanas by the cooperative could increase production.

BENEFITS OF A HEALTHY LOCAL STOCK OF LARGE LOBSTER/SEXUALLY MATURE ADULTS

- According to studies presented in Cancún (May, 2014) it's possible that there is on average 20% local recruitment
- Maintaining a local population of large reproducing lobsters can have results if the protected area is sufficiently large, at least covering one bay.
- The presence of a healthy local population of large reproducing lobsters brings benefits for the coral reef.
- Release of live lobsters costs money and labour, but will likely have benefits in 3-4 years. **These costs are moderate and will pay off in the short-medium term.**
- In the medium-long term, the introduction of a maximum size limit is a regional objective. The proposal is to include a maximum size limit as part of the **internal regulations of the cooperative**. Effective and simple!

Acknowledgements

• Socios y directivos de la cooperativa "Andrés Quintana Roo", "Langosteros del Caribe" y "Cozumel".

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• Apoyo institucional de ECOSUR, staff administrativo y de apoyo.

• Aportación de fondos: **GCFI/NOAA CRCP.**

APPENDIX XIV

Monitoring and evaluation of the lobster fishery in Arrecifes de Xcalak National Park

Project supported by GCFI-NOAA CRCP; implemented by ECOSUR –CONANP.

Ericka Hernandez Montenegro/CONANP
E. Sosa-Cordero, A. Ramírez González/ECOSUR
Beatriz Hernández Millán, Severo Díaz Larios.

ECOSUR CONANP

Barbados 2014

SUMMARY

- Monitoring and evaluation of lobster in Arrecifes de Xcalak National Park
- Principal results achieved
---> Catch effort in the lobster fishery
---> Size composition, sex and observations (eg. lobster health, presence of lionfish)
- Recommendations for management
- Next steps and additional considerations

Form 1: Catch effort, size and sex per fishing trip

PPD /Integradora de Pescadores SA de CV/ RB Sian Ka´an-CONANP
Monitoreo de la Pesqueria de Langosta *Panulirus argus* /**Bahía de la Ascensión**

Formato 1: Captura-esfuerzo y tallas-sexo, por viaje de pesca (1/2)

Colectores:

#	Longitud Carapacho (mm)	Peso Total (g)	Sexo (M/H)	Observaciones*	#	Longitud Carapacho (mm)	Peso Total (g)	Sexo (M/H)	Observaciones*
01					31				
02					32				
03					33				
04					34				
05					35				
06					36				
07					37				
08					38				
09					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				

Collectors:
* Indicate: Other species, female with eggs (HO), tail size (length, abdominal mm), recent moult (S)

Form 2: Catch effort, size and sex per fishing trip

Ingresos del viaje de pesca:
Captura de langosta_____# o Kg ☐ entera ☐ colas Precio_____ $/kg Subtotal $_____

Especies incidentales	Kg	$/Kg	Subtotal $
1.			
2.			
3.			
4.			

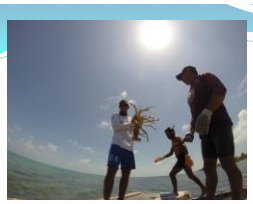
Datos del esfuerzo de pesca:
Lugar_____ Nombre de la embarcación/pescador_____ **Fecha**_____
Método de pesca: ☐buceo a pulmón ☐Hábitat natural ☐Casitas
Arte de pesca: ☐gancho ☐jamo ☐lazo
Area de pesca_____ Posición (GPS)_____ _____ Profundidad_____brazas
Tripulantes_____ Hora de salida_____ Hora regreso_____ Casitas revisadas_____

Costos del viaje de pesca de la embarcación
Gasolina _____ l precio, gasolina _____$/l Aceite ____l precio, aceite _____/l Alimento $___ Hielo $___
Colectores:

New questions added:
-- Relative abundance of lionfish at fishing sites
-- Lobster health

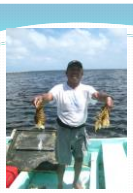
MONITORING: KEY VARIABLES

- Catch - number or weight
- By-catch
- Other questions about lionfish and lobster health
- Fishing effort - time of departure and return, number of divers, fishing area/site
- Costs – fuel, oil, food, ice, bait etc











2013-2014 MONITORING ARRECIFES DE XCALAK

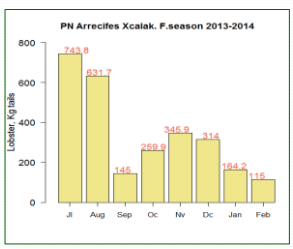
Meses	Entrevistas, captura-esfuerzo (viajes, n)	Tallas de langosta (mediciones, n)
Julio	122	2,467
Agosto	66	950
Septiembre	71	1,047
Octubre	40	619
Noviembre	40	517
Diciembre	7	414
Enero	42	162
Febrero	44	811
PN Arrecifes de Xcalak	432	7,223

Sampling

- ❑ Every month
- ❑ Large sample sizes

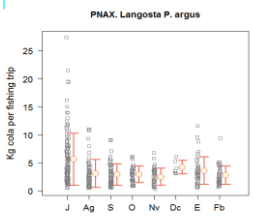
COOP ANDRÉS QUINTANA ROO/ MONTHLY CATCH

Total Catch 2013-2014: **2,719.5** **kg of tails**
14,974 **number of lobster**



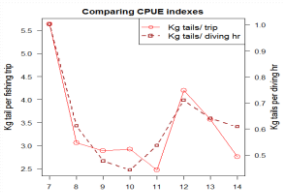
Month	Number
Jul	3,978
Ago	3,727
Sept	778
Oct	1,398
Nov	1,800
Dic	1,746
Ene	931
Feb	644
Total	**14,974**

CPUE: KG OF TAILS PER TRIP / 2013-2014 LOBSTER SEASON

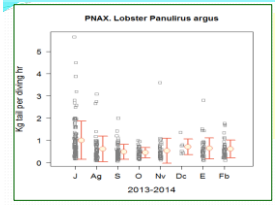


- Sampling during 8 months, **n= 430** fishing trips
- Monthly CPUE mensual, relative **abundance index,** productivity of site

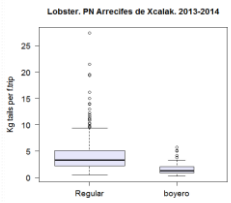
- Seasonal pattern typical of the central coast and south of Quintana Roo, with greatest catch at the start of the season
- Average CPUE in the park is highest at the start of the season, with 5.6 kg of tails per trip, and gradually reduces to 2.5 kg in November.



CPUE: Kg of tails per hour of diving / 2013-2014 Season

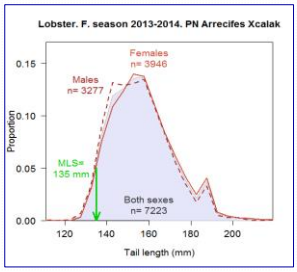


- Second index, based upon dive time and number of divers per vessel
- Monthly CPUE is preferable index of relative abundance
- Typical seasonal pattern increses for both indices of CPUE. Decae Jul-Nov; Dic*



- Sampling during 8 months, **n= 430** fishing trips
- Monthly CPUE mensual, relative **abundance index,** productivity of site

Lobster size, total and by sex / 2013-2014 Season

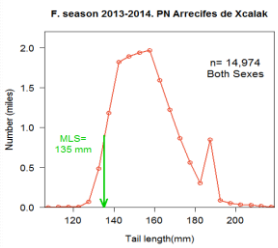


Total samples

Sampling during 8 months **n= 7,723** lobster

- **45.4%** male and **54.6%** female
- Similar male and female size distribution by size intervals
- Few illegal lobster **(3.7%)**. Minimum size: **13.5 cm tail and 74.5 mm de carapace.**

Coop Andrés Quintana Roo / size frequency



Of the total catch of **14,974** lobster; **3.7 %** de langostas sub-legales (=559)

Moderate-high presence of large lobster of 160 to 190 mm.

The presence of lobster larger than 160 mm indicates the existence of a **local population of large reproducing lobster**.

DISCUSSION

- Monitoring of the lobster fishery was completed from July 2013 to February 2014; and included all months. There was complete monitoring of the season.
- A large sample size was achieved for catch effort (***n***= 430) and size (***n***= 7,723).
- In general, the findings can be considered to reflect the successful application of best fishing practices. There is no reason for alarm.

RECOMMENDATIONS

- The total production of lobster in Arrecifes de Xcalak National Park was **2,719.5 kg of tails in 2013-2014, or** approx.**14,974** langostas. Their sale generated around **$1,000,000 pesos** MN. If they had been sold whole, they would have generated **$1,468,000 pesos**. This represents a potential profit to the cooperative of $**468,000 pesos** (USD $ 34,600).
- It is important to continue this high level of contact between fishers, authorities (including CONANP) and researchers.
- The continuation of monitoring permits not just the evaluation of the resource, but facilitates close relations with fishers.
- The introduction of casitas cubanas by the cooperative could increase production.

BENEFITS OF A HEALTHY LOCAL STOCK OF LARGE LOBSTER/SEXUALLY MATURE ADULTS

- According to studies presented in Cancún (May, 2014) it's possible that there is on average 20% local recruitment
- Maintaining a local population of large reproducing lobsters can have results if the protected area is sufficiently large, at least covering one bay.
- The presence of a healthy local population of large reproducing lobsters brings benefits for the coral reef.
- Release of live lobsters costs money and labour, but will likely have benefits in 3-4 years. **These costs are moderate and will pay off in the short-medium term.**
- In the medium-long term, the introduction of a maximum size limit is a regional objective. The proposal is to include a maximum size limit as part of the **internal regulations of the cooperative**. Effective and simple!

Acknowledgements

• Socios y directivos de la cooperativa "Andrés Quintana Roo", "Langosteros del Caribe" y "Cozumel".

• P.Biól. Beatriz Hernández Millán y P.Biól. Severo Díaz Larios, estudiantes del ITCH, por su intenso trabajo en el campo.

• Apoyo institucional de ECOSUR, staff administrativo y de apoyo.

• Aportación de fondos: **GCFI/NOAA CRCP.**

Appendix XV

Assessing tour guide practices and knowledge about Costa Occidental de Isla Mujeres, Punta Cancun and Punta Nizuc National Park in Mexico

[Cancun] (July 10, 2014) ***A new study is underway in Cancun about tourist guide knowledge and practice in relation to the national park.***

With more than 3 million visitors annually, the Cancun area is Mexico's largest tourist destination and most popular beach resort. One of the favorite tourist sites is the National Park, especially Isla Mujeres. Located in the northern part of the Mexican state of Quintana Roo, the NATIONAL park was officially decreed on July 19, 1996, many years after a local grass root organization and the community of Isla Mujeres began lobbying with the Federal Government for the creation of a protected area in its surrounding waters.

"This national park came about as a result of local concern to protect the coral reefs against further degradation," explains the NATIONAL park Director Dr. Jaime Gonzalez. "This includes protection from fishing pressure. In all three areas of the park, Punta Cancun, Isla Mujeres and Punta Nizuc, fishing activities (finfish, conch and lobster) have been prohibited."

"Because of the high number of tourists visiting the park, snorkeling, diving and boating can cause direct physical damage to reefs. This damage consists mostly of breaking fragile, branched corals or causing injuries to massive corals. Although most divers and snorkelers could cause minimal damage, a few can cause severe or widespread damage, and the sum of all these injuries may result in more severe and high impact damage to the reef.

During the period of June 22 until July 3 a new assessment related to the National Park was carried out to measure attitudes, practices and perceptions using a socio-economic monitoring method called SocMon. Regional SocMon Coordinator, Arie Sanders from Zamorano University in Honduras, commented "In this assessment we are especially analyzing the influence of knowledge and attitudes on the practices of tourist guides working in the National Park with respect to environmental change and health."

The park is managed locally by the Management Authority, which consists of a group of three professionals (mainly marine biologists) and six park guards (local community members) who report to the National Commission of Natural Protected Areas (CONANP). Tourist enterprises need permission of the park authority to operate in the protected area, and tourist guides and dive masters must be certified by CONANP.

“Tourist guides can play an important role in protecting the national park and its coral reefs. The adequate training of tourist guides can greatly help to reduce tourism’s negative impacts in the protected area, and our study will help show where and how training should be focused” explained Arie Sanders.

Face-to-face interviews have been held with 137 tourist guides and the results of the study will be available in the end of August 2014.

The training was initiated by the National Park in partnership with the Gulf and Caribbean Fisheries Institute (GCFI). It is part of a two-year cooperative agreement with NOAA’s Coral Reef Conservation Program to build marine protected area management capacity in the Mesoamerican Reef region.

For more information please contact: Arie Sanders (asanders@zamorano.edu)

Appendix XVI

Assessing tour guide practices and knowledge about Costa Occidental de Isla Mujeres, Punta Cancun and Punta Nizuc National Park in Mexico

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For more information please contact: Arie Sanders (asanders@zamorano.edu)

APPENDIX XVII

Appendix XVII

Management Plan Generated from the CaMPAM MPA Database

The CaMPAM Database was developed to provide a repository of information to MPA managers and other stakeholders on the resources within the region on an individual MPA scale (http://campam.gcfi.org/CaribbeanMPA/CaribbeanMPA.php). As part of the MesoAmerican Capacity Building project, GCFI developed a template in MSWord which collects data from each MPA record in the database and provides an output in an editable format for further development. The tool is intended to provide a place for an MPA manager to start in the development of their Management Plan. The tool is based upon the guidelines provide by IUCN (see http://www.iucn.org/about/work/programmes/marine/marine_resources/?1600/Marine-and-Coastal-Protected-Areas-A-guide-for-planners-and-managers&ei=3RvST9jYM).

When a user views the record for an MPA, an option is presented that allows that person to view the Management Plan template (Figure 1.)

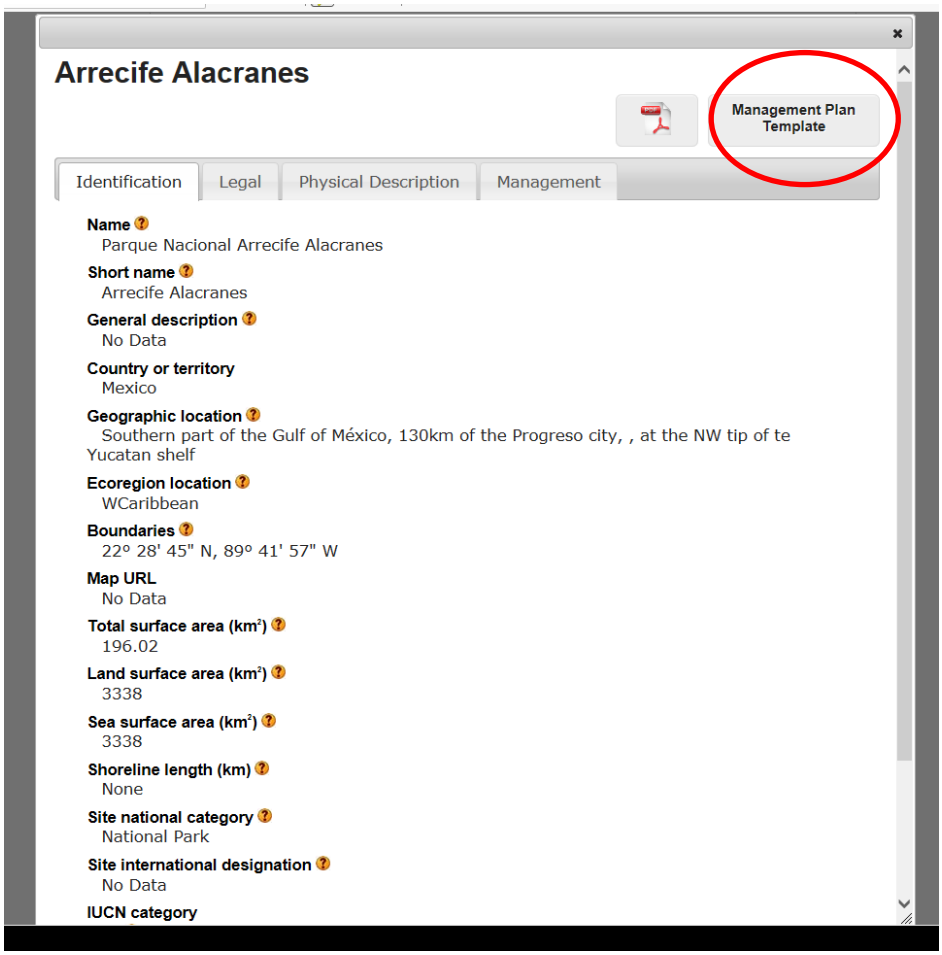
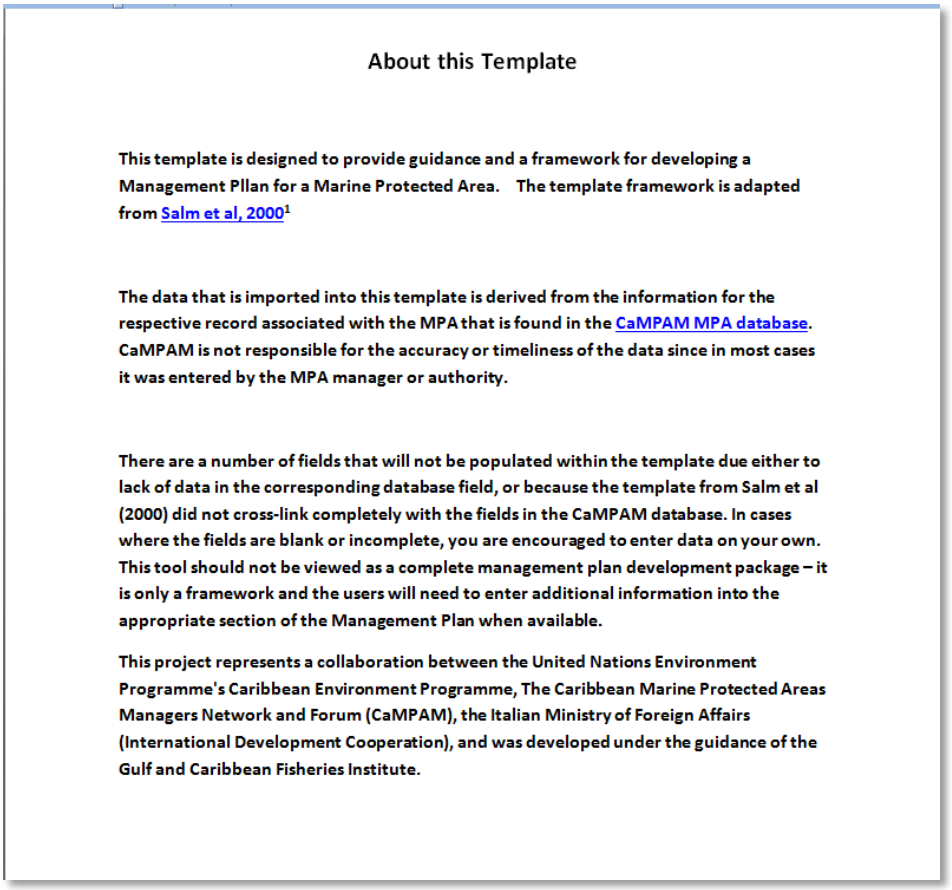


Figure 1. Management Plan template button to begin developing a management plan.

When the user clicks on the management plan template button (Figure 1), (s)he is directed to a screen which provides information about the template including how it should be used (Figure 2).



About this Template

This template is designed to provide guidance and a framework for developing a Management Pllan for a Marine Protected Area. The template framework is adapted from Salm et al, 2000[1]

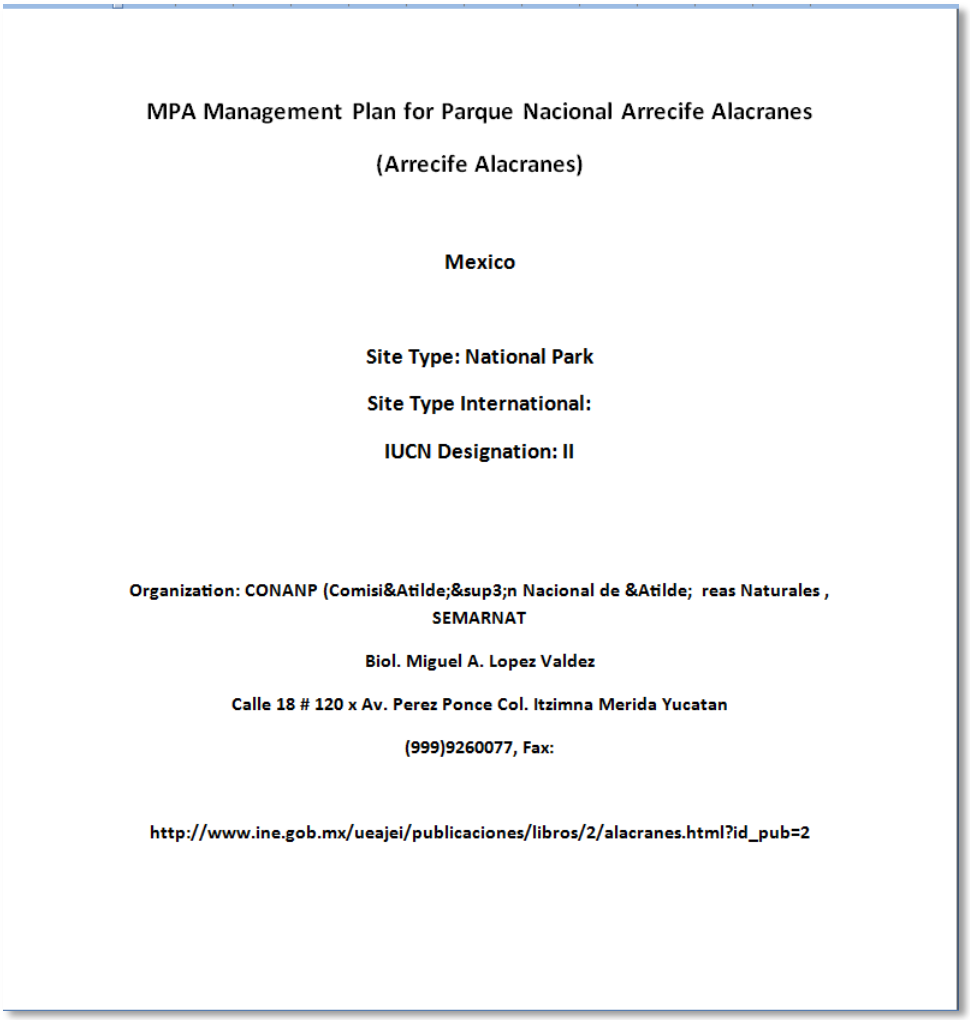
The data that is imported into this template is derived from the information for the respective record associated with the MPA that is found in the CaMPAM MPA database. CaMPAM is not responsible for the accuracy or timeliness of the data since in most cases it was entered by the MPA manager or authority.

There are a number of fields that will not be populated within the template due either to lack of data in the corresponding database field, or because the template from Salm et al (2000) did not cross-link completely with the fields in the CaMPAM database. In cases where the fields are blank or incomplete, you are encouraged to enter data on your own. This tool should not be viewed as a complete management plan development package – it is only a framework and the users will need to enter additional information into the appropriate section of the Management Plan when available.

This project represents a collaboration between the United Nations Environment Programme's Caribbean Environment Programme, The Caribbean Marine Protected Areas Managers Network and Forum (CaMPAM), the Italian Ministry of Foreign Affairs (International Development Cooperation), and was developed under the guidance of the Gulf and Caribbean Fisheries Institute.

Figure 2. The opening screen for the Management Plan template

The user can then scroll down in the document to edit the fields as they are presented. The opening page (Figure 3) provides information about the MPA; subsequent pages provide more details to include within the management plan, if desired (Figure 4). All data is editable to ensure that the management plan is in the format that best suits the needs of a particular MPA.



MPA Management Plan for Parque Nacional Arrecife Alacranes

(Arrecife Alacranes)

Mexico

Site Type: National Park

Site Type International:

IUCN Designation: II

Organization: CONANP (ComisiÃ³n Nacional de Ã reas Naturales , SEMARNAT

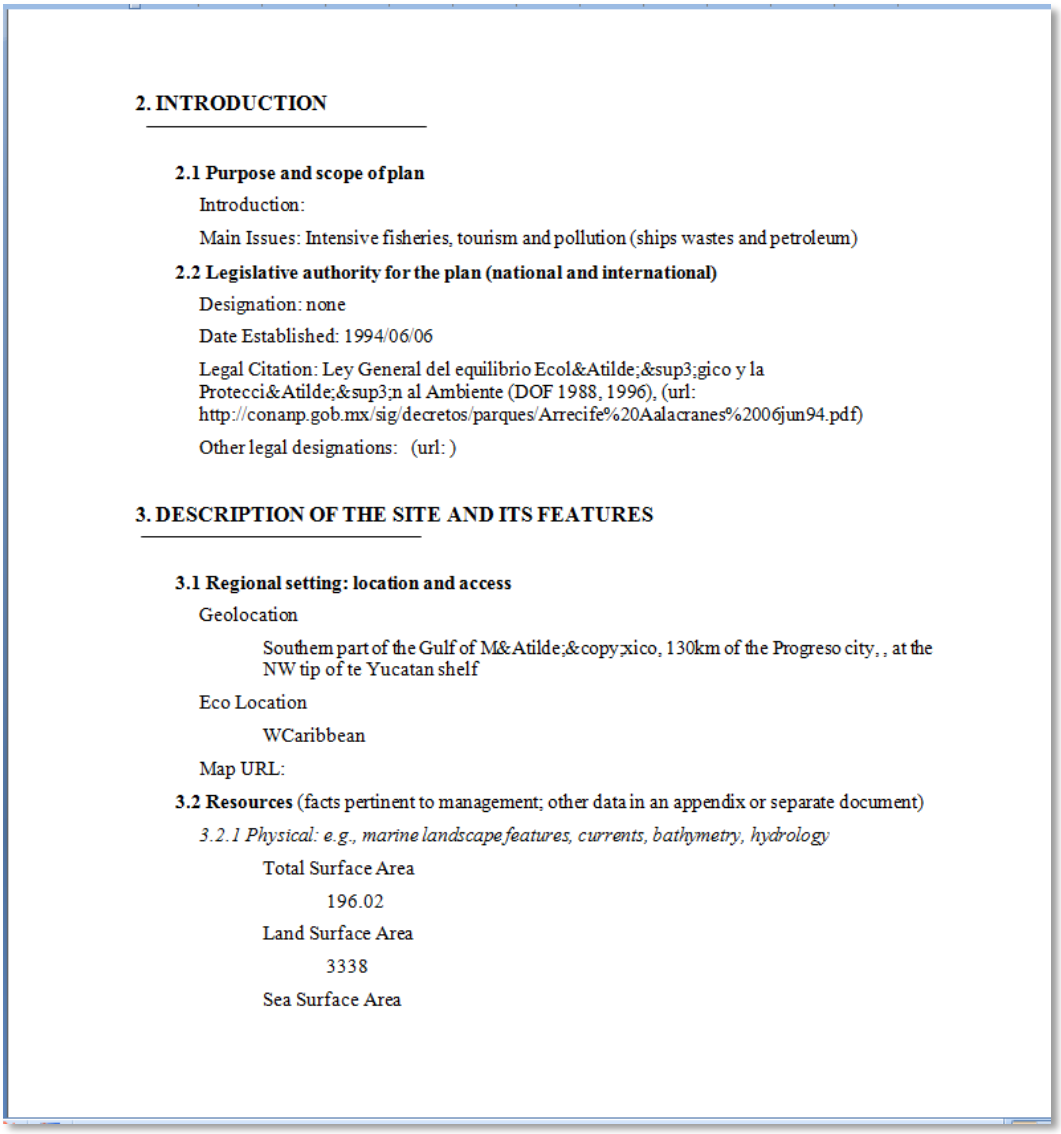
Biol. Miguel A. Lopez Valdez

Calle 18 # 120 x Av. Perez Ponce Col. Itzimna Merida Yucatan

(999)9260077, Fax:

http://www.ine.gob.mx/ueajei/publicaciones/libros/2/alacranes.html?id_pub=2

Figure 3. The opening page of the MPA Management Plan in MSWord format. All information can be changed to best meet the needs of an individual MPA.



2. INTRODUCTION

2.1 Purpose and scope of plan

Introduction:

Main Issues: Intensive fisheries, tourism and pollution (ships wastes and petroleum)

2.2 Legislative authority for the plan (national and international)

Designation: none

Date Established: 1994/06/06

Legal Citation: Ley General del equilibrio EcolÃ³gico y la ProtecciÃ³n al Ambiente (DOF 1988, 1996), (url: http://conanp.gob.mx/sig/decretos/parques/Arrecife%20Aalacranes%2006jun94.pdf)

Other legal designations: (url:)

3. DESCRIPTION OF THE SITE AND ITS FEATURES

3.1 Regional setting: location and access

Geolocation

Southern part of the Gulf of MÃ©xico, 130km of the Progreso city, , at the NW tip of te Yucatan shelf

Eco Location

WCaribbean

Map URL:

3.2 Resources (facts pertinent to management; other data in an appendix or separate document)

3.2.1 Physical: e.g., marine landscape features, currents, bathymetry, hydrology

Total Surface Area

196.02

Land Surface Area

3338

Sea Surface Area

Figure 4. Example page of the MPA template in MSWord which can be edited to meet the needs of individual MPAs.

Appendix XVIII

Implementing Capacity Building in the Mesoamerican Reef MPA Community, 2012-2014

End of Project Meeting

Isla Bonita Yacht Club, Level 2 (through white arch), San Pedro, Belize

September 29 – 30, 2014

Growing out of discussions at the 64th GCFI meeting held in Puerto Morelos, Mexico in 2011, this project started on October 1, 2012 and comes to its conclusion on September 30, 2014.

The project goal was to build capacity for effective implementation of marine protected areas (MPAs) in the Mesoamerican Reef (MAR). Objectives for each site were to improve the tiered ranking of capacity in at least one of the priority management capacity needs as identified in the Caribbean MPA Management Capacity Assessment (http://campam.gcfi.org/CapAssess/CaMPAMCapacityAssessment2011.pdf).

The MPA Management Capacity Assessment showed that the MPAs of the MAR shared particular needs for capacity building that the project addressed, namely: socio-economic monitoring, the development of alternative livelihoods and fisheries management. There are also site-specific needs for sustainable financing and outreach/education that were addressed through the project.

In Year 1, the project included a joint regional workshop on alternative livelihoods and sustainable tourism for MPA staff and stakeholder representatives, and a joint SocMon training workshop. In Year 2, the project permitted implementation of socio-economic monitoring for the MPAs that prioritized this. In both Years 1 and 2, there were a series of special projects to address site-specific priorities at different MPAs, including sustainable financing, fisheries management, sustainable alternative livelihoods and outreach/education.

At this meeting we will focus on sharing the results of the various site-specific projects on which each MPA partner has been working during the last two years. We will focus on the application of findings and recommendations to MPA management, and will work together to ensure that final reporting needs are met. GCFI has been successful in securing funding from NOAA for Phase II of the project, and we will discuss the scope of work and key activities included in this next phase.

This is also a great networking opportunity for the participating MPAs, who last came together in Corozal in February, 2013, and an opportunity to talk with regional experts on Queen Conch, Spiny Lobster and SocMon.

The project has been funded through a FY12-13 Cooperative Agreement with NOAA , to help build MPA management in line with NOAA's international program, in particular following the international strategy to work with regional initiatives to develop and implement long-term MPA capacity building programs based on capacity assessments.

Sustainable tourism field trip, Belize, November 2012

SocMon field work, Coper Bank, Belize, February 2013

SocMon field trip, Belize February 2013

Arrival of Participants - Sunday, September 28, 2014 and Monday, September 29, 2014

Day 1 - Monday, September 29, 2014		
Time	**Activity**	**Presenter**
9:00am–9:30am	Welcome and recap of project objectives, partners and activities Final reporting requirements, match letters	Ms. Emma Doyle, Project Manager, GCFI
9:30am-10:00am	Results of population assessment of Queen Conch *Strombus gigas* in **Parque Nacional Arrecife Alacranes**, Mexico Recommendations for MPA management and monitoring Questions and answers	Dr. Alberto de Jesús Navarrete, EcoSur
10:00am-10:15am Coffee Break		
10:15am-10:45am	Results of fishery assessment of Spiny Lobster *Panulirus argus* in **Parque Nacional Arrecifes de Xcalak,** Mexico Recommendations for MPA management and monitoring Questions and answers	Dr. Eloy Sosa, EcoSur
10:45am-11:00am	Discussion of conclusions and next steps for MPA management and monitoring of Spiny Lobster *Panulirus argus* in **Parque Nacional Arrecifes de Xcalak,** Mexico	Mr. Jorge Goméz Poot, Sub-Director, Parque Nacional Arrecifes de Xcalak
11:00am-11:30am	Progress report on fishery assessment of Spiny Lobster *Panulirus argus* in **Monumento Natural Marino Cayos Cochinos,** Honduras Questions and answers	Mr. Marcio Aronne, Director Conservación y Desarrollo Sostenible, Monumento Natural Marino Cayos Cochinos
11:30am-12:00pm	Progress report on certification programme for lionfish *Pterois miles* and *P. volitans* capture in **Zona de Protección Especial Sandy Bay-West End**, Roatán, Honduras Questions and answers	Mr. Giaco Palavicini, Roatán Marine Park
12:00pm-1:00pm Lunch		

Day 1 - Monday, September 29, 2014 - continued		
Time	**Activity**	**Presenter**
1:00pm-1:30pm	Implementation of microgrant programme to promote sustainable alternative livelihoods in the fishing communities associated with **Half Moon Caye and Blue Hole Natural Monuments**, Belize Lessons learned Questions and answers	Mr. Lucito Ayuso, Community Liaison Officer, Belize Audubon Society
1:30pm-2:15pm	Implementation of microgrant programme and seaweed cultivation to promote sustainable alternative livelihoods in the fishing communities associated with **Port Honduras Marine Reserve**, Belize Lessons learned Questions and answers	Ms. Celia Mahung, Executive Director, TIDE
2:15pm-2:30pm Coffee Break		
2:30pm-3:00pm	Implementation of Reef Protectors education programme, **Half Moon and Caye and Blue Hole Natural Monuments**, Belize Lessons learned Questions and answers	Mr. Lucito Ayuso, Community Liaison Officer, Belize Audubon Society
3:00pm-3:30pm	Progress report on education and outreach activities, **South Water Caye Marine Reserve**, Belize Questions and answers	Mr. Samuel Novelo, Reserve Manager, Belize Fisheries Department
3:30pm-5:00pm	Working session - preparation of final project reports	All participants

Day 2 - Tuesday, September 30, 2014		
Time	**Activity**	**Presenter**
9:00am–9:30am	Results of SocMon baseline study for **Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc**, Mexico Recommendations for MPA management Questions and answers	Mr. Arie Sanders, Regional SocMon Coordinator
9:30am-10:00am	Discussion of conclusions from SocMon study for MPA management at **Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc**, Mexico	Mr. Arturo González, Sub-Director, Parque Nacional Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc
10:00am-10:15am Coffee Break		
10:15am-10:45pm	Results of SocMon baseline study for **Half Moon Caye and Blue Hole Natural Monuments**, Belize Recommendations for MPA management Questions and answers	Mr. Arie Sanders, Regional SocMon Coordinator
10:45am-11:15am	Discussion of conclusions from SocMon study for MPA management at **Half Moon Caye and Blue Hole Natural Monuments**, Belize	Mr. Shane Young, Marine Manager, Belize Audubon Society
11:15am-11:45pm	Progress report on sustainable MPA financing - Ridge to Reef Expeditions, **Port Honduras Marine Reserve**, Belize Questions and answers	Ms. Celia Mahung, Executive Director, TIDE
11:45pm-12:15pm	Overview of Phase II: Building MPA Management Capacity and Coral Reef Resilience in the Caribbean's Mesoamerican Reef Region, 2014-2016 Questions and answers	Ms. Emma Doyle, Project Manager, GCFI
12:15 Lunch		
Afternoon	Working session on SocMon reports with BAS and Cancun	Mr. Arie Sanders, Regional SocMon Coordinator
Afternoon	Working session on MPA enforcement planning with Xcalak and Roatan	Ms. Emma Doyle, Project Manager, GCFI

Departure of participants - Tuesday afternoon, September 30, 2014

Meeting Participants and Contact Information

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