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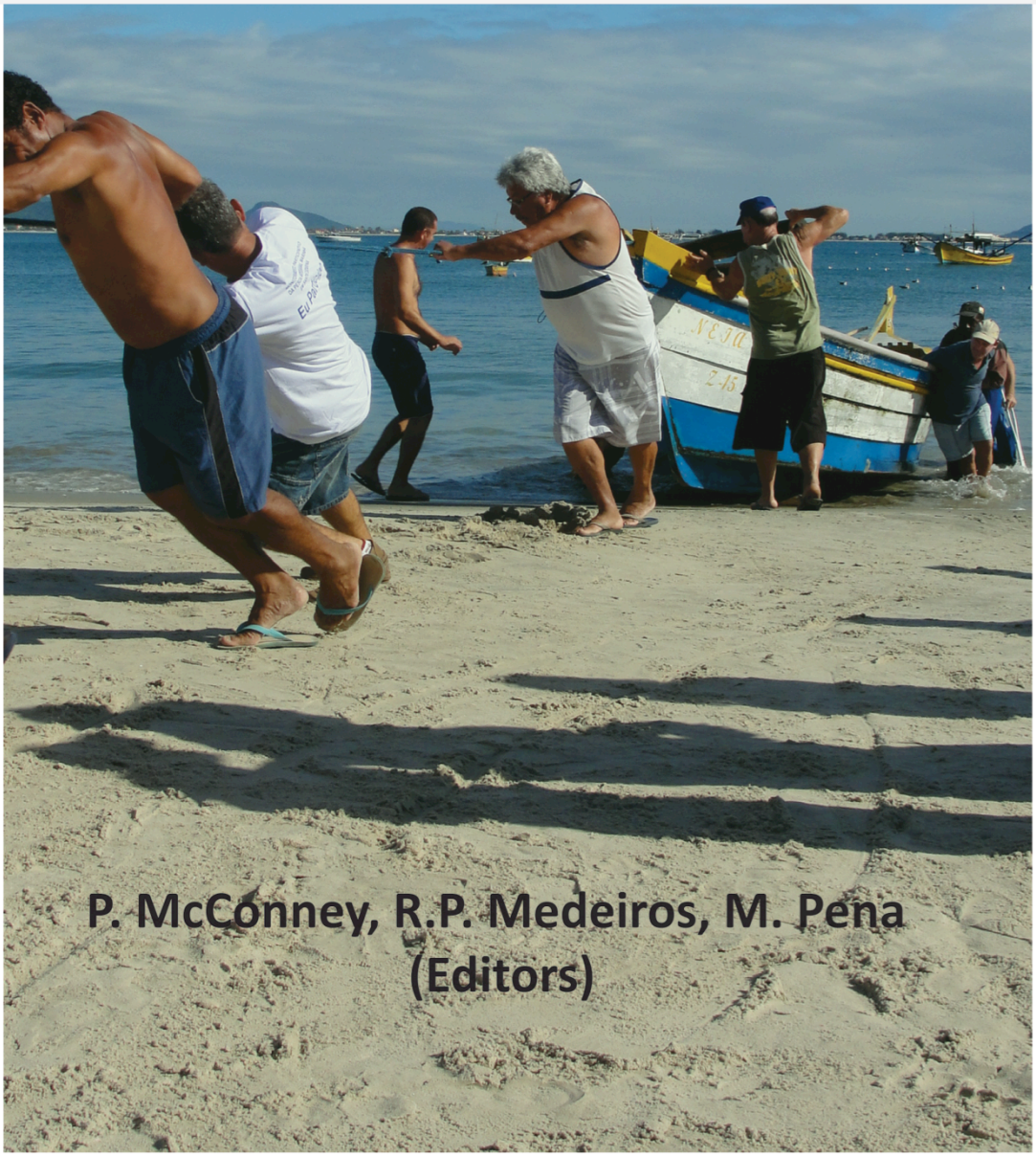
Special Edition

ENHANCING

STEWARDSHIP IN SMALL-SCALE FISHERIES

practices and perspectives



P. McConney, R.P. Medeiros, M. Pena
(Editors)

CERMES UWI

Too BIG To IGNORE
Global Partnership for Small-Scale Fisheries Research

CERMES TECHNICAL REPORT N° 73

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ENHANCING STEWARDSHIP IN SMALL-SCALE FISHERIES: PRACTICES AND PERSPECTIVES

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2014

Acknowledgements

As editors our gratitude must go first to the many authors who made this publication possible. Several authors did not make it from the expression of interest through to the end, but we thank those who started with us, and more thanks to those who also finished and whose contributions are shared in this volume.

There is a great diversity between these covers. Authors range from men and women who have recently concluded, or will soon conclude, their MSc or PhD research to veterans of small-scale fisheries in NGOs, universities or consulting. Special mention must be made of the fishers who provided perspectives. One was the first to submit an article for this e-book.

Even the TBTI Project Director took the time to contribute to a chapter. We thank her, other TBTI colleagues and especially the many supporters of WG4, and the Latin America and the Caribbean region, for making TBTI a truly rewarding SSF research partnership.

Several of the authors, including some who did not continue, served as peer reviewers. We really appreciated the extra input that you made to ensure the quality of this publication. It was especially gratifying to have a truly interdisciplinary set of reviewers to call upon.

Finally we acknowledge the support of our academic institutions at the Centre for Resource Management and Environmental Studies (CERMES) of The University of the West Indies (UWI) in Barbados, and the Centro de Estudos do Mar (CEM) of the Universidade Federal do Paraná (UFPR) in Brazil for allowing us the latitude and time to pursue this publication.

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Introduction

We are facing a rapidly changing world. The last few decades have brought unprecedented changes in ecosystems and in societies [1]. Loss of ecosystem health and biodiversity; social asymmetries and inequities; and food insecurity are leading to increased vulnerability and a reduction of the resilience desirable in social-ecological systems.

Change creates both challenges and opportunities. People have amply demonstrated their capacity to alter the life-support system of the planet. Climate changes and escalating species extinctions are realities amidst an increasing gap between the wealthy and the poor [1]. However, with appropriate stewardship, human capacity can be mobilized to slow or reverse these negative trends. Enhancing stewardship facilitates societal development.

Concerns about the oceans, and especially fisheries, have motivated people to work together in order to address the global "fisheries crisis" [2]. Small-scale fisheries (SSF), and the uncertainties about how they affect or are affected by changes in ecological and social system dynamics, are among the key issues that require immediate attention. Enhancing stewardship is a critical ingredient in the mix of measures required to address the crisis.

TOO BIG TO IGNORE (TBTI)

Too Big to Ignore (TBTI) (toobigtoignore.net) is a global research network and knowledge mobilization partnership on SSF. The main goal of TBTI is to enhance the understanding of the real contribution of small-scale fisheries to food security, nutrition, sustaining livelihoods, poverty alleviation, wealth generation and trade, as well as the impacts and implications of global change processes such as urbanization, globalization, migration, climate change, aquaculture, and communication technology on small-scale fisheries. This SSF research partnership is also concerned with the lack of understanding about both the impacts of SSF on ecosystems and the contribution of SSF to stewardship and conservation.

TBTI is organized around regional issues and thematic research conducted by working groups (WG). One of the themes that TBTI addresses is "Enhancing the Stewardship," which is the focus of WG4. WG4 has worldwide membership and collaborators. The three co-editors are affiliated with WG4. McConney leads WG4, assisted by Pena, at the Centre for Resource Management and Environmental Studies (CERMES) located at The University of the West Indies (UWI), Cave Hill Campus, in Barbados. Medeiros is a member of WG4, working at the Centro de Estudos do Mar (CEM) of the Universidade Federal do Paraná (UFPR) in Brazil. WG4 has three main components associated with social-ecological system concepts and guiding questions.

CONCEPTS AND QUESTIONS

Taking into consideration recent approaches to conceptualizing complex adaptive systems and social-ecological systems [3,4], we acknowledge that SSF are complex adaptive social-ecological systems. Far from trying to control such systems, the approach to stewardship must rely on our ability to develop strategies for understanding and adapting to the complex, unpredictable and emergent properties of such systems [2]. This approach highlights the need for adequate action to promote fisheries sustainability. Cross-disciplinary, participatory

perspectives are essential since multiple interactions between fisherfolk and ecosystems should be understood from different worldviews and disciplinary fields. The perspectives must be linked to practical action, not just theory, if SSF stewardship is to be successful.

For the above reasons this e-book is concerned with both perspectives and practices. The components and guiding questions for WG4 encompass concepts and their application. They are set out in Figure 1.

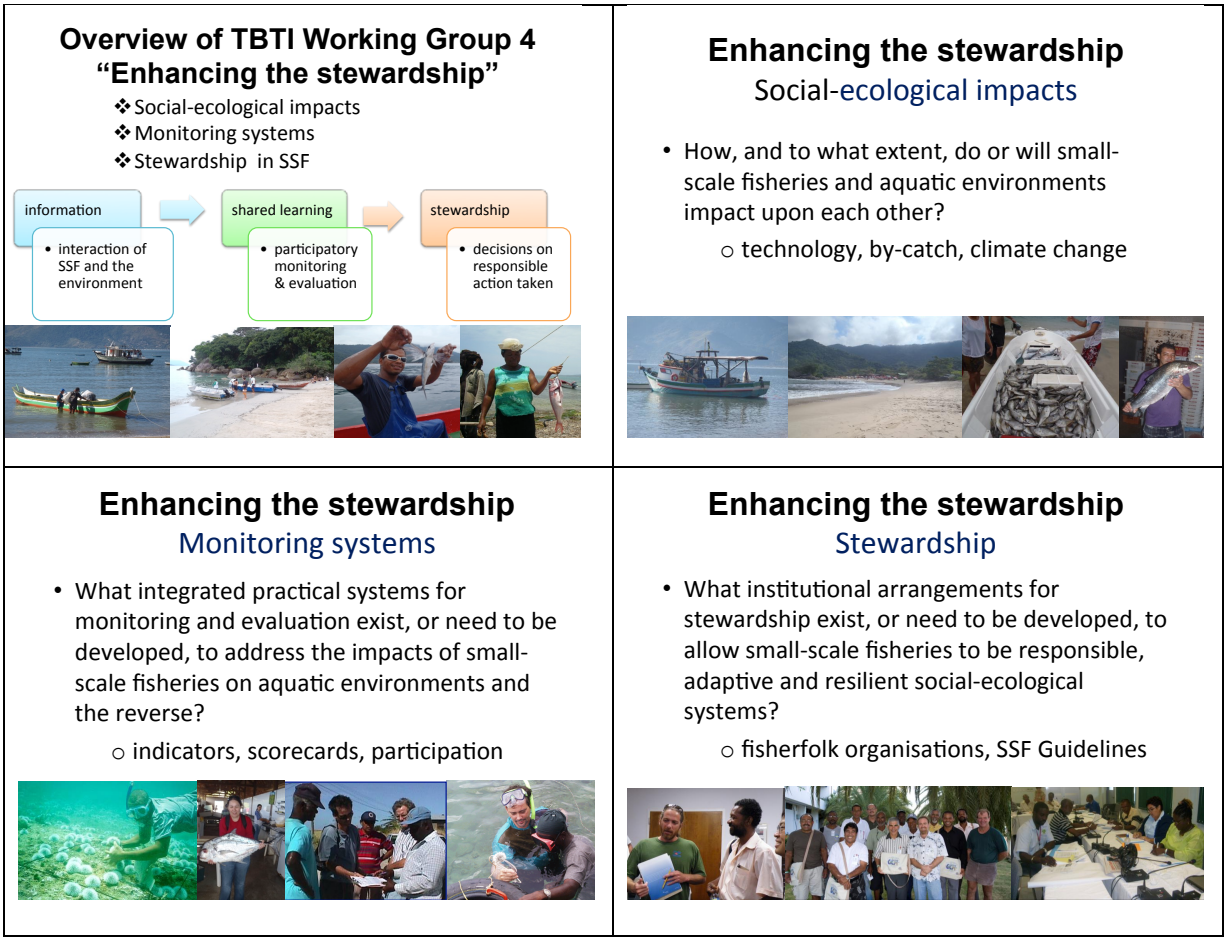

FIGURE 1 OVERVIEW AND GUIDING QUESTIONS FOR THE THREE WG4 COMPONENTS

First, we call attention to the notion of ecosystem stewardship of social-ecological systems. We argue that ecosystem stewardship is necessary to foster resilient and sustainable small-scale fisheries. Ecosystem stewardship here refers to strategies human societies develop in order to address sustainable pathways [5] such as: i) to reduce risks and vulnerabilities; ii) to foster resilience; and iii) to embrace opportunities and transform from undesirable trajectories.

Specific to SSF, what trajectories are undesirable or unsustainable? Three perspectives on this question are prominent. First, we need to consider ecosystem changes and fish stock overexploitation. For example, failure to properly value and manage mangroves and coral reefs leads to conversion of these ecosystems into hotels and ports. Loss of biodiversity and nursery grounds is among the negative outcomes from this conversion. Overexploitation also affects fisheries worldwide, increasing livelihood vulnerability and exposing fishing households to greater risk and food insecurity [6-9].

Second, socio-economic development in coastal areas exposes rural people, including fishers, to higher risks and marginalization [10-12]. The situation is worsened when governing systems neglect or interfere with local institutional dynamics and cultural aspects [13,14]. Abrupt ecosystem changes are not priority concerns of development where newly emerging economic activities, such as mass tourism, temporarily bring wealth while on a trajectory of irreversible and negative environmental change.

Third, the world is overwhelmed by repeated failures to properly manage fisheries and other coastal systems. Fisheries and environmental policies centred on trying to control systems have led to increased unsustainability and social crisis [15]. Institutional inconsistencies regarding what rules should be designed and implemented, which stakeholders should be included or wield power, and how rigid or adaptive to changes the arrangements should be all affect the success of governance [16,17].

As reflected above and in the guiding questions, we need to understand social-ecological impacts; be able to monitor the positive and negative consequences of those changes; and institutionalize stewardship to add resilience to governance.

ORGANIZATION OF THIS BOOK

This book navigates through a variety of experiences from the field shared by authors who offer perspectives and practices relevant to how SSF are dealing with situations that lead to undesirable or to sustainable pathways. Their contributions from all around the world help us to better define what we should expect or promote as ecosystem stewardship. They allow us to better understand and learn from SSF experiences in order to address effective strategies to be adaptive and successful stewards of a rapidly changing world.

The three sections of this book relate to the three questions and components of TBTI WG4 on social-ecological impacts, monitoring and stewardship as shown in Figure 1. There are short academic articles followed by one or more brief perspectives (mainly opinions and experiences). The authors have tried to make the content accessible to a broad audience. There is inevitably some technical and scientific terminology, but the main storylines behind each article should be clear even to readers not used to the jargon of fisheries science. The book concludes with a very short synthesis to pull together some of the main threads in the articles and weave them into a very small tapestry of what sustainable stewardship may look like. We know that SSF are not only too big to ignore, but also too big to fully capture in a volume such as this. However, as you read on, we hope that you get a glimpse of a brighter future for SSF stewardship based on the diverse perspectives and practices. That is our aim.

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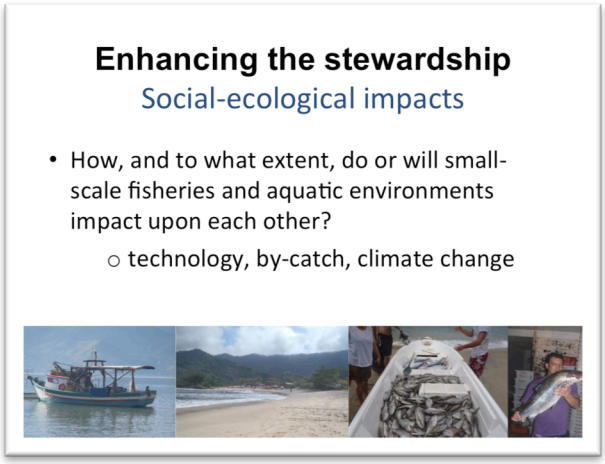
Ecological impacts



Five chapters and a perspective deal with social-ecological impacts, focused more here upon the ecological side of the fishery systems. The articles are from several countries and cultures. A common thread through them is the need to really understand underlying factors and drivers in fisheries systems from the perspectives of the fisherfolk.

In **We always did fish the eels"- Qalipu Mi'kmaq ecological impacts in the American eel fisheries of Western Newfoundland**, the authors evaluate ecological impacts of small-scale eel fisheries and highlight the importance of embracing the local narratives and the understanding of those who participate in fisheries. Their comprehension provides room for ecosystem stewardship by building local institutions to foster resilience and sustainability.

Fishers' perceptions and their responses to changes are explored in **Coral reef fisheries in a changing environment: Perceptions of change and livelihood responses**. Authors discuss how perceptions fluctuate according to local conditions in study cases and highlight how the ability to understand changes can help to nourish sustainable pathways.

Climate change is also a subject of analysis. In **Assessing the vulnerability to climate change of small scale fisheries: The Grenada example**, the authors developed small-scale fisheries specific indicators for the spatial vulnerability assessment of Grenada fisheries to help build the adaptive capacity of Grenada's fishers.

The challenges of evaluating changes in fishery dynamics are addressed in **Assessing changes in small-scale fisheries: Contributions from monitoring in the Aventureiro community at the southeast coast of Brazil**. The authors compared data from research projects after an elapsed period of 15 years and showed how fisheries remained dynamic and relevant despite changes in socio-economic development and institutional changes.

Understanding tradeoffs in fishers decision making: Catch, distance, and safety influence where fishers fish, explores what elements influence fishers deciding where to fish in a coral reef system in the Central Philippines. The authors underline how fishing ground attributes generate trade-offs that fishers factor into making their choices.

Finally we have a fisher perspective on changes in fisheries and ecosystems in **How and to what extent does small-scale fishing (SSF) and the aquatic environment impact each other?** He shows concern about what drives change and calls attention to research needs in order to better understand the interactions between fishing and ecosystems.

“We Always Did Fish the Eels”- Qalipu Mi’kmaq Ecological Impacts in the American Eel Fisheries of Western Newfoundland

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ABSTRACT

To help address the inherent lack of data and knowledge on small-scale fisheries, this research paper investigates the ecological impacts of a small-scale fishery in Western Newfoundland, Canada, from the perspective of Qalipu Mi’kmaq First Nation Band members. Guided by a review of secondary data and semi-structured in-depth interviews, this exploratory study demonstrates research participants’ perception that the ecological impacts of Qalipu fishing practices and gear types in the American eel fisheries are limited both in number and severity.

Key words: small-scale fishery, ecological impact, American eel, Mi’kmaq First Nation

INTRODUCTION

While much research has been conducted on the damages from large-scale fishing practices such as trawling [1], little is known about small-scale fisheries’ ecological footprints. Unfortunately, it is often difficult to assess the ecological impacts of this sector due to the nature of the industry. Small-scale fisheries generally are conducted in remote areas with a lack of monitoring systems, utilize several gear types, operate seasonally, target several species, and are often combined with other livelihood practices.

It is increasingly recognized in environmental policy that the knowledge of indigenous fishers is useful to achieve ecologically sustainable fisheries management and conservation [2]. Improved understanding of indigenous fisheries, technology and management approaches is, however, needed. This study aims to contribute to this understanding through the specific example of the Qalipu Mi’kmaq First Nation Band (QMFNB) members’ participation in American eel fisheries.

BACKGROUND

There have been very few studies on the American eel in the Northern portion of the species’ geographic range, and even fewer studies in Newfoundland and Labrador (NL) [3]. The American eel is currently listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a threatened species and is under consideration for listing by the Federal *Species at Risk Act*. According to its *Endangered Species Act*, the Government of NL also identifies the American eel as a vulnerable species.

In NL, eels are fished recreationally, commercially, and also for food, social and ceremonial (FSC) purposes. Formed as a landless Band, the QMFNB does not currently hold a FSC licence. It is anticipated in the future that the QMFNB may enter into negotiations with Fisheries and Oceans Canada (DFO) to obtain FSC licences for Mi’kmaq culturally

significant species such as the American eel. For the purposes of this article the fishery is, therefore, divided into commercial and recreational practices. The American eel supports "seasonal commercial fisheries at the juvenile (yellow) and sexually mature (silver) stages," and is also the "focus of many fisheries which are of great importance to Aboriginal peoples." Known as 'Kat, Katew or Kataq,' the American eel and its fisheries have been traditionally important to the Mi'kmaq communities in Western Newfoundland since it has been "one of the few fisheries that can be harvested year-round and easily preserved" [3].

Fisheries and Oceans Canada manage American eel fisheries in NL through licence, gear and seasonality restrictions. Due to a DFO ban on the issuance of new American eel commercial licences in 1998 and recreational licences in 1999, the number of commercial and recreational licences has decreased approximately 50% to 192 as of 2009 (154 commercial and 38 recreational) [4]. Of the 154 licenced commercial harvesters, only 40 reported sales. The majority of these landings and all recreational licences came from the southwest coast region, particularly from the Bay St. George/Port au Port Peninsula area. The area is home to multiple Mi'kmaq communities and is where harvesters were interviewed for this study.

While Mi'kmaq peoples have inhabited NL for at least three centuries, most of the province's Mi'kmaq only gained the opportunity for legal recognition with the ratification of the Agreement-in-Principle in 2008 [5,6]. More than 20,000 people from Western Newfoundland have received status as QMFNB members under the *Indian Act*. Over 100,000 people (nearly 20% of the provincial population) have applied to become members [7]. As a relatively new and one of the largest bands in Canada [8], the QMFNB's fishing gears and practices have not been widely assessed.

THE PROJECT

To help address the knowledge gap surrounding ecological footprints in small-scale fisheries, this study explores the ecological impacts of indigenous fishing gear types and practices in Western Newfoundland and whether they could be determined to be low-impact and sustainable according to criteria set by the Marine Stewardship Council's (MSC) risk-based framework (RBF). The MSC's RBF was considered an appropriate framework for use in this study because MSC is considered a global leader in fisheries sustainability certification and places particular focus on the harvesting stage in its assessment of ecological impacts [9,10]. While the MSC offers a valuable framework for the assessment of environmental impacts, the authors acknowledge that multiple concerns and challenges exist related to MSC certification, including marginalization of small-scale and community-based fisheries [9, 11]. This study employed a recently developed MSC methodology for undertaking a risk-based assessment in data deficient situations such as the NL eel fishery and many other small-scale fisheries. Further, the RBF helps address issues with conventional approaches' strong focus on assessing fisheries' sustainability via strictly quantitative data [12].

Through an analysis of the MSC's RBF criteria on direct impacts of fishing, the following categories were identified as applicable to the American eel fishery in Western Newfoundland: capture (e.g. fishing); direct impact without capture (e.g. gear loss, anchoring); movement of biological material (e.g. discarding catch); and the disturbing of physical processes (e.g. through navigation). Data pertaining to each of the categories was

sought and examined in this exploratory study.

The study used interpretative phenomenological analysis, whereby the primary author was able to deeply reflect on her stance in the research and sought to suspend judgment, bias and assumptions during the conduct of ethical research [13,14]. Through the use of this approach, the primary author was able to focus on her interpretation of the phenomenon under review and that of interview respondents, particularly those of Mi'kmaq fishers. Findings were determined through the identification and analysis of themes/patterns in collected data after thorough reading of the interviews' transcripts.

This article is based on findings from a mixture of the researchers' personal experiences and self-reflection, photography, review of previous related scientific knowledge and academic research, and qualitative evidence based on the observations and experiences of eel fishers and fisheries management professionals. Literature review pertaining to the background of the American eel and its recreational and commercial fisheries, the QMFNB, and underlying theory regarding ecological sustainability in fisheries was supplemented with in-depth semi-structured interviews with ten key informants from management agencies and eel fishers from the from the Bay St. George area, where there is a concentration of Mi'kmaq eel fishers [15]. Consistent with the Aboriginal Fisheries Strategy Agreement's terms and conditions, the Aboriginal Fisheries Guardians Program interest is in the "conservation, protection and management of inland fisheries resources." Although the Program started as a one-year initiative, it has been renegotiated each year since 1992.

The interviews offered extensive, specialized knowledge of the ecological impacts of the American eel fisheries in Western Newfoundland based on informants' intimate involvement in these fisheries. The participants in the study included five active and former Mi'kmaq eel fishers, both commercial and recreational (three active and two retired), that were recommended as key informants by the QMFNB as gatekeepers. One of these respondents was also a former River Guardian and an Aboriginal Elder. Four representatives of DFO and one representative of the Government of NL's Wildlife Division were also interviewed, representing key individuals with responsibility for management of the eel fishery.

FISHERIES NARRATIVES

Recreational Fishery

There are three primary periods of recreational eel harvesting by QMFNB members in Western Newfoundland. Information on harvesting was obtained primarily by interview. The first period occurs during the month of May when the fishers pursue eels that are travelling from inland down towards oceanic waters. The second period spans during summer months and typically occurs within "the first part of June, July and August" along coastlines during low tides. During these first two periods, the main fishing gear used by QMFNB members is a traditional handmade gaff. According to an Elder, a gaff is "a stick about three feet long with a fishing hook on the end." The practice of gaffing has been used to harvest both lobsters and eels by QMFNB members, and takes considerable patience and technique.

FIGURE 1 WINTER EEL SPEARING

"It's the only fishery that I miss." [Interview]

The third occurs during late fall and early winter; It typically starts in November and continues until "the ice gets too thick to be able to cut through to get at the mud level" within the mud banks of inland waters. The greatest fishing effort exerted by QMFNB members in the recreational fishery is during the winter period. Starting in November, the fishers will travel to frozen estuaries and cut holes in the ice of approximately three feet in diameter. Eel fishers have generally crafted their own spears, each averaging approximately 12 feet in length. Although the water is generally no more than four to five feet deep, the long handle of a spear allows fishers to achieve multiple angles underneath the ice while spearing.

Predating the usage of gear commonly used in the current commercial fishery, spearing eels has been a longstanding tradition for the Mi'kmaq of the Bay St. George area. As one eel fisher suggests, "We always did fish eels, from my grandfather's time right up to my father's time right up to me, to our time. … But those days – our parents' days – they never did fish with the nets; they always fish it with spears."

Overall, according to one Elder, there remains in excess of "150-200 [members of the QMFNB] who pursue the eel fishery for recreation." However, recent changes to fisheries management regulations from DFO appear to have made it more difficult for QMFNB members to traditionally fish for the pursuance of food due to a ban on new commercial and recreational American eel licences. Interviews with QMFNB members revealed that many spearers were taken aback by the ban.

During interviews with QMFNB members, it became clear that they have tended to perceive their participation in the American eel fishery as artisanal or small-scale in nature rather than recreational. Although the Miawpukek First Nation in southern Newfoundland hold a FSC licence for American eel, the QMFNB does not possess such a collective licence. While in the eyes of fisheries management, members of the QMFNB have conducted recreational eel harvesting for decades and members of the QMFNB have had to apply for recreational American eel licences, their primary purpose to fish eels for personal consumption appears

to side with the Food and Agriculture Organization of the United Nations (FAO) definition of artisanal fisheries rather than recreational fisheries. The FAO suggests that artisanal fisheries are traditional fisheries that use "relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption", while recreational fisheries are for "personal use, fun, and challenge" and exclude sale, barter or trade [16,17].

Commercial Fishery

In NL, fyke nets and pots are the only two gear types allowed by DFO for commercial harvesting of American eel. These regulated fishing gears do not have as deep traditional roots such as gaffing and spearing. According to DFO's commercial eel licence conditions, eel fishers must set their gear within the location coordinates indicated by their licence [18]. Interview respondents indicated that most QMFNB commercial fishers start their season by setting their fyke nets in late August or early September. The majority of eels are harvested from "around the 15th of September to the 5th of October" as that is the "best run for eels" in the Bay St. George region.

Commercial eel fishers of the QMFNB suggested that the eel fishery was a very important part of their livelihood for financial reasons both in regards to costs and revenue. One Aboriginal commercial eel fisher stated that the eel fishery is "Very important because…[it has] less maintenance on it and is easier fishing for us, and not so much expense like it was with the regular fishing." Interviewed commercial eel fishers suggested that on an average 'good year' they might land between 6,000-8,000 pounds of eels, which may yield upwards of approximately CAD$10,000-$15,000 depending on the market price for eels. One commercial eel fisherman suggested that they currently, "do just as good at the eels as I'd do in any other fishery."

Although many of the eel fishers in Western NL are of Mi'kmaq origin, one Aboriginal commercial eel fisher explained his entry into the commercial eel fishery in Western Newfoundland as follows: "You didn't know whether they were native. It's only recently since the Band came out, everybody pried into their background…and then you found you were native, and then went on from there. But back then, no. It was just different altogether. Overall, according to an Elder, approximately eight to ten active commercial fishers are remaining in the Bay St. George area and are members of the QMFNB. If the ban on new recreational and commercial American eel harvesting licences in Newfoundland by DFO continues, it can be assumed that the number of eel fishers in the Bay St. George region will decrease as fishers retire without a long-term strategy for the transfer of established licences.

Ecological Impacts and Sustainability

Fisheries management authorities and academics have often disregarded the ecological and environmental impacts of small-scale fisheries until recent times [1]. Current analyses frequently give contradicting arguments such as how "small-scale fisheries contribute to the current general decline of fisheries resources worldwide (e.g. dynamite fishing, reef bleaching)," or rather that "small-scale fisheries are more sustainable than industrial fisheries when considering their relatively lower levels of fuel consumption, discards and subsidies received" [1].

Eels are caught in various ways in Canada, depending on local preferences and environmental conditions [19]. This study's interviews revealed that QMFNB members generally use fyke nets when commercially harvesting eels. From interview data it was found that the American eel fisheries by and large use 'passive' gears in which "the fish come to it" and have little effect on the local environment, such as river-bottom habitat alteration. For example, one eel fisher concluded that fyke nets in particular have little ecological impact, as the "nets are just sitting there – it don't move, it don't drag." Iron or wooden poles used to restrain gears in waters, and rope used to restrain boats to surrounding trees are also perceived to have little impact on the benthos and flora. The interviews further revealed the perception that there are little ecological impacts as a result of gear loss. Reported gear loss was generally from instances of theft or damage by other fishers, and often only required the mending of fyke nets.

During the interviews, it was discovered that both fishers and government participants have the perception that there are small amounts of by-catch associated with spearing, pots and fyke nets. Concerns regarding fyke by-catch have been raised in the fisheries management literature both nationally and internationally [20-22]. Common by-catch species mentioned by participants in the commercial fishery include: 'frost fish' or 'plug eyes' (*Mircogadus tomcod*), banded killifish, trout, smelts, flat fish, and green crab. The volume of by-catch in the commercial eel fishery in NL has declined in recent years due to a mandatory DFO requirement for salmonid exclusionary device on fyke nets, and all by-catch continues to be released alive.

Another ecological impact noted by participants was transportation. Launching, navigation and anchoring of rowboats or canoes were perceived as 'environmentally friendly'. Ecological impacts such as carbon emissions associated with transportation of eel fishers and gear to and from fishing sites were presumed to be uneven amongst fishers due to variables such as distance travelled to fishing sites and mode of transportation (e.g. truck or quad). Although the distances travelled by interviewees varied considerably, the majority of participants suggested that fuel consumption and carbon emissions were not a significant ecological impact associated with commercial eel harvesting among the QMFNB.

Qalipu MIi'kmaq First Nation Band members generally expressed a sense of ownership over their designated fishing area and believed that their stewardship practices has an impact on the American eel stocks. While grading, the practice of selectively harvesting eels of higher length, is not amongst MSC RBF criteria, they were perceived by fishers as the most important ecological impact of QMFNB members' fishing practices. Minimum mesh sizes on fyke nets have also been put in place in the province to restrict catches of small eels [22].

A representative of DFO suggested that, "They [Aboriginals located in NL] looked at the ecosystems approach even before fisheries management did." During interviews, it was perceived that government representatives however have a different role in the preservation of American eel stocks. One DFO representative explained: "We are not in the business of preserving fish. We are in the business of determining what the sustainable harvest is."

CONCLUSIONS

Small-scale fisheries are continually unaccounted for in policy and decision-making, leading some academics to suggest that small-scale fisheries are 'too big to ignore' [23]. FAO, cited

by Chuenpagdee [23], suggests that, “Fisheries support the livelihoods of approximately 540 million people, or about 8% of the world’s population.” Although 90% of those livelihoods are related to small-scale fisheries, “information and knowledge of small-scale fisheries remain scattered and scarce.” The same can be said of our knowledge base about the American eel fishery.

To obtain a clearer perception of the sustainability of the American eel stocks and eel fisheries as an example of small-scale fisheries, one must look at available fisheries science and established management regulations, but also at fishing practices and the narratives and understandings of those who participate in recreational and commercial eel fisheries. In the absence of long streams of scientific data on the American eel in Newfoundland, our research revealed that research participants, including both harvesters and DFO managers, perceive the ecological impacts of QMFNB members’ fishing practices and gear types used in the American eel fisheries within Western Newfoundland as limited both in number and severity. Where ecological impacts do exist, they are minimal in comparison to other fisheries that use more destructive harvesting methods. These findings concur with research in other jurisdictions suggesting, “the ecological risks associated with the eel fishery are low” [20] and provide an example of an indigenous small-scale fishery with apparently limited ecological impacts.

The study also points to the importance of better understanding the stewardship practices employed in indigenous small-scale fisheries and for institutional arrangements that incorporate this understanding into small-scale fisheries management approaches. These discussions should include consideration of the long-term sustainability of indigenous and other local fisheries under circumstances such as the current ban on new eel fishing licences. As fishers and their indigenous fishing practices and knowledge are lost, incorporating Aboriginal Traditional Knowledge and Traditional Ecological Knowledge into fisheries management will become more difficult in the eel fishery of the future.

Hopefully, the blend of academic and local knowledge within this exploratory study will help create a dialogue on not only the ecological impacts of the American eel fisheries in NL, but also on issues that may range from definitions of small-scale, artisanal and recreational fisheries to management policy on small-scale and indigenous fisheries. Our attempt to share the stories of QMFNB eel fishers is only one of many steps needed in helping address how small-scale fisheries in Newfoundland and across the globe are simply ‘too big to ignore.’

ACKNOWLEDGEMENTS

The authors would like to thank the Mi'kmaq Alsumk Mowimsikik Koqoey Association and the eel fishers of the QMFNB for their generous invitations to their homes for a yarn and cup of coffee. They would also like to thank Dr. Mike Van Zyll De Jong, Dr. Gabriela Sabau, and Dr. Paul Foley for feedback and their support.

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Coral Reef Fisheries in a Changing Environment: Perceptions of Change and Livelihood Responses

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ABSTRACT

Livelihoods that depend on Caribbean coral reef fisheries face an uncertain future as global climate change threatens the integrity of these important ecosystems. Fishers' perceptions of past change in the environment can affect their current decision-making and behaviour. This in turn can influence the effectiveness of management measures and policies intended to conserve resources and ensure sustainable fisheries. Interviews were conducted with commercial and recreational fishers in 12 communities across four Caribbean countries (Barbados, Honduras, St Kitts and Nevis, and Belize) to identify perceptions of past change in reef-related resources and anticipated future responses to hypothetical changes in catch. The results identify diverse perceptions and anticipated responses to change both within and between communities. These are discussed in relation to the sustainability of coral reef fisheries and implications for effective management of natural resources are considered.

Key words: coral reefs; small-scale fisheries; environmental change; Caribbean

INTRODUCTION

Small-scale fisheries form the major component of fisheries activity in the Caribbean, particularly in small island developing states (SIDS), where their contribution to national economies and livelihoods is often undervalued [1]. Coral reefs provide ecosystem services that support small-scale inshore fisheries [2], but the health of Caribbean reefs has declined rapidly in recent decades [3,4]. This decline presents a threat to human societies, because complex coral reef structures are important for fisheries productivity [5]. Coral reefs face future threats from rapid population growth, which creates increasing demand for reef ecosystem services, and predicted impacts from climate change and other environmental stressors [2]. Historical overfishing, in combination with current and predicted future environmental change, threatens the livelihoods and food security of people in Caribbean coastal communities. Failure to address these issues and tackle the complexity of small-scale fisheries has led to calls for improved management and governance of Caribbean fisheries [6–8]. An important element of managing reef-dependent fisheries involves developing a better understanding of how fishers perceive and respond to change. This study explores small-scale fishers' perceptions of change in coral reef fisheries, and their anticipated responses to hypothetical future changes, in four Caribbean countries.

METHODS

Fieldwork was designed to collect information representing some of the diversity of coastal communities found across the Caribbean. Four countries, Barbados, St Kitts and Nevis,

Honduras, and Belize, were selected to represent various levels of social and economic conditions, and dependence on marine resources (Figure 1). Three study sites were chosen in each country for research at the community level. Selection of communities attempted to capture differences in reef resource use, selecting one site where reef use was predominantly reef fisheries, one where reef-related tourism was important, and one where many residents were actively involved in reef-related tourism and fishing.

Household surveys were conducted with coral reef resource users in each community, including those involved in reef-related fishing. Resource users were mainly targeted through opportunistic and snowball sampling. Between 24-60 fishing households were interviewed in each community, with a total of 498 fisher interviews completed during 2011-2012. Many fishers used multiple gear types, with hook and line being most common (n=364), followed by graining or spearing (i.e. free diving; n=144), traps (n=101), trolling (n=51), graining or spearing with SCUBA (n=44), and nets (n=36). Some interviewees were involved in vending (n=8) and processing (n=8) of reef fish. Interviews lasted 30-90 minutes, and included questions relating to perceptions of change in coral reefs and associated fish populations, perceptions of the impact of climate change on reefs, and future changes to reefs. Fishers were presented with two scenarios about possible future declines in the number of fish in their catch (a 25% decline and a 50% decline compared to the present catch), and asked to state their anticipated response in terms of change in fishing effort.

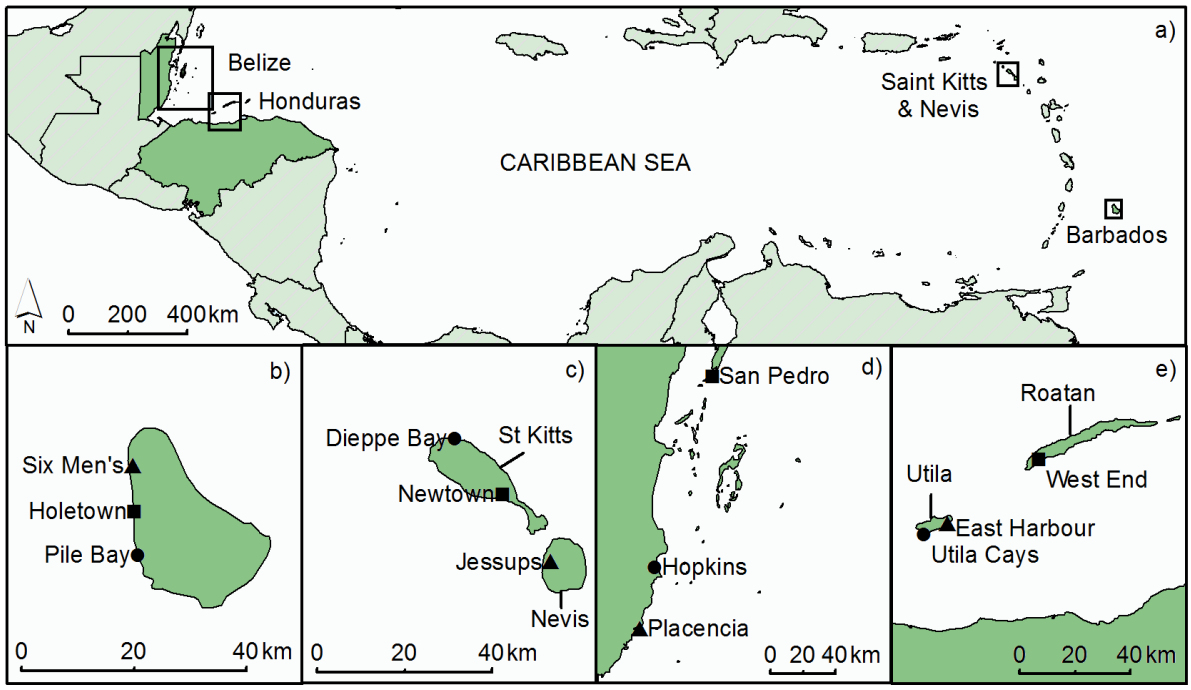

FIGURE 1. MAPS OF A) STUDY COUNTRIES, AND B-E) STUDY SITES WITHIN BARBADOS, ST KITTS AND NEVIS, BELIZE AND HONDURAS. SYMBOLS REPRESENT REEF-USE CHARACTERISTICS: ● PREDOMINANTLY FISHING, ▲ MIXED FISHING AND TOURISM, ■ PREDOMINANTLY TOURISM.

RESULTS

Over 50% of fishers in all communities had noticed a decline in the abundance, size or diversity of reef-associated fish species over the past ten years (Figure 2). Declines in reef fish resources were most commonly perceived in Barbados, where over 80% of fishers interviewed in each community had perceived a negative change. In all communities but two

(Placencia in Belize and West End in Honduras), fishers noticed declines in reef fish resources more commonly than declines in the reef itself. Negative changes observed in the reef included changes to the colour (e.g. loss of colour, bleaching) or the structure (e.g. physical damage or reduced extent) of the reef in the vicinity of the community. Perceptions of decline in the coral reef itself were on average more common in Belize and Honduras than in Barbados and St Kitts and Nevis (Figure 2).

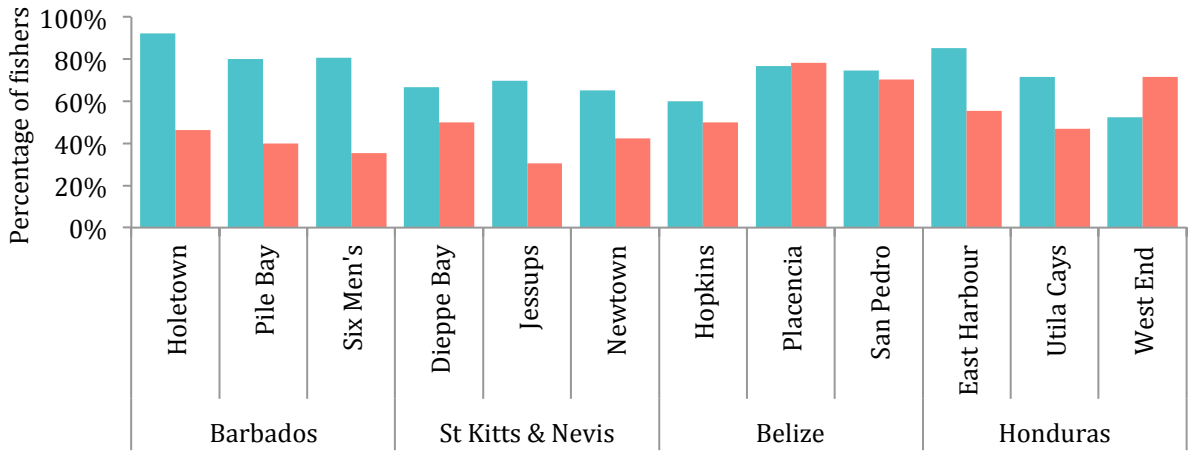

FIGURE 2 PERCENTAGE OF FISHERS IN EACH OF THE 12 COMMUNITIES SURVEYED PERCEIVING DECLINE IN REEF-ASSOCIATED FISHES (BLUE) AND CORAL REEFS (RED) OVER THE PAST TEN YEARS (N=418)

Perceptions of how climate change would affect reefs in the future varied among communities (Figure 3). A high proportion of Belizean fishers (>75% in each community) believed that climate change would negatively impact coral reefs. In contrast, in St Kitts and Nevis, over 35% of respondents in each community were either unsure, or believed that climate change would not affect coral reefs.

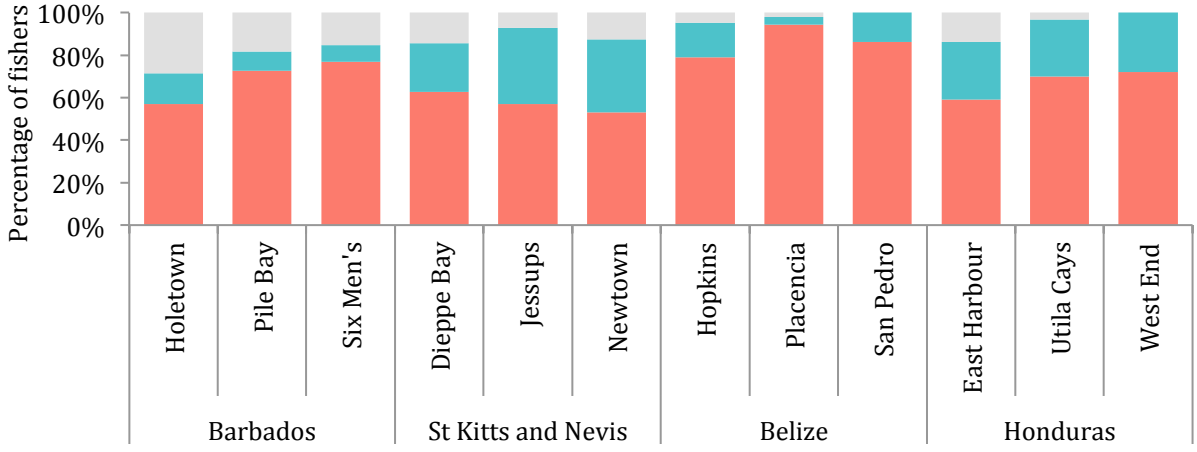

FIGURE 3 PERCENTAGE OF FISHERS IN EACH COMMUNITY BELIEVING THAT CLIMATE CHANGE WOULD AFFECT CORAL REEFS (N=315): YES (RED), NO (BLUE), UNSURE (GREY)

Fishers' anticipated responses to change were diverse, both within and between communities (Figure 3). In response to a 25% decline in catch, fishers stated that they would either reduce fishing effort to save costs (20-50%), or exit the fishery (0-28%), as fishing would no longer be worthwhile. In some communities a high proportion of fishers expected to maintain or increase their current level of fishing effort (e.g. Dieppe Bay in St Kitts and

Nevis, 80%; and Utila Cays in Honduras, 63%; Figure 4). In response to a more severe decline of 50% in reef fish abundance, more fishers (7-61%) anticipated exiting the fishery. However, in half of the communities (Pile Bay and Six Men's in Barbados, all three communities in St Kitts and Nevis, and Utila Cays in Honduras) more than 50% of fishers anticipated maintaining or increasing their current levels of fishing effort to sustain catches.

FIGURE 4 ANTICIPATED RESPONSES TO A) 25% DECLINE AND B) 50% DECLINE IN THE NUMBER OF FISH CAUGHT IN THE FUTURE: STOP FISHING (DARK BLUE), FISH LESS (LIGHT BLUE), NO CHANGE (LIGHT RED), FISH MORE (DARK RED)

DISCUSSION

Differences identified in perceptions of ecological change within and between communities may be due to a number of factors. First, patterns of ecological change may differ among the four countries. For example, reef-related fisheries have historically been considered overexploited, particularly in island nations with narrow shelves such as Barbados [9]. In comparison, in countries such as Belize which border the extensive Meso-American Barrier Reef system, reefs may be healthier and changes may be more recent or less apparent [10]. Second, fishers' observations may differ depending on their own experience, including whether or not they directly observe the reef underwater (e.g. spear fishers). Third, in some communities many fishers were involved in the tourism industry, guiding diving or snorkelling trips, which may increase awareness of changes in the reef. This was observed in communities such as Placencia and San Pedro (Belize), and West End (Honduras).

Perceptions of environmental health and change have important implications as they inform fishers' decision-making and behaviour, influencing the effectiveness of management measures and conservation policies. For example, resources may be overexploited where they are not perceived to be in decline and fishers do not perceive a problem [11].

Understanding resource users' perceptions, and motivations in responding to change is therefore essential for developing context-specific actions that support the effective management of small-scale fisheries [12].

Effective fisheries management may be more easily achieved where resource users are able to detect and respond to change, and understand the implications of changes in ecosystem processes and dynamics at an appropriate scale [13,14]. Elsewhere, greater awareness of factors relating to coral reef degradation has been identified in communities where marine resource dependency is higher, and where local conservation initiatives have involved a strong element of environmental education, contributing to elevated awareness [15]. These factors may explain some of the differences identified here, as environmental education initiatives were common in communities displaying greater awareness. Variable knowledge of the potential impacts of climate change on reefs among the study communities suggests that in some areas fisheries management may benefit from increased effort directed towards environmental education. For example, participation in resource monitoring may enhance stewardship by increasing awareness and informing fishers' decision-making.

While perceptions of the environment influence decision-making, response to change can also be affected by a range of social, economic and contextual factors. Anticipated responses to future change varied, reflecting differences among study communities. Fishers from communities with higher dependence on fishing and fewer alternative livelihood options more commonly anticipated maintaining or increasing fishing effort, even in the face of severe resource decline. Understanding how fishers might respond to ecological change and the drivers motivating these decisions is important for exploring opportunities to enhance stewardship in particular contexts. Fisheries management efforts should consider the social and economic factors that influence resource use behaviour and incentives for stewardship.

CONCLUSIONS

Effective management of reef-related fisheries is critical given the important contribution of small-scale fisheries to livelihoods in the Caribbean. This study highlights the diverse perceptions and potential responses of Caribbean fishers to ecological changes that, in turn, may affect management success. More informed and effective small-scale fisheries policies may be developed by taking into account fishers' decision-making mechanisms and anticipated responses to change. Sustainability in small-scale fisheries may be enhanced by increasing awareness of resource health and understanding of future threats among resource users, and by taking socio-economic and contextual conditions into consideration when developing management initiatives and incentives to promote stewardship.

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Assessing the Vulnerability to Climate Change of Small-Scale Fisheries: The Grenada Example

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ABSTRACT

Small-scale fisheries, critical to the livelihoods, coastal economies and food security of coastal communities, are particularly vulnerable to the impacts of climate change. As such, developing sustainable resource management for this sector depends on our ability to predict the risk of climate change on small-scale fisheries and harness the capacity of coastal communities to cope or adapt with these changes. This chapter describes progress to date in building a spatial vulnerability assessment of Grenada fisheries. A framework to guide these types of assessments, the indicators developed to date, and the challenges and opportunities encountered in building the Grenada fisheries vulnerability assessment are discussed.

Key words: small-scale fisheries, climate change, coastal hazards, vulnerability assessment, risk assessment, Eastern Caribbean

THE ISSUE

The changes predicted for our oceans and the projected climate specific impacts to fisheries will have serious implications for the 520 million people who depend on fish for their livelihoods and the nearly three billion people for whom fish is an important source of animal protein [1]. Not surprisingly, coastal communities are disproportionately dependent on fish and fish related industries to provide food and jobs. In the Caribbean the fisheries sector employs nearly 200,000 persons, earns between US$5,000 million and US$6,000 million in foreign exchange, and accounts for approximately 10% of the region's protein intake [2]. As in other parts of the world, small-scale fisheries make important but undervalued contributions to the economies and the animal protein needs of the region.

Given these figures, the economic and social dimensions of the threats posed by climate change to fishing communities in the region are evident. Our ability to predict the risk of extreme climatic effects and to harness the capacity of coastal communities to cope or adapt becomes essential as we try and develop sustainable strategies for resource management and community development. This is particularly important for the millions of small-scale fisherfolk who are among the most vulnerable to climate change [3].

Assessing and mapping the vulnerability of fishery dependent people and regions to the impacts of climate change will allow decision makers to focus climate change responses where they are most needed. Historically, most global and regional climate vulnerability assessments have focused on agricultural production. Although there has been a recent surge in fisheries global assessments, examples of national, sub-national and site level assessments remain limited. Yet predictions at these scales are urgently needed, especially for some small-scale fisheries, as these are the scales most relevant and most compelling

for local fisherman. Also, most policy responses relating to planned climate change adaptation and fisheries management are or will be implemented at national levels which relies on a solid understanding of national, sub-national and site level vulnerability.

Vulnerability analyses have been used to identify priority activities for future development and hazard mitigation, and several examples exist of mapping specific aspects of vulnerability [4], some specifically related to fisheries [3,5]. A number of these efforts use indicators in combination with risk assessment vulnerability frameworks. Examples of the application of this approach exist mainly at the global scale, e.g. [6], with some promising examples at the regional and site-specific scales [3,5], but very few sub-national level examples.

This chapter will outline our progress to date in building a national, sub-national and site level spatial fisheries assessment for Grenada. Our intention is not to report on patterns observed in the vulnerability of Grenada fisheries, but rather to share challenges and opportunities encountered in building a fisheries vulnerability assessment. Our hope is that this experience can provide guidance for managers who are interested in assessing climate and disaster risk to small-scale fisheries.

THE GRENADA CONTEXT

Grenada is comprised of the main island of Grenada, two smaller islands (Petite Martinique and Carriacou), and a number of smaller uninhabited and semi-inhabited cays. It marks the southern end of the Caribbean's Windward Islands and is among the youngest islands in the Insular Caribbean (Figure 1).

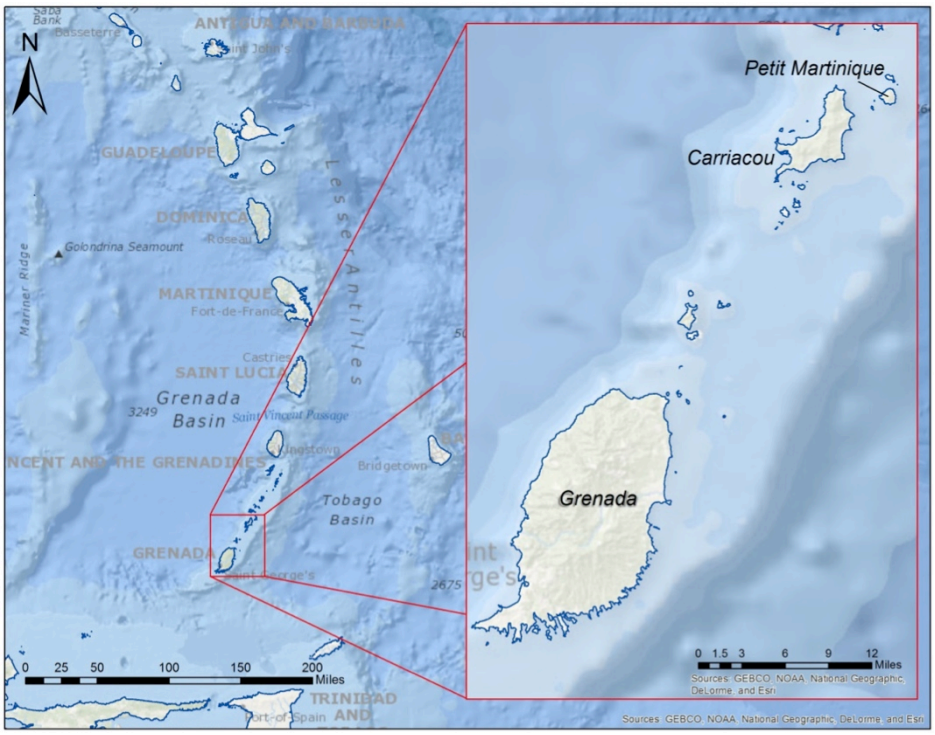

FIGURE 1 LOCATION OF GRENADA AND THE GRENADINE ISLANDS IN THE SOUTHEASTERN CARIBBEAN

Despite the fact that this island nation is among the countries emitting the least amount of climate changing greenhouse gasses, its high coastal population densities, limited land space, geographic location, scarce freshwater supplies, and high dependence on natural resource based livelihoods (specifically tourism, fisheries, and agriculture), make it among the most vulnerable to climate change impacts. The government of Grenada is actively working to develop responses to climate change. Although capacity has been evolving rapidly, the individuals, agencies, and local organizations charged with developing adaptation strategies have limited access to information and tools needed to help articulate current impacts, visualize likely future events, understand the socio-economic implications of those events, and take action to protect people and the environment.

To help decision-makers identify vulnerable areas and develop adaption strategies we conducted a spatial analysis that identifies communities most vulnerable to inundation from sea level rise and storm surge. As part of this effort, we formulated fisheries indicators across a suite of both ecological as well as socio-economic characteristics, populated those for which we could rapidly collect information and embedded them in an overall coastal vulnerability assessment.

DESCRIBING THE VULNERABILITY OF FISHERIES

The vulnerability of fisheries to climate change has been examined using a variety of frameworks. A common thread has been to measure vulnerability as a function of exposure, sensitivity and adaptive capacity. We used a framework promoted by the IPCC [7] to describe the vulnerability of coastal communities of Grenada to sea level rise and storm surge. This framework helped us organize, synthesize and communicate information about the climate and disaster risks to fisheries.

Exposure

Exposure is the degree to which a community experiences climate change as defined by the amount of the community that was inundated by a given scenario. For fishing communities, exposure captures the amount of the resource or infrastructure, which they depend upon, that will be impacted by a climate change scenario. In this particular study we examine storm surge and sea level rise scenarios.

Sensitivity

Sensitivity captures the characteristics of a community that influence its likelihood to experience harm under a given scenario. These characteristics determine the impact from climate exposure. The sensitivity of social systems depends on economic, political, cultural and institutional factors that allow for buffering of change [5]. For fishing communities, sensitivity is related to the degree to which a particular community is dependent on fish for food and livelihoods, with the idea being that if that community is highly dependent on fish for overall protein intake or whose livelihoods are highly dependent on fisheries, that community will be more sensitive to climate change.

Adaptive Capacity

Adaptive capacity describes the ability of a system to anticipate, respond to, cope with, and recover from climate impacts. This category captures variables that determine how flexible individuals may be, for example, in adapting to new employment opportunities or shifts in

living patterns brought about by climate variability or change. For fishing communities this is often related to the diversity of livelihood, fishing grounds and gear types fishers have access to and the level of social networks in place.

DESCRIBING THE FISHERIES VULNERABILITY OF A PLACE – THE INFORMATION NEEDS

In order to make decisions on what information to use to populate our framework with the appropriate social and ecological indicators, we examined the availability of fisheries information and existing gaps across the five following categories: 1) resource characteristics, 2) governance, 3) livelihood, 4) infrastructure (social and physical), and 5) economics. For each of these areas we asked ourselves "what are the key pieces of information necessary to describe a place (be it a section of the nation's coastline or a section of a site's bay)"? The following indicator types emerged for each category:

1. Resource characteristics: abundance of the resource (e.g. catch per unit effort data, biomass data), and distribution of the resource (e.g. distribution of particular species)
2. Governance: level of management in place and institutional capacity
3. Livelihood: number of fishers and/or number of registered vessels
4. Infrastructure: number of critical fisheries facilities (e.g. marketing centers, landing sites, storage lockers), fisher networks (e.g. fisher cooperatives)
5. Economics: investment and revenue from fisheries (e.g. dollars invested in gear, vessels, and fisher facilities; revenue generated from catch, fisheries infrastructure)

Next we examined the availability of information to populate these indicators at the national, sub-national and site level. Most successful site level fishery vulnerability assessments rely on extensive field surveys (e.g. [5]). In order to build an information base for Grenada without conducting extensive field surveys we accessed a variety of information types. We drew from the following sources to generate indicators: information collected from government programs (fisheries, physical planning and government census departments), and stakeholder-based methodologies (fisher focus group surveys, and participatory mapping). Information from government programs has been especially useful for national and sub-national level assessment, while stakeholder-based methodologies are proving to be the most useful for site level assessments.

INDICATORS – SOME EXAMPLES

Below we illustrate some examples of fisheries related vulnerability indicators that we computed to date. As outlined above, to calculate these we used a combination of government data and information collected via participatory mapping and fisher focus group surveys for specific sites. For the suite of indicators to describe the vulnerability of coastal populations of Grenada, a full description as well as details on methodology, is outlined [8].

Exposure

We modeled several different inundation scenarios and calculated exposure of fishing related structures to inundation from two-metre sea level rise and a Hurricane Ivan type storm (Figure 2). Ideally, to measure the exposure to storm surge and sea level rise, one would also capture an ecological indicator (e.g. given a particular flooding/storm surge scenario, the amount of destruction of X habitat with the assumption being that this would in

turn generate a decrease or displacement in fish) but these types of data are not generally available in the region.

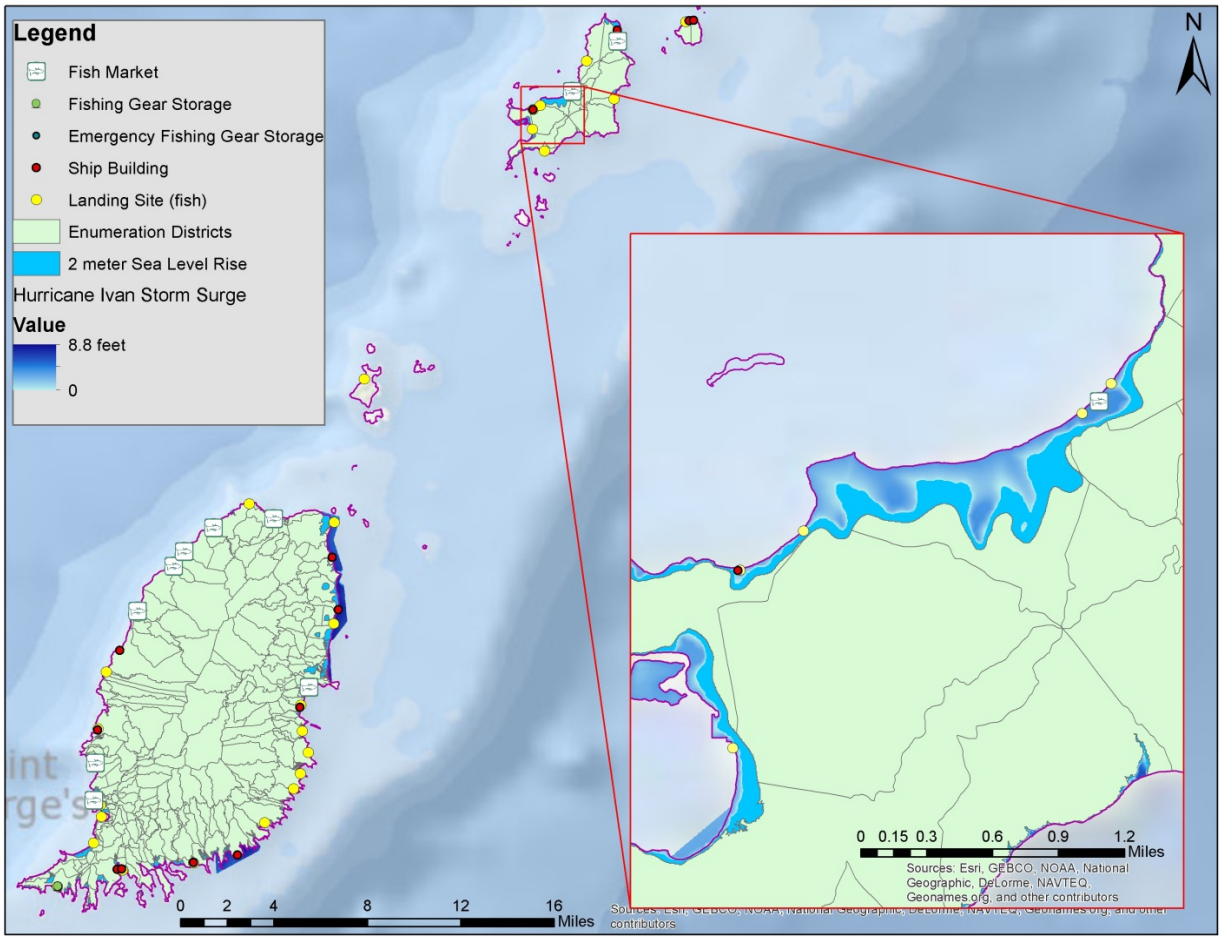

FIGURE 2 LOCATION OF FISHERIES FACILITIES AND EXTENT OF FLOODING FOR TWO DIFFERENT INUNDATION SCENARIOS: A TWO-METRE SEA LEVEL RISE INUNDATION PROJECTION AND A MODELED STORM SURGE INUNDATION FROM A HURRICANE IVAN TYPE STORM. INSET DETAILS INUNDATION SCENARIOS FOR WESTERN CARRIACOU

Sensitivity

To measure how fisheries are contributing to sensitivity of coastal communities we examined different aspects of community dependence on fisheries. Some examples include:

a) The share of the population whose primary income comes from fisheries (the more reliant on fisheries a community is the more sensitive); and the number of fishing facilities in the census district or enumeration district (the fewer fisher facilities the more sensitive a community is). See Figure 3.
b) Site specific distance to fish markets that fishers rely on (the greater distance a fisher has to travel to reach a landing site or fish market the more sensitive as there is more opportunity for that passage way to be flooded in the event of a storm). See Figure 4.

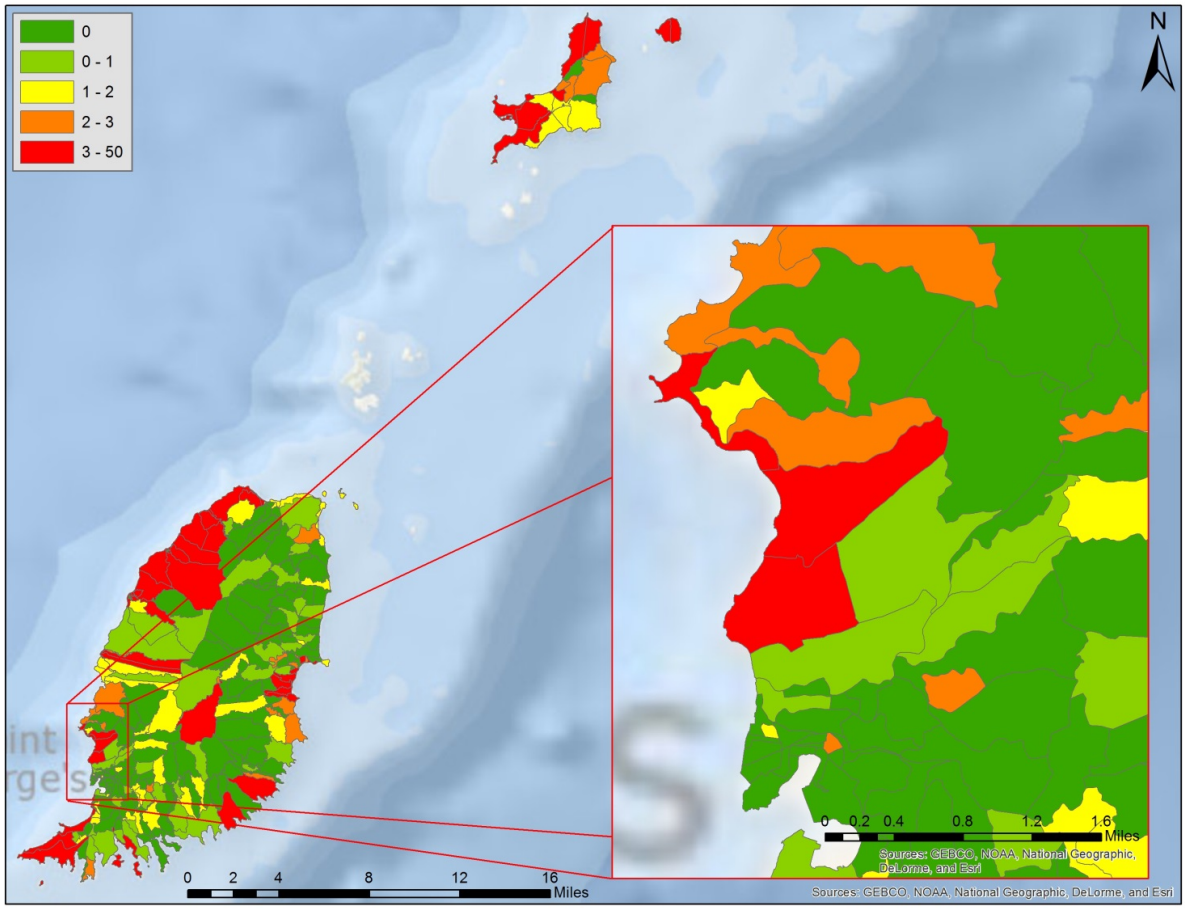

FIGURE 3 PERCENT OF FISHERIES RELATED WORKERS BY CENSUS DISTRICT IN GRENADA, CARRIACOU, AND PETITE MARTINIQUE. DATA DERIVED FROM THE CENSUS DEPARTMENT

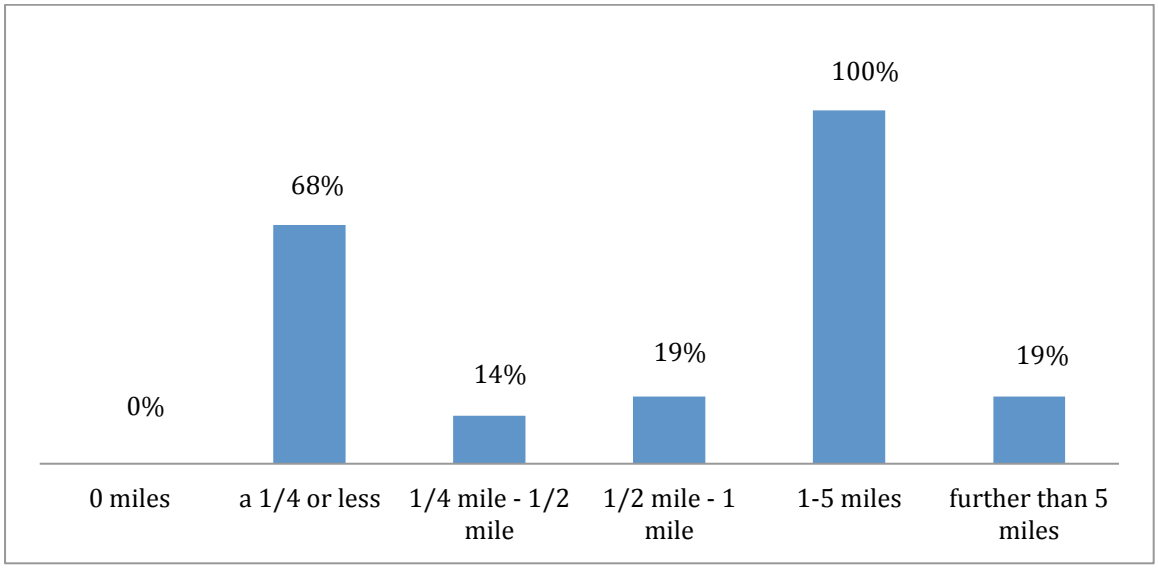

FIGURE 4 DISTANCE PEOPLE TRAVEL TO GET TO THE CLOSEST FISH MARKET IN GRENVILLE, GRENADA (N=37). DATA DERIVED FROM HOUSEHOLD SURVEYS CONDUCTED IN GRENVILLE

Adaptive Capacity

One of the indicators we computed to measure the adaptive capacity of a fisheries community is the diversity of livelihoods available by census district (Figure 5). The assumption being: when there are more livelihood options available to, and practically feasible for fishers, there is a higher chance that they will be able to adapt to a different industry if something were to happen to their primary livelihood option. Another example of a site level indicator is: % belonging to a fisher cooperative association (Figure 6). Social networks, such as fisher co-operatives, provide important means for developing and maintaining social cohesion. The more social cohesion the more adaptive a community is.

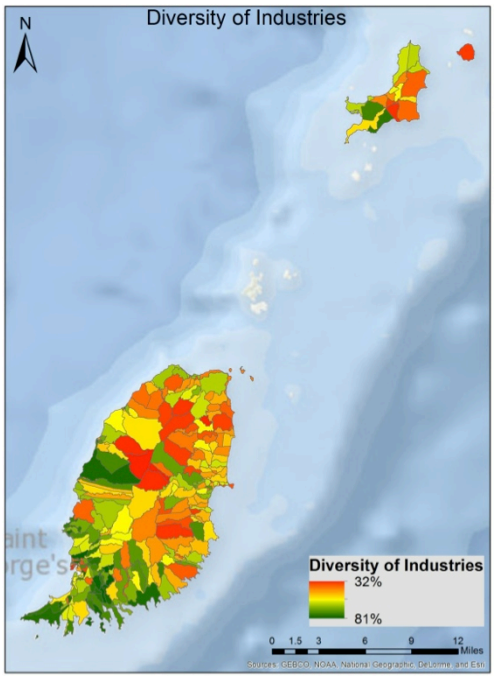

FIGURE 5 DIVERSITY OF LIVELIHOODS OPTIONS BY ENUMERATION DISTRICT IN GRENADA, CARRIACOU, AND PETIT MARTINIQUE. THE HIGHER THE PERCENTAGE THE MORE LIVELIHOOD OPTIONS AVAILABLE. DATA DERIVED FROM THE CENSUS DEPARTMENT.

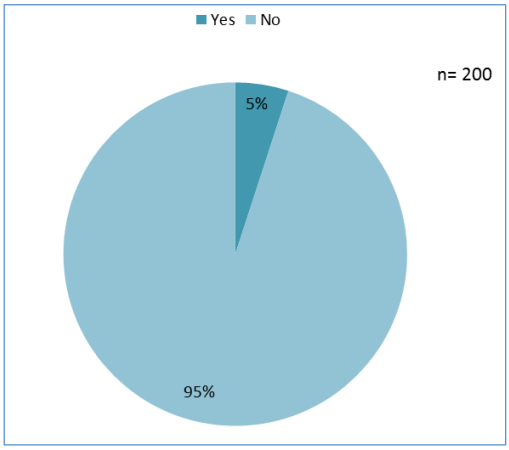

FIGURE 6 PERCENT OF GRENVILLE INHABITANTS THAT BELONG TO A FISHING CO-OPERATIVE (N=200). DATA FROM HOUSEHOLD SURVEYS CONDUCTED IN GRENVILLE

LESSONS LEARNED

Integrating Vulnerability Assessments Across Sectors

As outlined above, the fisheries assessment we conducted in Grenada is embedded in a wider assessment that addresses coastal vulnerability across sectors. Given the dependency of coastal communities on fish and fish-related industries to provide nutrition and jobs, addressing fisheries within the wider climate and disaster risk context will increase not only the adaptive capacity of the fisheries sector but of coastal communities overall. However, in contrast with agriculture and freshwater, fisheries have been largely ignored in climate policy discussions. There is a need to mainstream fisheries considerations in these discussions. Vulnerability assessments such as the one discussed above can be a good vehicle for this. They will help the fisheries sector come to the table with a specific set of needs and recommendations related to risk and facilitate conversations.

Filling Information Gaps

Given the close links between the biophysical components of marine ecosystems and the socio-economics of fisheries, understanding climate change impacts on marine fisheries requires integrated assessments across disciplines [9]. For regions largely dominated by small-scale fisheries such as the Eastern Caribbean the availability of appropriate bio-physical information is limited, unless a research program is in place to collect this information (e.g. [5]). In contrast, stakeholder-based methodologies (e.g. fisher focus group surveys) as well as government programs (e.g. census) allow for either access to or relatively rapid collection of socio-economic information on fisheries. This leads to vulnerability assessments that focus on the socio-economic aspects of fisheries vulnerability, and have limited ability to characterize the biophysical aspects. Such has been the case to date for our Grenada efforts. As we move closer to designing solutions and potential adaptation approaches this will become more of an issue, as the lack of a clear picture of how access to fish will change in time will limit our ability to help fisher communities adapt to that change.

Conducting Spatially Explicit Assessments

Spatial information plays a key role in the design of adaptation measures as both the effects of climate change as well as many adaptation measures have spatial impacts ([10]). As countries develop adaptation strategies to cope with climate change, there is need for a better spatial understanding of exposure, sensitivity, and adaptive capacity and how they contribute to a communities' overall socio-economic vulnerability. The type of understanding such as the one we developed for Grenada will allow governments and communities seeking to develop and implement fisheries adaptation plans to develop more targeted strategies to reduce vulnerability.

Leveraging a Variety of Information Sources to Represent Multiple Scales

Our aim in Grenada was to describe vulnerability of fisheries at national, sub-national and site levels. However, conducting a vulnerability assessment across scales is not a simple feat. While the framework and general principles used to build indicators are mostly interchangeable, the access to information to describe vulnerability at multiple scales varied in Grenada, as is common in many places. As described in the section on vulnerability of fisheries we used a variety of information types. One of the challenges this presents for a spatial assessment is identifying a common study unit to facilitate comparison across data-types. Some of this information (e.g. government information, information from 3D participatory mapping) is more easily integrated into a spatial platform, than other forms (e.g. fisher focus group interviews).

Involving the Fisher Community

In our efforts in Grenada we have used a variety of stakeholder-based methodologies to collect spatial as well as non-spatial information (e.g. fisher focus groups, participatory mapping) and engage fisherfolk. This has been very effective to both rapidly fill key information gaps (e.g. on adaptive capacity), as well as learn about fisher needs and perceptions. Both of these are critical pieces for the design of effective and sustainable adaptation strategies. Also, the more fishers have a full understanding of their vulnerability and help design adaptation strategies, the more these will be effective and sustainable into the future.

CONCLUSIONS

Small-scale fisheries are among the most vulnerable to climate change. As such, their management should address climate and disaster risk. Vulnerability assessments such as the one described above are an excellent tool to help prepare for, cope with and adapt to climate and disaster risk. Climate change is amongst the various stresses that small-scale fishing communities face. Many of these communities are economically, socially, and politically marginalized due to poor access to infrastructure, markets, and social services. As climate and disaster risk jeopardize that access, addressing these multiple stresses using cross-sectoral approaches becomes critical. Vulnerability assessments provide a solid foundation for cross-sectoral collaboration. Vulnerability assessment such as the one we conducted in Grenada can also be a strong vehicle for community engagement. The sustainability and ultimately effectiveness of solutions to help decrease vulnerability of small-scale fisheries depends on this. Given the degree to which tropical coastal communities rely on fish for food security and livelihoods, the investments we make on increasing the resilience of small-scale fisheries will benefit resilience of coastal communities overall.

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Assessing Changes in Small-Scale Fisheries: Contributions from Monitoring in the Aventureiro Community at the Southeast Coast of Brazil

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ABSTRACT

Change is an intrinsic feature of coastal systems. Understanding the social-ecological changes and the path-dependent set of conditions operating in evolving coastal communities may contribute to the analysis of the stewardship within small-scale fisheries (SSF). Assessing and monitoring social-ecological systems may provide important tools for analysis and policy. This study is about assessing SSF in Aventureiro – an isolated community in a Southeastern island of Brazil - in two points in history over a 15-year period. SSF stewardship is fundamental for sustaining local livelihoods. At Aventureiro, SSF are important for food security and highly significant due to community characteristics such as geographic position, high level of resource dependence, and a shared sense of community identity and culture. Over the years, SSF have maintained the diversity of fishing gears and fishing spots, but have also increased investments in gears and vessels, as financial resources have increased in the community due to community-based tourism development. Despite the fact that the SSF system has remained active and sustainable, even in face of several drivers of change related to conservation issues, there is a lack of local institutions that promote stewardship at the community level. Effort should be made to strengthen fisher and community organization, networking and social capital, increasing stewardship as well as social-ecological resilience.

Key words: social-ecological changes; participatory monitoring, stewardship

INTRODUCTION

Change is an intrinsic feature of coastal systems. Multi-dimensional pressures on ecosystems by various economic sectors have caused more rapid and extensive change. Such pressures intensify the competition among users of natural resources, and all these factors together have affected the livelihoods of many coastal communities [1, 2]. For this reason, processes of change in coastal systems at the local level have been the subjects of several studies. As one example, Pinkerton describes how maritime anthropology examines the factors that made preindustrial livelihoods sustainable, and the changes that occur when these old fishing communities become part of the modern world [3]. She poses questions such as; what changes and what remains the same, and, what kind of histories can these local coastal systems tell?

The rights recognition of fishermen and fisherwomen to access resources, the legitimacy of their local knowledge, their participation in decision-making processes and their significant role in the data collection and analysis for the diagnosis and monitoring of socio-ecological systems make the governance of natural resources more sensitive to change [3]. In this

sense, management approaches that demonstrate collaboration and adaptation have been considered ideal for promoting resilience in fishing systems.

Artisanal or small-scale fisheries, despite their importance as a source of income and subsistence for around 120 million people worldwide [4] have had little incentive and strategic policies in Brazil. The lack of accurate information about the status of artisanal fisheries around the Brazilian coast reinforces how little attention the activity has received by governments [5-7]. Socio-economic surveys are scarce, especially due to the government prioritizing support for industrial fisheries over small-scale fisheries [6]. Moreover, comparative studies over time are rare due to the difficulty in obtaining data, and even rarer are those that consider fish landings and socio-economic aspects: key elements for monitoring and very important for verifying possibilities for collaborative management [5].

Given the importance of monitoring small-scale fisheries for the governance of coastal systems, this study presents an initial monitoring effort at the local level, in two points in history over a 15-year period. The study area comprises the Aventureiro village, located on Ilha Grande, an island in the southern coast of Rio de Janeiro state, Brazil (Figure 1).

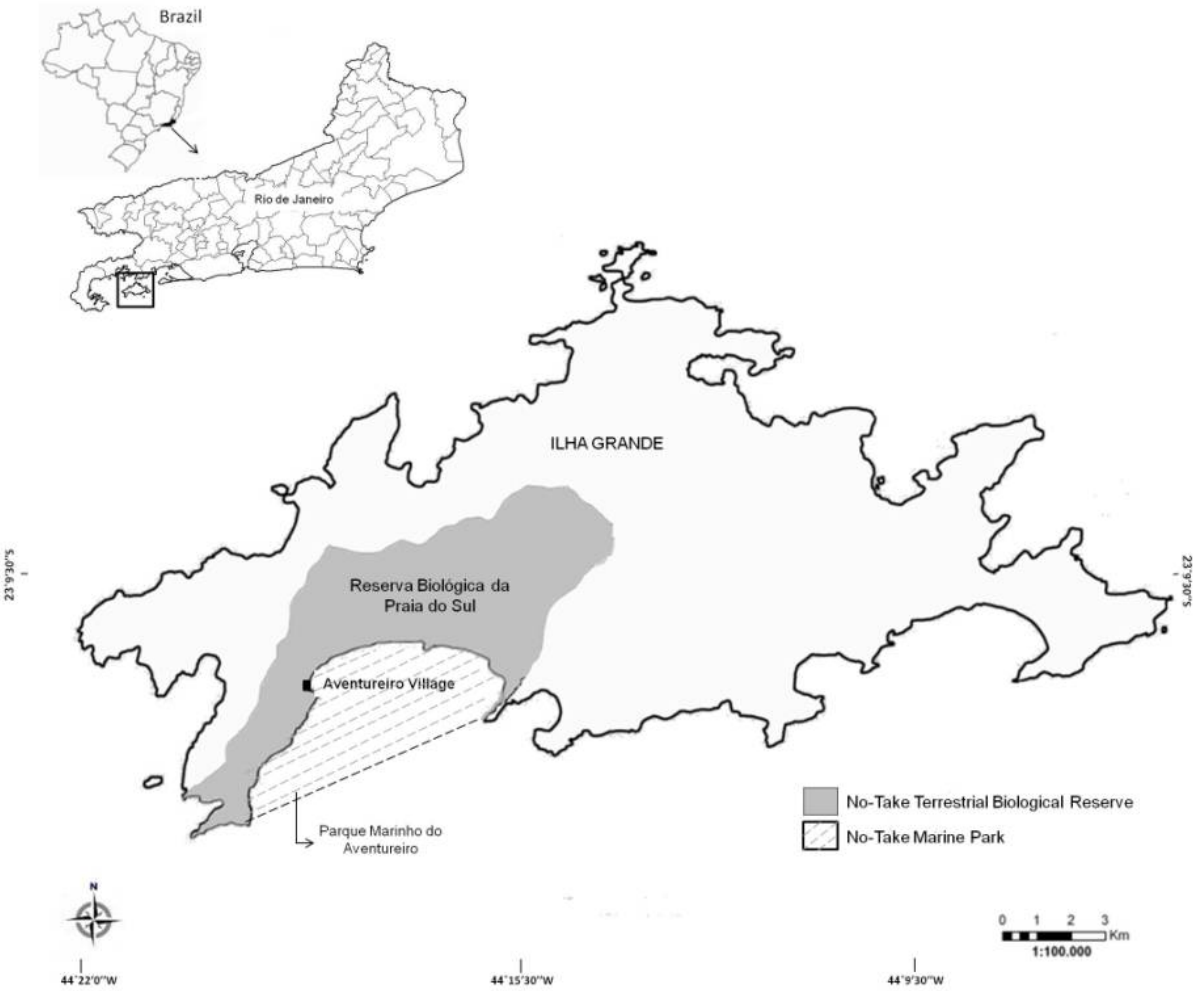

FIGURE 1 REGION AND LOCATION OF STUDY SITE

Fish landings were documented for seven consecutive days, bimonthly over one year during 1995-1996 and again from 2011-2012. We also conducted semi-structured interviews with

fishers and participant observation of fishing activities. Although sporadic rather than gradual monitoring has been carried out, the effort to collect data on the same days provided information on key socio-ecological changes in a time frame of 15 years.

MONITORING SMALL-SCALE FISHERIES AT AVENTUREIRO VILLAGE

An assessment of the overall changes in fisheries was carried out regarding the dependence on the activity among households, changes in fishing gear, production level, vessels and fishing spots used (Table 1), among others. Monitoring showed that small-scale fisheries remained extremely important for households, especially regarding subsistence fishing activity. The main fishing gears used are hook and line (hand line, reel or rod) and gillnets, with purse seines and beach seine used at a lower intensity. The fishing activities are conducted on the rocky shores (i.e. without the use of vessels) as well as in canoes, motor boats and other vessels.

The rate of catching fish, when compared with other communities, can be considered of relatively low importance. However, it is essential considering that fishing on Aventureiro has trading as a secondary feature, necessitated by its geographical isolation and the lack of infrastructure, such as electricity. The lack of infrastructure undermines the catch storage, a common reality in many regions of the Brazilian coast. Beyond the economic importance of the activity on a regional or national setting, small-scale fishing in this community has a substantial importance for food security and for maintaining several social and cultural aspects, often not considered in fishery statistics that foster public policies for this sector in Brazil.

One of the main changes between 1995-1996 and 2011-2012 was the reduction of employment in industrial fisheries. In 1995-1996 all fishermen interviewed worked as crew on large trawlers, which is considered a synonym for labour exploitation; being far from family, physically exhausting and dangerous. Because of the increasing income coming from tourism activities that were developed in the community, in 2011-2012 only one household out of 20 had their source of income exclusively dependent on fishing.

A key factor promoted by small-scale fisheries is food security, since 65% of households reported that they eat fish everyday or almost everyday, and the other 35% eat fish up to three times a week. Exchange networks and donation of fish in this community ensure not only food security, but also stimulate networking and social cohesion which strengthen the social capital and this is important for resilience and stewardship.

Although the comparison of 15 years of fish landings at Aventureiro does not allow for precise statements about the state of the marine ecosystem, considering the normal oscillation of resources and their relationship with climatic variations, we can precisely state that small-scale fisheries remain active and have a substantial importance on livelihoods for all households in many ways. For details on all data collected, see Prado [8]. The interviews and field observation indicated the need to strengthen local institutional arrangements in order to promote greater community participation and organization, to cope with change, and to strengthen local socio-ecological resilience.

TABLE 1 MONITORING DATA FROM SMALL-SCALE FISHERIES AT AVENTUREIRO VILLAGE, ILHA GRANDE (RIO DE JANEIRO, BRAZIL). TO ACCESS THE FULL DETAILS, SEE PRADO [8]

Monitoring	1995-1996	2011-2012
Vessels	From land - without vessels (62.8%) Paddle canoes (25%) Motor boats (12.2%)	From land - without vessels (23.8%) Paddle canoes (45.2%) Motor boats (9.5%) Launch (12.7%) Kayak (4%) Baleeira (2.4%) Canoe and boat (1.6%) Dinghy (0.8%)
Fishing Gears	Hook and line (73.4%) Surface set gillnet (19.7%) Bottom set gillnet (4.3%) Purse seine gillnet (1.6%) Hook and fishing rod line (0.5%) Hook and fishing reel line (0.5%)	Hook and line (55.6%) Surface set gillnet (15.1%) Bottom set gillnet (14.3%) Purse seine gillnet (4.8%) Hook and fishing rod line (8.7%) Hook and fishing reel line (0.8%) Beach purse seine (0.8%)
Fishing Spots	Remaining the same	
Average production for each catch	4.67 (±9.38) Kg	19.07 (±86.3)Kg
Fisheries dependence	All fishermen interviewed were crew on large trawlers, at industrial fishing of Sardine	The livelihood diversification, like the insertion of community-based tourism, allowed the fishermen to leave the industrial fishing. The small-scale fisheries, which is carried out mainly for subsistence and local trade showed strengthening

PARTICIPATIVE MONITORING

The monitoring effort carried out in this study provided relevant information on the state of fisheries in the study area. The systematic gathering of data is rare in small-scale fisheries, in comparison to medium and large-scale fisheries that generally have fixed landing points. Small-scale fisheries have several landing points, and a great deal of effort would be required for government agencies to monitor these points. An alternative to this effort is to create procedures for participatory monitoring, where the communities actively participate in the data collection. This data could support policies at regional and national levels and/or also be used by the community to establish local fishing rules. Such procedures may contribute to the participation and engagement of the population in decision-making processes relating to fishing activities.

In these cases, participation must be considered not only as a methodological resource, but also as a process in itself, involving factors such as the culture of the group or the community [9]. Cultural and institutional aspects are endogenous components of the

participation dynamics, important in processes of governance such as adaptive co-management and stewardship.

It is also essential to consider that the steps of engagement and local participation in monitoring should happen from the planning phase and include information that is relevant to all stakeholders [10], as well as in the implementation and evaluation phases. As long as legitimacy is increased, participatory monitoring can promote shared learning and therefore resource conservation and the maintenance of small-scale fishing activity.

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Understanding Tradeoffs in Fishers Decision Making: Catch, Distance, and Safety Influence Where Fishers Fish

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ABSTRACT

Here we explore the tradeoffs between the distances that gleaning and non-gleaning fishers travelled, and the benefits they gained. We found that gleaners stayed close to their starting location and obtained larger, more valuable catches when they travelled further. Non-gleaning fishers travelled four times further on average, but travelling far did not correspond to larger or more valuable catches. Regardless of gear, fishers described important fishing grounds as having desirable catches and being nearby, but also being safe and having good habitat quality. Our findings suggests that management could benefit from accounting for the spatial and economic differences among fishing methods, and from identifying the diversity of attributes of fishing grounds that fishers value.

Key words: small-scale fisheries, spatial management, Philippines, artisanal fishing, subsistence

INTROUCTION

Spatial management tools are often used for small-scale fisheries. Given the complexities of small-scale fisheries (i.e. many fishers, wide diversity of gears, species caught, and habitats exploited; [1]) and lack of historical data, classic tools like establishing catch limits based on stock assessments are unlikely to be practical or effective. In contrast, spatial management tools like marine protected areas (MPAs) have roots in many traditional small-scale fishing communities [2] and can be implemented and managed at the village level. This has led to their proliferation in places like the Philippines [3]. Although spatial management tools are increasingly adopted, an understanding of where fishers fish and why they fish there is not always incorporated into management plans. Developing a better understanding of the choices that fishers make about where to fish can be important for effective management and conservation.

To understand where fishers fish, a growing array of data-collection methods have been developed and are beginning to reveal detailed information of spatial fishing patterns. Existing studies have gathered spatial fishing information by asking fishers to identify their activities on maps or recording coordinates of fishing grounds. Digital tracking technologies, more commonly applied to monitor industrial fisheries, are also beginning to be applied to small-scale fisheries [4,5]. Research on why fishers choose certain fishing grounds have often been framed on the assumption of a simple tradeoff between cost and expected profits. Under these assumptions, fishing trips further from home should yield larger catch rewards [6] and fishing should be concentrated in places with high CPUE [7]. To predict where small-scale fishers will fish and why, research is moving beyond assumptions about profit maximization, to include a broader range of driving factors [8]. The type of fishing method that fishers use can have an overarching influence on spatial fishing patterns. For example, fishers using traps can be highly aggregated, while fishers using diving may travel

more widely [4]. Fishers movements can also be influenced by factors such as culture and familiarity with local conditions [9], which highlights the importance of social context on spatial fishing patterns.

In this chapter we seek to understand potential drivers of where fishers fish, focusing on tradeoffs related to distance travelled and the qualities that fishers attribute to important fishing grounds. To assess these topics we bring together data from two complementary case studies which we use to investigate the practices and perceptions of small-scale fishers in the Danajon Bank ecosystem of the Central Philippines (Figure 1). First, we assessed the cost-benefit tradeoffs of travelling far to fish by using digital tracking (GPS) to measure how far fishers travelled (a metric of cost) and recording the resulting catch and its value (a metric of benefits). Second, we identified the tradeoffs that fishers consider when they choose where to fish by asking fishers to describe the positive and negative attributes of their most important fishing grounds. In this paper we examine intertidal (gleaning) and subtidal (nets, diving, hook and line, and traps) fisheries. Taken together, our approach offers insight into the diversity of spatial fishing behaviours and can contribute to spatial management tools by offering specific knowledge about the decision-making and priorities of fishers.

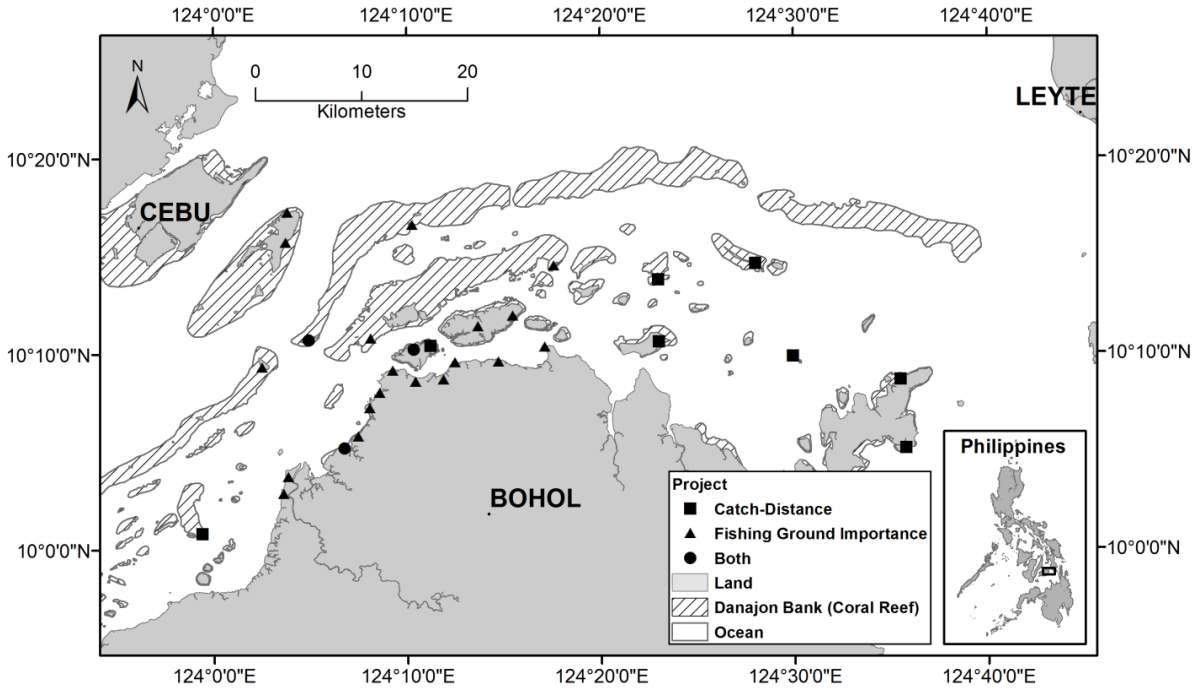

FIGURE 1 THE VILLAGES INCLUDED IN THIS STUDY ARE LOCATED IN THE DANAJON BANK REGION OF THE CENTRAL PHILIPPINES.

METHODS

Study Area and Fisheries

Our work took place in the Danajon Bank, a coral reef system in the Central Philippines that has been degraded by overfishing and destructive fishing practices (Figure 1). Coral reefs, seagrass beds, and deep water channels are all habitats found on Danajon Bank [10]. The villages of Danajon Bank have limited infrastructure, high population densities, stark poverty (i.e. 42% of households are below the Philippines poverty line; [11]), and a strong reliance

on marine resources. Spatial management measures include small MPAs (over 35 have been established), national legislation that prohibits commercial fishing in nearshore waters, and a legal restriction on small-scale fishers to fish only in their own municipal waters, although the latter is widely unenforced. The authors and the Project Seahorse team (www.projectseahorse.org) have worked with fishing villages in the region since 1995 to assess and foster sustainable fisheries.

In Danajon Bank there are at least 30,000 small-scale fishers [12] who use over 60 fishing gears. We simplified this gear diversity by grouping the most commonly used fishing gears into five methods: (1) gleaning (walking in intertidal areas, but not submerging the head); (2) diving (swimming with submerging, with or without a physical instrument (e.g. spear)); (3) hook & line (both single and multi-hook gear); (4) nets; and (5) traps.

Case Studies

We bring together two complementary data sets collected between 2010 and 2012 in villages chosen to represent the geographic diversity of the Danajon Bank. The first study occurred in 12 villages. Using GPS tracking we recorded the path 126 fishers traveled on a fishing trip (Figure 2).

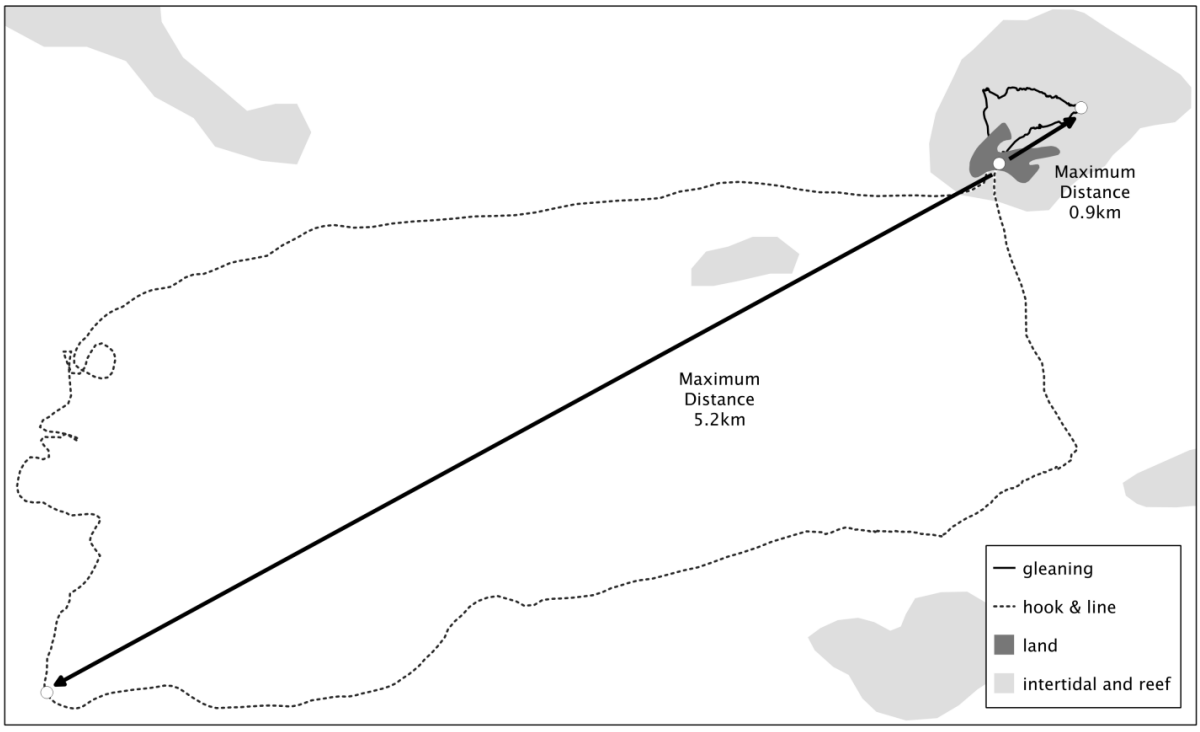

FIGURE 2 FISHING TRACKS WITH THE MAXIMUM DISTANCE CALCULATION METHOD ILLUSTRATED. TRACKS ARE FROM FISHERS IN BILANG-BILANGAN WEST, TUBIGON, BOHOL AND ARE TYPICAL OF THE WIDESPREAD PATTERN WE FOUND WHERE GLEANERS STAY CLOSE TO SHORE AND SUBTIDAL FISHERS TRAVEL MUCH FURTHER

For each fishing trip we recorded the catch size (kg), monetary value (in Philippine pesos (PHP)), and biodiversity (number of species). GPS tracking is an accessible way to precisely document the spatial patterns of fishing trips. These data were collected as part of a larger study on gender and fisheries, so gleaning, primarily the fishing method of women, is represented in equal numbers to all other fishing methods, primarily the fishing method of

men [13]. The second study used fisher interviews and thematic analysis to understand why fishing grounds were important to fishers and took place in 21 villages. Interviewing fishers is a widely used method to better understand the drivers behind fishing behaviour. This was part of a larger study that focused on the spatial dynamics of men's fisheries, consequently the proportion of gears represented in interviews represents the distribution of male fishers using those gears in the focal villages. In total, twenty-eight villages were included in the studies as three villages were included in both studies. All data were collected in a manner that would allow us to protect the anonymity of respondents.

Quantifying Spatial Fishing Behaviour

To quantify spatial fishing behaviour, we recorded fishing trips for all five fishing methods with GPS units between September 2011 and January 2012. We calculated the maximum distance travelled for each trip (km), which we defined as the maximum distance between the starting point and the furthest fishing point (Figure 3). For each tracked fisher, we also recorded catch. We identified individual species caught (using local classification); their weight (kg); their fate (for household consumption/subsistence or for sale); and their total value (in PHP for those sold). We used the edible yield of all animals with shells to calculate the total weight to edible weight (wet weight of meat) of each animal caught. We calculated, for each fishing trip: catch size (total edible biomass in kg), catch value (PHP); and species diversity (measured as richness, the total number of species). Finally we tested the assumption that catch size, value, and/or diversity increase with the maximum distance travelled. For several analyses we pooled subtidal fishing gears (hereafter 'subtidal fishing methods') because of small sample sizes and because we found that they travelled similar distances (see Results).

Explaining Spatial Fishing Behaviour

Since recorded fishing trips revealed fishers did not always choose where to fish based on maximizing catches (see Results), we interviewed fishers about their fishing ground choices. We asked fishers to identify their most important fishing grounds, to describe the reasons that those fishing grounds were important to them, and to explain the disadvantages of those same sites. We coded fisher responses using thematic analysis and then pooled the responses into nine fishing ground attributes. Each attribute was coded as (a) attributes that fishers valued or (b) attributes that were disadvantages in the otherwise important fishing ground (hereafter referred to as 'positive' or 'negative' attributes, respectively). We asked about positive and negative attributes of fishing grounds recognizing that fishing anywhere involves a tradeoff, which we wanted to address explicitly. We combined responses about distance and cost because fishers spoke about these two characteristics interchangeably (e.g. the expense of getting to distant fishing grounds). Using the coded data, we evaluated how the fishers' perceptions of positive and negative attributes varied (a) overall (i.e. among all fishers) and (b) between fishers using gleaning and fishers using other methods. We compared gleaning and fishing to keep the comparison consistent with the results from our quantification of spatial fishing.

RESULTS

Quantifying Spatial Fishing Behaviour

During GPS tracking, we recorded the movements and catches of 126 fishing trips from 63 gleaners, 14 divers, 16 hook & line fishers, 17 net fishers, and 16 trap fishers. We found

striking differences between gleaners and subtidal fishing methods for both spatial behaviour and catch metrics. Gleaners fished closer to shore than other fishers on average, traveling less than one quarter of the distance (mean = 0.89 km) from their starting location than other fishers (mean = 4.19 km). The range of distances that fishers travelled were smallest for gleaners, medium for traps, and largest for nets, dive, and hook and line methods (Figure 3). Differences in the mode of travel likely affected these distances and the habitats accessed. While gleaners traveled mostly on foot (only 13% of gleaning trips used boats), remaining close to the shoreline of their village, fishers using subtidal methods traveled by boat (92% of trips) and therefore were not restricted to intertidal areas or habitats. While both gleaners and divers shared the intertidal, they rarely overlapped because gleaners focused on mangrove and rock habitats while divers more frequently exploited reef crests further offshore.

Catches by gleaners were less valuable than all subtidal fishing methods, although catches from all five fishing methods were surprisingly similar in size (Table 1). The fate of the catch also differed, while gleaners' catch was more frequently used solely for subsistence (66% of trips), the majority of subtidal fishers' catch was sold (only 17% of trips were solely for subsistence). Finally, gleaners were the only fishers for who traveling further resulted in larger and higher value catches. An increase of 1 km of distance traveled by gleaners resulted in an average increase of 1.58 kg, and 24.02 PHP. Catches by gleaners were more diverse overall, but for all fishing methods traveling further did not involve catching a greater diversity of species.

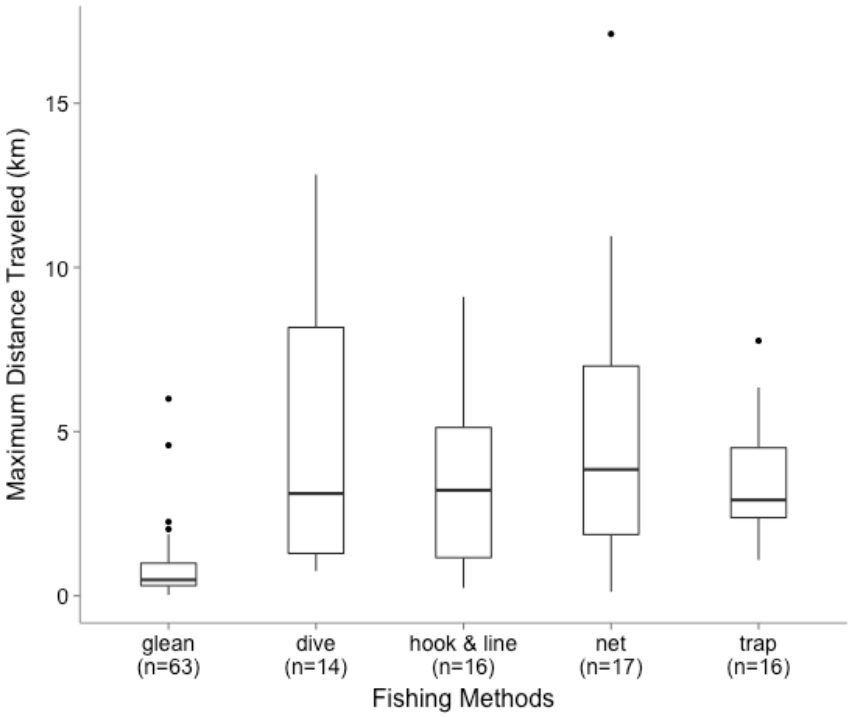

FIGURE 3 GLEANING FISHERS TRAVELLED SIGNIFICANTLY SHORTER DISTANCES THAN FISHERS USING SUBTIDAL FISHING METHODS

TABLE 1 GLEANERS HAVE SIMILAR CATCH SIZES, BUT THEY ARE LESS VALUABLE AND MORE DIVERSE THAN SUBTIDAL FISHING METHODS

Catch Characteristic	Mean Gleaning Catch (n=63)	Mean Subtidal Fishing Catch (n=63)
Size (kg)	1.41	2.38
Value (PHP)	23.13	158.09
Diversity (Species Richness)	8.08	4.90

Explaining Spatial Fishing Behaviour

We interviewed 284 respondents: 37 gleaners, 110 divers, 76 hook & line fishers, 146 net fishers, and 20 trap fishers. Fishers reported that valuable catches were part of the wide variety of reasons why fishing grounds were important to them (thirty-three themes which we pooled into nine attributes; Figure 4). When describing a fishing ground's positive attributes, fishers most frequently cited three characteristics: (1) catch/income (93% of fishers); (2) distance/cost (45% of fishers); (3) safety (39% of fishers). For example many fishers said, 'I like fishing here because I can still catch some fish' while other fishers reported, 'I like fishing here because it's close so the cost of fuel is not too high.' Respondents mentioned a variety of other positive attributes including site condition (e.g. habitat quality; 17% of fishers) and suitability of the site for their gear (10% of fishers).

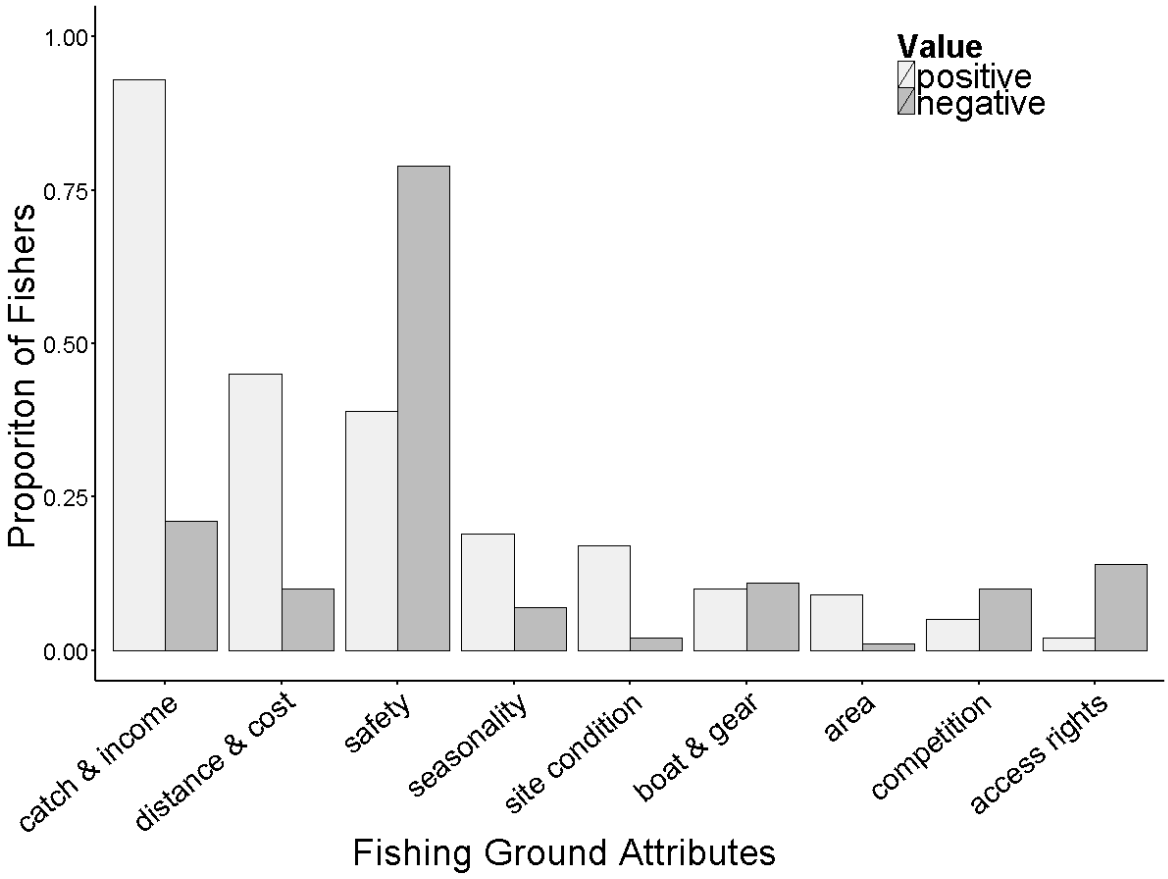

FIGURE 4 THE POSITIVE AND NEGATIVE ATTRIBUTES THAT FISHERS USED TO DESCRIBE THE TRADEOFFS OF THEIR MOST IMPORTANT FISHING GROUNDS (N = 284)

Fishers also reported that fishing grounds were important to them, despite having negative attributes. Although safety was mentioned as a positive attribute of fishing grounds (e.g. 'I like fishing here because it is safe from the wind'), 80% of fishers said they valued fishing grounds even though they were not safe (e.g. 'I like fishing here even though it is dangerous when it is windy'). Fishers also explained that fishing grounds were important despite providing low catches (21% of fishers), being far away (10% of fishers), or having restricted access (e.g. fishing grounds that had become seaweed farms; 14% of fishers). When we compared the attributes of important fishing grounds from gleaners and subtidal fishers, we found only one significant difference: while some fishers mentioned the cost/distance of a fishing ground as being a disadvantage, gleaners did not find the cost/distance to their fishing grounds problematic.

DISCUSSION

Our research reveals that the spatial differences among most fishing methods are poorly explained using cost-benefit analysis and that the value of a fishing ground emerges from more than catch alone. We found that travelling further only increased the catch for one fishing method (gleaning). The distance that fishers travelled unsurprisingly corresponded to fishing method and boat use, but our GPS tracking allowed us to confirm these differences in a novel, quantitative way. Although our findings demonstrate that catch characteristics (catch volume, fish size, target species) were considered the most valuable attributes of fishing grounds, other valued attributes included distance/cost, safety, and the condition of the site. These findings have important implications for ecological impacts, monitoring and stewardship, which we will detail below.

The mismatch between where we recorded fishers fishing and the types of grounds they reported preferring could be explained by fishers' uncertainty about the spatial distribution of their prey. Ninety-three percent of fishers reported that fishing grounds with large catches or valuable species were important, revealing that fishers value fishing in profitable places. Yet many fishers who took on the high cost of fishing at further distances did not obtain larger or more valuable catches. The disconnect between what fishers value and what they receive may be due to small-scale fishers' inability to identify large scale gradients in the distribution of targeted species [8] due to the relatively short distance that they travel (e.g. in this study mean distance = 0.89 km and 4.19 km for gleaning and subtidal fishing methods, respectively). Additionally, many small-scale fishing methods target mobile animals that fishers can't see, making it difficult for fishers to predict where the best catches will be on a given day [8]. Another reason for this disconnect may be a study limitation as interviewed fishers were not the same fishers who were tracked. However we expect that the studies' random sampling, plus large sample sizes captured patterns and opinions characteristic of the region. Our results support the work in this area showing that factors such as income, distance, and safety are important considerations influencing fishers' movement (e.g. [14]).

Gleaners were the only fishers who achieved larger and more valuable catches when they traveled farther. Gleaning primarily targets sedentary species [13] and fish in intertidal areas where they can see plainly the spatial distribution of their potential catch. Gleaners may use this information to continually update their effort decisions throughout a fishing trip, resulting in a tighter link between catch and effort. Additionally, catches in distant gleaning areas may be higher than those in gleaning areas near villages as those sites may not be fished as frequently or as intensely. Although our approach to measuring distance was not able to

distinguish between fishing time and travel time, we feel that we appropriately compared effort across fisheries because travel time is incorporated into fishers' decision-making [8]. Our results concur with other human ecology studies that also found gleaners' catches to be small, but consistent in volume and to increase linearly with fishing effort [15]. Gleaners' strategies may thus favor small-but-consistent catches over large-but-variable catches. Overall our results support previous research showing that gleaning is socially, spatially, and ecologically distinct from other fishing methods [16].

When considering non-monetary attributes of important fishing grounds, fishers most frequently spoke of concepts of safety. Here most fishers offered a paradox of opinions; in 76% of villages fishers simultaneously valued safe fishing grounds and reported that these same places were disadvantageously dangerous. This dichotomy may reflect individual attitudes toward the widespread danger that is part of fishing. Fishers must constantly balance minimizing personal risk with maximizing productivity. Faced with declining catches and debt, as many of the fishers in our study region are [17], they may take greater risks. However, the type of risk that individuals are willing to take can be influenced by their cultural perception of risk or by their familiarity with the dangers of fishing [9]. For example, fishers who are from fishing families in the US [18] and fishing castes in India [19] are more comfortable with the risks of fishing. Therefore this paradox of opinions about safety may stem from the fact that risk is unavoidable, but that some fishers deem a greater risk to be acceptable. The risk that is deemed acceptable can then influence spatial patterns of fishing [9].

Ecological Implications

Since the ecological impacts of fisheries differ, understanding the spatial distribution of fishing effort can strengthen ecosystem management and biodiversity conservation. Our research shows that fishing methods, in particular gleaning, differ in their spatial patterns and highlights the often overlooked human exploitation of intertidal areas and the greater biodiversity of targeted intertidal species. Recent work on gleaners in our study region has shown that they catch a much larger volume of invertebrates than subtidal fishers [13]. However, management in our study region has largely ignored human exploitation of intertidal areas. Using spatial data from all fishing methods can prevent such oversights, thereby making management more comprehensive and effective.

Monitoring

Our research assessed the spatial variability of several aspects of small-scale fisheries, which could be important to incorporate into long-term monitoring programs. To date, long-term monitoring in the Danajon Bank, as in many regions of the world, has focused on ecological aspects of small-scale fisheries (e.g. fish biomass, fish diversity, and coral cover). We assessed the ecological aspects of biomass and biodiversity as they relate to distance travelled, yet our work goes on to capture other important components of fisheries that could contribute to their successful stewardship. Specifically we measured the economic and subsistence use of catch, and assessed how fishers valued their fishing grounds, including attributes such as safety concerns and access rights. With shifting ecological and economic contexts, the use of catches and the important attributes of fishing grounds may also evolve. Our research suggests that these economic, subsistence, and social characteristics can be useful to monitor so that their dynamic influence on the fishing practices of all fishing gears, including gleaning, can be accounted for in management.

Stewardship

Synthesizing quantitative and fisher knowledge, as we have done here, can improve stewardship by providing insight into important, interdependent aspects of fisheries. Spatial information can identify what locations fishers depend on, while complimentary interviews can reveal underlying considerations in fishers' decision-making such as catch distributions, site conditions, and safety. The incorporation of fisher knowledge also allows management to recognize the priorities of fishers. This may safeguard against criminalizing fishing methods that are essential for food security. Such criminalization has occurred when no-take MPAs were placed in important nearshore fishing habitats used predominantly by gleaners.

Our detailed documentation of the tradeoffs associated with small-scale fishers' spatial behaviour leads us to offer two recommendations for management. First, management could account for the spatial and economic differences among fishing methods. For example, MPAs close to shore will disproportionally affect fisheries tied to the shore (e.g. gleaning). Our results suggest that this may adversely affect food security if these fisheries' harvests are consumed by local families (subsistence) instead of sold to broader markets. Second, because the value of a fishing ground to a fisher incorporates more than catch alone there is the need for communication and collaboration between fishers and managers. We encourage such dialogues to identify and account for important aspects of fishing grounds when developing spatial fishing regulations.

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How and to What Extent do Small Scale Fishing and the Aquatic Environment Impact Each Other?

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MAIN IMPACT IN JAMAICA

The greatest impact on small-scale fishing in Jamaica is the massive reduction in fish stocks which has severely impacted the socio-economic status of small scale fishers. This is as a result of many underlying factors of which I will discuss a few.

Pollution from industrial waste and the continuous release of effluent has destroyed a great portion of the marine life. The Hotel chains also contribute to these types of pollution. Pollution such as this causes over fertilization of the green algae and as a result overgrowth and proliferation of the algae have suppressed other marine vegetation on the ocean floor and also smother the coral reefs. The reduction of the parrotfish population which is herbivorous in nature and are grazers who feed on the seamoss also contribute to the over growing of the algae and the eventual smothering of the reefs.

Thirty years ago there was a strong population of a particular herring-like small fish known as ‘trapung fries’ and another similar species called ‘juba broad head’. These small fishes traveled in large schools along the inshore coastline and were favourite feeding for the pelican seabirds that could be seen from a great distance striking in the school of small fishes. We, the small-scale fishers, were great beneficiaries of those activities, because the seabirds striking in these fishes helped us to identify where the schools of larger fishes were who also feed on these smaller fishes.

The disappearance of these creatures has not only negatively impacted us the fishers, but also the seabirds who for lack of sustenance have now resorted to the fishing beaches wrestling with humans and dogs for the fish offal that is thrown away by fish cleaners. This is a very ominous sign. The disappearance of these fishes is not as a result of overfishing but that of either pollution or changes in the weather that affects the whole ecology. These are some of the conditions that scientists need to research.

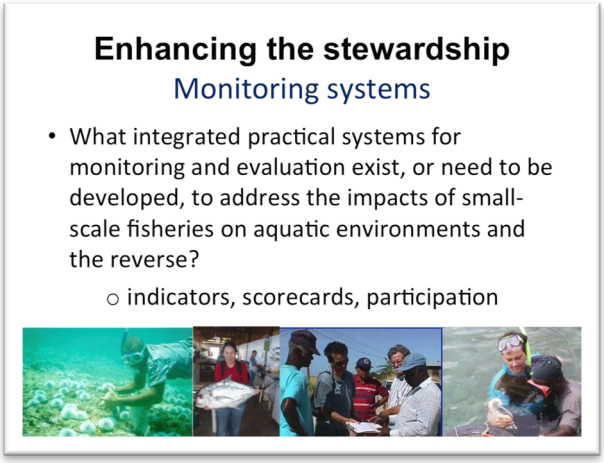
Another adverse factor is the current species of porpoise (Dolphins) with which small-scale fishers must contend. A few years ago the dolphins were harmless and friendly. They were no threat to fishermen or their equipment but extremely adversarial to sharks. Today the current species of dolphins are very destructive to our nets and fish pots. I would recommend that scientists study the change in behaviour of these animals. We need to know whether this is an exotic species resulting from the establishment of Dolphin Cove in Jamaica or a change in the ecology which has affected their sustenance and consequently resulted in a change their behaviour.

The most salient problem that small-scale fishers experience in Jamaica currently is the proliferation of the lionfish. These strange predators are now threatening the residue of the edible fish population that is left by consuming the eggs as well as the juvenile fishes. The lionfish has now pervaded most of Jamaica’s fishing ground and part of the Pedro Banks.

CONCLUSION

Based on these observations it is obvious that the challenges faced by small-scale fishing in Jamaica and the Caribbean are colossal due to complex adverse situations. It therefore requires a great deal of research in order to identify possible means whereby these adverse conditions can be mitigated.

Monitoring systems



Beyond understanding the ecological impacts in fishery systems, we need to monitor and measure the impacts and changes, and interpret consequences. Participatory monitoring and evaluation supports understanding fishery systems and also achieving shared learning. In this section we read about integrated, practical systems for monitoring and evaluation that exist, or need to be developed, to address the impacts of SSF on aquatic environments and the reverse.

A methodological perspective is presented in **Socio-economic Monitoring for Coastal Management (SocMon): Application of a Participatory Monitoring Tool to Small-Scale Fisheries**. The authors describe SocMon steps and main characteristics as well as its potential to be a comprehensive methodology to understand fisheries system dynamics.

A new spatial approach to SocMon is explored in **Incorporating GIS into Socio-economic Monitoring for Coastal Managers (SocMon)**. Different methodological approaches were tested to evaluate how participatory Geographic Information Systems (PGIS) can add value to SocMon by facilitating spatially based assessment and monitoring of SSF.

The authors of **Integrating Multiple Objectives in Fisheries Management – A Case Study Application for Eastern Caribbean Flyingfish** use multi-criteria analysis (MCA) to explore fisheries management objectives based on an ecosystem approach to fisheries. This was one ingredient in developing a sub-regional fisheries management plan for flyingfish.

A collaborative approach to document and monitor marine biodiversity is shared in the article on **Prediction and Verification of Reef Fish Spawning Aggregation Sites in Quintana Roo, Mexico.** The authors demonstrated the importance of bridging knowledge types in order to improve the quality of information as well as a means of engaging multiple stakeholders in conservation and management strategies.

Efforts have been made worldwide to get people together to develop innovative methods and collective action for conservation and fisheries co-management. A Brazilian perspective on the experience of **Setting and Implementing a Programmatic Agenda for Coastal-Marine Networks in Brazil** describes the collaborative work of various networks in creating coordinated actions for a Programmatic Agenda supporting management and conservation.

Readers will find interdisciplinary approaches to monitoring are becoming more common in SSF. More attention is being paid to the ecological and social knowledge of resource users. A major challenge is to integrate these knowledge systems with science to benefit stewards.

Socio-economic Monitoring for Coastal Management (SocMon): Application of a Participatory Monitoring Tool to Small-Scale Fisheries

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ABSTRACT

The significance of socio-economic monitoring of coastal resources, like small-scale fisheries is generally acknowledged but is usually marginalized even though national and regional fisheries, marine protected area and other management plans require this information. Socio-economic Monitoring for Coastal Management (SocMon) is a practical and flexible participatory monitoring methodology developed specifically for coral reef and coastal management. It is part of a global initiative to enhance understanding of communities and their relationship to coastal and marine resources. Socio-economic information can help fisheries and coastal managers identify potential problems and shocks, mitigate negative impacts and focus management to achieve priority objectives. SocMon is therefore a means of promoting the use of social and economic data in fisheries and coastal management decision-making. Its uptake improves fisheries and coastal management capacity and the sustainable use of resources.

Key words: Socio-economic monitoring, participatory, small-scale fisheries

GETTING TO KNOW SOCMON

Socio-economic Monitoring for Coastal Management (SocMon) is a global initiative of the IUCN World Commission on Protected Areas (WCPA-Marine), Global Coral Reef Monitoring Network (GCRMN) and the National Oceanic and Atmospheric Administration (NOAA) in partnership with university departments, NGOs and other agencies. Visit www.socmon.org for more information. The initiative is implemented globally through regional nodes with the goal of establishing socio-economic coastal and marine site level monitoring programmes worldwide [1, 2]. It is a practical and flexible participatory monitoring methodology developed initially for coral reef and coastal management aimed at enhancing our understanding of communities and their relationships to the natural resources upon which they depend.

Socio-economic information can help fisheries and coastal managers identify potential problems and shocks, mitigate negative impacts and focus management to achieve priority objectives. Schemes for participatory monitoring such as SocMon, can be a means of promoting social and institutional learning and decisions. Fisherfolk can take part in SocMon from the design of monitoring through to final communication of key learning for decision-making. These activities help to develop adaptive capacity and inform adaptive management within fisheries systems. There are currently six regions globally conducting SocMon, each of which has its own specific guidelines for socio-economic monitoring. The regions are: Caribbean, Central America, Pacific Islands, South Asia and Southeast Asia. Brazil is soon to be the seventh region.

SocMon is coordinated by a Global Coordinator based at the NOAA Coral Reef

Conservation Program in Washington D.C. The six Regional Coordinators or nodes implement SocMon on a voluntary basis. With repeated rounds of SocMon in each of the regions, the methodology has been adapted and enhanced in many ways to add value. For example, in the Caribbean, add-on modules in differing areas of specialization such as resource valuation, livelihood analysis, co-management and MPA management effectiveness have been offered in SocMon training to suit the site monitoring requirements and the information needs for decision-making.

SocMon Process

Within each region SocMon is implemented through the Regional Coordinators working with local partners to facilitate community-based socio-economic monitoring. There are six main phases to establishing a socio-economic monitoring program for fisheries – (1) preparatory activities, (2) planning and scoping, (3) data collection and observation, (4) data analysis and validation, (5) key learning and communication, and (6) decisions and adaptive management. It is a highly iterative process with loops, feedbacks and checks. The results of later phases will likely modify earlier information and decisions, and may cause previous steps to be repeated in order to improve the quality of the monitoring (Figure 1).

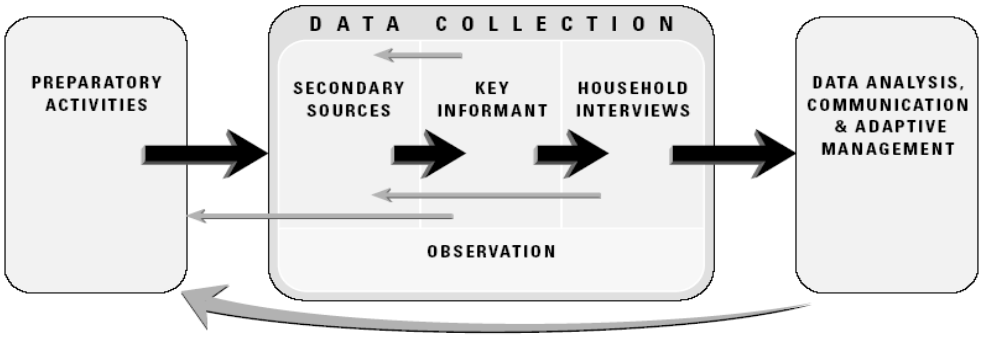

FIGURE 1. SCHEMATIC SHOWING FEEDBACK IN THE SOCMON PROCESS [2]

Details on each of the phases of the methodology may be found in the Global Coral Reef Monitoring Network (GCRMN) manual [1]. As companion publications, the regional guidelines provide prioritized lists of socio-economic variables for monitoring that are not rigid and can be tailored to each site's need [2]. The regional guidelines are used together with the GCRMN manual, which provides details on a wide variety of field methods for monitoring and working with stakeholders on visualizing the data that they are generating.

SocMon requires flexibility and adaptability in the monitoring programme. Typically, socio-economic monitoring at sites can be completed in eight weeks [1]. However, the duration of monitoring depends on many factors including:

- Size of the study area versus available resources
- Iterations in design and implementation
- Constraints or delays from many sources

SocMon is meant to be affordable without external funding in order to be sustainable as on-going monitoring rather than just occasional or ad hoc assessments conducted on a project by project basis. In the Caribbean, socio-economic monitoring has been implemented on a budget of USD$2,000 to 2,500 per site. This may not be an annual expense, as not all

variables have to be measured yearly or require fieldwork as extensive as the in first assessment. However, the value of SocMon or any monitoring programme is lost unless monitoring is done on a regular basis, and that means having funds securely allocated for the purpose. Highlights of SocMon include:

- Early consultation with stakeholders to gain buy-in and support for SocMon and its outcomes is necessary.
- Thorough planning of the process for conducting SocMon - development of a work plan and budget - will ensure efficient and effective collection of data.
- Selection of variables for monitoring is one of the most important stages of SocMon. Variables must always be linked to goals and objectives for monitoring.
- SocMon uses an iterative multi-method process for collecting data. Secondary sources of data and observations are used for scoping and compiling background information to determine gaps in knowledge. To build the big socio-economic picture at each site key informant interviews and interactive methods such as group interviews, focus groups and visualization techniques are useful. If finer socio-economic details are still required, surveys and in-depth interviews may be conducted.
- Validation or confirmation of SocMon results is a very important step in any SocMon programme. Feedback to stakeholders is crucial for fostering trust and respect, gaining buy-in and support for management initiatives, paves the way for follow-up and provides community empowerment.
- Communication products for sharing SocMon findings should be tailored to the site situation and target audience.
- SocMon results are used for adaptive management in order to improve management, planning, accountability and reduce impacts.

Brief Notes on SocMon Variables

- 70 socio-economic variables may be used in monitoring
- Variables are presented in the guidelines according to the means of data collection
    - 32 key informant interview and/or secondary sources variables
    - 28 survey variables
    - 10 climate change-specific (addendum to SocMon guidelines)
- Variables selected for monitoring depend on site goals and objectives
- SocMon guidelines suggest links between monitoring goals or objectives and variables
- Flexibility of the methodology means new variables for monitoring may be designed
    - Projects associated with regional conservation initiatives – the Micronesia Challenge and the Caribbean Challenge Initiative have developed variables [3, 4]

PRACTICAL APPLICATION OF SOCMON GLOBALLY

Globally, the goals and objectives for socio-economic monitoring have generally included:

- Baseline data gathering on coastal communities against which to measure changes
- Informing fisheries and MPA management plans
- Developing socio-economic profiles for fisheries
- Promoting the use of socio-economic data in fisheries management
- Assessing management effectiveness of MPAs to inform and adapt management
- Determining the adaptive capacity of coastal communities to climate changes
- Using socio-economic data to complement biophysical monitoring
- Enhancing management capacity of stakeholders.

Many of the site monitoring programmes in each of the SocMon regions, have collected socio-economic information on marine protected areas (MPAs) in relation to small scale-fisheries. This is partly due to the establishment of, and increasing and directed interest in, recent coral reef conservation initiatives such as the Coral Triangle, Micronesia Challenge and Caribbean Challenge initiatives. As such, international funding strategies for socio-economic monitoring, such as the NOAA Coral Reef Conservation Program International Strategy 2010-2015, have tailored grant funding to support socio-economic monitoring at MPAs. Since marine livelihoods are integrally linked to MPAs, the monitoring has included socio-economic information on fisheries such as demographic data on primary occupation; coastal and marine activities; types of resource use; household market orientation; attitudes and perceptions on resource conditions; and perceived threats. In addition, governance data on awareness of rules and regulations, compliance, enforcement and participation in decision-making, among others, have been collected during site monitoring. Socio-economic data collected so far indicate *inter alia:*

- a high level of livelihood dependency on fishing, particularly subsistence and small-scale;
- declining resource conditions and accompanying reduction in catch at some sites;
- reluctance to change to alternative livelihoods due to a number of factors;
- threats such as restricted access, overfishing, pollution, sedimentation, among others

In particular in Central America, SocMon has been combined with the Sustainable Livelihoods Approach in several studies in which traditional, subsistence and small-scale fishing are considered the main occupation of the majority of communities studied [5-9].

In the English-speaking Caribbean, SocMon studies conducted between 2005 and 2013, have either generated socio-economic profiles of SSFs [10-12] or data on these fisheries systems have been collected as components of SocMon at MPAs [13-19]. See Table 1.

TABLE 1. PROFILES OF SOCMON CARIBBEAN STUDIES SPECIFIC TO FISHERIES

Study site(s)	**Monitoring goal and source report**
*Anegada, Tortola, Jost Van dyke & Virgin Gorda, BVI	Determination of the socio-economic importance of the lobster fishery of the British Virgin Islands [10]
Colihaut, Dublanc, Bioche, Dominica	Monitor impacts of present and proposed development with a view to ensure sustainable use of the resource base of the Dublanc, Bioche, and Colihaut communities [11]
*Grenadines Islands, St. Vincent & the Grenadines	To acquire socio-economic information on fisheries in the Grenadines for future use in fisheries and integrated coastal management decision-making [12]
Shoal Bay-Island Harbour Marine Park, Anguilla	Collect and document baseline socio-economic data of the Shoal Bay-Island Harbour Marine Park [13]
Oistins, Barbados	Monitor the impacts of present and proposed development in Oistins on its fisheries-based culture [14]
East coast fishing villages, Grenada	Assess the stakeholders in coastal settlements [15]
Rose Place, St. Vincent	Gather baseline socioeconomic information to inform development decision-

Study site(s)	Monitoring goal and source report
	making and enhance the environmental condition of Rose Place [16]
Molinière/Beauséjour, Grenada	Assess the feasibility of alternative livelihood options for the communities surrounding the Molinière/Beauséjour Marine protected Area (MBMPA) [17]
Woburn/Clarke's Court Bay, Grenada	To determine the changes and impacts that accompany the introduction of management planning to the WCCBMPA [18]
*Negril Marine Park, Jamaica	To inform fisheries management planning at the Negril Marine Park [19]

* SocMon-based assessment conducted for CERMES MSc research

USE OF SOCMON IN FISHERIES

In the Caribbean, valuable socio-economic data have been collected in studies directly and indirectly relevant to fisheries. For instance, in most MPA studies much of the data relate to fisheries. A selection was presented in Table 1. Such assessments include determining the socio-economic impact of a management measure such as a closed season on dependent communities (lobster in Corn Island on the Caribbean coast of Nicaragua; [20]). Another concerns strengthening conservation and management of managed marine areas that are traditionally used for fishing and heavily depended upon by rural coastal communities due to environmental and socio-economic constraints (e.g. Glover's Reef Marine Reserve, Belize; [21]). SocMon has been used for developing fisheries profiles for future use in fisheries and integrated coastal management decision-making (Grenadines islands; [12, 22]). The list of studies is fairly extensive but few of them were conducted with fisheries management planning as their focus or institutional target.

Consequently, there are gaps in the information management chain in the region between data and decision-making. An example is fisheries management at the Negril Marine Park in Jamaica. In 2005, a socio-economic survey of ten fisheries oriented communities adjacent to the Negril Marine Park along with fisheries consultation meetings and interviews with fisheries industry stakeholders were used to provide information needed for the development of the first Fisheries Management Plan for the Negril Marine Park [19]. Although drafted [23] the plan was never implemented and fisheries resource conditions within the park may have worsened.

Socio-economic information from SocMon, or any other approach, is seldom used in coastal and marine resource management decision-making anywhere in the world [24]. However, SocMon can assist in providing a better understanding of the contribution of SSFs to food security, sustainable and alternative livelihoods, poverty alleviation etc. as well as impacts and implications of global processes such as climate change on these social-ecological systems. As such it has an important role to play in enhancing the adaptive capacity of management authorities, communities and fisherfolk organizations and hence SSF stewardship through developing and building capacity (knowledge and skills) in the use of socio-economic data in management of SSFs. SocMon may inform strategies for stewardship, improving or increasing the ability of SSFs and stakeholders to adapt to shocks and uncertainty. The uptake of SocMon therefore in any SSF monitoring programme provides opportunities for improvement.

In the Caribbean region, SocMon is already moving in new directions to further enhance

what is already a sound participatory monitoring methodology, all of which are applicable to informing data needs of SSFs. A quick look at these new directions is provided below.

- The examination and development of core sets of variables to introduce a component of standardization within the methodology for easy comparison of socio-economic information among sites and for building a regional socio-economic picture of site conditions - ***opportunity for developing SSF-specific variables***;
- The incorporation of participatory GIS into SocMon for spatial representation of socio-economic characteristics at sites is being tested for further development of an enhanced application for coastal, marine and fisheries management, "SocMon Spatial". This presents an additional method of storing, analyzing and representing spatially-based socio-economic variables by providing spatial references locations, boundaries, trends and changes with respect to resources, people and their interrelationships [25] – ***opportunity for visualizing SSF trends****;*
- Identification of missing or inadequate links in the information management chain between data and decision-making in order to promote the more efficient use of SocMon data for effective decision-making and adaptive management through the development of a Decision Linking System – ***opportunity for impacting SSF policy and management***
- Due to built knowledge and capacity in SocMon, there is also the potential opportunity for developing regional SSF SocMon networks that could be linked globally – ***opportunity for SocMon collaboration among sites and information sharing***

The enhancement of SocMon through these applications and products can be used to inform and adapt SSF management, and ultimately improve resilience and reduce vulnerability of social-ecological systems.

In conclusion, globally, SocMon goals and objectives have focused on differing socio-economic aspects of coastal communities and coastal management sites. Due to the flexibility and adaptability of SocMon, opportunities exist to enhance the methodology through development of core sets of variables for comparing socio-economic characteristics of systems such as SSFs at the regional level; linkage with Geographic Information Systems to enhance visualization and use of socio-economic data in decision-making; and developing a decision linking system to promote more efficient use of data for effective decision-making and adaptive management. For the SocMon methodology, greater use in fisheries and further enhancement and evolution to meet to the demands of SSFs are next steps in the way forward.

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Incorporating GIS into Socio-Economic Monitoring for Coastal Managers (SocMon)

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ABSTRACT

Understanding biological and physical parameters of coastal ecosystems is vital for adaptive management. However, the socio-economic contexts of coastal management also impact success and failure. Monitoring socio-economic variables helps to guide approaches to successfully manage human interactions with natural resources at and around coastal sites. Socio-economic Monitoring for Coastal Managers (SocMon) is a global program that provides a practical and flexible standardized methodology for collecting and learning from social and economic monitoring data for coastal management. Socio-economic information from SocMon can improve decision-making on community needs for livelihoods, food security and equitable use of resources. Although SocMon was not designed for use in Geographic Information Systems (GIS), many of the monitoring variables are spatial. We describe methods for incorporating GIS into SocMon to develop 'SocMon Spatial' as an enhanced application for coastal, marine and fisheries management.

Keywords: Caribbean, GIS, PGIS, socio-economic monitoring, SocMon, spatial

INTRODUCTION

Coastal and marine habitats are complex and very vulnerable. In the Caribbean they have declined in health over the past few decades [1]. Historically, coastal regions have been heavily developed, populated and associated with a variety of uses that result in socio-economic and environmental conflicts and threats. These problems are a result of interacting anthropogenic and natural pressures that present challenges requiring prudent and adaptive management. This necessitates a comprehensive understanding of the socio-economic features that interact with natural environment components. Socio-economic assessments help us to understand the social, cultural, economic and political conditions of individuals, communities and organizations.

Introducing SocMon

The Global Socio-economic Monitoring Initiative for Coastal Management (SocMon) offers a methodology for the collection, analysis and presentation of socio-economic information for coastal and marine management [2]. A global network of six regional coordinators supports SocMon by conducting or assisting socio-economic monitoring mainly for coastal and fisheries management and marine protected areas (MPAs) (visit www.socmon.org). Each region has its own guidelines (e.g. SocMon Caribbean) but all utilize a similar set of variables for measuring socio-economic features at the site level. Data collected via SocMon can be applied in a variety of ways to enhance fisheries management. SocMon has the potential to benefit management by providing relevant information for enhancing our understanding of the socio-economic context within which management strategies are being undertaken [3]. SocMon is a useful tool for improving coastal and SSF management (see

chapter on SocMon by Pena and McConney in this book). It can help in the assessment of present conditions and possibly the prediction of future circumstances.

Spatial Representation

A Geographic Information System (GIS) is an effective tool for environmental management due to its capacity for storing, visualizing and analyzing large quantities of data from multiple sources for use in SSF and aquaculture [4]. Many fisheries management measures are spatially based, such as area closures or restrictions, quota allocations for specific regions, or community-based management. GIS can be used to map the location and status of resources, key habitats and features of the built environment [5]. GIS is increasingly utilized to assist ocean zoning (even for entire Exclusive Economic Zones) and coastal marine spatial planning including SSF) [6].

Conventional GIS applications, are criticized for their focus on biophysical considerations; downplaying the importance of the social components of management. Participatory Geographic Information Systems (PGIS) can support community participation to produce socio-economic information, thereby indirectly aiding sustainable resource use and marine governance [7-11]. Yet, methods of spatial representation using PGIS have seldom been applied to enhance the SocMon initiative.

AIM AND OBJECTIVES

We developed an adaptive methodology to assimilate PGIS into SocMon to create SocMon Spatial. The aim was to identify and test a selection of commonly used SocMon variables for representation in a GIS platform, and to develop a method for synthesizing SocMon data into a PGIS approach. The research and development had four main objectives:

- Selection of SocMon Caribbean variables most suitable for spatial representation allowing for incorporation into a GIS.
- Determination of suitable methods for collecting, analyzing and representing SocMon data.
- Development of practical methods for integrating SocMon and PGIS to enhance coastal, marine and fisheries management initiatives.
- Creation of a demonstration module for the application of this methodology which can be employed to provide recommendations for further development and training in SocMon Spatial.

STUDY SITES

The two study sites were Pile Bay on the west coast of Barbados and the South Coast Marine Conservation Area (SCMCA) in St. Vincent. Different methodologies were applied at these sites to compare techniques and determine those best suited for the development of SocMon Spatial. Pile Bay was used mainly to test the incorporation of PGIS into SocMon as a field method, whereas SCMCA was used mainly to test the spatial representation of data previously collected as a SocMon assessment, including using key informants as guides.

Pile Bay

Pile Bay on the west coast of Barbados features a diverse array of activities in the coastal zone. Marine resources include coral reefs and turtle nesting beaches. Two popular beaches there are heavily utilized by locals and visitors for recreational and tourism activities (i.e. jet skis, tourist accommodation, snorkelling, diving). Fisheries activity is spread around the

fishing village, landing site and fish market. The diverse resource uses and users in the small area, and their possible conflicts and threats, present many opportunities for spatial representation and analysis.

South Coast Marine Conservation Area (SCMCA)

The South Coast Marine Conservation Area (SCMCA) on the south-west coast of the mainland island of St. Vincent has a wide array of resources. These include various reef fish, nearshore pelagic fish, sea turtles, sea urchins, coral reefs and seagrass beds. The Blue Lagoon area provides nursery habitat for fish and other marine organisms, adding to the diversity of ecosystems in the area. The SCMCA is of particular management importance due to its dense human population and high levels of activity. It is the main tourism hub on the mainland and has a highly productive fish landing site. Furthermore, plans to upgrade the area to MPA status will require increased space use planning and regulation.

METHODOLOGY

Tools and techniques to integrate PGIS with SocMon were assessed in several components. The study adapted the methodologies of both SocMon Caribbean [12] and the Grenadines Marine Resource and Space-use Information System (MarSIS, www.grenadinesmarsis.com) [8,10,11]. The Grenadines MarSIS is a PGIS that integrates different types of marine-based knowledge, including several aspects of fisheries, to provide a database to inform coastal and marine planning and management. Figure 1 outlines the main study components.

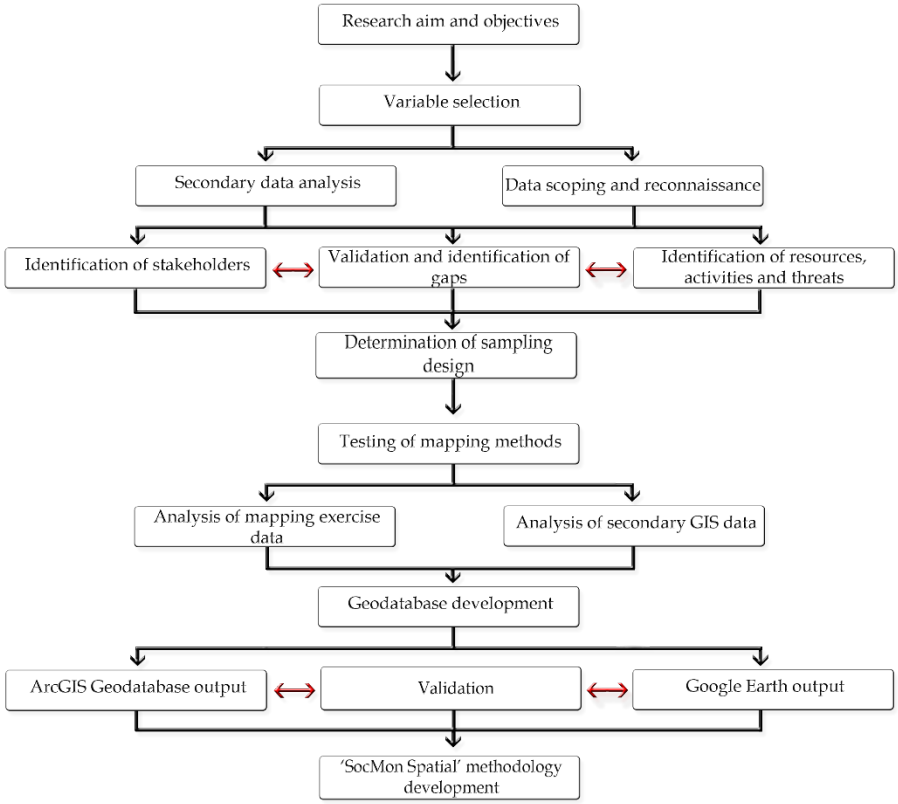

FIGURE 1 COMPONENTS AND PROCESS OF THE STUDY

Eight of the 60 SocMon variables were selected for use with SocMon Spatial. This was based on their frequency of use in previous Caribbean SocMon studies and their inherent

spatial characteristics for incorporation into PGIS. Data were collected to provide spatially referenced information for each selected variable. The criteria and processes for selecting SocMon variables for spatial representation were set out to guide future development.

Mapping exercises were then conducted with a variety of stakeholders using different mapping tools to evaluate them for use with SocMon Spatial. The data collected were digitized, stored in study area geodatabases, and later analyzed using a variety of geoprocessing tools in ArcGIS before formatting and finalizing the geodatabases. Attribute data fields were filled using information provided by respondents. Different geodatabase structures were used for each study area to assess the effects of structure on functionality and ease of use. Although ArcGIS is the preferred software package of many researchers and government authorities, various less costly or complicated open source alternatives were tested to determine their suitability for SocMon Spatial.

Once the geodatabases were finalized, they were converted into Google Earth (.kml file) format for use as a public communication tool. Attribute data from the SocMon Spatial geodatabases were added directly into Google Earth map windows. Additionally, images taken during field visits were attached to map features using the Google Maps web application and then made available on the SocMon Spatial demonstration website (sites.google.com/site/socmonspatialdemo) using an Application Programme Interface (API). Feedback on the product and process was later recorded during validation exercises. Study participants, including fisherfolk, were provided with a link to the SocMon Spatial website and instructed on how to view the associated dataset and provide feedback on the website's message board.

FINDINGS

Following are major findings and recommendations for the use and further development of SocMon Spatial. Also listed are benefits for SSF management that utilizes SocMon Spatial.

Variable Selection

SocMon Spatial studies conducted subsequent to a full SocMon study will have pre-selected variables. In this case the spatial relationships between these variables must be analyzed in order to decide on the best geodatabase structure and to determine if variables necessary for spatial representation are missing.

The variable selection process should follow the guidelines of the SocMon methodology [9]. However, spatial characteristics and relationships should also be considered during initial variable selection. This will guide researchers to select variables which are spatially related and allow them to develop a preliminary geodatabase structure during the initial stages of the project rather than have an inefficient add-on.

Data Collection and Mapping Tools

Researchers must focus on the spatial relationships between features. This spatial awareness helps to facilitate data collection and geodatabase development. Furthermore, respondents with an intimate knowledge of the area and its spatial characteristics are required (i.e. living or regularly working in the area).

The efficiency of tools was tested for both the researcher and respondents. Tools were ranked based on: cost; practicality in the field; ease of data collection; and data integration

into ArcGIS. The primary difference between the mapping tools, is ease of use. Respondents generally preferred letter-size paper maps in the field. However, for indoor exercises a combination of paper maps and a laptop computer were the most effective.

Mapping tools should be chosen based on the characteristics of the study. If financial resources are scarce, then small paper maps provide a cheap, yet effective, option. If funds are not limiting, then direct digital input using a tablet computer may be the best option. The exercises should be kept short (less than 15 minutes) to limit disruption of the daily routine of the respondents and to allow the collection of data from more persons.

Data Analysis

GIS software provides many geospatial analysis tools to interpret and manipulate data. The analysis choices are left up to the researcher and should be based on the characteristics and objectives of the study. For example, depending on the number of respondents, we used different geospatial analysis tools (Merge/Intersect) to either exclude outliers or include minority perception (Figure 2).

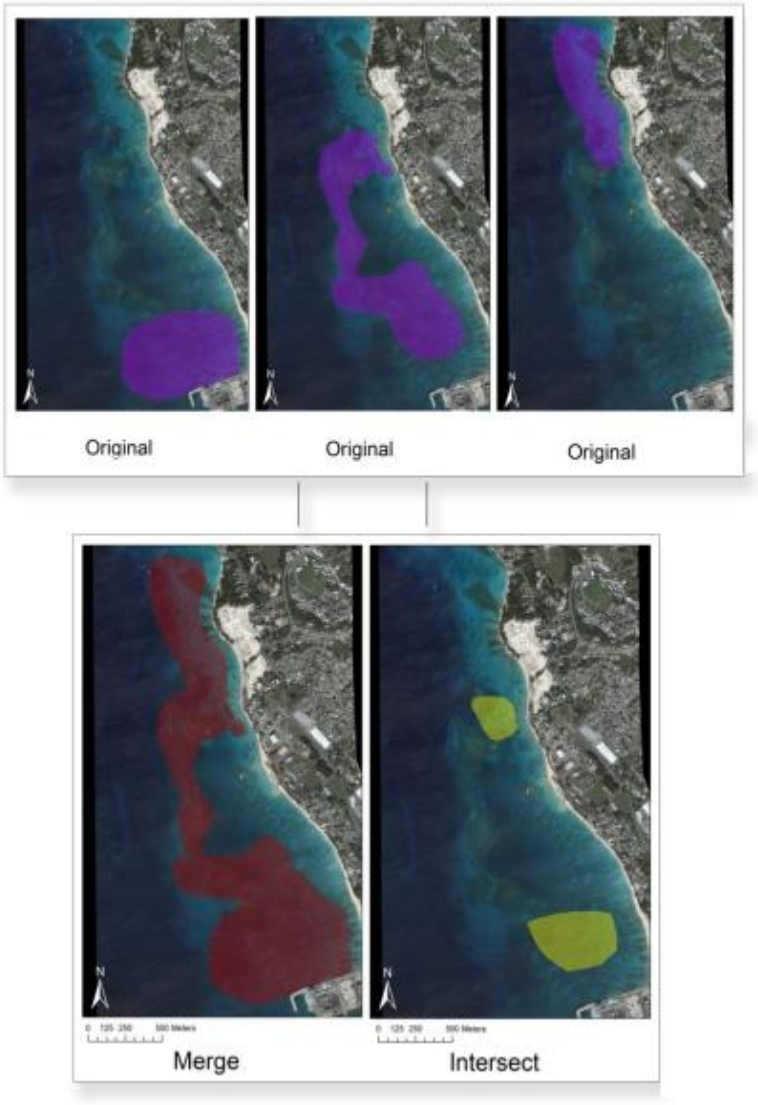

FIGURE 2 RESULTS OF DIFFERENT GEOSPATIAL ANALYSES '(MERGE' AND 'INTERSECT') ON THE SPEARFISHING SHAPEFILE

For example, where only three spear fishermen could provide precise boundaries of fishing areas, all three of their responses were included using the merge tool as intersection would only reveal two small areas that would not adequately represent the reported extent of spearfishing.

Geodatabase Development

The geodatabase structure is essentially the organization of spatial data within the database. For this study, the geodatabase design was guided by the selected SocMon variables and their inherent properties and relationships. Variable type (feature or attribute) should be determined during the variable selection process. Furthermore, geodatabase structure should be left up to the researchers. This process should be flexible and customized to suit the situation.

Presentation of Results

This is an integral stage of the process; the spatial data should be made freely accessible and easy to understand/use. Web-based GIS is a powerful tool that allows data to be shared with a wide range of stakeholders.

More than double the number of persons was reached through the SocMon Spatial web-map in just two weeks compared to those contacted in the entire original project. Visitors viewed the database page (Figure 3) for an average of six minutes and forty-eight seconds. More individuals were exposed to, and engaged by, the online product than were involved in the other phases of the study.

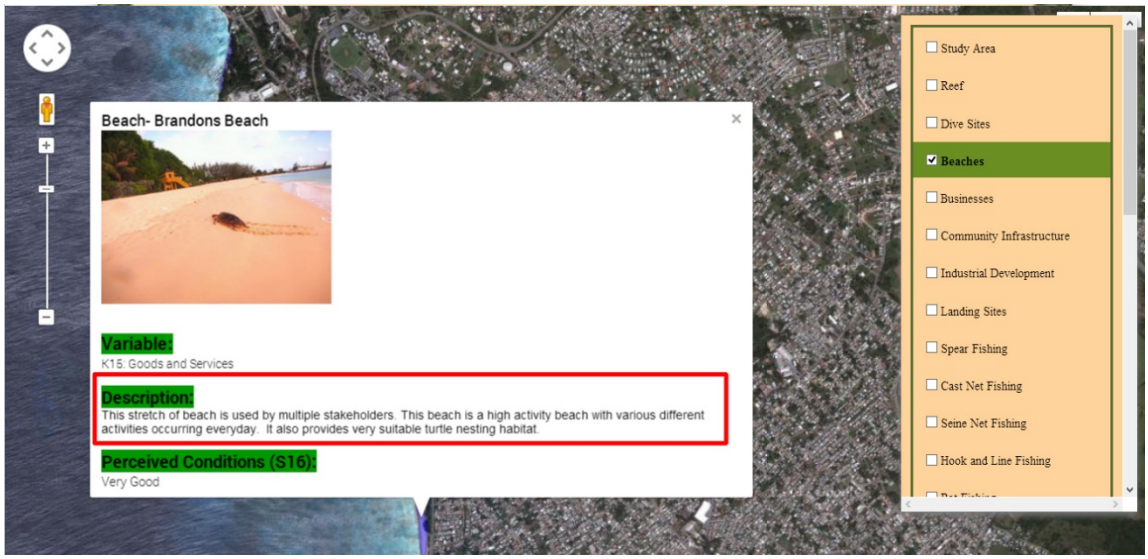

FIGURE 3 SOCMON SPATIAL WEB MAP USER INTERFACE (HTTPS://SITES.GOOGLE.COM/SITE/SOCMONSPATIALDEMO)

Benefits for Management

SocMon Spatial provides the same benefits as any other SocMon study by:

- Providing socio-economic data for MPA, fisheries and coastal area management.
- Improving understanding of the socio-economic characteristics of coastal and marine resource use.
- Assisting education and decision-making efforts.
- Improving communication and information exchange between stakeholder groups.

However, the spatial nature of the data collected using PGIS can have other benefits. Spatially referenced categorical data enhances stakeholder understanding. For example, natural ecosystem conditions and the intensity of impact from stressors both vary spatially.

In Figure 4 categorical data were used to show the relationship between variations in perceived reef conditions and pollution impacts. The visualization of this variation can help managers to target areas and demarcate boundaries for different management strategies. This is valuable for monitoring because it allows researchers to see changes in specific areas over time and the effects of management strategies on these areas.

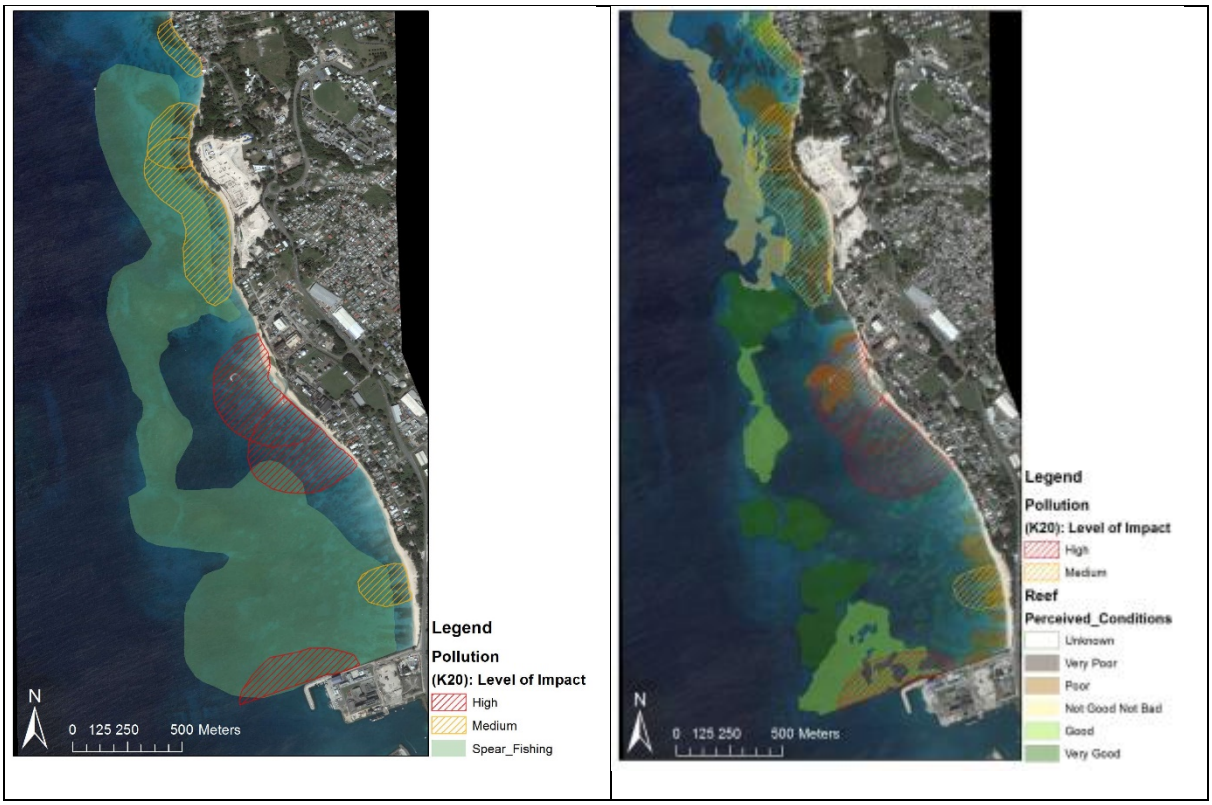

FIGURE4 MAP OF SPEARFISHING, REEF CONDITION AND POLLUTION DATASETS SHOWING HOW CATEGORICAL DATA CAN BE REPRESENTED

SocMon Spatial also has other benefits, for example:

- Providing information which is specifically suited to addressing spatial issues.
- Supplying a database for the storage and analysis of socio-economic data.
- Legitimizing and promoting local knowledge to be used for informing decision-making.
- Establishing engaging and accessible means of representing and sharing SocMon data.

CONCLUSION

The SocMon Spatial methodology that was developed is intended to conform to the principles of the global SocMon initiative and PGIS. It closely follows general SocMon methods to assist integration into existing SSF monitoring projects. Although this was an exploratory study, the benefits of SocMon Spatial can be easily identified. Various types of

information, from a variety of sources, can be incorporated into a single database and analyzed to meet multiple goals. This presents a powerful tool for the ecosystem approach to fisheries. Also, the visual representation of socio-economic considerations can be of value for generating interest and be beneficial for engaging stakeholders [9,10,13]. SocMon and PGIS can be effectively integrated with great potential for enhancing SocMon. Further exploration and development of SocMon Spatial should be considered.

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Integrating Multiple Objectives in Fisheries Management: A Case Study Application for Eastern Caribbean Flyingfish

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ABSTRACT

Ecosystem-based management is an approach that recognizes fisheries as complex socio-ecological systems. However, conventional fisheries management approaches still tend to rely on biologically-driven models to guide top-down decision-making which neglect the complexity of values and priorities that drive primary stakeholder actions. A consequence of these approaches is limited inclusion of stakeholder views in prioritization of a full range of management objectives, and an inability to evaluate performance of these objectives in pursuit of an ecosystem approach to management. In support of a more integrated and stakeholder-supported management approach, we test an application of multi-criteria analysis (MCA) as a possible tool to better incorporate multiple objective considerations into management planning and to provide a more holistic assessment of fishery health. With a focus on flyingfish fishery stakeholders in Barbados, Tobago and St. Lucia, the method develops a management framework that incorporates stakeholder feedback on the relative importance of a set of management criteria. The result of this process yields a set of management priorities for the regional flyingfish fishery that have been ranked through a simple card-sorting activity. We present a set of management priorities for the flyingfish fishery which are weighted in order of importance, by stakeholders. Such outputs can enrich and strengthen successful and transparent co-management planning, and, if the analysis is supported by appropriate baseline data, it can provide a dynamic framework for monitoring management performance across a range of social, economic, and ecological fishery objectives. Findings support the use of this approach for integrating multiple objectives into fisheries management planning, and as a framework for a more balanced consideration of multiple fisheries management objectives in analysis and decision-making.

Key words: Multi-criteria analysis, flyingfish, assessment, ecosystem-based, management

MULTI-CRITERIA ANALYSIS (MCA) AS AN INTEGRATED FISHERIES ASSESSMENT TOOL

Conventional fisheries assessment tools focus primarily on measuring biological criteria with species-specific and fishery-dependent data on catch and effort. While this approach has been used to guide management practices relative to specific biological objectives such as maintaining sustainable production of individual fish stocks, they do not address other management criteria that are associated with a fishery. This constraint is particularly evident in multi-species fisheries which have a diverse range of users and where the ecological effects of fisheries are complex and difficult to determine. To address this complexity, a wider range of values and objectives should be incorporated into fisheries policy and management advice. Supplementing traditional, single-species models with more nuanced

evaluations based on resource-users' inputs and knowledge, in the form of direct observations, experiences and views, can better represent the complexity of multiple objectives in fishery management.

In pursuit of a method to supplement traditional fishery models, we demonstrate and test a framework for evaluating the performance of key social and ecological values of a major multi-user regional fishery, the Eastern Caribbean flyingfish fishery. This fishery has added complexity as a multi-species fishery, as most fishers target flyingfish as well as larger pelagic species on the same trips. The flyingfish fishery was assessed in 2008 using a traditional model [1], and while this work is considered to be sound in terms of modelling single species population dynamics, it should be supplemented and enriched by a more dynamic approach, which can incorporate social as well as biological indicators.

Multiple Criteria Analysis (MCA) is a dynamic methodology for representing both qualitative and quantitative management objectives and assessing how well they are being met over time. While the method is most commonly used as a decision tool [2, 3], resource managers have also tested the method as a way of organizing and ranking stakeholder preferences for management actions or what is most important about a resource [4-6]. In this way, the MCA can act as a dynamic assessment tool.

The MCA method involves three steps. In Step 1, a list of management objectives and related criteria is compiled from interviews, stakeholder workshops, or existing reports and management plans from around the region and organized into a management hierarchy. In Step 2, these objectives are evaluated and explicitly ranked in relative order of importance by a sample of interviewed stakeholders on three different Eastern Caribbean islands. The output of this process yields a stakeholder-driven prioritization of a multi-objective fisheries management framework that reveals the comparative importance of key management criteria for the fishery. In Step 3, the framework is operationalized as a dynamic assessment tool if indicators are then developed and applied to evaluate the performance of each management criterion. In our study, Steps 1 and 2, as well as identification of some preliminary potential indicators in Step 3, were completed for the Eastern Caribbean flyingfish fishery. For a more detailed description of our study, please see [7, 8].

We see potential for using this method as a supplement to traditional forms of assessment. MCA is a comprehensive yet dynamic framework which can be updated when new data are available on the performance of each management criterion. Moreover, MCA converts the heavy data and science outputs related to multiple management criteria into a combined and easily comprehensible 'snapshot' of performance.

Terminology varies slightly between different applications of MCA [4-6] but note that in this study the following terminology is used:

- **Vision-** a broad overarching intention with an intangible quality that provides the context for the fishery
- **Objective**-provides the framework and guiding principle for action toward the accomplishment of the vision
- **Criteria**- standards to measure how well objectives are being met
- **Indicator**- a variable which indicates the performance of a criterion

Step One: Develop a Management Framework with a Hierarchy of Goals and Objectives

The management framework is a compilation of fisheries management objectives organized into a hierarchy diagram. Arrangement of the objectives within the hierarchy indicates how they are connected to each other. Objectives are generated by consulting fishery stakeholders on their management priorities and goals.

Previous studies and efforts to develop an Eastern Caribbean flyingfish fishery management plan included some level of consultation, and had already produced core, agreed goals for the fishery as well as a draft plan [1,9,10]. Hence, we made use of these agreed goals in order to create a nested hierarchy including "vision," "objectives," and "criteria" for management of the flyingfish fishery (Figure 1). In the next phase of the study, the criteria were presented to stakeholders in Barbados, Tobago and St. Lucia to evaluate validity and prioritization.

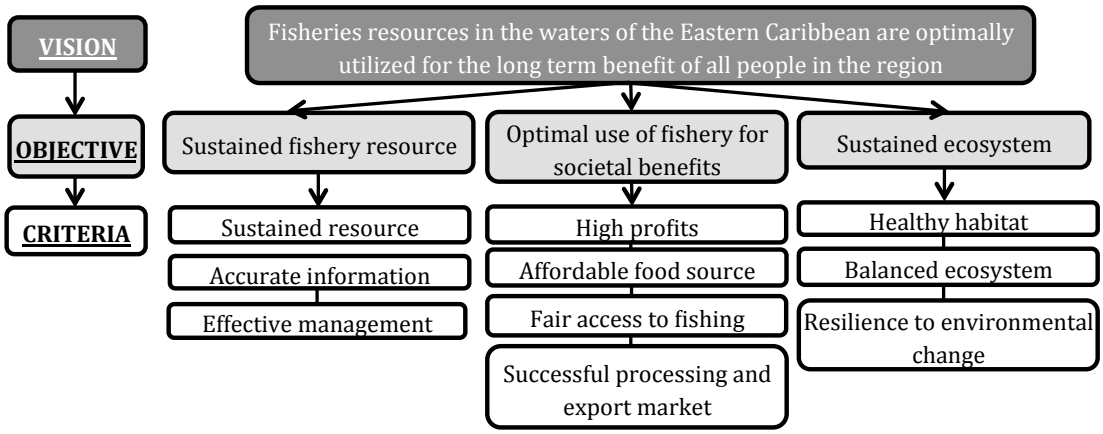

FIGURE 1 MANAGEMENT FRAMEWORK FOR THE EASTERN CARIBBEAN FLYINGFISH FISHERY, ADAPTED FROM MANAGEMENT PLANS AND REPORTS WHICH WERE DEVELOPED THROUGH STAKEHOLDER CONSULTATION. THE "CRITERIA" REPRESENT CATEGORIES FOR DYNAMICALLY ASSESSING SOCIO-ECOLOGICAL HEALTH OF THE FISHERY, AND WERE PRESENTED TO STAKEHOLDERS FOR EVALUATION (SEE FIGURE 2).

Step Two: Apply Weights to Management Objectives

To determine the weight of each management objective in relation to the others (i.e. their relative importance), we then consulted with stakeholders in key resource-user locations. We met with 114 fishers, fish processors, and fishery managers in the Eastern Caribbean islands of Barbados, Tobago and St. Lucia. Based on data provided by the national fisheries authorities on the nature, extent, and distribution of industry operations, we selected a sample of primary, secondary and tertiary landing sites and fish processing sites on each island, and traveled to each site with a government fisheries department representative. We then approached fishers or fish processors to explain the study and invite them to participate. We contacted fishery managers directly ahead of time, and arranged a meeting for them to complete the activity of ranking management objectives and criteria. All participants were adults, and while we did not select for gender, the majority of fishers and fishery managers included were men while the majority of fish processors included were women.

Each participant individually completed a modified form of pairwise comparison known as the “pack of cards” method [13]. Each person was presented with a set of ten cards, with each card containing an illustrative photo and simple text description of each management criterion (see Figure 1 for list). We also verbally explained the contents of the cards using standardized descriptions, and then asked each person to sort the cards in order of importance and to discuss the reasons for their ranking. Figure 2 illustrates the card-sorting process, where cards depicting management criteria are organized in order of importance from most important (left column) to least important (right column). Where criteria were ranked equally, they were placed in the same column.

FIGURE 2 EXAMPLE OF AN INDIVIDUAL’S RANKING OF MANAGEMENT CRITERIA USING THE CARD METHOD. THE CARDS INCLUDE DESCRIPTIONS OF CRITERIA WHICH WERE READ TO RESPONDENTS. NOTE THAT RESPONDENTS WERE ABLE TO ASSIGN MULTIPLE CARDS THE SAME LEVEL OF IMPORTANCE, I.E. CARDS APPEARING IN SAME COLUMN, ONE BELOW THE OTHER.

The sorting order of stakeholder respondent cards and stakeholder comments were recorded on a standardized data form. According to the MCA method, sort data were then analyzed to derive the weight scores for each criterion. These weight scores represent the level of importance of each criterion, and are shown as percentages in Table 1.

The objectives “Sustained fishery resource” and “Optimal use of fishery for social benefit” were the most highly ranked, with 38 and 37.5% respective importance. Among criteria, “Sustainable resource” had the highest weight score in all three countries, while “Effective management” was estimated to be of second (St. Lucia) or third priority (Barbados, Tobago). Divergence in the ranking pattern for top priorities occurred for Barbados and Tobago, where the second highest management priority was estimated to be “Healthy habitat” and “Successful processing and export market” respectively.

With criteria weighted to indicate relative importance, it is clear that this framework can be used to as a tool to recommend priorities for management planning. If performance of the various criteria is measured, this framework can prioritize management decisions as well. As seen in Table 1, this method can also quantify differences in opinion between stakeholders in different regions. If sufficient numbers can be surveyed from each group, the method could also quantify different opinions between types of stakeholders.

TABLE 1 CRITERIA WEIGHTS FOR BARBADOS (*N*=52), TOBAGO (*N*=28), ST. LUCIA (*N*=34) AND A COMBINED AVERAGE AS INDICATED BY RESPONDENTS IN EACH COUNTRY. WEIGHTS REPRESENTING IMPORTANCE OF EACH CRITERION ARE INDICATED AS A PERCENTAGE.

Management objective	**Average weight (in %)**	**Criteria**	**Weight = Importance (%)**			
			Total	Barbados	Tobago	St. Lucia
Sustained fishery resource	37.5	Sustained resource	13.3	14.1	16.2	9.8
		Accurate information	11.5	10.5	9.4	15
		Effective management	13	11.4	15	13.8
Optimal use of fishery for social benefits	38.0	High profits	10.4	10.2	8.8	12
		Affordable food source	7.5	6.7	7.6	8.8
		Fair access to fishing	7.4	8.3	8.9	4.7
		Successful processing and export market	12.1	10.4	15.8	11.7
Sustained ecosystem	24.5	Healthy habitat	9.9	12	8.4	7.8
		Balanced ecosystem	7.1	9	5.9	5.1
		Resilience to environmental change	7.6	7.3	3.8	11

Step Three: Operationalize the Management Framework to Assess the Fishery Health by Adding Performance Scores of Available Indicators

When indicators are applied to the weighted framework, it becomes a dynamic assessment tool that can provide a real-time assessment of the state of the fishery in relation to multiple objectives. To measure the multi-objective health of the fishery, the framework can be loaded with variables representing indicator data and then multiplied by the importance weight of each objective. As many variables are qualitative and not immediately comparable, they must be converted to a normalized scale before multiplying by the value of each criterion's weight.

As may be expected, the data currently available are strongly skewed towards biological and economic indicators, to comply with traditional assessment needs and also more recent attempts to conduct bio-economic analyses. This data limitation is particularly evident in the Caribbean, and prevented us from completing this phase of the MCA method.

However, to provide an example of a framework, we present here a sample set of potential indicators (Table 2) which can be populated in the future to create an assessment framework and to measure performance of the Eastern Caribbean flyingfish fishery against multiple objectives. This sample framework was generated from guidelines provided in the literature and indicators included in management plans in multiple jurisdictions. Furthermore, we selected sample indicators which we considered to be realistic in terms of available or potentially available data. Prior to putting into practice, any set of indicators should be discussed by all stakeholder groups, who would be expected to adjust the list or even add additional indicators, in accordance with present and emerging management needs.

TABLE 2 EXAMPLE OF POTENTIAL QUALITATIVE AND QUANTITATIVE INDICATORS FOR ESTABLISHING AN ASSESSMENT FRAMEWORK FOR THE EASTERN CARIBBEAN FLYINGFISH FISHERY. THIS INITIAL SET OF INDICATORS IS SELECTED, TAKING INTO ACCOUNT CURRENTLY AVAILABLE DATA AND DATA THAT COULD BE COLLECTED USING PRACTICAL MEANS BY THE COUNTRIES CONCERNED. IN THIS RESPECT, THE PRESENT SAMPLE SET DOES NOT NECESSARILY REPRESENT AN 'IDEAL CASE'.

Objective	**Criteria**	**Proposed indicators (up to three indicators proposed per criterion)**		
Sustained fishery resource	Sustained resource	Stock status–e.g. a composite of reproductive rates, fitness, biomass, or maximum sustainable yield, as available	Catch per unit effort	Total annual catch
	Accurate information and monitoring	Types of data collected in census and surveys	Sampling coverage, e.g. number of data collection days	Coverage of data collectors at landing sites, e.g. as a percentage of all sites
	Effective management	Formality of management plan, e.g. degree of integration into policy, legal and governance structures	Degree of activity of fisher organizations, e.g. measure of representation, participation in meetings	Implementation status of management plan, e.g. number and frequency of evaluation reports, usage of plan by industry
Optimal use of fishery for social benefits	High profits for fishers and fish processors	Gross profit for fishers and fish processors	Sale price of flyingfish per kg	
	Affordable food source	Average household income	Percent of landings available for domestic consumption	Domestic price of flyingfish vs. other fish
	Fair access to fishing, e.g. distribution of fishing licenses	Access/licensing arrangements, application of such arrangements across user groups	Number of resolved/ unresolved disputes	Formality of conflict resolution process, its transparency, demand for its usage (frequency)
	Successful processing and domestic and export market (postharvest performance)	Number and quality of postharvest facilities	Usage of postharvest facilities - amount of processing, usage by various user groups	Average export price of flyingfish per kg
Sustained ecosystem health	Healthy habitat	Development of fishing best practices	Status of associated species or key species within habitat	Pollutant levels compared to known thresholds
	Balanced ecosystem	Relative biomass to predator species	Species biodiversity	
	Resilience to environmental change	Level of mitigation infrastructure	Development of disaster plan	Adaptive capacity of various user groups

To address existing data gaps, we strongly urge that more social data should be collected if it is not immediately available; this will enable realization of the full potential of MCA to deliver holistic, ecosystem-based scenarios for consideration by fishery planners and decision-makers.

EVALUATION OF THE METHOD

The MCA and its components were effective in determining collective stakeholder priorities for management, and have also revealed key data gaps. In particular we believe that existing data on catch and fishing effort are incomplete based on respondent comments, and these are the main data at present. Poor availability of data is a chronic problem for many fisheries yet these indices remain the primary basis for assessment. Though there is a need to improve the quality of present conventional fisheries management data, there can be immediate benefit in utilizing assessment methods like MCA which can combine available quantitative data with easily observable qualitative criteria. In view of this, we recommend that specific attention be given to the collection of stakeholder-agreed indicator data to facilitate evaluation of the social, economic and ecosystem objectives agreed for the Eastern Caribbean flyingfish fishery.

We found the “pack of cards” method to be an engaging, non-technical approach which was well received by stakeholders. The method was a good balance of speed and complexity, as respondents were more willing to participate in a brief activity and our time for field work was limited. However, if richer data are required, the sorting/ranking activity could be expanded or discussion points added. Documentation of stakeholder comments also provides an important qualitative context for a deeper and more accurate interpretation of results.

Throughout discussions with stakeholders it became clear that the Eastern Caribbean flyingfish fishery is truly a multi-species fishery, as it was difficult to separate activities and options related to flyingfish from other species. Accordingly, we suggest that for multi-species fisheries, it may be appropriate to broaden the scope of the exercise to include several inter-connected species, i.e. key predator-prey relations and also all species that may be caught during the same fishing operations, as well as the social and economic dimensions that may be associated with these related species.

CONCLUSION

We recommend the multi-criteria analysis method outlined in this study as a practical option to assess fisheries according to the ecosystem approach, which considers large-scale socio-ecological systems. The method allows different management objectives and criteria to be prioritized and evaluated simultaneously for planning and decision-making purposes. While indicator data were not available for completion of Step 3 of our study, we have proposed an assessment framework which includes practical indicators for data collection purposes in the immediate future. This framework includes a hierarchy of agreed management objectives and their relative importance, which is a critical tool for management planning. This framework has been shared with the fisheries officials who used it in the process of developing a trans-boundary management plan for the flyingfish fishery and management resolution, [12] which have both recently been approved for implementation [13,14].

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Prediction and Verification of Reef Fish Spawning Aggregation Sites in Quintana Roo, Mexico

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ABSTRACT

Working with small-scale fishers throughout the Mexican state of Quintana Roo, the non-governmental organization Comunidad y Biodiversidad, A.C. (COBI) is leading the development of a network of marine reserves designed to ensure the long-term sustainability of fisheries and marine resources in the region. Recognizing the value of protecting spawning aggregation sites from fishing, this study was designed to map and characterize spawning locations throughout the region. Based on fisher expert knowledge and a geomorphological model, we predicted the location of two, previously undocumented spawning aggregation sites. We verified the accuracy of our predictions by documenting spawning aggregation sites in both locations. Sites were characterized and mapped in collaboration with trained local fishermen using low-cost bathymetric mapping techniques, and underwater visual observations and video. This study provides increased evidence that multi-species reef fish spawning aggregation sites occur predictably at reef promontories.

Key words: Spawning aggregations, marine reserves, bathymetry, Mexico, grouper, snapper.

INTRODUCTION

The Mesoamerican Barrier Reef System (MBRS) is the largest barrier reef in the western hemisphere spanning territorial waters of Honduras, Guatemala, Belize and Mexico. The MBRS contains exceptional examples of diverse and healthy Caribbean coral reef ecosystems, serves as home to many threatened and endangered species, and has become an international priority area for marine conservation. The MBRS region also provides home for nearly two million human inhabitants [1], many of whose livelihoods depend on marine resources through fishing and tourism industries. To combat noted declines in fisheries resources, there has been an increased focus on the designation and management of a network of marine protected areas (MPAs) throughout the MBRS region.

Fish spawning aggregations (FSAs), whereby large numbers of fishes congregate temporarily at specific times and locations for the sole purpose of reproduction [2] are prime targets for inclusion within MPAs because of their obvious importance in supporting fisheries. FSAs are the sole source sites of larvae for most snapper and grouper species. Nonetheless, there are repeated examples of localized extirpations of spawning aggregations. Aguilar-Perrera et al. [3] documented the disappearance of a once-healthy Nassau grouper spawning aggregation in the Mexican Caribbean. Sala et al. [4] documented major declines in the Nassau grouper spawning aggregation site at Caye Glory in Belize. The site supported harvests upwards of 20 tons of gravid Nassau grouper during its peak

(week-long) spawning periods in the 1960s but only nine individual fish were caught at the site in 2001.

To combat declines in Nassau grouper and other aggregating species, Belize developed a spawning aggregation working group designed to monitor and conserve FSAs and the species that use them. Through a process of intensive collaboration between fishermen, scientists, NGOs and managers, Belize mapped and characterized multi-species FSA sites throughout the nation [5]. Belize declared a suite of 11 no-take MPAs at FSA sites throughout the nation in 2003 [6].

Comunidad y Biodiversidad Asociación Civil (COBI, A.C.), a grass-roots organization, joined the Kanan Kay Alliance, a multi-agency consortium that was formed to promote the establishment of a network of marine reserves along the coast of Quintana Roo [7]. The long-term goal of the Alliance is to contribute to sustainable fisheries management and biodiversity conservation that directly benefits the small-scale artisanal fisheries of the region [8].

In 2011 COBI launched a program of prediction and verification of FSAs in the northern MBRS – specifically, in the Sian Ka´an Biosphere Reserve and the Banco Chinchorro Biosphere Reserve. COBI assembled a team to work directly with fishermen to integrate local knowledge and anecdotal information with modern scientific tools including bathymetric surveys, SCUBA, and underwater video for prediction of the timing and location of FSAs. Our team consisted of community organizers and scientists from COBI, Commission of Natural Protected Areas (CONANMP), and U.S. academic and private research institutions – all working in close collaboration with local fishermen (Figure 1). Our team included specialists in community development and training, SCUBA, reproductive ecology of reef fish spawning aggregations, marine geomorphology and biology, and geospatial sciences. The scientists recognized the importance of working with local fishermen and merging their local knowledge with scientific approaches based on marine ecology, physical oceanography and geospatial science.

FIGURE 1 THE FIELD TEAM ASSEMBLED AT PUNTA HERERRO WITH FISHERMEN, SCIENTISTS AND NGO REPRESENTATIVES

This paper discusses the collaboration between the multiple stakeholders to identify and verify reef FSA sites in the southern coast of Quintana Roo. The goal of this project was to map and characterize spawning locations in the surroundings of the Sian Ka´an Biosphere Reserve and the Banco Chinchorro Biosphere Reserve in part to test our ability to predict and verify FSA sites, and also in support of conservation and management strategies. This paper offers a model approach whereby scientists and community stakeholders collaborate using local ecological knowledge and low-cost mapping techniques to successfully predict and verify FSA sites in the MBRS.

Kobara and Heyman [5] conducted a comprehensive study in Belize characterizing the seafloor of 14 FSA sites. All 14 sites occurred at convex-shaped shelf edges or reef promontories with steep walls, adjacent to deep-water zones. Specifically, all FSA sites evaluated were located <100 m from shelf edges and <200 m from reef promontory tips, and a mean of 78 ± 62 m from the 100 m depth contour. Using the distinctive geomorphological patterns from other sites as a model, the study successfully predicted and verified the locations of two previously unidentified FSAs that had similar geomorphological characteristics. With the exception of two sites that lacked recent observations, the study documented multi-species aggregations at 12 of 14 sites in Belize.

Sosa-Cordero et al. [9] provided the first comprehensive study of multi-species spawning areas along the Quintana Roo coast. They interviewed fishermen along the entire coast and compiled anecdotal information into a geographic database containing 39 FSAs. However, this investigation did not follow up with an *in situ* verification [10]. As a follow-up study, in 2006 Franquesa-Rinos and Loreto-Viruel [10] conducted an exploratory field study to verify seven sites located within the Sian Ka´an Biosphere Reserve, six listed in Sosa's study and one additional as suggested by a fisherman from Punta Allen.

We predicted the locations of several FSAs in the state of Quintana Roo Mexico based on fishermen anecdotal information and findings of previous studies [9, 11] and on the analysis of seafloor geomorphology of FSA sites in Belize [5]. We selected two sites for field verification, one within the Banco Chinchorro Biosphere Reserve the second at the edge of the Sian Ka'an Biosphere Reserve (Figure 2).

PREDICTION AND VERIFICATION CASE STUDIES

Cayo Lobos, Banco Chinchorro Biosphere Reserve

Cayo Lobos is located on the southern edge of the Banco Chinchorro Biosphere Reserve, 22 km south of Cayo Centro, the only inhabited area in the atoll. Lobster fishing in the atoll provides the primary economic base for fishermen of the Fishing Cooperatives Langosteros del Caribe, Banco Chinchorro and Andres Quintana Roo. Using fish landings data collected by the Commission of Natural Protected Areas (CONANP) and fishermen interviews [9, 11] the Cayo Lobos area in the south of the atoll was highlighted for field verification.

The western side of the channel, where fishermen consistently caught mutton snapper during their spawning season, has a gently sloping shelf with a sand bottom and many healthy patch reefs. Working closely with CONANP staff in July 2011, we created bathymetric maps of the area and used SCUBA to dive and describe the area. The site was less than 5 m deep with a sand bottom, a long distance from the shelf. In short, it did not

look anything like a spawning site based on criteria that we used in other areas. Though the fishermen did catch a relatively large number of mutton snapper at the site (Figure 3), fishing at night, it was not necessarily were the fish spawned (Figure 4).

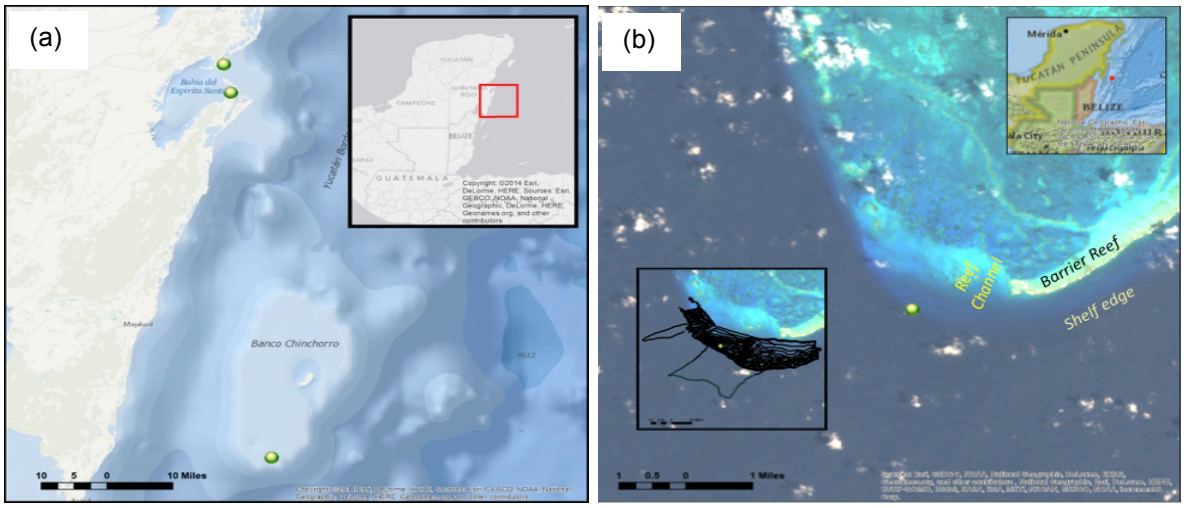

FIGURE 2 (A) THE STUDY AREAS ON THE YUCATAN COAST OF MEXICO SHOWING THE VILLAGES OF PUNTA HERRERO AND MARIA ELENA AT THE MOUTH OF THE BAHIA ESPIRITU SANTO AND THE SIAN KA'AN BIOSPHERE RESERVE AND THE LOCATION OF CAYO LOBOS ON THE SOUTHERN EDGE OF CHINCHORRO BANKS; (B) DETAILED VIEW OF THE CAYO LOBOS SITE AT THE SOUTHERN END OF BANCO CHINCHORRO. THE GREEN DOT ILLUSTRATES THE "SPAWNING" LOCATION BASED ON FISHER INTERVIEWS, IN RELATION TO THE SHELF EDGE, THE REEF CHANNEL, AND THE BARRIER REEF. THE SMALL INSET MAP SHOWS THE LOCATION OF OUR TRACK LINES, USED TO CREATE BATHYMETRIC MAPS OF THE AREA.

FIGURE 3 FISHERMEN AT CAYO LOBOS AND THEIR CATCH OF GRAVID MUTTON SNAPPER. PHOTOS KINDLY PROVIDED BY CONANP, RESERVA DE LA BIOSFERA BANCO CHINCHORRO.

By contrast, the eastern edge of the channel, had characteristics more similar to those sites identified previously – a hard bottom area with a curving shelf edge that could be described as a reef promontory (Figure 5). We mapped the eastern side of the channel, and conducted exploratory dives along the curving shelf edge, seeking signs of fish spawning aggregations. At the inflection point of the convex curving shelf edge occurred a divot, whereby the shelf-edge curved shoreward, creating a vertical bowl along the shelf edge. Within the bowl, in 55m of water in the late afternoon, we observed an aggregation of mutton snapper – at least 3,000 individuals. Though we only saw them from a distance, it was clear that they were in the process of spawning.

The moral of the story is that fishermen can tell you where they catch a significant number of fish and help get you close to FSA sites but that does not mean necessarily they know the exact location where spawning occurs. This speaks to the value of collaboration between fishermen and scientists and provides a nice juxtaposition of local knowledge and science. Fortunately, both sites are already included within the Banco Chinchorro Biosphere Reserve so access to the site is highly restricted.

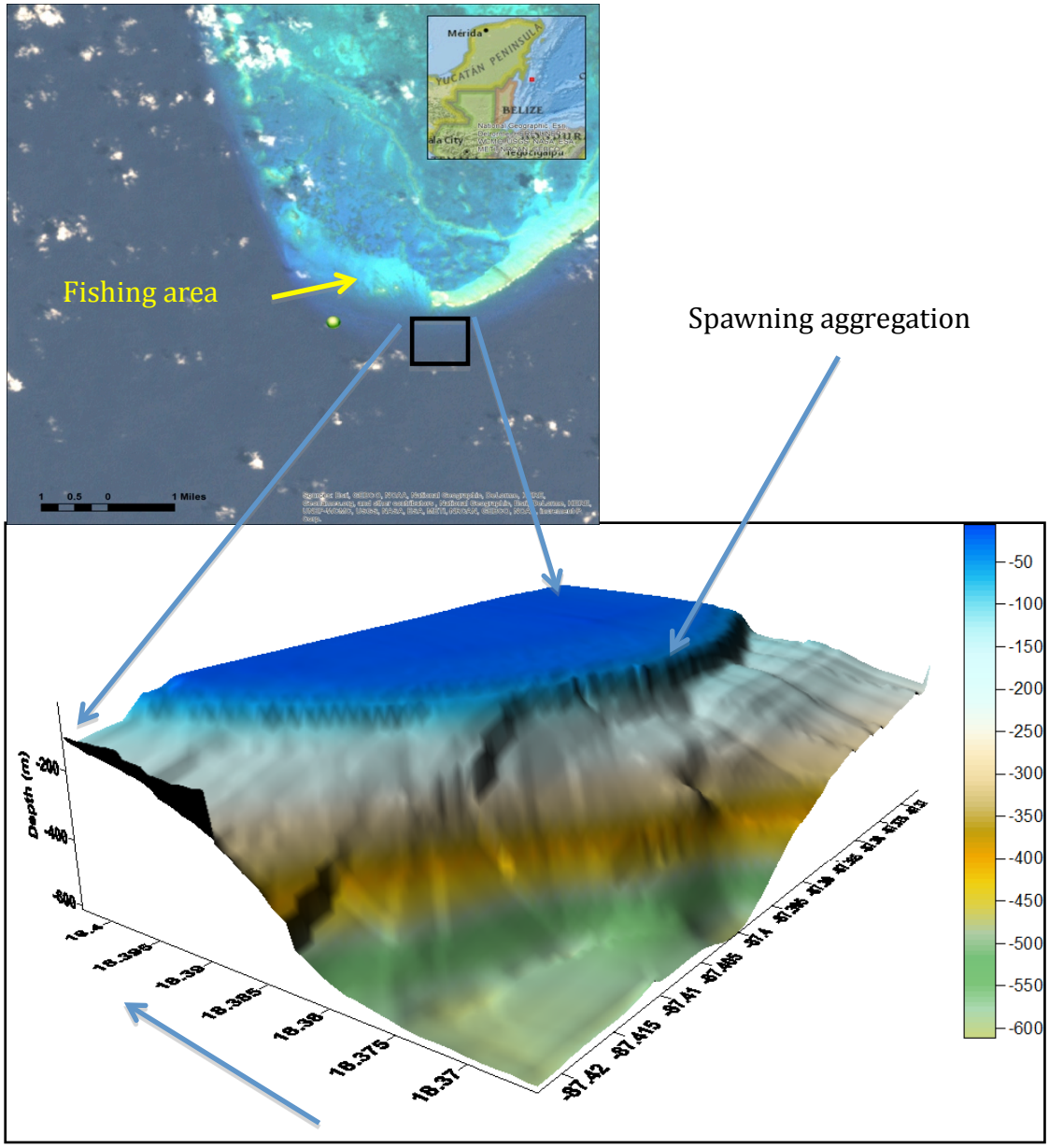

FIGURE 4 DETAILED VIEW OF THE CAYO LOBOS AREA SHOWING THE FISHING LOCATION ON THE SHALLOW WESTERN EDGE OF THE CHANNEL COMPARED TO THE LOCATION WHERE FISHES ACTUALLY SPAWNED ON THE EASTERN SHELF EDGE. DETAILED 3D BATHYMETRY OF A PORTION OF THE EASTERN SHELF IS SHOWN BELOW.

Punta Herrero and María Elena, Sian Ka'an Biosphere Reserve

The Bay of Espiritu Santo, the southern of two large bays in the Sian Ka´an Biosphere Reserve is home to two fishing communities. Punta Herrero is home to the Fishing Cooperative José María Azcorra. The village is 70 km from Mahahual, the closest town with access to public transportation, electrical and telecommunication grid. María Elena, located

a further 12 km by boat from Punta Herrero on the other side of the bay, is home to the Cozumel Fishing Cooperative. Both communities depend economically on lobster fishing but also capture fish, primarily during the lobster closed season (March through June).

The José María Azcorra Cooperative has 22 members and the Cozumel Cooperative has 48, with both cooperatives having additional aspiring members awaiting membership when space allows.

Although the two cooperatives share the same bay, they operate independently and because of this we worked with each cooperative individually. We believe that the fishers would be more willing to provide details of potential aggregation sites if the information remained confidential inside the cooperative.

We separately approached the fishermen in Punta Herrero and María Elena to propose the plan to predict and verify FSA sites. We explained to them the benefits of preserving and protecting FSAs by establishing marine protected areas and discussed the long-term benefits and potential increment of fish stocks and therefore a more sustainable fishery. We offered a comprehensive plan that included training, collaboration, production of bathymetric maps, and compensation of their time and boat equipment utilized during the time of the project. Since both of these communities primarily focus on lobster, neither community was financially dependent on fishing the spawning aggregations. The fishermen agreed to our partnership, thus COBI, the group of marine and geospatial experts, and fishermen together embarked on a shared journey of applied science.

We worked with the group from Punta Herrero in January 2013 and January 2014, and with the group from María Elena in May and August 2013. Since both locations are only 12 km apart, the collected data allowed us to generate quasi-continuous bathymetric maps and 3D models. By the end of the fieldwork conducted in May 2013, the bathymetric data and three-dimensional models appeared satisfactory to make detailed predictions of FSA locations. Based on the geomorphologic characteristics, relevant published literature, fishers' expert knowledge, and data from Belize, we selected several areas as possible FSA sites for verification (Figure 5). Field verification expeditions were conducted in August 2013 with a focus on snappers and January 2014 to focus on groupers in the predicted FSA sites. Immersive photographic and video equipment and SCUBA diving were utilized for FSA verification while we also collected additional bathymetric data.

Cubera snapper were documented with underwater video in August 2013 in relatively high numbers and very high densities, in what appeared to be FSAs. These observations, made towards the end of the reproductive period for this species, served as a good indicator of a Cubera FSA site in the close vicinity. Additional observations during April – June, during the peak of their spawning season, may provide unequivocal verification. Nassau groupers (Figure 6), yellowfin groupers, and dog snappers were documented using underwater video in January and February 2014, in what appeared like FSAs. These observations constitute indirect evidence of multi-species FSAs, tentatively confirming our predictions.

The discovery brought new incentives and optimism to members of COBI and the Kanan Kay Alliance who immediately restarted a FSA working group with the idea to establish a long-term plan and to continue mapping, exploring, and ultimately protecting FSAs along the Mexican Caribbean.

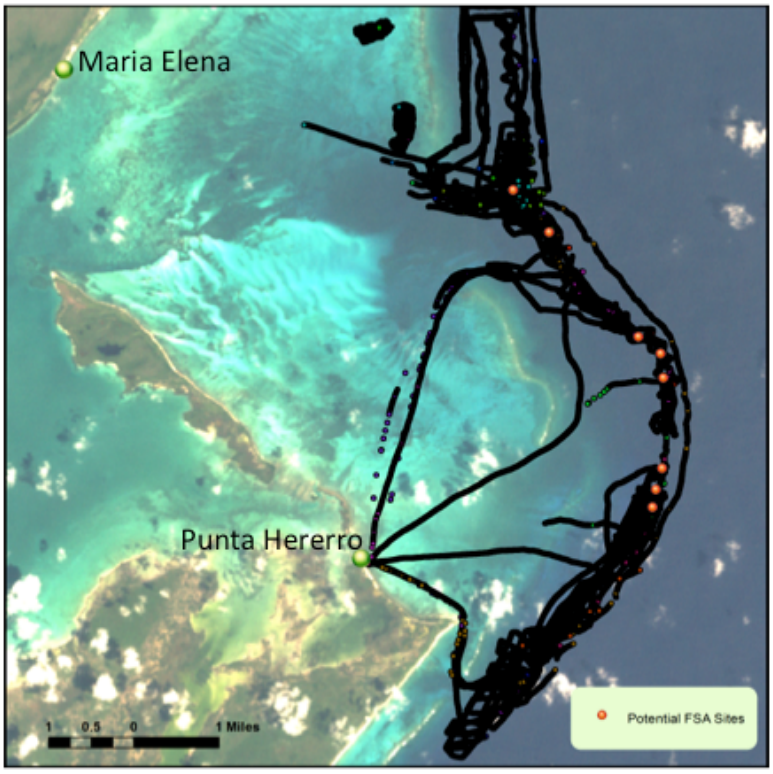

FIGURE 5 DETAILED VIEW OF THE MOUTH OF THE ESPIRITO SANTO BAY IN THE SIAN KA'AN BIOSPHERE RESERVE SHOWING THE VILLAGES OF MARIA ELENA AND PUNTA HERERO, THE TRANSECT LINES (BLACK) USED TO CREATE BATHYMETRIC MAPS OF THE SHELF EDGE, AND THE PREDICTED LOCATIONS OF MULTI-SPECIES FSAS (RED DOTS).

FIGURE 6 NASSAU GROUPER SPAWNING AGGREGATIONS AT PREDICTED SITE. NOTE VARIOUS COURTSHIP COLORATIONS, DISTENDED ABDOMENS PRESUMABLY FILLED WITH ROE, AND THE HIGH DENSITY OF THIS ENDANGERED SPECIES.

DISCUSSION AND LESSONS LEARNED

This case study offers an example of the prediction and verification of FSA sites. The success is likely due to the collaboration between fishermen, scientists, government and NGOs working closely together. We coupled anecdotal information from fishermen, published studies, and low cost bathymetric mapping for prediction. We used underwater

video, SCUBA and direct observation to verify aggregations of Cubera snapper, dog snapper, mutton snapper, Nassau grouper and yellowfin grouper.

Given the endangered species status of Nassau grouper and the documented disappearance of a Nassau grouper FSA on the coastal area near Mahahual, Q.R. in 1996 [3], there is a great urgency to document and protect FSAs for Nassau grouper and other species that form FSAs and serve as the basis for local fishing economies. This study offers a practical method to couple research, training, and conservation and may be a model for other areas wishing to document and conserve FSAs as part of a sustainable marine resources management plan.

Summarizing the key lessons learned from these case studies on prediction and verification of FSAs.

- Multi-species spawning aggregations occur predictably at shelf edge reef promontories in the MBRS region and perhaps in other areas as well.
- Fishermen's knowledge and participation, low-cost bathymetric mapping, and knowledge from other areas serve as sufficient basis for successful prediction of FSA sites.
- The collaboration between NGOs and government, fishermen and scientists can help fill gaps in government supported research and conservation efforts.
- Including fishermen in research increases their interest and willingness to participate in management and conservation efforts that will contribute to long-term sustainability.

ACKNOWLEDGEMENTS

We would like to thank the fishers that work in the Banco Chinchorro and Sian Ka´an Biosphere Reserves for willingly sharing information about fish catches and potential aggregation sites. We thank the CONANP staff that participated in the field work and contributed to the study. Finally we also thank The Summit Foundation, The Oak Foundation, PNUD México, Marisla Foundation, The Packard Foundation, and The Nature Conservancy.

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Setting and Implementing a Programmatic Agenda for Coastal-Marine Networks in Brazil

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ABSTRACT

By acknowledging and engaging with alternative forms of governance that are recently emerging (see [1]), this brief note reports on one of such processes in Brazil, namely the *Ombudsperson of the Sea* [2] event (Portuguese: Ouvidoria do Mar). We provide an overview and update of the on-going process of setting and implementing a Programmatic Agenda for coastal-marine networks; and provide the authors' opinion regarding its instrumental potential in improving Brazilian democracy.

Key words: marine governance, ombudsperson of the sea, coastal-marine networks

THE 1ST OMBUDSPERSON OF THE SEA EVENT - MAJOR OUTCOMES AND THE ROAD AHEAD

The event was self-organized by civil society during the *People's Summit* (Rio de Janeiro, 18 June 2012), with the objective of creating opportunities for civil society '*understand the crisis and formulate proactive and integrated agendas amongst coastal-marine networks*'. People and organizations from Brazil and other countries were invited to participate by means of three calls spread in social networks and e-mail lists related to coastal-marine environments.

The political nature of the preparatory and realization phases of the event fostered communication contexts freed from corporations and autonomous from governments – as a means of prioritizing the representation of the perceptions and expectations of society. Fiscal agencies such as the Federal Public Ministry (*Ministério Público Federal*) and the Federal Court of Accounts (*Tribunal de Contas da União*) of Brazil were invited to participate. Members of over 70 institutions and research and action networks related to oceans were present, contemplating an expressive diversity of actors.

The event started with four keynote lectures given by knowledgeable persons over coastal-marine issues in Brazil; followed by participative dialogue workshops over two general topics: Integrated Coastal Management, and Marine Protected Areas and Fisheries. The dialogues were facilitated to acknowledge the three 'Guiding Axis' of the People's Summit: 1) Reporting of structural causes of the crisis and false solutions; 2) New solutions and paradigms; and 3) Planning future integrated actions.

By the end of the *1st Ombudsperson of the Sea*, the participants decided to follow the event *Sustainable Development Dialogue* – theme *Oceans* (19 June 2013). This event was co-

organized by the Brazilian government and the United Nations (UN), with the objective to facilitate dialogue between global civil society and the high-level Rio+20 process (United Nations Conference on Sustainable Development).

In the months following these events the facilitators prepared a detailed report [3]. This document was open for public scrutiny and later transformed into a synthesis report that encompassed the events' outcomes (Theme 2-3), and set forth a "*Programmatic Agenda*" for creating synergy amongst coastal-marine networks (September 2013).

The Programmatic Agenda is currently operating through a first set of 25 programmatic linkages, namely Convergence Codes (refer to original document) - that allows visualization of priority links for convergence and synergy amongst coastal-marine networks. The idea is that each Convergence Code will offer a sufficiently broad pathway to enable future detailing; and are specific so it allows for mutual acknowledgment of the most relevant programmatic linkages amongst networks. In order for institutions to voluntary adhere to the Programmatic Agenda a web form was made available at the Blog (ouvidoriadomar.tumblr.com). The information will be recurrently updated at the Blog so that volunteers can collectively continue pushing for convergence, gradually developing legitimate means for synergy and a renewed political culture.

Therefore, the social function of this initiative is to contribute with voluntary convergence and synergy amongst coastal-marine networks. The *1st Ombudsperson of the Sea* emphasized a hybrid and autonomous political/institutional nature for civil society, as well as careful procedures for transparency, participation, documentation and facilitation. The facilitators of the initiation event expect that these should be preferably adopted in future events that are conceptually linked to the *1st Ombudsperson of the Sea*. Such events could propose new Convergence Codes, or develop upon those proposed therein.

As outcomes of the *1st Ombudsperson of the Sea*, web-based environments for communication amongst coastal-marine networks were also established using freely available social media tools (e.g., Facebook, Twitter, Google+). It is suggested these environments be preferably used for discussions related to programmatic linkages, actions, partnerships and ocean related campaigns. Whenever possible, it is advisable that any content shared therein explicitly refer to specific Convergence Codes so as to help the coalescing of information around meaningful criteria.

More recently (February 2013), a voluntary working-group with currently 31 individuals from various backgrounds and territorial locations has been created (following the mandate established by one of the Convergence Codes – OM4) to push forward the implementation of the Programmatic Agenda. These volunteers are finding out ways to face the challenges of virtual collaboration, including: identifying, agreeing upon and learning about available technologies for conducting virtual meetings; setting-up and coordinating priority actions for each Convergence Code; and arranging organizational implications for implementing new events related to the *1st Ombudsperson of the Sea*, amongst other issues.

IMPROVING BRAZILIAN DEMOCRATIC STRUCTURES

The on-going process of setting and implementing a Programmatic Agenda for convergence and synergy amongst coastal-marine networks is a challenging but promising one. This

initiative is progressing slowly but steadily forming new structures for communication around collectively identified and meaningful semantics. A close look at the Programmatic Agenda's Convergence Codes shows proposals dealing with general problems of communication and interaction amongst actors (e.g., broad governance issues) while it also includes objective goals related to fisheries and marine protected areas. Many coastal-marine problems are *wicked* because they are frequently larger or beyond the ability of formulation and resolution of interacting actors (e.g. constitutional, cultural, civilization problems, etc.) [4]. We thus propose that the scope of the initial set of Convergence Codes provides legitimate grounds over which to improve shared ability to formulate and address some of the wicked problems affecting Brazilian coastal-marine environments.

Communication is now an integral part of entire political systems and no longer operates only as unilateral or government-led strategies to inform or persuade the public. The public is also not only targeted by corporations aiming to influence their views with no other option. Communication network allows the public to build up their own opinions based on information disseminated by diverse stakeholders mainly through social media tools. In such a politically diverse arena actors today count on an array of interactive information technologies in order to share meanings and position over matters of State.

While social media platforms are connecting people's intentions across space-time, several governments and legislative chambers have now also opened consultation channels to connect with citizens as a way to legitimize policy development and implementation - offering new opportunities for democratic participation. For instance, at the end of 2013 a federal deputy presented a bill in the Congress aiming to improve the coastal and marine governance in Brazil. The new bill called a National Ocean Law is engaging sectors such as artisanal and industrial fisheries and other productive sectors, government agencies, educational and research institutions and broader civil society organizations. The process aims to ensure representation and participation of these actors in monitoring the long process of proper conduct, improvement, and maintenance of the basic principles for which the law needs to be formulated. This is a process that could take many years, and the *Ombudsperson of the Sea* will offer further collaborative means to support this public policy building process.

In this regard, both the structure and content brought up by the *Ombudsperson of the Sea* is promising considering the current Brazilian political scene. For instance, it may be helpful to consider that in 2014 Brazilian democracy will be under the spotlight – and not only because of the forthcoming presidential elections to be held in the second semester. While this years' football World Cup will attract a worldwide public and media attention to Brazil, it will likely be accompanied by a series of parallel public manifestations and protesting similar to June 2013, when the country's whole political system was scrutinized. In keeping with the general dissatisfaction with the corrupted political system and expectations raised for political reform, we hope the upcoming critical interactions will (peacefully) help to coalesce awakening citizens into significant and clear propositions. We therefore expect that the programmatic agenda will be instrumental to inform loosely agitated individuals and institutions to effectively converge into and strengthen synergetic coastal-marine coalitions.

Further information about the *Ombudsperson of the Sea* can be found at the Blog.

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Stewardship

The third and final section seeks to explore stewardship more in-depth. Contributions surround the WG4 research question for this component, deepening understanding of what institutional arrangements exist for stewardship, or need to be developed. The aim is to allow SSF to be more responsible, adaptive and positively resilient as complex social-ecological systems. Seven chapters and four perspectives comprise this section.

The chapter on **Inter-sectoral Conflict and Recreational Fisheries of the Developing World: Opportunities and Challenges for Co-operation** refers to conflicts of governance, fisher competition for access to resources, cultural differences and demographic change among small-scale recreational, commercial and subsistence fisheries. The authors analyze how conflicts affect stewardship and what strategies related to enhancing communication, empowerment and management could be designed in order to promote conflict resolution.

In the chapter **Multi-stakeholder Participatory Research: Opportunities and Challenges in Coastal Uruguay**, the author draws attention to principles, strategies and pitfalls related to addressing local SSF problems from an inclusive and participatory approach. Adaptive co-management is still a work-in-progress in many places, and there is much to learn about it.

Ecosystem stewardship is put in a legal perspective in **Stewardship as a Legal Duty and Its Application to Small-Scale Fisheries**. The author illustrates some legal implications to stewardship, or the lack of it, and shares perspectives on some challenges to implement it.

The author of **Small-scale Fisheries in Portugal: A Brief Overview** describes some of the characteristics and challenges that SSF struggle with in order to survive in a competitive and developed continent such as Europe. She reminds us that SSF are not only in developing countries and small island states in tropical regions. SSF are critically important everywhere.

The chapter on **Social Agency in Marine Conservation Initiatives at the Central Coast of Chile** describes how political and institutional changes in SSF and biodiversity conservation policies have provided an institutional environment that nourishes MPA governance. The author explores ecosystem stewardship from the perspective of social agency. Institutional changes triggered stakeholder self-organization and participation to foster co-management.

An integrated coastal management perspective on SSF is shared by the authors of the chapter on **Enhancing Stewardship Through Interactive Institutions: A Case Study from Koh Chang, Thailand.** The article posits that institutions play an important role in enabling or constraining stewardship. They suggest that through mechanisms that are

inclusive of a range of actors, context-appropriate, locally-engaged and interactive, institutions can provide a platform from which stewardship can be cultivated.

The challenge of creating empowered organizations and supporting collective action in Caribbean SSF is addressed in **Caribbean Network of Fisherfolk Organisations: In Pursuit of its Mission**. Here the authors describe the Caribbean experience of building a regional fisherfolk organization using a network design. The process is as important as the product if the capacity for stewardship is to be developed.

Fishermen Investing in a Network of Fish Refuges (No-take Zones) in Quintana Roo, Mexico reports on experience involving fishing cooperatives and a NGO on the Mexican Caribbean coast to enhance stewardship by creating no-take marine protected areas. The authors highlight the importance of bridging organizations in providing support to enhance ecosystem stewardship in SSF.

The first stewardship perspective on **Fisher's Perspective on the Network of Fish Refuges in Quintana Roo, Mexico** is linked to the previous chapter. An active fisher leader shares views on what he and colleaguse have acccomplished in collaboration with scientists and NGO personnel. It is encouraging to learn of enthusiasm for stewardship from a fisher.

In **Fishing in Bolivia's Northern Amazon: History, Problems and Perspectives** another voice from the fisherfolk constituency calls urgent attention to how ecosystem changes and socio-economic development affect fishing livelihoods, and how fisherfolk are responding to change by empowering their organizations. Collective action is often critical in stewardship.

The chapter on **Development of the Bejuco Bottom Longline Snapper Fishery, Northern Pacific Coast, Costa Rica** describes an experience in which fisherfolk organizations and researchers work together to identify sustainable fishing methods. This collaboration is then followed by the design of a "replicable sustainable coastal model" in order to improve the fish value chain, such as by increasing fisher access to high-end consumers and tourism establishments. The author provides another perspective on stewardship by exploring how organization empowerment can also provide economic assets to deal with changes in SSF and coastal development.

The experience presented in **Sustaining Fisheries and Traditional Coastal Livelihoods in Southwest Madagascar** describes how positive outcomes in the state of fisheries and income can increase fisherfolk engagement in conservation and management initiatives. It illustrates that an incremental approach to stewardship, moving at the pace of the people, can be valuable in supporting sustainability and resilience that is both ecological and social.

Our expectations of this book are modest. By the time you reach the end of this section you should have, after also having read the previous two sections, much better comprehension of SSF ecological impacts, monitoring and stewardship. Stewardship is deeply embedded in culture and institutions. We did not set out to develop a grand plan for SSF or framework for implementing stewardship. By now you should have an appreciation that many people all around the world are actively developing alternatives to the so-called 'fisheries crises' by investigating and practicing stewardship. We hope that the authors who shared their views, research findings and experiences will be rewarded when you too join, or seek to strengthen your existing involvement in, such initiatives. In the final section we synthesize some of the key learning that we believe will assist even further in enhancing the stewardship.

Inter-Sectoral Conflict and Recreational Fisheries of the Developing World: Opportunities and Challenges for Co-Operation

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ABSTRACT

The recreational fishing sector is growing rapidly in the developing world with the potential to realize economic benefits estimated at tens of billions of dollars annually. These opportunities are accompanied by numerous ecological risks such as overfishing and habitat disturbance. To date, there has been little focus on sociological issues surrounding the growth of recreational fisheries in these areas. This chapter examines sources of potential conflict among small-scale fishing sectors in the developing world with particular attention paid to identification of key issues constraining stewardship of recreational fisheries. We identified conflicts related to fisher competition for access to resources, socio-demographic change, cultural differences, and governance as areas of concern among small-scale fisheries, and offer examples of successful and failed attempts to reduce, mitigate or solve these conflicts. The reality of limited resource availability will require that communication, proactive management strategies and cooperation be encouraged among sectors to maximize resiliency of the social-ecological system and to promote sustainability of fishing practices. We recommend stewardship initiatives that include avenues for stakeholder participation and establishing adaptive management strategies, particularly for emerging recreational fisheries in the developing world.

Key words: Small-scale fisheries, recreational fisheries, social conflict, angler education, governance, fisheries management, conflict resolution, stewardship, fisheries development

INTRODUCTION

The UN FAO's 'Technical Guidelines for Responsible Recreational Fisheries' refers to recreational fisheries as "activities in which the fisher targets aquatic animals that do not make up the user's dominant source of protein and is not generally sold or traded at market" [1]. This definition separates the recreational sector from small-scale subsistence and commercial enterprises. Recreational fisheries represent the dominant use of fish stocks in inland water of industrialized nations and are growing swiftly in developing nations around the globe [2, 3]. Numerous examples of this growth are found in marine recreational fisheries, such as those targeting bonefish (*Albula vulpes*) and giant trevally (*Caranx ignobilis*) in tropical waters, and in inland systems such as the tigerfish (*Hydrocyrus vittatus*) fisheries of the Zambezi watershed (see [4]). Although under-reported and understudied at a

global scale [1], estimates based on known catch data suggest that recreational fisheries could account for as many as 47 billion fish caught and harvested or released each year [5]. Further to this, recreational fisheries contribute approximately US$190 billion to the global economy [6], and have participation rates ranging from 220 million [6] to 700 million people worldwide [5].

In the developing world, recreational fisheries have been explored as an alternative livelihood strategy through ecotourism to generate revenue for local communities (e.g., island nations in the Pacific; [7]). It has also been explored as a conservation initiative and economic incentive to protect fish species and habitat in developing countries by earning potential revenue from non-destructive activities such as catch-and-release angling tourism (e.g., taimen (*Hucho taimen*) fishery in Mongolia, mahseer (*Tor* spp.) fishery in India, [8]). The growth of the recreational fishing sector in the developing world, however, will not occur without potential for negative consequences. Overfishing, population- and ecosystem-level impacts via directional selection, stocking, habitat loss and introduction of invasive species have all been identified as potential drivers of ecological change as a result of recreational fishing practices [9, 1], while social conflict within and among sectors has been documented in numerous studies as having a negative impact on the fishery social-ecological system (e.g., [10]).

Small-scale subsistence and commercial fisheries operating in the developing world are often highly marginalized and face numerous challenges related to governance and fish allocation rights [11]. Consequently, the growth of the recreational fishery sector in these regions may act as an alternative livelihood strategy yet may also result in heightened social conflict when management is lacking, especially when larger numbers of individuals (including fishers from afar) compete for access to the resource. Since communities in the developing world exhibit decreased resilience to economic and ecological shocks [12], the ramifications of social conflict resulting from such circumstances may be severe.

Understanding potential conflicts that arise from a growing recreational fishing industry in the developing world and exploring associated strategies to alleviate such conflicts is necessary for institutions to effectively prevent and/or deal with conflict, and for ensuring long-term stewardship and sustainability of their natural resources.

In this chapter, we discuss, in two parts, social conflicts associated with recreational fisheries in the developing world as a barrier to resource stewardship and long-term sustainability of the fisheries. In the first section, we explore conflict among small-scale recreational, commercial (including artisanal), and subsistence fisheries to identify key issues that may constrain both stewardship of aquatic resources and the sustainable growth of the recreational sector in the developing world. In the second section, we evaluate examples of successful and failed attempts to address these key issues and consider the roles of various top-down and bottom-up management strategies as support mechanisms for fostering stewardship.

SECTION I: KEY SOURCES OF INTER-SECTORAL CONFLICT IN RECREATIONAL FISHERIES

Conflict emerges when ‘the interests of two or more parties clash and at least one of the parties seeks to assert its interests at the expense of another party’s interests’ [13]. To date,

very little research and information exists that addresses potential social/fisheries conflict associated with existing and emerging recreational fisheries in developing countries. In this section, we identify and discuss potential causes and sources of conflict from a recreational fisheries perspective by drawing parallels from conflicts that have occurred among other fishing sectors. However, we grouped the sources of conflict because they share underlying circumstances and are closely linked; hence some unavoidable overlap between sections.

Competition and Access to Resources

Competition for a common and limited resource is inevitable, particularly with the demands of a rapidly growing human population. This 'common resource property' problem leads to challenges for sustainable development and resource stewardship as it creates conflict among user groups via disputes over resource and spatial access. In the developing world where millions depend on fisheries for nutrition, food security, and livelihoods [12], the potential ramifications of such conflicts are great.

Conflicts between industrialized and small-scale fisheries are common in developing countries, especially with users of different fishing technologies [14]. Fishers using passive gears (e.g., long-line and trap nets) often get caught and tangled with more active gear (e.g., trawls and purse seine nets) leading to conflict [10]. Similar gear differences between recreational fisheries and other sectors have been reported, such as fish hooks being caught in drift nets when both parties fish in the same space (i.e., spatial competition). In this circumstance, recreational fishers in developing countries may be viewed by traditional subsistence and commercial fishers as another competitor in the fight over a 'common property'. As reported in other areas when conflict among recreational fishers emerge from crowding and increased interaction of user groups [15], recreational fishers are also able to access remote fishing areas that may be traditionally fished by subsistence/artisanal fishers; thus becoming new competitors in inland waters. Socio-demographic differences such as wealth inequality among participants may serve to influence the capacity of fishers to access and exploit resources (for e.g., by purchasing gear allowing for effective harvest), which may heighten conflict related to competition.

Socio-Demographic Change and Cultural Differences

Globally, the number of fishers in coastal areas has doubled in two decades (from 12.5 million fishers in 1970 to 29 million in 1990), growing faster than the world's population [16]. In many communities, this increased immigration to coastal areas may strain resources, exacerbating existing cultural, ethnic and religious differences. In the developing world, such socio-demographic conflict may be further polarized by issues surrounding the distribution of wealth. For example, wealthier individuals may fish recreationally, while poorer individuals continue to pursue subsistence and/or commercial activities. Immigration of wealthier residents or foreigners to coastal communities could lead to income-based stratification and increased competition for common resources. Immigration of new resource users also often undermines the effectiveness of informal understandings about established users about resource allocation, and temporary users (e.g., tourist fisher) may have little interest in the long-term sustainability of the resource) [17]. For example, in Bangladesh and Turks and Caicos, there was a high degree of blame placed on other ethnic or religious groups for gaining resource access at the local fishers' expense, and these groups were further blamed for a rise in conflicts and decline in fish stocks [18]. As such, potential for conflict exists when the socio-demography of a community changes (due to economic growth, birth rates,

immigration, societal trends), when there is an influx of 'newcomers', and when there is a stratification in cultures and ideologies [17].

Tourism-based recreational fisheries may introduce foreign culture and differences into a community, which could result in conflict with resident subsistence fishers. The sources of this conflict may be multi-faceted, such as economic competition arising when fishers compete for jobs in the growing recreational fishing sector, or cultural conflict arising from disparate views on management strategies aimed at promoting conservation. For example, voluntary catch-and-release (i.e. live release of fish to the water after capture) could potentially cause conflict or animosity due to different views about this concept. Locals may view it as unethical and as "playing with fish for no good reason" [19]; a debate that is prevalent in Germany among recreational anglers and other groups (e.g. animal rights groups, general public). Thus, cultural and ideological differences can exacerbate conflict associated with recreational fisheries in developing countries.

Governance

Fisheries governance is a framework of institutions, rules and practices that set limits and provide incentives for the behaviour of individuals and organizations [20]. As such, governance has a strong influence over the emergence of conflicts as well as resolutions or exacerbations of conflicts (e.g., institutional capacity to deal with change, governance structures and priorities). Conflicts related to governance often centre on the use of different management approaches for different sectors, and mismatches in harvest rights, management responsibilities and objectives [21]. For instance, recreational fishers in most developed countries are not required to contribute to sustainable fisheries management (e.g., catch reporting, cost recovery, monitoring) to the same extent as the commercial sector, but do not receive the same harvest benefits either. Management inefficiencies and the imbalanced decisions when weighting economic, biological and social values and dimensions of aquatic resources may lead to conflict associated with resource access and competition (as indicated above). With recreational fishing as tourism, residents may also view losing allocations to non-residents as unfair and conflict may arise [1].

Fisheries management decisions are also often criticized as being political rather than based on long-term sustainability of the resource [22]. Developmental pressures such as changes in policy focus from livelihood protection to economic growth and gain may potentially lead to politicization of fisheries [23]. The recreational angling tourism industry in developing countries can push for change in market demands, economic and social forces associated with industrialization, and increase in alternative employment opportunities. The growth of the recreational fishing industry may ultimately displace resident subsistence and commercial fishers if governments favour decisions that promote the tourism fishery by allocating exclusive access rights to fishing areas, supporting and subsidizing costs, or allocating unequal harvest quotas. Recreational fishers are also often viewed as 'stewardship leaders' with a strong political voice. For this reason, they may exert a strong influence over decision makers. In Brazil, catch-and-release angling has been widely adopted and the rationale that 'a fish released is a fish alive' has led to the proposal of closure of some areas to commercial fishing with exclusive access for recreational fishers, which has led to severe conflicts [24].

Perceptions

A common theme that emerges from the aforementioned categories is that of perception. Often, conflicts between groups emerge when one group *perceives* another group as gaining at their expense [18] leading to competitive feelings and animosity. Furthermore, there exist pre-established beliefs surrounding the negative impacts of commercial fishing (i.e., overfishing caused by over efficient technologies) as opposed to considering the impacts of other influential factors external to the fishery (e.g., pollution via development, agriculture). Similarly, there may be pre-established beliefs surrounding recreational fishing (i.e., only tourists and wealthy people participate), which may contribute to the alienation of recreational fishers and serve to foster disagreement.

Additionally, conflict among stakeholder groups may be a matter of *perceived conflict* rather than *actual conflict*. Maynou et al. [25] documented that small-scale fishery participants reported high perception of conflict with recreational fishers and perceived them as competitors, while recreational fishers did not report conflict with small-scale fishers. Perceived conflict that spreads among user groups can engender actual conflict, and negative perceptions of fisheries governance can also lead to lack of cooperation and increased conflict. Thus, it is important to reconcile any pre-established beliefs and perceptions of fisheries resource users.

SECTION II: KEY COMPONENTS OF RECREATIONAL FISHERIES CONFLICT RESOLUTION

The successful mitigation or resolution of social conflict will be a key component of aquatic stewardship in developing recreational fisheries. Successful conflict resolution can cultivate stronger relationships and increase voluntary adherence to the rules and regulations surrounding resource use and extraction [26]. Like the sources of conflict themselves, attributes of potential solutions are wide-ranging, inter-connected, and their success will vary according to the dynamics of the individual fishery socio-ecological system and circumstances surrounding the conflict. In this section, we examine the implementation of successful and unsuccessful conflict resolution strategies among fishing sectors according to three areas: communication, empowerment and management, though it will be seen that successful solutions include aspects of all three categories and can be applied to all aforementioned sources of conflict. We define ‘successful resolution’ here as those circumstances in which the devised solutions result in both a decreased level of conflict and the on-going sustainability of local fish populations.

Communication

Adequate communication among stakeholders has been identified as a key component of successful conflict resolution in fisheries systems [27]; however, the nature and timing of communication strategies are essential to their success and include components such as consultation, education and research.

Consultation

The need for consultation is particularly relevant to conflicts involving growing recreational fisheries in the developing world, where perceived socio-demographic and cultural differences can lead to aggravated competition and access conflicts. The development of balanced stakeholder networks and consultation prior to, during, and after resolution actions

can assist to identify key areas of concern related to possible conflict solutions, encourage communication among sectors throughout the conflict, and serve as a channel for guiding adaptation in the future. In New South Wales, Australia, conflict between recreational and commercial fishers occurred as a result of perceived decline in stocks and led to a ban on commercial fishing in a target area in spite of research indicating no decline had occurred [27]. Consultations that favoured one party over another and occurred irregularly throughout the resolution process resulted in confusion and dissatisfaction among fishers. Conversely, when competition and access conflicts arose among subsistence, commercial and agricultural users of inland waters of Bangladesh, a communication framework was established to ensure that key stakeholders were consulted throughout the resolution process which resulted in a significant decrease in the number of conflicts in the target areas and an improvement in fisher attitudes regarding the outcomes [28]. Adequate consultation and stakeholder engagement may also play a key role in addressing access, governance and perception-based conflicts stemming from issues of equity [29].

Education and Research

Once consultation has identified the source(s) of conflict, education and research may be used as tools to bring fishers and other stakeholders to a collective understanding and serve as a focal point for resolving cultural and perception differences related to fishing practices. For example, in the rockfish (*Sebastes* spp.) fisheries of British Columbia, Canada, recreational fishers blamed commercial fishers for decreasing stocks and believed that their own methods did not contribute to the decline. Research indicated, however, that the practice of catch-and-release used in the recreational fishery resulted in a high level of barotrauma-related mortality in key habitat zones. As a result of this education, recreational fishers ceased blaming commercial fishers for the stock decline and formed a coalition to address the problem by altering their own practices. This adaptation, along with the voluntary protection of key habitat zones by both sectors, has served to contribute to the recovery of the target species [30].

An alternate outcome can be seen in the recreational mahseer (*Tor* spp.) fishery of the Cauvery River, India. After noting a decline in mahseer abundance in the 1970's several angling groups that advocated for conservation of the threatened genus began working to encourage catch-and-release practices, decrease poaching and support employment alternatives that would enable a sustainable fishery in the area. A partial closure of the fishery in 2009 led to subsequent access conflict between local angling groups and government officials, in spite of preliminary research indicating that these user-driven initiatives had resulted in increased community involvement and increases in catch rate. This decision continues to impede efforts for continued conservation of mahseer and greatly reduces the income generated by the fishery on a regional basis [31].

Empowerment

Small-scale commercial and subsistence fishery activities are often undervalued economically and socially [11], leading to a perceived lack of empowerment when negotiating conflict resolutions between sectors, and increasing fears of fishing restrictions or closures. Strategies for empowerment should therefore include communication regarding the alignment of conflicting and mismatched objectives of different sectors [32], and encouraging consideration of factors such as well-being, equity and social contribution when conducting economic evaluations of the sectors [33]. The community-based coastal

resource management programs (CCBRMs) instituted in the Philippines, for example, have been described as a system that facilitates empowerment through the use of co-management regimes. In this process, local resource users were encouraged to influence, participate in and control management decisions, including the establishment of marine protected areas. Participants reported increased empowerment, reduced conflict (a result of increased immigration to coastal regions from farming communities) and minimal impacts on fish abundance [34]. It should be noted that the success of this resolution process is based on fisher perceptions, including those related to environmental impacts; therefore, research regarding abundance, distribution and catch are necessary to support these perspectives, and empowerment-based solutions must take into account the ecological limitations of the fishery system. Facilitating compromise between sectors to promote empowerment at the expense of maintaining sustainable fish populations will likely result in heightened competition and conflict in the future.

Management

Conflict management regimes themselves can potentially cultivate conflict if mechanisms are not implemented successfully [17], yet aspects of 'bottom-up' and 'top-down' management systems are essential for supporting successful outcomes of conflict resolution in fisheries. Many researchers suggest that 'bottom-up' strategies such as co-management and traditional resource management better support local fishing communities. The 'bottom-up' strategy supports sustainable local resource management by fostering social capital and improving compliance with accepted rules and regulations, regardless of their incorporation into law [26]. In addition, this type of regime allows for management at fine scales, as it is argued that broader arrangements are unable to adequately address local issues [35]. Others note that while these strategies may serve for local communities, some 'top-down' management in the form of legislation and enforcement is required to clearly identify access rights and prevent poaching, such as in marine protected areas [18]. 'Top-down' legislation that includes stakeholder consultation may also be better-suited to addressing conflict arising from unequal political influence and a lack of delineation among sectors (e.g., establishing distinctions between subsistence and recreational fisheries). Both structures benefit from incorporating adaptive management responses into the conflict resolution process to address the dynamic and ongoing nature of conflict situations [36].

The growth of recreational fisheries in many areas of the developing world may support the need for 'top-down' management in the form of legislation and enforcement. Recreational fisheries research outcomes have supported the use of enforceable management strategies such as seasonal, size, slot and bag limits, licensing and/or the promotion of catch-and-release practices in order to reduce the likelihood of over-fishing. There exist a number of cooperative cases between government, managers and fishers of all sectors which highlight potential benefits of 'top-down' partnerships, such as the successful establishment of a replacement recreational fishery targeting native species instead of invasive species in the Orange Vaal River, South Africa [30]. The inability of the localized co-management system in San Salvador, Philippines to solve conflicts that extended beyond the fishery community is an additional example that further supports the suitability of 'top-down' management strategies in similar circumstances [37]. However, rules, regulations and local enforcement may also be implemented successfully as a 'bottom-up' strategy, such as in the taimen (*Hucho taimen*) recreational fishery of northern Mongolia, where little official enforcement is needed as a result of voluntary public involvement and investment in the success and

sustainability of the fishery (for a description of the fishery, see [38]). The adoption of 'bottom-up' strategies may also relieve conflict related to wealth distribution and political influence. As discussed earlier, recreational fishers are often perceived as having different socio-economic status and greater lobbying power [17], attributes that can exacerbate conflict when considered alongside the belief that government actions in response to conflict situations are often motivated by politics rather than legitimate need (for example related to commercial/recreational sector conflicts, see [27]; for value of social capital, see [26]). Regardless of the management strategies implemented, successful conflict resolution will rely heavily on the adoption of mechanisms appropriate to the conflict and locality, and on the appropriate use of communication and empowerment strategies to identify and explore them.

CONCLUSION

The growth of recreational fisheries in the developing world will likely lead to increased conflict related to competition, access, socio-demographic differences, and issues of governance. While a unilaterally successful resolution to any conflict situation is likely to be rare, there exist a wealth of tools at our disposal that can facilitate positive outcomes through effective communication, empowerment and proper institution of management strategies. These processes can bring about better understanding, communication and co-operation among sectors, which we believe will advance collective stewardship of local aquatic resources.

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Multi-stakeholder Participatory Research: Opportunities and Challenges in Coastal Uruguay

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ABSTRACT

Empowering participatory research in which scientists, community members, and other stakeholders, are co-researchers in addressing local environmental concerns is an invaluable approach, although not without challenges. This chapter is based on a multi-stakeholder participatory research initiative in Piriápolis (coastal Uruguay), involving artisanal fishers, university scientists, a fisheries manager and NGO representatives. The two main problems addressed collectively were the sea lion impact on the artisanal fishery, and the market competition from imported *pangasius*. Based on the evaluation performed throughout the first year of this participatory research initiative, the main process features (e.g., involvement of all stakeholder groups in every research stage), outcomes (e.g., social learning) and challenges (e.g., low fisher participation) are presented. These, along with the advantages and disadvantages of participatory research (as recognized by fishers and scientists), are discussed in light of the trend of promoting participatory approaches to research and management. The contributions of multi-stakeholder participatory research to enhance stewardship are also addressed.

Key words: participatory research; evaluation; fisheries; co-management; stewardship

INTRODUCTION

Participatory research is a knowledge co-production approach with an action-oriented component based on local interests and concerns, in which local people participate in the entire research process, and whose final aim is community empowerment [1]. Participatory research has become increasingly common in the context of natural resources and environmental management [2], including fisheries [3, 4]. It offers one way to create power-sharing relationships between researchers and communities, to develop locally appropriate resource management strategies, and to strengthen social relationships. Nevertheless, participatory research of the empowering mode has been difficult to achieve [1, 5]. Empowering participatory research requires that the whole process is developed collectively by participants as co-researchers, including: (1) definition of objectives or hypotheses; (2) methodology design or planning of activities; (3) fund raising and allocation; (4) data collection or development of activities; (5) analysis; (6) evaluation; and (7) dissemination.

In 2011, a participatory research process that would address artisanal fishers' local concerns, with the underlying purpose of studying the contributions to the emergence of conditions for fisheries co-management, was initiated in Piriápolis, coastal Uruguay [6]. After an initial stage in which fishers decided that this initiative should address the problem of sea lions (which feed from their nets and long-lines, damaging them), other stakeholders were invited to participate: the National Directorate of Aquatic Resources (DINARA, the country's agency in charge of fisheries management); biologists from the National University, doing research on sea lions and their interaction with the fishery; and two local nongovernment

organizations (NGOs), SOS, dedicated to marine animal rescue and rehabilitation, and Ecópolis, a multisectoral, umbrella group of Piriápolis citizens and local organizations that promote sustainable development. The initiative targeted an empowering participatory research, in which multiple stakeholders (fishers, scientists, government, NGOs) would work together as colleagues on issues of mutual importance, learning from one another.

The aim of this chapter is to present the main findings arising from the evaluation conducted throughout the first year of this participatory research in coastal Uruguay. The ultimate goal is that the lessons from this experience will contribute to a wider use of the participatory research approach, which has great potential to enhance stewardship (as discussed in the final section).

PARTICIPATORY RESEARCH IN THE PIRIÁPOLIS ARTISANAL FISHERY

Fifteen participants from four stakeholder groups were committed to the participatory research initiative in Piriápolis: fishers (n=7; 4-10 participated in different stages), artisanal fisheries manager (DINARA, n=1), University scientists (n=5, 4 biologists, and 1 social scientist interested in communication and culture), and local NGO representatives (n=2). For all of them, this was the first involvement in a participatory research initiative. Since May 2011, stakeholders have been meeting regularly in Piriápolis (Figure 1), generally on a monthly basis. These workshops (Figure 2) have been facilitated by a research group of the Science and Development Unit (National University of Uruguay - UDELAR). Stakeholders volunteered their time to participate.

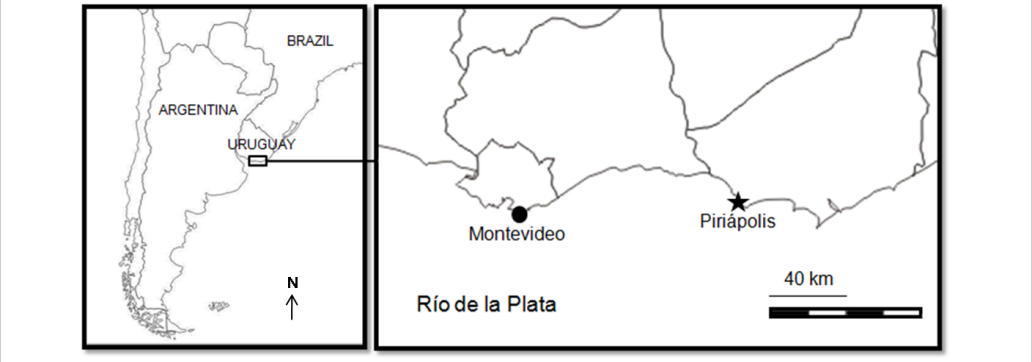

FIGURE 1 LOCATION OF THE CASE STUDY AREA, PIRIÁPOLIS (URUGUAY), ON THE COAST OF THE RÍO DE LA PLATA. THERE ARE APPROXIMATELY 50 ARTISANAL OR SMALL-SCALE FISHING BOATS (SOME ONLY USED SEASONALLY) AND NO LARGE-SCALE FLEET.

During the first workshop in Piriápolis, stakeholders exchanged ideas and knowledge regarding the interaction between fishers and sea lions, such as sea lions' population status and feeding habits. The next step consisted of defining a research question of interest to all participants. Due to the high impact of sea lions on long-lines (which is a costly gear) and the lack of scientific data about that in Piriápolis since 2002, participants decided to investigate the current interaction between sea lions and long-lines. The second workshop was dedicated to the discussion of study methods, which ended in a protocol for joint data collection during fishing trips. This protocol was created with input from all participants, based on a previous protocol developed by scientists. The data collection phase could not start, however, because the long-line fishing season was ending at that time (June-July 2011) and fishers started to migrate along the coast, in response to the movements of whitemouth croaker (*Micropogonias furnieri*).

Concomitantly with the progress of the planning stage of the study on sea lions' impact, the group started to discuss a second local concern that was initially brought up by one fisher and caught the attention of the other stakeholders. This was the market competition of imported *Pangasianodon* (farmed catfish from Vietnam, locally known as *pangasius*), which is sold at a cheaper price than local fish. In fact, restaurants that used to buy local fish in Piriápolis were serving *pangasius*, often being dishonest with consumers about the identity and origin of the fish. Once participants discussed this problem and possible actions, the group agreed to work on communication strategies to promote local fish. As part of that effort, the First Artisanal Fisheries Festival (*Primera Feria de la Pesca Artesanal en Piriápolis*) was organized. The objectives of the Festival were to: 1) achieve informed consumption, leading people to have more local fish and less *pangasius*; 2) make people value local fish and the artisanal fishery; 3) bring consumers closer to fishers; and 4) improve the life quality of consumers and fishers in the long-term. The group needed a name, and through a brainstorming exercise, the name "POPA – *Por la Pesca Artesanal en Piriápolis*" (For Artisanal Fisheries in Piriápolis) was chosen. The organization of the Festival required intensive group work, and sub-groups were formed to divide up the tasks. The Festival was considered as the first significant accomplishment of POPA. It took place during a weekend in February 2012, and approximately 3,000 people attended. The main attractions of the Festival were a photo exhibition entitled, "A day in the life of artisanal fishers"; an exhibition of fishing gear, art inspired by artisanal fisheries, talks on health education, focused on the nutritional properties of local fish, and local fish tasting (Figure 2).

FIGURE 2 (A) ARTISANAL FISHING BOATS AT PIRIÁPOLIS PORT, (B) ONE OF THE MONTHLY WORKSHOPS HELD IN PIRIÁPOLIS, AT THE VENUE OF THE NATIONAL PORT AUTHORITY (DNH), (C) PREPARATIONS FOR THE FIRST ARTISANAL FISHERIES FESTIVAL IN PIRIÁPOLIS, (D) GROUP MEETING TO EVALUATE THE FIRST DAY OF THE FESTIVAL. PHOTO CREDITS: MICAELA TRIMBLE (A, C, D) AND PATRICIA IRIBARNE (B).

The following sections are based on the evaluation conducted throughout the participatory research initiative, from May 2011 to April 2012, by means of individual face-to-face semi-structured interviews with participants; participant observation during workshops, group/subgroup meetings, and the Festival; and informal conversations with stakeholders.

Lessons From Evaluating POPA's Participatory Research

Evaluation criteria related to the participatory research process and to its outcomes were applied to the Piriápolis case [7]. Rather than listing those criteria, Table 1 summarizes the main findings of the evaluation, in terms of the process features, outcomes, and challenges faced. Process and outcomes are closely interrelated, and thus, ineffective processes (e.g., fishers as collaborators of scientists rather than co-researchers, or unbalanced power sharing during decision making) might lead to undesirable outcomes. As analyzed in another publication [6], the Piriápolis case contributed to shedding light on how the process and outcomes of participatory research can contribute to laying the groundwork for co-management.

TOWARDS WIDER USE OF THE PARTICIPATORY RESEARCH APPROACH

Participants in Piriápolis considered it appropriate to promote participatory research to address problems originating from the interaction between environment and society (i.e., environmental problems). Although the three arguments to advocate for citizen participation – normative, substantive, and instrumental [8, 9] - were evident in their responses, the substantive argument was the most frequent. Basically, participants from the four stakeholder groups (fishers, scientists, DINARA and NGOs) emphasized the need to consider multiple understandings, perspectives and judgements. This is also consistent with some of the advantages of participatory research identified by fishers and scientists, as Table 2 shows.

The benefits or advantages that participants, and stakeholder groups in general, perceive from participatory research can contribute to a wider use of this approach. First, scientists probably need to find scientific rigour within participatory research (including opportunities for publications) so that they do not underestimate this approach, a frequent challenge. They should neither see participatory research as less reliable or valid than more conventional approaches. Incorporating participatory research into university curricula will provide students with real-world experience and will likely contribute to increasing scientists' openness to other modes of doing science (e.g., valuing local knowledge). Secondly, participatory research not only needs to persuade scientists but also fishers, who might be hesitant or not confident about their contributions for every research stage. Thirdly, even though participatory research originally tended to involve community stakeholders and researchers, it is now known that engagement with stakeholders at all levels is essential, especially if policy-makers are to be influenced by participatory research.

TABLE 1 PARTICIPATORY RESEARCH IN THE PIRIÁPOLIS ARTISANAL FISHERY: PROCESS FEATURES, OUTCOMES, AND CHALLENGES

Process features	Outcomes	Challenges
The problems or topics addressed (sea lions and *pangasius*) were of interest to local and additional stakeholders.	The objective of promoting artisanal fisheries through the Festival was noticeably achieved, but not so the objective of studying sea lion impact. However, the participatory research process was evaluated successfully. The honest and respectful dialogue among participants and the group cohesion were highlighted.	The number of participating fishers in group activities was low, despite the continuous effort made throughout the process to invite all local stakeholders.
Most of the stakeholder groups in the problem selected initially (sea lions) became involved. Participants of four stakeholder groups (fishers, DINARA's Artisanal Fisheries Unit, University scientists and NGOs) were engaged in every research stage. The actions taken to address the two topics were all done collectively.	Social learning and co-production of knowledge took place. Participants learned participation and communication skills; they learned about participatory research and the topics addressed, among others. The data collection protocol for investigating the sea lion impact was an example of a situation in which local and scientific knowledge were integrated.	Government participation was questioned. Even though DINARA was formally invited, the fisheries manager was not clear about his role as representative. DINARA's Marine Mammal Department declined the invitation arguing that solving conflicts is not among its duties.
The independent facilitation team ("independent" in the sense that it was not involved in the topics addressed) ensured that participants exchanged opinions and made decisions collectively through deliberation.	Social networks among participants were strengthened. New relationships were built between the four stakeholder groups, and existing relationships improved (e.g., between fishers and DINARA). Existing conflicts among stakeholder groups were partially allayed by working together.	Barriers to integrating different sources of knowledge were apparent. Fishers' knowledge was underestimated by some scientists, and scientists' findings were not trusted by some fishers.
The process was adaptable, consisting of iterative cycles of planning, acting, observing and reflecting. Stakeholders who had been initially reunited to address the sea lion problem soon started to address the market competition from imported *pangasius*. This motivated them to continue working as a group and to resume the study about sea lions.	Internal legitimacy of the participatory research process and of the outcomes was achieved. The ability of the group to receive funding (in 2012-2013) from non-governmental organizations and from the government (for a research proposal jointly developed) is a sign of external legitimacy.	Even though social relationships among participants improved, their opinion about the respective organizations did not change (i.e., the organization cannot be judged based on one person).

TABLE 2 ADVANTAGES AND DISADVANTAGES OF PARTICIPATORY RESEARCH COMPARED TO CONVENTIONAL RESEARCH, FROM FISHERS' AND SCIENTISTS' VIEWPOINTS (*)

Participatory vs conventional research	Fishers	Scientists
Advantages		
A societal problem is addressed.		✓
It is more comprehensive because the problem is understood from the viewpoints of all participants.	✓	✓
Everyone's knowledge and opinions contribute to the research.	✓	✓
Data are collected objectively.	✓	
Mistakes are better corrected collectively.	✓	
Participants learn from one another.	✓	
Results are valid to all participants.	✓	✓
Government agencies will consider the results (after having participated).	✓	✓
Disadvantages		
It has less scientific rigour.		✓
Research questions might not be of scientific interest.		✓
Research questions might be more difficult to answer.		✓
Its longer timeline might not be considered by donor agencies.		✓
Results might be detrimental to local stakeholders.	✓	

(*) *The table was prepared based on the answers given by the seven fishers and five scientists who participated in the Piriápolis initiative. When asked this open-ended question, the fisheries manager stated that participatory and conventional research are complementary, whereas NGO representatives did not identify advantages or disadvantages.*

In late 2012, less than two years after the beginning of the participatory research initiative in Piriápolis, evidence from POPA members emerged showing that the advantages of this approach outweighed its disadvantages. Following the offer of the group's biologists, POPA decided to design a research project to try fish traps as alternative gear, applying for government funding (DINARA-ANII, National Agency for Research and Innovation). This was one of the first times in Uruguay when artisanal fishers worked collaboratively with researchers and other stakeholders on defining the entire research proposal presented as a team. POPA biologists could have decided to apply for this funding with a conventional research proposal but they did not, suggesting that they advocate the participatory research approach. POPA fishers travelled from Piriápolis to DINARA's main office in Montevideo for group meetings in which the research proposal was discussed, a sign of their commitment. Furthermore, members of another division of DINARA (the Fisheries Technology Lab) were involved in the proposal, opening up a possibility for increased government representativeness.

In August 2013, POPA was informed about the approval of its research project "Mitigation of the impact from the interactions between sea lions and artisanal fisheries: Participatory research to evaluate fish traps as alternative fishing gear". This suggests that there is potential for this innovative approach to start gaining recognition in the country. POPA's new project provides an opportunity for making efforts to overcome the challenges identified during the evaluation, such as fishers' representativeness and integration of different sources of knowledge.

CONCLUDING REMARKS

Given that participatory research aims at involving stakeholders in finding solutions to local problems, the origin of a participatory research project has to be based on local interests. The origin of the process may vary. The topic can be either identified by local stakeholders, who then contact additional stakeholders (e.g., academics, government, NGOs) to be part of participatory research, or by external stakeholders who recognize a problem and then assess local stakeholders' perceptions about it and their interest to participate. Regardless of who selects the topic, all stakeholders should participate in defining the specific problems or research questions to be addressed, and they should also participate in the ensuing stages. The process features shown in Table 1 should be considered conditions or guidelines to develop empowering participatory research (see [7]).

This mode of participatory research, in which the different stakeholders are co-researchers, has great potential to enhance ecosystem stewardship (an action-oriented framework intended to foster the social–ecological sustainability [10]). To embrace the uncertainty of social-ecological systems, flexibility to adapt to uncertain futures needs to be maximized. The evaluation of the participatory research initiative in coastal Uruguay shows that this approach contributes to enhancing stewardship by fostering social learning, knowledge co-production, and trust building among stakeholder groups (fishers, government, scientists, NGOs). In this regard, enhancing social learning to facilitate adaptation is one of the strategies proposed in the ecosystem stewardship framework for responding to and shaping uncertain change [10]. Throughout its new project, POPA can keep enhancing social learning and strengthened social networks, among other participatory research outcomes that help build adaptive capacity and enhance stewardship.

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Stewardship as a Legal Duty and Its Application to Small-Scale Fisheries

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ABSTRACT

This chapter addresses stewardship from a legal perspective: defining a legal duty of stewardship and applying that duty to fishers. Stewardship is the obligation to be responsible for taking care of another person's property. This concept applies well to fisheries, especially since the public is the true owner of the fisheries in most countries. Assigning a duty of stewardship to fishers has several potential advantages: it may promote responsible behaviour, and the social problems that may result from trading catch rights can be avoided. The concept of stewardship is well justified by several principles that are often recommended for fisheries governance: environmental ethics, sustainability, food security, precautionary regulation, and inclusiveness. This chapter will introduce the concept and its applicability to fisheries, including small-scale fisheries.

Key words: stewardship, legal perspective, small-scale fisheries

INTRODUCTION

In its most basic form, the concept of "stewardship" is an obligation to be responsible for taking care of another person's property. In Iowa, this concept has been recognized and validated in common law with respect to land [1, p. 137]. Fisheries, as a shared resource, fall prey to the tragedy of the commons. The theory of the tragedy of the commons hypothesizes that multiple individuals, acting independently and rationally on behalf of their own self-interest, will ultimately deplete a shared limited resource if there are no individual property rights. Fishing regulations are the ongoing attempt to prevent this outcome. The duty of stewardship promotes the conservation of natural resources, because it assigns a social responsibility to preserve. This obligation, in tandem with Individual Transferable Quotas (ITQs), provides an effective solution to some problems that arise under many fishery management schemes.

THE DUTY OF STEWARDSHIP IN FISHERIES

The duty of stewardship can be comfortably applied to fisheries because fisheries are shared resources owned by the public. This remains true for catch share regimes because holders of ITQs do not own uncaught fish; they possess the right to catch a pre-designated quantity of fish. Catch shares are a right-based management tool given to individuals, communities or associations to harvest a specific area or percentage of a fishery. Assigning a duty of stewardship to fishers would overcome a significant weakness of most fisheries management schemes: under most schemes, fishers bear no responsibility for the ongoing health and productivity of the resource from which they extract their livelihood. Instead, the regulator alone is accountable for protecting the resource – the fishers must only obey the regulator's rules.

Sustainable fishing is achieved by being a steward of common resources. The Marine Stewardship Council (MSC) defines a sustainable fishery as a fishery that:

- can be continued indefinitely at a reasonable level;
- maintains and seeks to maximize, ecological health and abundance;
- maintains the diversity, structure and function of the ecosystem on which it depends as well as the quality of its habitat, minimizing the adverse effects that it causes;
- is managed and operated in a responsible manner, in conformity with local, national and international laws and regulations;
- maintains present and future economic and social options and benefits;
- is conducted in a socially and economically fair and responsible manner.

Proper fisheries management preserves the health and viability of fisheries for current and future use. This duty of stewardship has already been adopted in many states' agricultural laws where, like in the case of fisheries, owners must think not only about today, but about the future productivity of their land. For example, Iowa defines "sustainable agriculture" as "preserving the high productivity and quality of Iowa's land" [2]. Consequently, farmers cannot simply deplete the land of nutrients and then move its operation elsewhere. They are required to be good stewards of the land and preserve the land's viability for future uses. For fisheries to be adequately protected for current and future uses, fishers must not only be limited in the numbers of fish they can take, but also be designated as stewards of the ocean.

OWNERSHIP-BASED REGULATION AND CONSERVATION

Most proponents of ownership-based schemes such as ITQs argue that ownership in and of itself promotes conservation and protection of the resource, because it is in the owner's best interest to maintain the resource so that he can continue profiting from it in the future. It is rational to expect owners to conserve if such conservation leads to future benefits that have a greater present value than the benefits of immediate extraction. However, if immediate extraction of the resource yields a greater benefit than conservation, then it can be expected that owners will prefer the current benefit, and will make no effort to preserve anything for the future.

Two possible ways to address this problem are (1) to ensure adequate enforcement, and (2) to hold fishers to a duty of stewardship. The effectiveness of enforcement can be a significant factor in determining the expected value of future returns. Illegal, unreported, unregulated (IUU) fishing alters the benefits that fishers can expect in the future. If fishers believe that other fishers can cheat and increase their returns, the future benefit stream will be seen as risky, and will be heavily discounted in fishers' evaluation. Enforcement, if effective and credible, will reduce the risk and bring current and future benefits into balance. Ownership of the resources alone is insufficient to promote conservation. Enforcement of fisheries regulations is necessary to ensure that fishers will value the existence of resources in the future.

A duty of stewardship must be as explicit and enforceable as the ITQs. Appropriate stewardship behaviour cannot be assumed to be the outcome of creating ownership rights with no overt requirement for stewardship. Many of the tools used in resource management,

including licenses or permits, embody some limited form of property rights. On the other hand, a duty of stewardship, without inclusion in the license to fish, is a legal duty that falls under tort law.

STEWARDSHIP AND FISHERIES META-PRINCIPLES

The principles and assumptions underlying governance structures may not always be explicit. “When governors define the problems they think should be addressed and the solutions to these problems, they inevitably draw on fundamental assumptions and worldviews that should be brought to the surface so they can be explained, defended and examined” [3, p. 241]. Underlying sustainable fisheries management are the principles of environmental ethics which inform the duty of stewardship. According to environmental ethics the preservation of species and ecosystems is morally good. The duty of stewardship promotes this ethic by assigning to ITQ holders a responsibility to preserve. If it can be implemented effectively as part of a fishery management scheme, such a responsibility or duty can promote conservation and the long-term health of the resource.

The scope of a duty of stewardship that is driven by the considerations of environmental ethics may vary. If a human-centered environmental ethic is chosen, then organisms other than humans are valued only according to their effect on humans. This would imply a narrower scope for a duty of stewardship than a nature-centered environmental ethic where all organisms are morally relevant. The meta-principle of sustainability also supports the application of a duty of stewardship to fisheries. Sustainable fishing, or meeting the needs of the present without compromising the needs of future generations, will effectively protect small-scale fisheries – fisheries in the greatest of danger.

APPLICATION OF THE DUTY OF STEWARDSHIP TO FISHERIES

Mandating the application of a duty of stewardship to fishers would formalize fishers’ obligation to be stewards of the fisheries. Fishers subject to the duty of stewardship would be liable for using or consuming a fish stock in a way that destroys that stock or its habitat. Explicitly associating a duty to conserve the stock with holding a quota or license would allow the possibility of legal action by a third party against a resource user who neglects this duty. This risk could motivate users to act as responsible resource managers.

Within the agricultural sector there exists a similar concern that leaseholders lack an incentive to conserve and protect their land. Many farm lease agreements include a “good husbandry provision”, which imposes a stewardship obligation upon the leaseholder. Retired landowners in Iowa are increasingly choosing to impose such a duty in farmland leases [4, p 5]. The Iowa Supreme Court has held that, “the purpose of a good husbandry provision is mandating the proper use of land rather than requiring high yields”, a finding that clearly creates an obligation to act as a good steward of the owner’s land [5]

The duty of stewardship would also be applied to those who lease the ITQ from ITQ holders. ITQ holders have an economic interest in restricting the lessees’ activities in order to protect the quotas’ value. If lessees overfish thereby diminishing the availability of fish stocks, then the value of the ITQ decreases thereby eliminating the ability of the ITQ holders to lease the quota or to use the quota themselves. Holding lessees’ to the duty of stewardship would allow the lessor to hold the lessee accountable for any damages caused.

In principle, the recognition of a duty of stewardship would make it possible to penalize a fisher, either as an owner or a lessee, who damages the health and productivity of the resource. Such an obligation would encourage mutual self-monitoring among the users. A properly defined duty of stewardship would enable legal actions to be brought on the grounds of ecosystem and fishery damage, and would enable them to be brought against those who actually caused the damage.

STEWARDSHIP AND SMALL-SCALE FISHERIES (SSF)

Many small-scale fisheries in developed countries are recognizing the importance of differentiating their products through sustainability. To be identified as sustainable fishers, these fishers present themselves as stewards of the sea. Native communities, like the Mi'gmaq people, have been self-described stewards of the sea for generations. For example, Jeff Basque states that the Mi'gmaq people believe that they have "sacred duties of stewardship" over fish and other natural resources [6]. He says that, "these duties are the basis of Mi'gmaq identity, culture, and livelihood. It is not something we Mi'gmaq people chose or accepted; we are duty-bound. We fish because quite simply, it's what we've done for millennia: we take what we need, no more, and govern our fishing to sustain our future generations" [6].

In devising fisheries management schemes, planners should become familiar with what it means to be stewards and why it benefits the fishers and the communities. Understanding the underlying community and culture improves the likelihood that the fisheries management structure will enjoy enough support and cooperation from the fishers to be successful. Efforts to organize and market fisheries in this way create incentives for these fishers to create for themselves and voluntarily adopt a duty of stewardship.

STEWARDSHIP AND INCLUSIVENESS IN FISHERIES GOVERNANCE

A duty of stewardship could also be used to increase inclusiveness in fisheries governance. In catch share schemes, the government authorizes individuals, boats or communities (quota holders) to use the fisheries. Other stakeholders are not included in the management framework. For example, conservation groups and environmental non-governmental organizations (NGOs) are often excluded, and can only affect the current system by way of public awareness and other activities outside the management scheme. The public is excluded as well; the government as trustee acts on behalf of the public.

A duty of stewardship changes the relationship between quota holders and other stakeholders. For example, conservationists, small-scale fishers or NGOs may be able to hold quota holders accountable for actions that violate their license terms. This in turn would allow stakeholders to take an active role in fisheries management and enforcement. In this system, the government is not the only regulator and enforcer – other stakeholders, like the community and NGOs, can help to govern the fisheries and ensure they remain a productive future resource. Furthermore, these non-quota holders can hold the government accountable for promulgating effective regulations as well as enforcing the issued licenses. Such a structure of governance ensures that a shared resource is managed by a variety of stakeholders with different interests in fisheries.

CHALLENGES TO IMPLEMENTATION

A proposal to introduce a duty of stewardship would create several challenges. First and foremost, due process requires that a statute clearly define the offense so that people will know what activities are prohibited, and so that the law will not be enforced in an arbitrary or discriminatory manner. A law is void for vagueness where its prohibitions are not so clearly defined that: (1) it gives persons of ordinary intelligence fair notice of the conduct prohibited; and (2) it does not supply adequate standards to prevent arbitrary and discriminatory enforcement. Because of the ever-changing nature of a fishery (e.g., fish stocks, pollution, climate change), fishery regulations are written in broad terms so that they can be applied with flexibility. Sometimes these regulations cross the line and become too vague. Writing sufficiently detailed fishery regulations is a challenge to the implementation of a duty of stewardship.

Furthermore, what is considered to be "bad stewardship" varies from jurisdiction to jurisdiction. The courts will ultimately determine this based on evidence and arguments presented in a case by case basis. A classic example of this problem is the question of whether bottom trawling is a "destructive practice" and, therefore, a tortious act that would be punishable under a duty of stewardship regime. Opponents of bottom trawling suggest that large trawlers deplete species that are critical to the food chain and have immense negative impacts on fisheries health and sustainability. However, the proponents of bottom trawling say that these negative consequences can be effectively managed through proper use of the equipment. They contend that bottom trawling in certain habitats (sandy habitats) cannot be considered a destructive practice while bottom trawling in more fragile habitats (coral reef) may be. Such complications make the implementation of a duty of stewardship challenging, but success is ultimately possible through identification of industry standards and communication between fishers and the regulatory agencies.

CONCLUSION

One of the most important challenges in fisheries management is ensuring the long-term sustainability of fish stocks. Various forms of regulation have been attempted, including ownership-based regimes such as ITQs, but none have succeeded entirely in protecting fish stocks and the marine environment. An explicit duty of stewardship would be a valuable addition to the tools available to fisheries regulators. Such a duty is appropriate for fisheries, because fish and shellfish are the property of the public. Consequently, fishers should be more than just owners, but also stewards.

A duty of stewardship could be used to strengthen the incentives for conservation within an ITQ regime, to promote and manage small-scale fisheries, and to increase inclusiveness and shared governance. Certain challenges must be overcome in order for a duty of stewardship to be implemented, but these can be overcome with careful planning and thorough stakeholder discussions.

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Small-Scale Fisheries in Portugal: A Brief Overview

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ABSTRACT

Small-scale fisheries are a major component of the European Union (EU) fisheries, especially in southern European countries. Portugal has the third largest Exclusive Economic Zone of the EU and the Portuguese are the largest consumers of fishery products in the EU. The fishing sector in Portugal is of major socio-economic importance for coastal communities, many of which are highly dependent on this economic sector. The Portuguese fishing industry is characterized by the high prevalence of small fishing vessels, up to 12 m in length, operating near to the coast, employing a diversity of fishing (mostly passive) gears and targeting a multitude of species. The small-scale fishing activity faces some challenges mainly related to the low prices at first auction, high expense of the fishing activity, low revenue from fishing, the lack of participation of the fishing industry in the management of their activity, lack of stewardship and increased restrictions to the fishing activity.

Keywords: small-scale fisheries, Portugal, European Union.

INTRODUCTION

The fishing industry in Europe is going through a phase of unprecedented change and fishery management is likely to change significantly in the near future. Numerous policies and initiatives implemented in the European Union (EU) over the last decade have been giving a new direction to fishery management.

Environmental concerns are now at the heart of fishery management initiatives [1, 2] and international obligations (e.g. agreement by OSPAR and HELCOM members) and legislation (Marine Strategy Framework Directive; MSFD). This puts pressure to build on the existing network of Marine Protected Areas (MPAs) and to extend their coverage to offshore waters. The increase in conservation measures is leading to conflicts between the fishing activity and conservation interests. Conflicts could be exacerbated in the near future with the recent call by the United Nations Convention on Biological Diversity (UN-CBD) for at least 10% of marine and coastal zones to be conserved as official MPAs by 2020. To add to that, the European marine environment is going through a new and unprecedented phase of planning and maritime development, through the Integrated Maritime Policy (IMP) and Marine Spatial Planning (MSP), and these zone schemes will further impact on the freedom of movement of the fishing industry [2,3]. Finally, the new governance system for fisheries, which will come into place with the reformed Common Fisheries Policy (CFP), will dramatically change the nature of fisheries management.

The European fishing sector has been facing difficulties over the last few decades. Stocks are in a poor state, although some of them have finally been improving, namely in the North Sea [4], the capacity of the EU fleet is excessive for the available resources, landings have

been decreasing, and employment in the catching industry has also been generally decreasing.

Small-scale fisheries, or artisanal fisheries, although having different importance in the several EU member-states, are a major component of EU fisheries, contributing to a large proportion of landings, mostly of fish for human consumption. The European small-scale fisheries fleet accounts for 83% of all vessels in number (10% in gross tonnage and 35% of engine power), employs 90 thousand fishers, and is responsible for one-quarter of all the value landed by the EU fleet. Greece, Spain, Portugal, Italy and France account for almost 70% of the small-scale fleet [5].

FISHING SECTOR IN PORTUGAL

Portugal has the third largest Exclusive Economic Zone (EEZ) of the EU and the tenth largest EEZ in the world. In 2009, Portugal submitted a proposal to extend its continental shelf to the Commission on the Limits of the Continental Shelf (CLCS) of the United Nations, which will almost double the Portuguese EEZ (Figure 1).

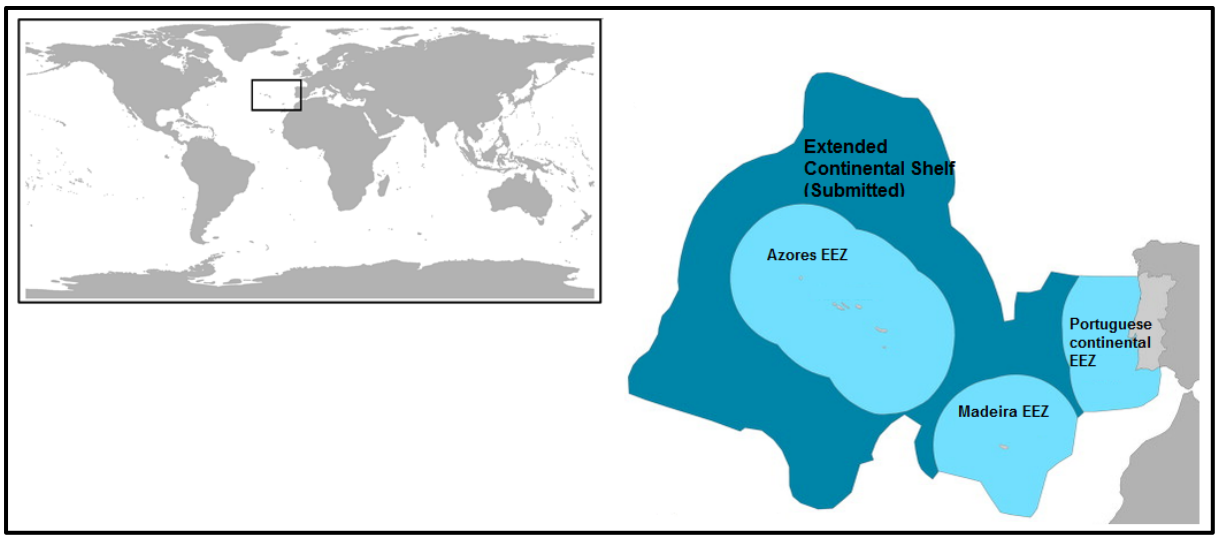

FIGURE 1 PORTUGUESE EXCLUSIVE ECONOMIC ZONE (EEZ)

The Portuguese fishing sector lands only a small proportion (4.4%) of the total EU-27 landing in quantity. Still, the sector accounts for 10% of the EU fleet in number, 6% of its gross tonnage, and 13% of the employment. The Portuguese are the most important consumers of fishery products in the EU, consuming more than double the average per capita for the EU (54.5 kg/head/year) and the country spends almost 5 times the value of fish landings importing fish food products (fish, crustaceans and molluscs) [6-8].

The fishing sector in Portugal is of major socio-economic importance for coastal communities, many of which are highly dependent on this economic sector. Fisheries contribute directly and indirectly to employment and income in rural coastal communities where there are restricted employment opportunities [9]. This fact becomes of more importance when considering that, according to the 2011 census of the general population, the Portuguese fisheries workforce (fisheries and aquaculture) is characterized by a middle-aged workforce, having on average 44 years of age, with low level of formal education, most

having less than 9 years of formal education (78%; with 9 years being the current compulsory level of formal education).

The Portuguese fishing industry is characterized by a high prevalence of small fishing vessels, operating a vast array of fishing gears and targeting a multitude of species. The fleet is composed of three segments, with different importance, realities and problems. In 2012, the multi-gear (polyvalent) fleet accounted for most of the catch volume (46%), followed by the purse-seine fleet (44%) and the trawling fleet (10%). There were 16,559 registered fishers, most of which were employed in the local (41%) and coastal (29%) multi-gear fleets. Local fleets are composed of vessels with less than 9 m in total length and 75 kW (or 100 cv) in power, operating always near to the harbour of registration, in inshore waters (less than 6 nm), and also in rivers, estuaries, lagoons and from the beach. Coastal fleets are composed of vessels between 9 and 33 m in total length (generally 9-15 m), power over 25 kW and gross tonnage below 100 GT.

The Portuguese fishing industry operates from 45 harbours all around the country. In 2012, 4,653 vessels were licensed to fish, i.e. fleet authorized to operate a certain fishing gear, in a specific area and for a specific period of time. On average, vessels hold licenses to use four gears per vessel. Most licenses are allocated to vessels less than 10 m in total length (85%), and mostly for hooks and lines (51%) and nets (31%) [8].

SMALL-SCALE FISHING SECTOR IN PORTUGAL

Small-scale, or artisanal, fisheries operate in a particular economic, legal and administrative framework, in permanent engagement and sometimes competition with large-scale fisheries, recreational fisheries, aquaculture, coastal tourism and urban development. Small-scale fisheries are composed of vessels up to 12 m in length, operating near to the coast (local or coastal fisheries), employing a diversity of, mostly passive, gears. This sector of the fishing activity employs more than 85% of all the registered fishers and accounts for 90% of the total registered vessels, accounting for almost 12% of gross tonnage and 40% of power (Table 1).

In 2012, the artisanal fishing fleet had 3,448 vessels licensed to fish (Figure 2). Of the 19,573 licenses issued for the artisanal fishing fleet, most were for fishing with hooks (51%), nets (31%), and pots and creels (13%). The majority of fishing trips done by small-scale fishing vessels take one day and around 2-4 people work per vessel [9, 10].

MAIN CHALLENGES FACED BY THE SMALL-SCALE FISHING ACTIVITY IN PORTUGAL

The main problems the small-scale fishing activity faces are related to the low prices of fish at first auction, high expense of the fishing activity, and low revenue from fishing. Other problems include the lack of participation of the fishing industry in the management of their activity, lack of ownership of resources, the EU “one model fits all” approach to fisheries management, generalized lack of stewardship and increased restrictions to the fishing activity.

TABLE 1 FISHERIES IN PORTUGAL, SMALL-SCALE FISHERIES AND TOTAL

Landings	**Small-scale fisheries**	**Total**
Landings (t)[a]	70 301	151 343
Landings (1000€)[a]	189 907	281 307
Average price at first auction (€/kg)	2,70	1,86
Fleet		
Vessels (number)	7 455	8 276
Vessels (GT)[b]	12 289	99 836
Vessels (kW)[c]	147 869	366 303
% number of SSF vessels in total	90.1%	–
Fishing licenses		
Total number of fishing licenses[d]	19 573	22 928
Average number of licenses per vessel	4	4
% of SSF licenses in total	85.4%	–
Employment		
Fishers (number)[e]	11 529	16 559
% SSF in total	70%	–

Source: INE, Estatistica da Pesca [8]
Notes: Small-scale fisheries (SSF) refers to vessels <12 m in length unless specifically mentioned; [a] SSF refers to landings from the multi-gear (polyvalent) fleet; [b] Vessels (GT) refers to vessels' tonnage in gross tonnage; [c] Vessels (kW) refers to vessels' power in kilowatts; [d] SSF refers to vessels <10 m in length; [e] SSF refers to fishers employed in local and coastal multi-gear (polyvalent) fleets.

FIGURE 2 EXAMPLE OF SMALL-SCALE FISHING ACTIVITY IN THE ALGARVE, SOUTH OF PORTUGAL: (A) A STATIC-GEAR SMALL-SCALE FISHING VESSELS, (B) OCTOPUS CREELS IN THE HARBOUR, AND (C) FISHERMAN BAITING AN OCTOPUS CREEL.

Fishers identify the need to implement fisheries management measures, which are adapted to the local situation, fleet, target species, and most importantly, which involve fishers in the solutions adopted to solve fishing problems. Fishers specially emphasize the lack of empowerment of fishing communities and frequently mention the need to increase the

participations and involvement of fishers in policy-making and the management of their own activity.

Portuguese fishers frequently mention the need to have a differentiated fishery management system for small-scale fisheries, both differentiating small-scale artisanal fisheries from larger-scale fisheries, as well as differentiating southern from northern European fisheries. They frequently complain that the EU does not tend to differentiate between southern and northern European fisheries and implements measures which might make sense in the north of Europe but not in the south. They mention the discard ban as an example of such a problem, mentioning the fact that northern European fisheries target a small amount of species, while this is not the reality in the south. This leads to the implementation of measures which are not adapted to the local reality, and a generalized problem of lack of stewardship.

The low income level of fishers and boat owners is identified as one of the major problems faced by the sector. Fishers frequently refer the need to warranty a reasonable and "decent" level of revenue from the fishing activity for both fishers and boat owners. Revenue levels have been decreasing considerably over the last few years due to price stagnation at first sale and continuous increase in production costs, mainly fuel costs. Several measures are already being put in place to increase the added-value of the catch, such as campaigns by DOCAPESCA S. A. – state-owned company (under the Ministry of Agriculture, Sea, Environment and Physical Planning), responsible for organizing the first sale of fish, and support fishing and fish ports – to promote the consumption of Portuguese fresh fish, such as mackerel (*Scomber japonicus*) and octopus (*Octopus vulgaris*), and as such increase the value of these species. DOCAPESCA is also passing the exploitation of several first sale auction places to Producers Organizations. These measures are seen by fishers as a step in the right directions, since it will allow for direct commercialization as well as increase the demand for national fish products and thus potentially contribute to achieve economic sustainability of the sector. To add to these, alternatives to traditional top-down management are currently being explored, such as a new initiative to implement a bottom-up, co-management, adaptive management system, entitled "responsive fisheries management system" (RFMS) for the octopus fishery in the Algarve (south of Portugal), where this fishery is of extreme social and economic importance for the local small-scale fishing sector. All these new developments have the potential to increase empowerment of the fishing industry and ownership of resources, as well as enhancing stewardship.

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Social Agency in Marine Conservation Efforts in the Central Coast of Chile

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ABSTRACT

In recent years the establishment of Marine Protected Areas (MPA) has intensified worldwide. Recent studies have shown the importance of social and political issues related to the implementation of MPAs. They influence the success and effectiveness of these management and conservation tools. This paper aims to summarize our understanding of the political process related to the implementation of MPAs in Chile based on the analysis of the emergence of the no-take marine reserve "Santuario Marino Bosque de Calabacillo de Navidad" in the Navidad Municipality. The MPA was created through the participatory effort of the fishers union, the municipal government and university academics. The results showed the role of social agency and of the different actors in guiding transformations in the system of governance of marine and coastal resources in the direction toward sustainability.

Key words: Chile, MPA, conservation governance, social agency

NAVIGATING OPEN WATERS: THE ROLE OF SOCIAL AGENCY IN MARINE CONSERVATION IN CHILE

Fisheries governance in Chile experienced a faster transformation in the last 20 years [1]. The drastic decline of catches caused by the neoliberal economy, led to the implementation of a new governance system [2].

The Fisheries and Aquaculture and Law (FAL-1991) came to fulfill this objective, providing the tools for regulation and administration of the activity [3]. For marine conservation, this represented the first institutional framework designed specifically for marine and coastal areas, establishing different categories of conservation and management: Marine Parks, Marine Reserves and Management and Exploitation Areas for Benthic Resources (MEABRs) [4]. The MEARBs are "an access regime that assigns exclusive rights to artisanal fishing organizations through a management plan based on the exploitation and conservation of benthic resources in previously defined geographic areas" (www.subpesca.cl). After the implementation of FAL, new conservation categories were created, such as Marine Coastal Areas of Multiples Use, which increased the number and the alternatives of Marine Protected Areas in Chile.

Up to 2011 Chile had 25 MPAs representing 4.3% of the 3,681,989 km^2 of Exclusive Economic Zone [1]. At the same time, the MEABRs increased in number and coverage, with 707 areas covering 1,100 km^2 of national coastal zone.

Following the creation of the Ministry of Environment in 2010, the development of a National System of Protected Areas that integrates terrestrial and marine conservation in a single

management agency and designated new categories of conservation has been discussed in National Congress [5].

Furthermore, local marine conservation initiatives have been consolidated through the effort of municipal governments, academics, fisherfolk unions and nongovernmental organizations (NGOs). These initiatives have used the existing institutional framework for marine conservation and fisheries management provided by the law, integrating no-take protected areas with MEARBs, in order to reorient the top-down approaches of conservation and management policies [6, 7].

In this context, social agency plays the mediator role between the social actor's actions and the structures that define political processes [8]. It highlights the potential of individuals to transform the *status quo,* and their capacity to change the set course of events [9]. Finally, it provides alternatives to navigate transformations in socio-ecological systems and guide individual and collective action towards sustainability [10].

WHEN SOCIAL ACTORS TAKE THE INITIATIVE: THE CREATION OF THE SANTUARIO MARINO BOSQUE DE CALABACILLO DE NAVIDAD

The Santuario Marino Bosque de Calabacillo de Navidad is located in the area known as "Las Brisas", in the Navidad Municipality, along the coast of the Region of Libertador Bernardo O'Higgins (VI Region), approximately 200 km southwest of Santiago, Chile's capital. The municipality has a population of 5,422 inhabitants, where 80% live in rural areas. The socio-economic level is low and 16% live in poverty conditions [11]. The main economic activities are agriculture, cattle rearing and fishing, made mostly autonomously.

The coastline in the Navidad Municipality is 30 km long, specific features are the presence of the Cordillera de la Costa mountain range reaching an altitude of 1400 m, wide oceanic terraces and a number of humid zones.

The fisheries sector is exclusively artisanal; there is no industrial activity and no aquaculture. One of the main activities within artisanal fisheries is the exploration for algae (seaweed), accounting for 76% of this region's production during the period 1998-2011. This activity includes approximately 80% of artisanal fishermen, described as "algae harvesters" under the National Fisheries Register. Among the species of algae exploited, the following predominate: luga (*Mazzaella laminarioides*), chasca (*Gelidium sp.*) and cochayuyo (*Durvillea antarctica*). The first two are utilized as raw materials in the food, cosmetic and pharmaceuticals industries and the latter is used for food consumption.

This economic activity is based on a long tradition of extracting algae, which has been carried out by family groups in the villages of Navidad, Pichilemu, Bucalemu, Matanzas, La Boca de Rapel and Topocalma. Successive generations of these groups have established permanent and semi-permanent settlements throughout the coastal area of the VI Region [12].

The Marine Protected Area created at Navidad has an area of approximately 11 hectares and protects a kelp forest of *Macrocystis pyrifera*, known as *huiro calabacillo*. It was officially recognized as a Nature Sanctuary by the Ministry of Environment in February 2013. This

category of protection designated as sites of special interest to the State and science, seeks to protect habitats and species by restricting the uses to scientific research and education.

The creation of this MPA emerged from collaborative work of scholars from the Catholic University of Chile, the Municipality of Navidad and fishermen's unions of the La Boca de Rapel and Matanzas, who saw the possibility to protect an ecosystem heavily threatened by aquaculture. The species *Macrocystis pyrifera* is used for feeding abalone (Haliotis sp.) in the aquaculture industry on northern coast of Chile. The intense exploitation led to their extinction on the northern and central coast of the country. It was an alternative to promote sustainability of small-scale fisheries of the municipality and propose alternatives for marine conservation at the local level [6, 7].

Official recognition of the MPA completed work that began almost 15 years ago, when the fisheries law enacted in 1991 began to be implemented in the region and when the first professionals of Servicio Pais, a public-private program of decentralization and modernization of local governance, came to Navidad. The activities of these new local actors concentrated on municipal planning and administration, and integrating new fields and issues in the municipality affairs. Environmental issues combined with the local economic development. These, in turn, linked the implementation of the fishery management tools contained in the Fisheries Law, such as the MEARBs system, with biodiversity conservation.

In these years the first attempts to protect the municipal coastal area were made, by trying different possibilities and seeking alternatives to funding the initiatives. The prior relationship between one of the new city officials and an academic of the Catholic University, allowed integration of the latter, providing the necessary scientific support to justify the proposal with the municipal council and funders, as well as locally legitimize the initiative.

The formalization of the MPA project needed approval from fishermen unions, because they were the main users of the area to be protected. Their support was essential in order to go ahead with the initiative. Thus, each social actor assumed and communicated his interest in the creation of an MPA. The academic approach to the sustainability of protected areas highlighted the benefits of establishing a no-take protected area between two MEARBs, as a way to promote the recovery of stocks and increase the abundance of commercial species. The municipality promoted the creation of the MPA as a way to support economic development of the artisanal fishers and as a pilot project of coastal planning. Finally, fishermen recognized that the MPA could become a natural seed bank and an alternative to adding value to their resources [7].

The articulation of the different actions and plans around the MPA allowed the Municipality of Navidad in 2009 to initiate proceedings for the declaration of the southern area of “Las Brisas” as a Nature Sanctuary. The mobilization of knowledge and economic resources by academics, the political articulation of the municipality and the commitment of fishermen unions made possible the realization of a pioneering project for coastal areas in Chile. The Santuario Marino Bosque de Calabacillo de Navidad has become an institutional alternative for integrated marine conservation and fisheries management at the local level, which puts fishermen unions at the center of the marine conservation governance system.

The draft bill of the National System of Protected Areas does not consider the municipal protected areas category and parliamentary discussion seem not to integrate this

conservation approach. Navidad's experience appears to be an alternative to centralizing conservation categories contained in the draft bill, enhancing existing conservation policies through the creation of a MPA network that integrates no-take MPAs (sanctuaries) with sustainable use areas (MEARBs) [1, 6].

SOCIAL AGENCY: LOCAL PATHS FOR SUSTAINABILITY

Social agency is a concept that refers to the mobilization and participation of stakeholders in the decision-making process. It emerges as the capacity of human beings to transform the established course of events and the possibility of imagining alternative futures. Navidad's conservation initiative showed the way that the fishermen's unions, municipal officials and academics articulated their different social agencies in the local arena, in order to create mechanisms to ensure the protection a threatened ecosystem. This experience is as an innovation in the governance system of marine resources in Chile, which represents the emergence of a local path towards sustainability.

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Enhancing Stewardship Through Interactive Institutions: A Case Study From Koh Chang, Thailand

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ABSTRACT

The concept of stewardship offers a comprehensive and broad perspective for understanding stakeholders' interactions with the coastal environment. In order to enhance stewardship among coastal stakeholders, this paper posits that institutions can play an important role. Through mechanisms that are inclusive of a range of actors, context-appropriate, locally-engaged and interactive, institutions can provide a platform from which stewardship can be cultivated. To illustrate ways in which institutions increase capacity for environmental stewardship, a coral restoration project by the United Nations Environment Programme and Global Environment Facility in Koh Chang, Thailand, will be presented.

Key words: coastal resource management; environmental stewardship; institutions

INTRODUCTION

Coastal areas are comprised of diverse, complex, and dynamic ecosystems of high ecological and anthropogenic value [1]. Essential for the maintenance of biodiversity and the provision of ecosystem services, coastal zones provide vital habitats and nurseries for many fisheries of global significance as well as a wide variety of societal and economic activities [2]. Coastal areas, at a global scale, are subject to an array of human-related pressures, such as coastal erosion caused by development, polluted waters from marine and land-based sources, declining fish stocks from fishery overexploitation, as well as destruction of corals and sponges from poor fishing and tourism practices [3]. These impacts exemplify only a few of the known threats to ecosystem health and to sustainable livelihoods of coastal communities. Thus, along with added impacts and uncertainties of climate change, we argue that there is a need to explore human interactions with the coastal zone through a more holistic approach, such as that offered by the concept of environmental stewardship.

Environmental stewardship both encompasses and extends beyond the operational level of resource management and conservation to include a wide range of meta-level attributes, such as ethics, morals, values, norms, and beliefs—whether secular or religious in nature [4, 5], as well as careful consideration about the 'second-order' governance, which relates mainly to institutional setting [6]. As described by interactive governance theory [7], these meta- and second-orders of governance play an important role in informing and influencing behaviours, actions, and decisions. Thus, attempts to foster stewardship should not only address behavioural aspects of humans' relationship with nature, but also the broad considerations about the type of institutions that may foster behavioural change. The case of Koh Chang presented in this paper is an illustration of the importance of setting up locally appropriate, context-based institutions to help enhance coastal stewardship among

stakeholders, particularly those whose livelihoods are closely linked to the health of coastal resources, like small-scale fishers.

Koh Chang is an island in the Gulf of Thailand, in Trat province, which is the most easterly province of Thailand, bordering Cambodia (Figure 1). Despite its national park status, the pristine marine ecosystem faces significant threats, mainly from tourism development. In 2005, it was selected as a demonstration site for a United Nations Environment Programme (UNEP) - Global Environment Facility (GEF) project. The organization aimed to facilitate co-management of coastal resources through various collaboration and coordination mechanisms in order to prevent further environmental degradation. During the three-year project cycle, many activities were pursued, which were conducive to facilitating environmental stewardship among local coastal stakeholders and governing agencies. This paper highlights how institution building, facilitated by the UNEP-GEF in Koh Chang, played an important role in strengthening stewardship in the area.

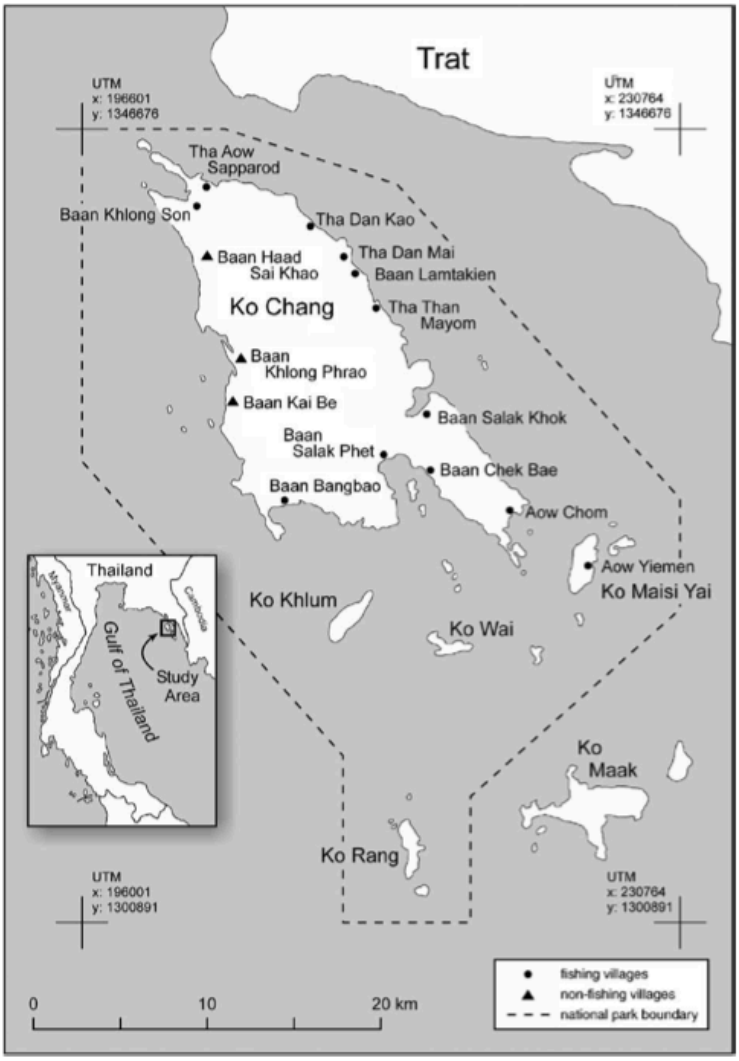

FIGURE 1 MU KOH CHANG AND THE NATIONAL PARK BOUNDARY [8]

KOH CHANG, THAILAND CASE STUDY

Background Information

Koh Chang—Thailand's second largest island—is part of the greater Mu Koh Chang archipelago, known for its natural beauty, with mountainous ranges blanketed by lush tropical rainforest. The diverse ecologies of the surrounding coastal waters are comprised of mangrove forests, rocky and sandy beaches, mudflats, seagrass beds, as well as fringing coral reefs [9]. These ecosystems support a vast array of coastal flora and fauna [10]. The marine biodiversity surrounding Koh Chang, in general, is considered to be comparatively high for the western region of the South China Sea, which encompasses the Gulf of Thailand [11].

The abundant natural resources of Koh Chang historically supported fishing and agrarian-based economies with the first fishing village, Salak Petch, being established in the 1920s [12]. However, the island has since experienced significant institutional and socio-economic changes within a relatively short time period. For instance, in 1982, Thailand's Department of Forestry established Mu Koh Chang National Park [12], encompassing about 47 islands in the archipelago, including Koh Chang. The establishment of the park took place through a largely top-down process [13], although its implementation after 2005 was participatory through a multi-stakeholder protected area committee. Because of the historical presence of fishing on the island, some small-scale fishing villages are enclave within its demarcation and inhabitants were permitted to stay [13; Figure 2]. The total area of the park is 650 km^2 with a substantial marine component comprising 70% of the park's area [10].

FIGURE 2 SALAK PETCH FISHING VILLAGE ON THE EASTERN COAST OF KOH CHANG

In the early 2000s tourism development in Koh Chang expanded due to new government policies and effective marketing schemes [14]. In 2004, the Thai government deemed both Mu Koh Chang and the coastline of Trat Province as a special territory under the control and supervision of a newly formed public organization called Designated Areas for Sustainable Tourism Administration (DASTA) [15]. DASTA's role, among others, is to heighten the region's profile as a tourist destination in an effort to increase its competitiveness and promote local investment [12]. The official tourism development plan for the Koh Chang archipelago aims to provide a niche market comprised mainly of resort-style tourism and ecotourism [16]. The tourism industry greatly favoured the western coast of the island. There, the white, sandy, sunset-oriented beaches attracted hotel and resort developers. Koh Chang's western coastline underwent a rapid transformation from a relatively unknown, and pristine destination, to one populated with hotels, bungalows, souvenir shops, banks, bars, Internet kiosks, and travel agencies [16]. Additionally, following the 2004 Indian Ocean Tsunami, which impacted the Andaman coast in Thailand, tourism within the Gulf of Thailand, and specifically in Koh Chang expanded [16]. In 2012, more than 900,000 tourists visited the Mu Koh Chang National Park, which was a significant increase compared to the 2003 figure of about 330,000 [17].

This rise in human activity has exacerbated local pressures on the island's coastal ecosystems. Fishing impacts and rapid development of the tourism industry are major causes of human-related environmental degradation in the area [14]. Fisheries, as characteristic of the Gulf of Thailand in general [18], have been heavily exploited. In some cases, damaging gear types are employed such as trawls, push nets, under-sized mesh gill nets, as well as reported use of cyanide to target reef fishes [14]. The influx of tourist and poorly planned tourism-related development has been identified as a source of coral reef degradation [16] with the collective threats of development, tourism, and recreational activities to coral reef health being considered high [19]. Development on the island has led to coastal erosion and subsequent sedimentation of marine ecosystems [11]. A lack of adequate infrastructure to support the level of development has resulted in sewage outflow in coastal waters, which has, in turn, caused algal blooms [11]. Tourist marine activities, such as snorkeling and SCUBA diving, have caused coral damage due to sedimentation or trampling of corals from negligent or inexperienced snorkelers and divers [14]. Further, the deployment of anchors from tourist boat operators in coral reef areas has also led to coral degradation [14]. Inadequate resources for law enforcement and poor coordination among management agencies made curtailing human impacts in the area difficult [9].

Mu Koh Chang Demonstration Site by the UNEP-GEF

Based on its biological diversity, environmental threats, transboundary importance, as well as potential for institutional support from Mu Koh Chang National Park and DASTA, Koh Chang was selected as a coral reef restoration demonstration site [11, 20]. The project was a part of the intergovernmental initiative entitled, "*Reversing Environmental Degradation Trends in the South China Sea and* Gulf *of Thailand,"* which was implemented by the UNEP and funded by the GEF. The main goal of the Mu Koh Chang Demonstration Site was to remove or reduce the causes of coral reef degradation by means of facilitating a new model of co-management as well as to restore degraded areas for both educational and tourism purposes [14]. During the project's operational phase from 2005 to 2008, a number of initiatives, described below, were implemented, according to the project's objectives of building coral ecological awareness, establishing networks, facilitating sustainable ecotourism practices, capacity building, developing alternative livelihoods, and rehabilitating

coral reefs [19]. The involvement of a range of local stakeholders and governing bodies was emphasized, including government agencies, universities, private sector, NGOs, and local communities. Broad participation was central to the project's goal of supporting co-management in the area, which encouraged collaboration and coordination throughout all stages of the project [14].

Knowledge building through enhancing public awareness and providing education on coral reef ecology and sustainable use was a key component of the project. The project supplied information to the public through various modes of communication, including local radio, television, pamphlets, and posters. Training programs on marine ecosystems also provided for students, tour guides, tourism businessmen, small-scale fishers, and other local community members [14]. The UNEP-GEF considered a high level of participation - across different stakeholder groups - to be imperative to sustainable management of coral resources [21]. Overall capacity building, among all levels and sectors, was also encouraged by the project through the provision of courses, equipment, and network building.

The development of networks was another key objective of the project. The formation of relationships among governmental institutions, NGOs, the private sector, and local community members was encouraged by the project for greater collaboration and coordination in coral reef management and conservation efforts [14]. Trat Province's Office of Natural Resources and Environment, for instance, established and coordinated volunteer groups made up of local tourist businesses, small-scale fishers, and other community members. Volunteer programs encouraged local participation in resource management as demonstrated by the coral protection volunteer group, which empowered local people to patrol coral reef areas. It thereby provided a means for them to actively protect reef resources themselves against the negative impacts of illegal fishing gears and commercial fisheries [14, 21].

A key strategy specifically tailored to small-scale fishers was the focus on developing alternative and/or supplementary income-generating programs for fishing communities. Not only was it intended to support local fishers, but also to reduce illegal fishing practices [14]. Fishers were then supported with training for more sustainable livelihoods in mariculture and tourism. Many local community members, who participated in the project's sustainable tourism training, later received licenses from the Tourism Authority of Thailand. The project established a Local Guide Centre as an entry point for fishers, and other community members, into sustainable tourism operations [21]. There, tourists could book tours directly and avoid hotel surcharges. Guides from the centre used small-scale fishing boats to operate tours to mangrove and coral reef areas [19]. Based on project outcomes, it was found that income of local fishers increased by approximately 50% [19].

The involvement of local communities in tourism was promoted through establishing sustainable eco-tourism activities. The project aimed to reduce some of the pressures incurred by popular coastal activities, particularly snorkeling and SCUBA, on coral reefs. As a result, a mooring buoy committee was formed as a sub-committee under Mu Koh Chang National Park. The committee was comprised of local tour operators and small-scale fishers. Through a collaborative process, mooring buoy locations were selected in sensitive reef areas to mitigate anchor damage from tour boats [14]. Reef cleanup activities were also organized under the project with participation by local government agencies, community members, and non-governmental organizations (NGOs). With the assistance of university

researchers, underwater snorkeling trails were established—complete with designated routes and waterproof species guides [14, 21; Figure 3]. These guides were then distributed among tour operators.

FIGURE 3 SNORKELING TRAILS ESTABLISHED UNDER THE UNEP-GEF PROJECT (PHOTO BY THAMASAK YEEMIN)

Coral reef restoration activities were also applied. Restoration involved the implementation of cement structures to provide substrate and facilitate coral recruitment; securing live coral fragments to dead branching corals; and attaching branching coral to PVC tubes [14]. These sites were not only established to mitigate human pressures on extant coral reefs, but also to act as a demonstration site for education, tourism, and research-related purposes [14, 21].

Moving Forward

In the years following the UNEP-GEF Mu Koh Chang Demonstration Site, some activities established under the project have been disbanded. As with many locally-based conservation activities that receive external financial support, projects often fail to become self-sustaining once funding is terminated [22]. Nonetheless, the provision of funding is only one aspect of project sustainability. The processes, such as knowledge, network, and capacity building involving a range of stakeholders, have provided a basis for new conservation and sustainable development projects in the area. Thus, the role of the UNEP-GEF project has been integral to laying the foundation for institutional arrangements that are conducive to stewardship in Koh Chang.

Tangible outcomes related to the UNEP-GEF project are still prominent in the area. DASTA, for instance, was established one year prior to the UNEP-GEF project's implementation and was a key local institution involved in the project's activities. After the project concluded, DASTA, along with a local NGO, assumed financial responsibility for the activities and programs that had been implemented [23]. DASTA addresses funding dependency issues by only providing financial support during project start-up phases. Afterwards, the onus is on

the activity leaders and participants to support the projects. DASTA, in line with the UNEP-GEF project, has instead emphasized technical training and education for projects so those involved will be better equipped to address problems should they arise in the future.

DASTA has formed close relationships with local administration units in Koh Chang and has established and facilitated numerous projects since UNEP-GEF's departure [15]. As a strong coordinating agency in the area, DASTA plays an important role in sustaining and developing networks inclusive of community members, private businesses, as well as other local and national governing agencies. It has implemented and facilitated numerous activities via approaches that exemplify, and build upon, the lessons learned from the UNEP-GEF project. For instance, they maintain communication and coordination through monthly meetings with communities; emphasize projects that provide additional income to locals involved in small-scale fisheries and farming; initiate voluntary coastal conservation groups; and support sustainable tourism development programs in the area. Eco- and cultural tourism is also promoted through homestay in small-scale fishing villages. Today, there are still examples of local, multi-stakeholder groups, including sustainable tourism organizations, a community eco-tourism cooperative, restoration initiatives for coral and mangrove ecosystems, and a national park committee.

Although DASTA was able to build upon the initial groundwork laid by the UNEP-GEF project, its placement was also intended to be temporary. DASTA was established in Koh Chang as a pilot study and is reaching the end of its term. In order to sustain the momentum of UNEP-GEF and DASTA-led initiatives, another institution or collection of institutions must be engaged or developed. Institutional design, as demonstrated in Koh Chang, is not only key to establishing new activities that align with environmental stewardship, but also necessary to continue to foster the mechanisms already set in place by their institutional predecessors.

Coastal areas, in general, can benefit from the establishment of context-appropriate institutions. Not only can they encourage coastal stakeholders to take part in organized conservation efforts and resource management activities, but they also facilitate the discussion of environmental concerns within a wider network. Coupled with awareness campaigns and educational workshops, values and norms associated with stewardship tendencies are, perhaps innately, contemplated through the reflection of personal behaviour. The diversity and complexity of coastal ecosystems call for these institutions to be cross-sectoral and interactive, focusing not only on integration but also on the co-design of projects and co-production of information for enhancing stewardship. In this context, small-scale fishers have a lot to offer with their close connection to, and knowledge about, the marine ecosystem [24]. Careful considerations are therefore required about what institutional building mechanisms are appropriate to foster active involvement and to sustain engagement of the diverse groups of stakeholders.

In sum, the institutions in place in Koh Chang have extended the capacity for local communities to become stewards of the coastal environments upon which they depend. The encouragement of collective stewardship, in particular, is important to the residents in this area who face external threats to the coastal environment, be they local small-scale fishers or tourism operators from the mainland. The environmental threats and level of coastal dependency are not unique to Koh Chang, and well-designed institutions can provide coastal stakeholders with opportunities to invoke a greater level of stewardship to safeguard

coastal environments against external pressures. For many Thai small-scale fishers, efforts to enhance stewardship align well with their traditional way of life and with the widely practiced sufficiency economy principle [25].

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Caribbean Network of Fisherfolk Organizations: In Pursuit of its Mission

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INTRODUCTION

The fisheries sector in the Caribbean Community (CARICOM)/ Forum of the Caribbean Group of African, Caribbean and Pacific (ACP) States (CARIFORUM) region employs over 182,000 persons, directly or indirectly, who are mostly from rural communities that lack other income earning opportunities. The mainly small-scale fisheries sector is a major source of protein and contributes to nutrition security, especially in these communities which usually exhibit a higher percentage of poverty than the national average.

From 2006 to 2009, the Technical Centre for Agricultural and Rural Cooperation (CTA) and the Caribbean Regional Fisheries Mechanism (CRFM) have worked together in support of the dynamic process initiated by fisherfolk organizations in the Caribbean to create a regional network of fisherfolk organizations called the Caribbean Network of Fisherfolk Organizations (CNFO). This included the following elements: identifying the potential for a regional network among fisherfolk groups; establishing and formalizing national fisherfolk organizations (NFO), as the core of the regional network; training fisherfolk leaders in areas related to network management, use of communication tools and advocacy work [1].

CNFO in partnership with the CRFM, Caribbean Natural Resources Institute (CANARI) and University of the West Indies - Centre for Resource Management and Environmental Studies (UWI-CERMES), with support from the CTA and Commonwealth Foundation, organized and convened two workshops in January and April 2009 on regional fisherfolk organization policy influence and planning, during which it embarked on the preparation of a strategy and work plan on engagement with decision-makers and stakeholders in regional fisheries policies. At this stage, the CNFO articulated its vision as *primary, national and regional fisherfolk organizations with knowledgeable members collaborating to sustain fishing industries that are mainly owned and governed by fisherfolk who enjoy a good quality of life achieved through the ecosystem-based management of fisheries resources* [2]. Its mission is *to improve the quality of life for fisherfolk and develop a sustainable and profitable industry through networking, representation and capacity building* [3]. In striving to achieve their vision and mission, the CNFO and its membership would also be playing their part in enhancing the stewardship for the living marine resources in the Caribbean Sea.

Based on their exposure at the workshops on policy influence and planning, and their involvement in the CRFM Special Forum on the elaboration of the Common Fisheries Policy and Regime, and continued engagement in the CRFM Forum, fisherfolk leaders have recognized the need to stay abreast of developments within the sector, including those related to policy. Fisherfolk have also recognized the need to share information about current fisheries policy and related matters, so as to be in a better position to make informed contributions to fisheries policy development at the national and regional levels.

Besides their involvement in the negotiations on the Caribbean Community Common Fisheries Policy, the CNFO has remained engaged in the discussions to operationalize the Castries (Saint Lucia) Declaration on IUU Fishing and matters related to trade in fish and fish products at the national, regional and international levels. Engagement at the CRFM Forum level has been providing the CNFO with the opportunity to interact with the main advisors on fisheries policy development and execution in the CARICOM/CARIFORUM region. It has also been providing the network with the opportunity to influence policy development and implementation in the region as well as gain access to the Ministerial Council by way of requests to the Forum. The CRFM was inaugurated on 26 March 2003 in Belize. Its mission is to promote and facilitate the responsible utilization of the Region's fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region.

CNFO representatives also participated in the EU-ACP Fish II Project which was aimed at assisting in fisheries policy development and execution in the CARICOM/CARIFORUM region and other parts of the ACP, and in the Transboundary Diagnostic Analysis phase of the Caribbean Large Marine Ecosystem Project which has a focus on governance of fisheries in the Wider Caribbean Region using an ecosystem approach to fisheries (EAF) [1].

CHALLENGES

Local, national and regional fisherfolk organizations and their leaderships have a critical role to play in relation to the development and implementation of fisheries and related policies in the CARICOM and wider Caribbean region [1]. However, for the CNFO and its member organizations to play a more effective role in policy influencing and implementation at the various levels, they need to address such challenges as:

- finding an appropriate legal structure that will enable the network to promote good internal participatory governance, better serve its members, strengthen its partnerships, mobilize resources and achieve financial sustainability;
- finalizing its strategy and work plan on engagement with decision-makers and stakeholders in regional fisheries policies;
- sustaining the commitment and effort needed to coordinate the network and participate in policy processes at the national, regional and international levels;
- promoting and supporting participatory governance throughout the network;
- developing mechanisms to sustain collaborative planning;
- identifying and developing a cadre of effective leaders at all levels;
- establishing mechanisms to ensure adequate succession planning;
- strengthening network and organizational management;
- developing mechanisms for regular monitoring and evaluation;
- developing national inter-agency and inter-sectoral networks for ecosystem-based management; and
- identifying the means to achieve sustainable financing [4, 5].

ACHIEVING ITS MISSION

The CNFO has come into being at a time when the environment would appear to be conducive to improving stakeholder participation in fisheries governance and management. However, a significant investment in capacity building will be required over a period of several years in order to facilitate the development of a sustainable organization or network. Also, partnerships between key technical agencies, applied research institutes and the

CNFO can contribute to the enhanced capacity and understanding of all parties and facilitate the development of consensual positions that reflect rather than ignore some of the inherent complexities of and tensions between conservation and livelihood considerations [4].

True to its vision, the CNFO under the ACP Fish II Project arranged the Training of the Caribbean Network of Fisherfolk Organizations in EAF and Climate Change Workshop, in St. Kitts and Nevis, in October 2012. This was aimed at building awareness of EAF and climate change impacts on fisheries and potential adaptation actions. It was also intended to build the skills of fisherfolk leaders to communicate and develop relationships for advocacy and policy influence as part of governance, and to serve as trainers for their member fisherfolk organizations (FFOs). Eighteen participants from national and primary fisherfolk organizations in 11 CARICOM/CARIFORUM countries participated in the workshop [6].

In terms of addressing the challenges, it had been suggested that the hiring of a dedicated paid coordinator for the CNFO would be the best approach to resolving these constraints [4]. To some extent, this will be addressed under the four-year (2014-2017) Eastern Caribbean Marine Managed Areas Network (ECMMAN) Project, which is investing over EC$14.7 million to improve fisheries and conserve and restore marine resources, while providing for sustainable job opportunities. It is being implemented in the six OECS countries of St. Kitts and Nevis, Antigua and Barbuda, Dominica, St. Lucia, St. Vincent and the Grenadines and Grenada, with one of the focus areas being to support fisherfolk organizations and provide support for new livelihood opportunities [7]. The CNFO will be provided with funds to recruit a coordinator and an assistant, which should contribute to improved management and coordination within the network. It will also support the establishment and operation of an Eastern Caribbean committee within the CNFO to ensure active and consistent participation and engagement of fisherfolk in project implementation.

The CNFO in collaboration with the project management team, The Nature Conservancy (TNC), for the ECMMAN and CANARI, for *the Strengthening Fisherfolk to Participate in Governance Project* will be seeking to address the challenge of establishing the CNFO as a legal entity.

The European Union funded, CANARI implemented, *Strengthening Fisherfolk to Participate in Governance Project,* is targeting the CNFO and its member fisherfolk organizations in the countries of Anguilla, Antigua and Barbuda, The Bahamas, Belize, Barbados, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Lucia, St Kitts and Nevis, St Vincent and the Grenadines, Suriname, Trinidad and Tobago and Turks and Caicos Islands. The over one million euro project is being implemented by CANARI, working in partnership with UWI-CERMES, Panos Caribbean, CNFO and CFRM. It is a four-year project (2013-2016), which is aimed at building the capacity of the CNFO and its member national fisherfolk organizations in the CARICOM region to better participate in fisheries governance and management at the local, national and regional levels in order to enhance the contribution of small-scale fisheries to food security.

This project has so far completed a needs assessment exercise to identify the capacity building priorities for fisherfolk organizations in the region to participate in fisheries governance and management at the national and regional levels; established the Caribbean Fisherfolk Action Learning Group comprised of 18 fisherfolk leaders and three leaders from government fisheries authorities as a community of change agents from across the region;

and established a regional group of 22 mentors to assist fisherfolk organizations in the 17 project countries in building their capabilities for governance. At present, it is conducting needs assessment activities for fisherfolk organizations in eight focus countries (Anguilla, Barbados, Dominica, Grenada, Jamaica, St Lucia, St. Vincent and the Grenadines and Suriname).

Both projects would appear to be contributing to the development of a cadre of fisherfolk leaders as well as putting in place support mechanisms for capacity building and organizational development at the local, national and regional levels. The CNFO and project partners are also seeking to coordinate and achieve synergies in the implementation of the respective small grants facilities under these projects in order to optimize on their use in addressing the gaps identified in the regional and national needs assessments to contribute to the achievement of the relevant objectives in both projects. Table 1 below also provides a timeline of other events/actions that have been contributing to the CNFO achieving its mission.

TABLE 1 TIMELINE AND DESCRIPTION OF EVENTS/ACTIONS TO ACHIEVE MISSION

Event/action	**Contribution to achieving mission**
FAO/CRFM/WECAFC Regional Small-Scale Fisheries Workshop, 6 - 8 December 2013, Jamaica - to support the development of the SSF Guidelines by providing inputs and advice, both with regard to good policies and practices in the region and in respect of overall principles and contents and to provide comments on the current Zero Draft of the SSF Guidelines. The workshop was also intended to promote cross-linkages between the SSF Guidelines and the policies and actions required in the Caribbean region [8].	Multi-stakeholder collaboration and information sharing for policy influencing among fisherfolk organizations, fisheries authorities, international and regional fisheries and related bodies, academia and NGOs. Sharing of perspectives on small-scale fisheries issues and developing consensus on the means to addressing them at the international, regional and national levels. Capacity building of the fifteen fisherfolk leaders from twelve CARICOM/CARIFORUM countries and the Caribbean Netherlands who participated in the Workshop.
CNFO/CRFM/CTA *Consultation on Implementation and Mainstreaming of Regional Fisheries Policies into Small-scale Fisheries Governance Arrangements in the Caribbean*, 25 - 28 February 2013, Guyana - to review and analyze the implications of regional fisheries policies for small-scale fisheries governance and management and develop common positions of fisherfolk organizations; identify options and opportunities for the implementation of regional fisheries policies, particularly regarding the unique role of fisherfolk organizations; and identify capacity needs for further strengthening of the CNFO network to enable it to play an effective role in regional fisheries policy development and implementation [9].	Multi-stakeholder collaboration for policy influencing and capacity building of the twenty-five fisherfolk leaders from fourteen CARICOM/CARIFORUM countries who participated in the Consultation. Information sharing among fisherfolk organizations, regional fisheries body, academia, development partner and NGOs. Provision of opportunities for multi-stakeholder networking and strengthening of partnerships.

Event/action	Contribution to achieving mission
Advocacy Strategy and Plan on Fisherfolk's Positions on Critical Issues concerning the Implementation of Regional Fisheries Policies in the Caribbean was also developed [10].	Development of a strategic approach to advocacy and policy influencing. Collaborative planning and utilization of stakeholder capacity to develop an advocacy strategy.
CNFO Case study: *Getting a seat at the table: fisherfolk empowerment for policy change in the Caribbean*, Conference on Hunger · Nutrition · Climate Justice, 15 - 16 April 2013 [11].	Representation of Caribbean fisherfolk issues at the global level, with opportunities for networking, collaboration and resource mobilisation.
Caribbean Week of Agriculture 2013 - CRFM /CTA/CNFO Workshop on Regional Fisheries Policies, 7 - 8 October 2013, Guyana - to raise stakeholder appreciation and understanding of key fisheries and fisheries-related policy matters (e.g. FAO Code of Conduct for Responsible Fisheries, Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security, International Guidelines for Securing Sustainable Small-Scale Fisheries, ILO Work in Fishing Convention, 2007 (C-188), Caribbean Community Common Fisheries Policy Castries Declaration on Illegal, Unreported and Unregulated (IUU) Fishing, Role of Fish and Seafood in Food and Nutrition Security, etc.) and the implication of these on the performance of the region's fishing industries.	Multi-stakeholder collaboration for policy influencing at the ministerial/decision-making level, and capacity building of the fifteen fisherfolk leaders from fifteen CARIFORUM/CRFM Countries who participated in the Workshop. Promotion of multi-stakeholder networking, strengthening of partnerships and information exchange among fisherfolk organizations, fisheries authorities, regional fisheries bodies and related intergovernmental institutions, academia and NGOs. The main conclusions and decisions of the workshop were presented by the CNFO to the Meeting of the Alliance for Sustainable Development of Agriculture and the Rural Milieu (The Alliance)
Resumed Session of the Technical Consultation on International Guidelines on Securing Sustainable Small-Scale Fisheries, 3 - 7 February 2014, Rome, Italy [12]	CNFO participation as an observer in the international negotiations on the SSF Guidelines. Provision of opportunities for capacity building in negotiation, global level networking and development of partnerships. Recognition of the constraints of being an observer in international negotiations, with the lesson being the need for civil society organizations to be part of a national delegation in order for its voice to be heard.

Through networking and partnerships, the CNFO has been fairly effective in collaborative planning, mobilizing resources for capacity building, information exchange, advocacy and policy influence. However, it still needs to put in place its overall strategy and action plan, including a strategy for financial sustainability, for the development of the CNFO and its member fisherfolk organizations. Also, as the CNFO and its members work towards improving on their internal governance arrangements and developing leadership capacity at all levels, they will need to activate and/or put systems in place for succession planning in

the respective fisherfolk organizations, including criteria/guidelines for the selection of and evaluation of the performance of its leaders.

WAY FORWARD

The CNFO would appear to be achieving its mission to improve the quality of life for fisherfolk and develop a sustainable and profitable industry through networking, representation and capacity building, with its strengths being in the areas of building partnerships, collaborative planning, representation and resource mobilization. Through these efforts it would appear to be putting in place the arrangements for ongoing capacity building of the CNFO and its membership while developing its leadership capabilities. However, with the setting up of a secretariat (coordinator and assistant), its viability may be dependent on the establishment of the network as a legal entity while strengthening the framework for participatory governance at all levels.

In terms of the way forward the CNFO should seek to:

- establish the network as a legal entity;
- improve on the internal governance arrangements of the CNFO and its member NFOs to promote participation, transparency and accountability;
- activate and/or develop criteria/guidelines for the selection of fisherfolk leaders and the monitoring and evaluation of their performance;
- activate and/or develop systems for succession at the leadership/executive levels of the various fisherfolk organizations;
- put in place systems for information sharing and dissemination and reporting;
- finalize its strategy and action plan and mobilize resources; and
- implement its strategy and action plan.

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Fishermen Investing in a Network of Fish Refuges (No-Take Zones) in Quintana Roo, Mexico

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ABSTRACT

Working with small-scale fishers throughout Quintana Roo, the non-governmental organization, Comunidad y Biodiversidad A.C. is leading the development of a network of marine reserves designed to ensure the long-term sustainability of fisheries in the region. Fishermen have been trained to SCUBA dive and monitor marine reserve resources, including fish and corals. They have taken part in bathymetric mapping and business management training. This brief article explains the process of stakeholder engagement, training and research, and how it is leading to the declaration and co-management of the network of reserves. This model can be replicated to promote community stewardship in other small-scale fisheries.

Key words: Fishers, co-management, no-take zones, stakeholder engagement

INTRODUCTION

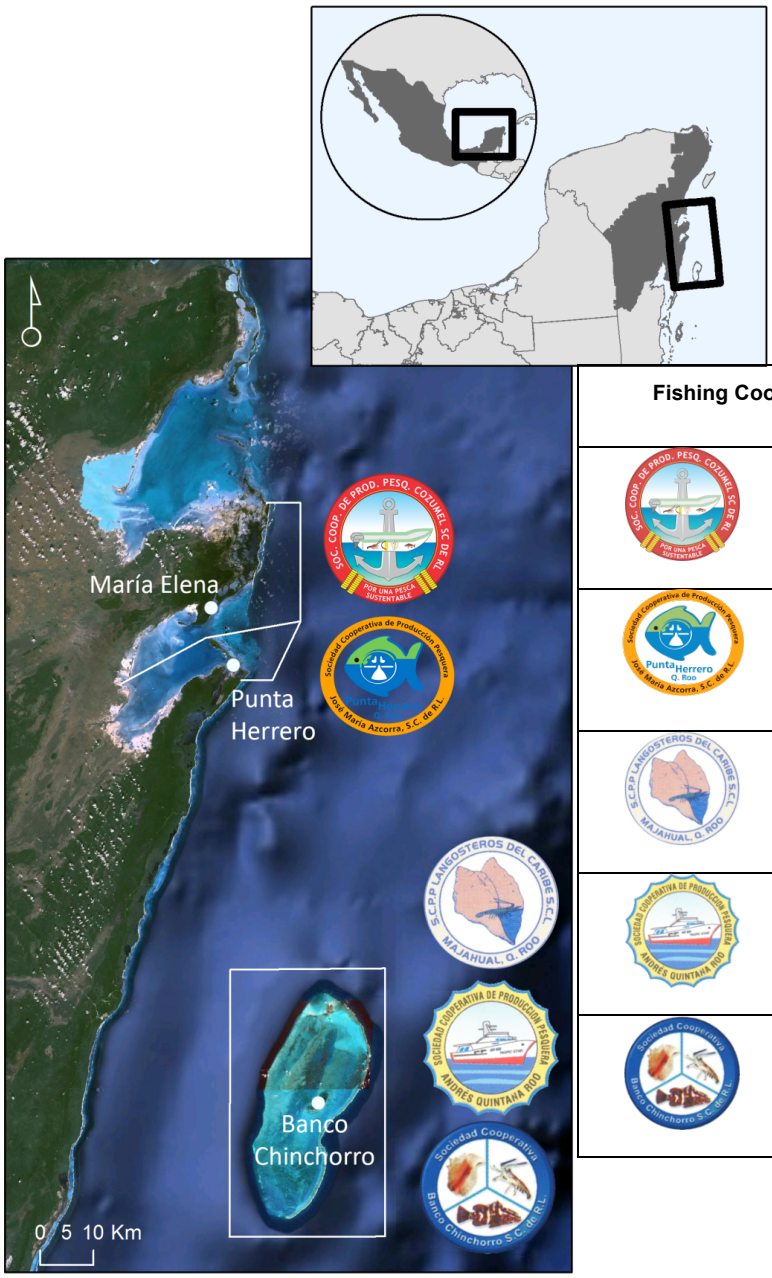
It is widely recognized that coral reefs are amongst the most threatened marine ecosystems in the world [1-3] and that Caribbean reefs have been in decline for decades [4]. Climate change is exacerbating the negative impacts of overfishing, pollution and uncontrolled coastal development. Along the coast of Quintana Roo, in the Mexican portion of the Mesoamerican Barrier Reef, the majority of coral reefs fall under the protection of a formal system of marine reserves and parks, however this has not been enough to prevent the continued deterioration of the reefs and associated environments [5]. In order to contribute to marine conservation, innovative conservation and management tools need to be used that not only support existing measures but act as catalysts to future actions by bringing stakeholders together under a common goal. No-take zones are a powerful and straightforward method of protecting ecologically important areas by preventing all extractive activities and reducing anthropogenic impacts. The scientific literature shows the power of no-take zones not only to protect the species inside the reserve but also contribute to population recovery outside the protected area through what is known as the spillover effect [6,7] in which larvae, juveniles or adults move away from the protected area in to adjacent areas.

The task of closing areas to commercial and recreational fishing is a difficult one, as many worldwide examples have shown. It is difficult technically, politically and socially. To minimize potential resistance to the creation of such areas, Comunidad y Biodiversidad A.C (COBI) has taken the approach of creating partnerships with key stakeholders in the fishing sector to allow consensuses to be reached on the use, extent and location of the no-take zones. An alliance has been formed between the fishing cooperatives, NGOs and regional

and federal government agencies to improve coordination between stakeholders and work towards a network of no-take zones spanning the entire Mexican Caribbean coastline. Whilst the fishers understood the biological and potential fishery benefits of the project, additional incentives were developed to reduce the opportunity cost to the fishers of the marine reserves. These incentives aimed to generate social capital and develop the fishing cooperatives' organization, administration, marketing and law enforcement skills.

Study Area

The project was undertaken in two protected areas in the Mexican Caribbean, the Sian Ka´an Biosphere Reserve and the Banco Chinchorro Biosphere Reserve (Figure 1).



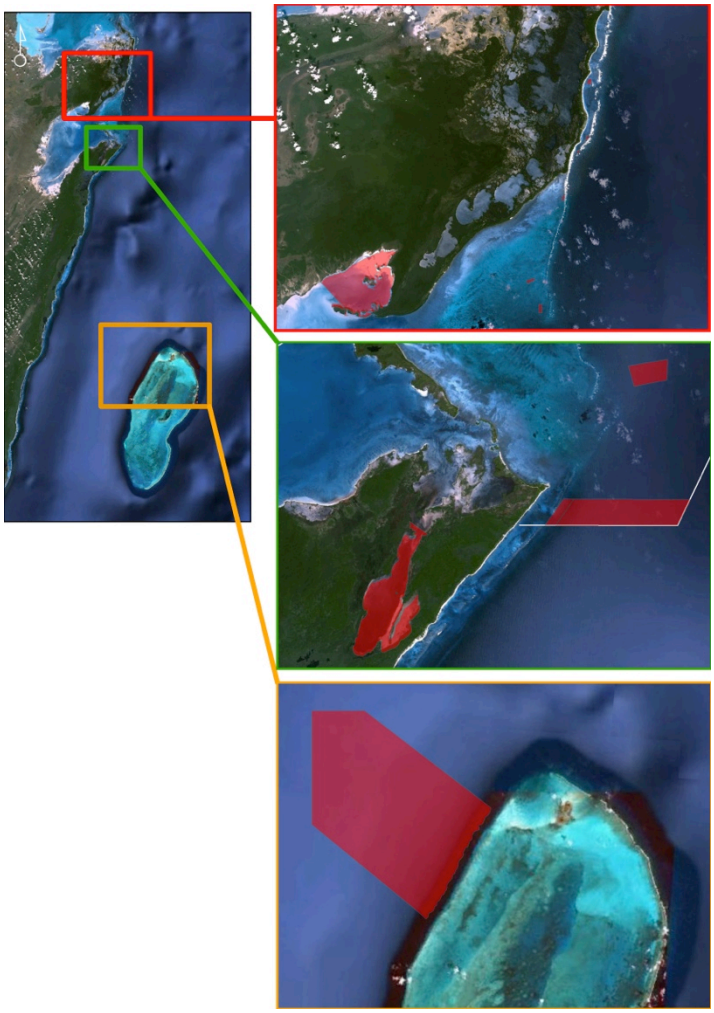
Fishing Cooperative		Established	Fishing Area
	Cozumel	1960	Sian Ka´an Biosphere Reserve
	José María Azcorra	1983	
	Langosteros del Caribe	1991	Banco Chinchorro Biosphere Reserve
	Andrés Quintana Roo	1956	
	Banco Chinchorro	1987	

FIGURE 1 FISHING AREAS OF THE FIVE COOPERATIVES THAT HAVE ESTABLISHED FISH REFUGES IN THEIR FISHING CONCESSIONS

Both Biosphere Reserves, managed by the National Park Commission (CONANP) are zoned for multiple uses however the areas where fishing is completely prohibited are small (3% of the reserve area in Banco Chinchorro and effectively 0% in Sian Ka´an). Three of the fishing cooperatives operate in the Banco Chinchorro Biosphere Reserve and the remaining two in the Sian Ka´an Biosphere Reserve. The five fishing cooperatives are responsible for approximately 44% of the state´s lobster production (by value $USD, [8]). All five of the cooperatives free dive for lobster to a maximum depth of approximately 20 metres. The fishers in Banco Chinchorro primarily fish on and around the reefs of the false-atoll, whilst the fishers in Sian Ka´an use the reef area to a lesser extent, employing extensive areas of "casitas cubanas" or lobster houses in exclusive access parcels as the principle means of production. The fishery in both biosphere reserves was certified by the Marine Stewardship Council in 2012 and is currently undergoing the first re-assessment.

The Fish Refuges

COBI began collaborative work in 2011 with five fishing cooperatives that operate in the southern and central part of Quintana Roo. The cooperatives have previously taken part in conservation projects with COBI, other local NGOs and the National Park Commission, and the initial rounds of talks produced positive results. Further workshops with the fishers in 2012 produced draft proposals of potential areas to set aside (Figure 2).



Cozumel Cooperative

Eight fish refuges covering a total of 1,048 Hectares.

Six fish refuges cover areas of patch and barrier reef with a depth range of 2 to 6 metres
Two are located in shallow bays, surrounded by mangroves; a key area of juvenile fish development. One of the areas is open to catch and release sport fishing

José María Azcorra Cooperative

Four fish refuges covering a total of 1,125 Hectares.

Two fish refuges cover fish spawning aggregation sites, deep coral reefs and other deep habitats.
One zone runs from the barrier reef to a depth of approximately 15 metres, but remains open to lobster fishing.
The final area is located in a shallow bay, surrounded by mangroves; a key area of juvenile fish development. It is open to catch and release sport fishing

Cooperatives Banco Chinchorro, Langosteros del Caribe and Andrés Quintana Roo

One fish refuges covering a total of 12,257 Hectares. Area starts at 12 metres depth and runs to deep water. Covers a range of reef habitats.

FIGURE 2 LOCATIONS OF THE 13 FISH REFUGES DECREED BY THE FIVE FISHING COOPERATIVES OF THE SOUTH OF QUINTANA ROO

These areas were assessed for biological suitability, and alternative areas suggested if necessary, before being marked by GPS and technical studies developed in coordination with the fishers to present to the responsible government agencies for review. The first fish refuges, belonging to the Cozumel Cooperative were established in November 2012 [9] and in September 2013 the fish refuges of the remaining cooperatives were also legally recognized in Sian Ka'an and Banco Chinchorro [10].

METHODOLOGY

The successful establishment by the community of no-take zones in their fishing concessions created the need for a regular biological monitoring programme to assess and evaluate the performance of the areas. The fish refuges have been established for an initial period of five years after which the cooperative may choose to relocate the closed area, keep it in place or open it to fishing. To promote community stewardship and increase fisher involvement in the project, fishers were trained to monitor the recovery of the protected areas (Table 1). Whilst the final fish refuges were being defined, each cooperative selected a team of fishers to undertake SCUBA diving training and a reef monitoring workshop. Fishers were trained to undertake coral, benthic cover, fish and invertebrate visual underwater censuses, with each fisher passing through a range of assessments to ensure the data would be sufficiently accurate.

TABLE 1 NUMBER OF FISHERS TRAINED IN BIOLOGICAL MONITORING TECHNIQUES

Fishing Cooperative	Number of fishers trained
José María Azcorra	9
Cozumel	6
Banco Chinchorro	7
Langosteros del Caribe	3
Andres Quintana Roo	3

Data were then collected by the fishers before the fish refuges were decreed to establish the biological baseline for the sites. Further monitoring has been conducted at six-month intervals to track the effects of the fishery closure on the biodiversity.

Two of the fish refuges in the Sian Ka´an Biosphere Reserve were established by the fishers with the explicit aim of protecting potential fish spawning aggregation sites that had been found in a previous study [11]. Fishers from the Cozumel and José María Azcorra Cooperatives were thus trained in low-cost adaptive bathymetric mapping techniques [12] to search for fishing spawning aggregations and also create 3D bathymetric maps of their fishing grounds (Figure 3). Fishers took part in GPS training, advanced SCUBA diving for deeper dives and fish spawning aggregation monitoring techniques. Through the adaptive bathymetric mapping process the fishers not only confirmed the presence of Nassau Grouper (*Epinephelus striatus*) and Yellowfin Grouper (*Mycteroperca venenosa*) inside one fish refuge, but also found two more possible sites of reproduction for Cubera Snapper (*Lutjanus cyanopterus*) and Dog Snapper (*L. jocu*).

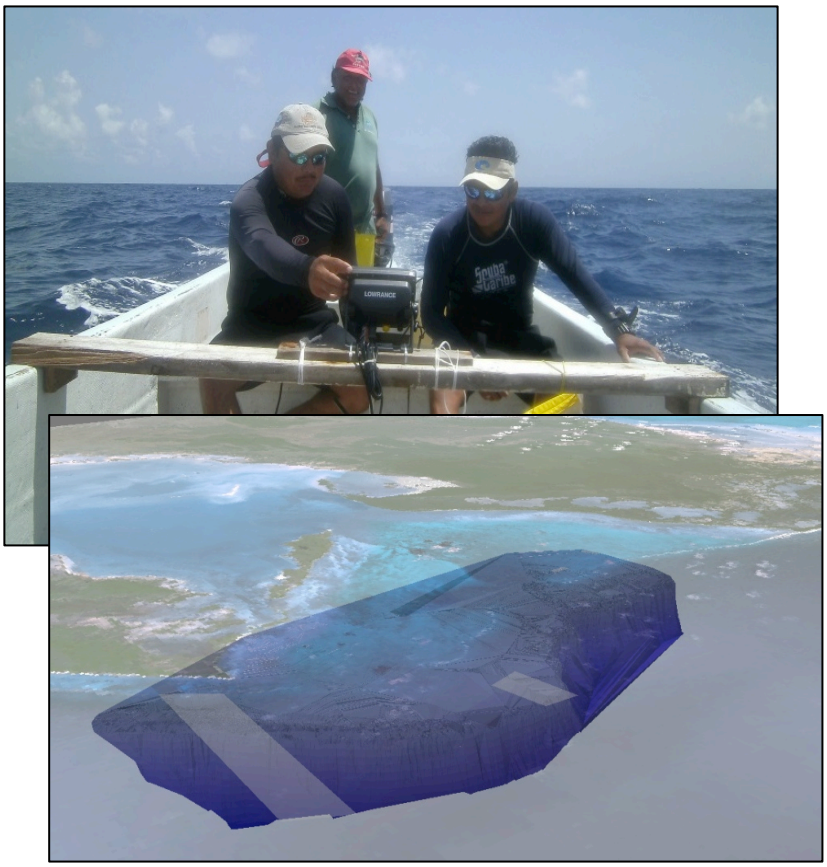


FIGURE 3 ABOVE: FISHERS COLLECTING BATHYMETRIC DATA IN THE SIAN KA´AN BIOSPHERE RESERVE. BELOW: BATHYMETRIC MAP DEVELOPED IN COOPERATION WITH THE FISHERS SHOWING THE NO-TAKE ZONES (WHITE). THE FISH SPAWNING AGGREGATION SITES ARE LOCATED ON THE SHELF EDGE AT 30 M DEPTH

The five fishing cooperatives are also participating in business management training with the aim of improving the competitiveness of the cooperatives in the marketplace and increasing economic efficiency. This project hopes to improve the economic standing of the fishers without increasing pressure on the fishery. The project is divided into three parts: 1) a diagnostic of the accounting, financial and leadership structure of each fishing cooperative and its mode of operation; 2) the development of a plan and tools to meet the specific business needs of each cooperative; 3) implementation of the cooperative-specific products guidance and mentoring by professional consultants.

DISCUSSION

The establishment of the fish refuges by the fishing cooperatives highlights the fact that community participation is a vital part of the process when working with a potentially controversial tool like fully protected zones. Fishers' traditional knowledge is important when working with biologists to select the appropriate areas, taking in to account biological richness, historical fishing pressure and community acceptance, amongst other factors. If the community is not consulted on the location of the zones there is a lower probability of them being accepted and respected, thus affecting potential recovery. The benefits of community-led biological monitoring go far beyond the data; the participants become

stewards of their resources, taking pride in sustainably managing their fishery. Fishers will see changes in the biodiversity of a site for themselves, reaffirming the importance of having fish refuges to promote sustainable fisheries and preserve their resources for the future. They also gain new skills that can lead to alternative activities, and they can see how conservation does not need to be an economic burden, but through efficient business practices and marketing it can also promote financial sustainability. Fishers have also proven adept at collecting scientific data to evaluate the progress of the fish refuges. Through their traditional knowledge of their fishing grounds and the behaviour of coral reef species the fishers have quickly learned both the local and scientific names of the species of fish, coral and invertebrates in the area and are highly competent at conducting coral reefs surveys.

This model of cooperation promotes community stewardship and can be replicated in other small-scale fisheries. The creation of the fish refuges in the south of Quintana Roo has shown that collaboration between fishers, NGOs and government agencies can produce beneficial conservation results and promote sustainable fishing practices when the fishers are engaged in the project from the beginning, consulted at regular intervals and when their traditional ecological knowledge is utilized to select the most appropriate areas that not only support healthy reef populations but that will be respected by the community.

ACKNOWLEDGEMENTS

First and foremost, the establishment of the fish refuges would not have been possible without the support of the forward-thinking fishing cooperatives. The members of the Kanan Kay Alliance, where each organization has worked tirelessly towards the common goal of marine conservation and fisheries restoration must also be recognized. We also thank The Summit Foundation, The Oak Foundation, MARFund, PNUD México, Marisla Foundation, The Inter-American Foundation, The Packard Foundation, The Nature Conservancy and Fondo Mexicano para la Conservación de la Naturaleza.

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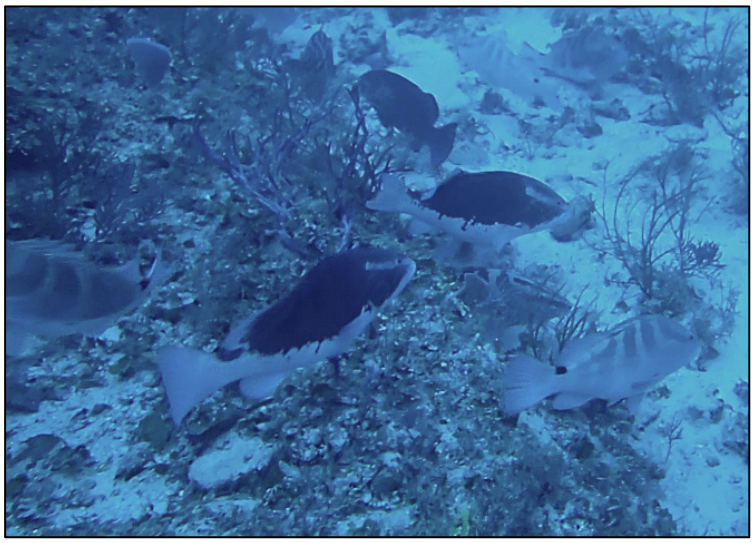
Fisher's Perspective on the Network of Fish Refuges in Quintana Roo, Mexico

— Víctor Manual Ucán Chan

Fisherman, Cooperative José María Azcorra, Punta Herrero, Sian Ka´an Biosphere Reserve, Quintana Roo, Mexico

I am Víctor Manuel Ucán Chan, fisherman and member of the Fishing Cooperative José María Azcorra. I am also part of the fish refuge biodiversity monitoring team which I joined in 2012, through personal interest as a diver, when the Cooperative and Comunidad y Biodiversidad (COBI) established the team. After two years monitoring our fishing grounds off the coast of Punta Herrero, in the Sian Ka´an Biosphere Reserve, we came across an interesting site for marine conservation and fishery recuperation.

A few days after this years´ January full moon we began diving to monitor potential fish spawning aggregation sites. This process had begun the previous year with Dr. Will Heyman and COBI. This January, at the end of several days diving, the monitoring team of the Fishing Cooperative José María Azcorra managed to find a spawning site for Nassau Grouper (*Epinephelus striatus*), inside one of the fish refuges that the Cooperative established in September 2013.



It was incredible to see so many Nassau Grouper in one site; it was like seeing a new world, something spectacular that is priceless. I´ve never seen anything like that. It is good to know that, in some places, there are still many individuals of this species, and that this site is important for sustaining the fishery. We hope to return on the next full moon to try to document the event again.

The decision to create the fish refuge was a decision made by all the cooperative members. The fishers thoroughly analyzed the proposal before making the decision, looking for the best option to improve the fishery and contribute to healthy reefs, full of fish. It is something new for the Cooperative but we know that we can contribute to a sustainable fishery, improve the quality of production and sales and at the same time improve the economic situation of the Cooperatives and its members.

We are full-time fishermen, and because of this, we need to take care of our resources, as our economic wellbeing depends on them. To the cooperatives that have not yet begun monitoring and conservations projects, we recommend that they should give them a go. We swear they will not regret it and they will learn a lot during the journey.

Fishing in Bolivia's Northern Amazon: History, Problems and Perspectives

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Commercial Fisheries in Bolivia's North Amazon date from the 1960s. Our parents and many people who now rest in peace gave their lives working and hoping for better days for the fishermen. They told us that fish were once abundant, in a single day one could catch more than 300 or 400 kg. Schools of fish such as: yatoranas, dorado de piel, and chananas, were visible travelling upriver, in pockets of the rivers you could see fins and tails. At that time, there was not a market and it was hard to sell the fish. In the 1990s, the decline of the fishery began. Not a lot is known about why the fish were disappearing, but we believe it was due to the appearance of "garimpo" rafts (mining boats) used to extract the gold.

The North Amazon is a part of the Bolivian Amazon located between Peru and Brazil. It is supplied with fishes travelling upstream from the Amazon River into the Madera River, which in turn is connected to the Mamore, Beni, Madre de Dios, Orthon and other smaller tributaries including the Yata, Biata, Geneguaya and Ivon rivers.

The Single Federation of Fishermen, Fish Sellers and Aquaculturists of Bolivia's Northern Amazon (FEUPICOPINAB) was born of a concern we felt as fishermen, of the abuses that we have suffered from some of the authorities. In 2010 we decided to organize, to strengthen ourselves as fishermen, to feel united because in reality all fishermen, we are a family, we have the same suffering in our day to day, and all year round. Fishing is an activity of great sacrifice, but also it is beautiful, fishing is our life, being in the river, in contact with nature, seeing so many landscapes. In total we are 15 organizations affiliated within the Federation, this includes peasants, indigenous fishers from urban areas and also merchants; we are more than 3,000 families of fishers of the Northern Amazon region.

In the 90s we witnessed the introduction of a new species (Arapaima gigas); we called it "Paiche". We spotted it when it was surfacing to breathe; many people when they looked at it were afraid, they didn't know what it was. Today it is one of the most highly valued fish in Bolivia. In 1992 and 1993 we began to fish it, by 1995-96 we could not fish any other species, especially in the Madre de Dios River. We were concerned, because the people did not have the custom of eating this fish, there was no market, local merchants had the initiative to introduce the "Paiche" to the interior of the country; to La Paz, Santa Cruz and Cochabamba, the "Paiche" was acquiring commercial value, and the fishermen were keeping and selling it at low price. Today, the "Paiche" is one of the most appreciated fish in Bolivia. We the urban fishermen, more than any others, have changed our activity from native species to fishing for "Paiche"; at least 80% of what we fish is "Paiche". As an organization, we are trying to use all the parts from the "Paiche" as much as possible, we are using its scales, its leather. We are currently supported by a project "Fish for Life", we are grateful to this project because they are training us in processing of fish meat, to provide greater food security to the consumers, they are also supporting us in strengthening our

organization and as a Federation. With the support from “Fish for Life” project we have worked on a draft of a fisheries law that has been developed and agreed by other organizations from other parts of the country. This draft was already presented to our Bolivian Government. We believe that it is very necessary because since the 1990s we have been in a legal vacuum due to the changes that occurred in the country, everyone was claiming ownership of the lagoons.

As fishermen of the North Amazon, we aspire that our families will have better life conditions, to raise our children to be good people, giving them the opportunity to continue their studies maybe even beyond Riberalta. Currently, we live entirely from fishing and it’s not enough to sustain our families — fishing is uncertain, hazardous at times and sometimes it goes well and more often it goes very poorly, even more so with the fish shortage and the threat that is coming down on us from the hydroelectric dams. We are working to unify and strengthen the entire fishing sector to work throughout the country and to provide a high quality fish. We are already coordinating with the Bolivian government. We want their support for the fisheries sector, we want to be involved in aquaculture, many of us are being trained in fish farming, but we need support from our authorities. We hope that someday the authorities and the rest of the country will see us as a very important sector, and that they will also see us as ‘producers’ and not just resource ‘extractors’, this is our perspective, because we know that everything will continue to decline. Our colleagues, campesino (traditional farmers) and indigenous people are suddenly engaging in [commercial] fisheries because they've seen in fishing an alternative to sustain their families.

Today, our colleagues from Cachuela Esperanza are feeling the impacts of the dams. In Cachuela Esperanza the main fishery is for yatorana, however, since the construction of the Brazilian hydroelectric dams on the Madera River (first dam completed in 2011), the impact on the fisheries has been huge. Last year the catches were low and this year they weren’t able to catch anything. We think that we in Riberalta are also going to feel these impacts, because we fish in the tributaries of the Amazon and Madera rivers. We know that this represents development for these countries but they also need to consider avoiding the impacts and damage to the nearby communities; you can’t think of development that favours some and impacts others, always making the others poorer, this is our situation as fishermen who are being affected by the construction of the dams. As fishery organizations represented by a Federation we have met and we are planning to prepare an international complaint probably to the human rights commission or other organizations, to denounce the effects of dams. As our colleagues say ‘you can’t eat electricity’, while many of us live from fishing. Especially, the people who live on the banks of the rivers and lakes, they eat fish almost every day. We as an organization see that the poorest are being affected, we are concerned and we continue in the fighting to do something to avoid the decline of the fisheries from the effect of damming the rivers.

We have other problems, including with our own authorities, for example they declare fishery closures without any kind of studies, and we think this is due to the legal vacuum that we are currently experiencing in relation to fishing regulations. Because no one says anything, everyone is the owner of everything and at the end, no one is the owner of anything depending on when it is convenient or not. At the end, this is because the fishing sector is a sector which has not positioned very well with the local authorities, that is the reason why we have worked in the development of the law, and we are now waiting for answers. Another

big problem is the lack of ice; the existing ice does not meet the demand and it is of poor quality.

As fishermen we are in high spirits and full of energy, to carry on working and fighting for our colleagues in the urban and rural areas, trying always to make sure that the fishermen's lives improve, that we achieve fair prices, so that our families can eat three times a day, so that we can send our kids to school, to support each other, give the opportunities to colleagues who don't have them, to those who have suffered from mishaps in their work. We are also thankful for the women who also live from fishing and provide support to the industry. Women play an important role in all the steps of the fisheries production chain, for that reason as a Federation, we are helping them to organize, so that they can also have better conditions and their rights are respected and not violated.

As you can see, we have the strength and the will to improve, but we need support from the government and non-governmental organizations. We have many problems and the challenge is huge. We are working to achieve food security for all Bolivians, so that the fish that comes out of our Amazon are distributed all across the national territory.

Development of the Bejuco Bottom Longline Snapper Fishery, Northern Pacific Coast, Costa Rica: A Replicable Solution to the Uncertain Economic Future of Costa Rica's Small-Scale Fisheries

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PROBLEM

All along Costa Rica's Pacific Coast, arriving tourists are shuttled inside the walls of beach resorts and not encouraged to leave until their reservations end. Each morning, fishers arrive at traditional docks just below the sight lines created by the resorts' walls. Kept unaware of the traditional fishing activity below, guests languidly go about their vacations, soaking up the sun and sipping icy drinks by the pool, while below, at the estuary, fishers return from their nightly trips where local buyers meet them and purchase their entire catch of snappers for the bottom barrel price of US$1.50 per fish. The fish are then loaded onto a truck and driven out of town and sold to another middleman who in turn sells them to another. Finally, the very same fish pass between enough hands to make their way back into town and inside the resort's front gates. The snappers are then seared and served to guests in the hotel dining room under the label "fresh catch" for US$25 a plate.

Artisanal fishers have little control over this existing chain of custody. Not only this, but any negative changes to the amount of snappers they are able to catch would put their economic well-being in serious jeopardy. Unfortunately, this very scenario is happening in the district of Bejuco, Guanacaste, where illegal shrimp trawlers, having already depleted the area's shrimp populations, now target snappers, the very same ones that the area's 50 artisanal fishers rely on to support themselves and their families. This destructive fishery has had a devastating economic impact on artisanal fishing communities. A precipitous drop in artisanal fishery landings along the country's Pacific coast from a high of 25,000 tons in 2001 to 16,000 tons in 2007 [1] has plummeted Bejuco's socio-economic ranking to 419th out of Costa Rica's 470 districts [2], and caused the area to fall into the country's highest category for poverty [3].

SOLUTION

Small-scale fishers from the district of Bejuco catch spotted rose snappers (*Lutjanus guttatus*) with bottom demersal longlines during nightly voyages not exceeding three miles from the coast. The Bejuco fishery is unique because its fishing grounds include two multi-use marine protected areas (MPA). The first of these protected areas, the Caletas-Arío National Wildlife Refuge's MPA, was created in 2006 while the Camaronal National Wildlife Refuge's MPA was officially established in 2009. Both MPAs prohibit the use of destructive gear types including shrimp trawl nets, gillnets, and surface longlines while allowing for more responsible artisanal gear types to be used including handlines and bottom longlines.

The Bejuco fishing community, however, was not consulted during the political MPA design process. If it had been, law makers would have learned that the majority of bottom longline

activity occurs in an unprotected zone between the MPAs, and in the same area where Costa Rica's national shrimp trawl fleet catches 30 times the amount of snappers than the Bejuco artisanal fishers can catch with their traditional gear. In order to better protect the local snapper population from the destructive shrimp trawl fishery, the area's artisanal fishers have organized themselves into three associations (Association of Coyote Fishers-Aspecoy, Association of Punta Coyote Fishers-Aspepuco, Association of Bejuco Fishers-Asobejuco) and are working with the Sea Turtle Restoration Program (PRETOMA) to spearhead a campaign to create a new marine managed area, located between the existing MPAs, that would prohibit unselective fishing methods like shrimp trawls, but allow for more selective ones including bottom longlines. A formal proposal for the new area is currently under review by Costa Rica's Environmental Ministry (MINAE).

PRETOMA is a Costa Rican based marine biodiversity conservation NGO. The organization's mission is to protect and restore populations of sea turtles, sharks, and other endangered marine species, by advancing a vision of sustainable fishing practices and community-based conservation, through scientific research, policy reform, public education, and strategic litigation. PRETOMA researchers have been working with Bejuco's artisanal fishers since 2007 to collect and analyze catch data in order to assess the sustainability of bottom longline use.

Using this data, researchers are studying the population dynamics of *L. guttatus* and common bycatch species, the ecosystem impacts of bottom longline use in the area, and snapper and other by-catch species spillover trends from the MPAs. In conjunction with the University of Washington (USA), researchers are performing a snapper stock assessment, something that has never been done on any coastal fish population in Costa Rica. A third party accredited Marine Stewardship Council (MSC) certifier is evaluating the results of this research. Such a certification would serve as a tool to call the attention of governments and law-making agencies to the importance that artisanal fisheries have on the overall economic development of coastal areas in the country. A snapper certification would also be an example for other small-scale fisheries in Central America and the Caribbean to follow as there are currently no MSC certified artisanal fisheries in this region. However, certification evaluators have warned that as long as the shrimp trawl fleet continues to extract unsustainable amounts of snappers from the local population, an artisanal certification cannot be issued. This makes closing the fishing grounds to shrimpers all the more important.

In December 2013 fishers began selling a portion of their catch to the upscale San José restaurant and seafood distributor, Product-C. While still in its infancy, this direct sale of fish to consumers in Costa Rica's central valley is an indicator of the demand that exists for responsibly produced seafood. A product certification would also be used as a marketing tool to further develop the direct sale of seafood not only between fishers and consumers in San José, but between fishers and the area's growing coastal tourism industry. Product-C managers, as well as local resorts and restaurants, support a snapper certification and are participating in chain of custody development and certification strategy meetings. The long term focus of this project is to create a market where buyers become stakeholders and in turn invest in future evaluations and in the management and monitoring of the fishery.

The project has had its share of shortcomings and setbacks that include quarreling between association members, and the absence of a locally adopted fisher led management strategy,

a process stymied by Costa Rica's top-down fisheries management structure that does not support the development of co-management initiatives [4], and a trend in Costa Rica that has snapper fishers switching techniques from bottom longlines to gillnets because of declining snapper catch rates.

REPLICATION

While the small-scale fishing industry's overall impact is minor compared to that of Costa Rica's industrial fleet, bottom longline fishers apply their trade up and down the country's Pacific coast, making project replication a desired outcome. This work, though, would not be possible without the technical support offered to fishers by PRETOMA. PRETOMA's place in the project, in turn, would not be possible without the support from multiple international funders. In addition, support from new project stakeholders is being sought in order to continue the MSC certification process, the chain of custody reform, and the campaign to create a new marine managed area, all crucial steps towards the strengthening of fisher livelihoods and resilience in Costa Rica.

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Sustaining Fisheries and Traditional Coastal Livelihoods in Southwest Madagascar

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Madagascar is one of the poorest countries in the world; 92% of the population lives on less than US$2 per day [1] and food insecurity affects 65% of the population [2]. Small-scale fishers account for 72% of catches in this island nation, yet the country's critically low capacity for fisheries management means that few fisheries are managed, existing legislation is rarely enforced, and a lack of monitoring has led to underreporting of national catches by as much as 500% over the past five decades [2].

The vast majority of the island's fishers are found in the southwest of the country, a region in which coastal communities depend on the sea for their livelihoods and cultural identity (Figures 1 and 2) [3]. In some regions fishing accounts for 82% of household income, and fish is a dietary mainstay, providing the sole protein source in up to 99% of household meals [4]. Reef octopus (*Octopus cynaea*) is one of the most economically important fisheries in the region, with 98% of catches sold to commercial buyers for international export. However, over recent years communities and seafood collectors alike have voiced concerns over declines in the stock due to poor management practices.

FIGURE 1 A TRADITIONAL SAILING PIROGUE IN ANDAVADOAKA (PHOTO © GARTH CRIPPS)

FIGURE 2 THE VEZO PEOPLE HAVE FISHED FOR OCTOPUS THIS WAY FOR HUNDREDS OF YEARS (PHOTO © GARTH CRIPPS)

In response to this situation, Andavadoaka, a village on Madagascar's southwest coast, partnered with conservation NGO Blue Ventures to trial a community-run temporary closure of a portion of their octopus fishing grounds in 2004. Due to its promising results, a further two villages replicated this sustainable management tool in 2005, and eight more villages decided to implement closures in 2006. The approach has since been adopted by more than 50 villages along hundreds of kilometres of coastline, with over 170 temporary closures held to date.

Studies conducted by Blue Ventures show that during the 2-3 month closures, timed to coincide with breeding and brooding periods in the octopus lifecycle, octopus grow in size and number, not only ensuring their long-term survival by allowing stocks to recover, but also providing greater yields and boosting incomes for local fishers when the reserves open

[5]. This model proved so successful in terms of its ecological and economic benefits that the government of Madagascar implemented a nationwide octopus fishery (Figure 3) closure.

FIGURE 3 A VEZO WOMAN GLEANS FOR OCTOPUS IN THE VELONDRIAKE LMMA (PHOTO © GARTH CRIPPS)

The viral uptake of temporary fishery closures has since been adapted to other small-scale fisheries, notably mangrove crabs (*Scylla* serrate) and spiny lobster (*Panulirus* spp), and has catalyzed community interest and engagement in broader coastal resource management efforts including the establishment of permanent marine reserves and bans on destructive fishing practices. In 2006, the Velondriake ("to live with the sea") Locally Managed Marine Area (LMMA) was established by a network of 25 villages (in 2013) including Andavadoaka, which developed and implemented a set of local laws (*dina*) governing the use of approximately 700 km^2 of coast and ocean, with sanctions enforced for non-compliance. To further legitimize the permanent reserves and to strengthen community support, the management association conducted ancestral ceremonies to mark the establishment of the marine area [6]. Concurrently, Blue Ventures worked with local and national partners to reinforce local management efforts through application for nationally recognized protected area status for Velondriake.

The Velondriake LMMA is the longest-standing locally-led marine conservation effort in the country, overseen by a management association consisting of elected members from its member villages. With the growing reputation of Velondriake as a model for community-based management, a number of exchange trips have been facilitated with fishers from coastal communities around Madagascar, as well as internationally from the Mauritian island of Rodrigues.

Following these community exchange events, LMMAs are growing and evolving throughout Madagascar and the Western Indian Ocean, with more than 50 LMMAs in the region today compared to just five in 2005. A national LMMA network (MIHARI) was created in Madagascar in 2012. MIHARI is an acronym in Malagasy that translates to "marine resource management at the local level". It was aimed at fostering connections between the country's 36 LMMAs, with support from Blue Ventures and other partner NGOs, including

Conservation International (CI), Wildlife Conservation Society (WCS) and World Wildlife Fund (WWF). The network facilitates peer-to-peer learning through annual forums, exchange visits and newsletters, and unites the voices of the hundreds of thousands of small-scale fishers, thus strengthening their ability to influence national policy-making.

The demonstrable economic benefits of these temporary fishery closures have proven to be instrumental in fostering community support for sustainable fisheries management, which in turn can provide the impetus for broader and more ambitious marine conservation efforts. Experiences of community led marine management in Madagascar over the past decade have shown compelling evidence that when fishers are engaged and inspired to manage their marine resources, they can become powerful and effective advocates of sustainable fisheries management (Figure 4).

FIGURE 4 THE VEZO'S INTIMATE LINK TO THE SEAS STARTS AT AN EARLY AGE (PHOTO © GARTH CRIPPS)

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Synthesis

These articles that you have read navigated through experiences shared by authors offering perspectives and practices relevant to how SSF are dealing with stewardship all around the world. In the introduction to this book we said that our aim was to give you “a glimpse of a brighter future for SSF stewardship based on the diverse perspectives and practices”. As reflected in the introductory concepts and guiding questions, we need to understand social-ecological impacts; be able to monitor the positive and negative consequences of those changes; and institutionalize stewardship to add resilience to governance. The contents should have allowed readers to better understand and learn from SSF experiences in order to address effective strategies to be adaptive and successful stewards of a rapidly changing world. This brief synthesis pulls together some of the main threads in the articles and weaves them into a very small tapestry of what sustainable stewardship looks like.

Although we introduced a linear image of enhancing stewardship, and organized the book around it, it is clear that enhancing stewardship entails multiple feedbacks and iterations (Figure 1).

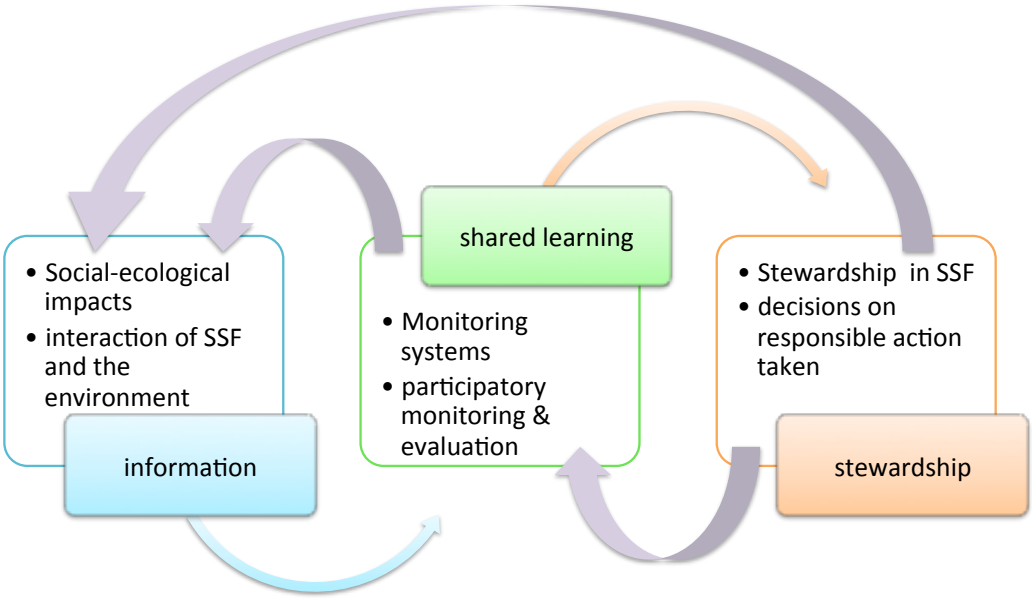

FIGURE 1 ENHANCING STEWARDSHIP ENTAILS MULTIPLE FEEDBACKS AND ITERATIONS

What we see here, supported by evidence from the authors in all three sections, is the necessity for intense and extensive communication as in adaptive collaborative management (or collaborative adaptive management, if you prefer) amongst all of the stakeholders involved. This promotes working and learning together — learning-by-doing as a key ingredient in stewardship via social and institutional learning [1, 2]. So, we are not talking about stewardship as a special project; it becomes the new normal.

As a consequence, in order for the stewardship to be enhanced, we need to look at the key lessons for learning-by-doing at all stages. The chapters and perspectives provide many. In this synthesis we select only a few for illustration, and keep the analysis fairly simple and

straightforward. In a follow-up, more academic publication we may go into the intricacies of this undertaking in more detail and tackle complexity. Table 1 summarizes some of the lessons that we have learned from the authors in this book.

TABLE 1 SOME STRATEGIES TO ENHANCE STEWARDSHIP, AND SUSTAIN IT, BASED ON THE THREE COMPONENTS OF WG4, AND AUTHOR PERSPECTIVES AND PRACTICES

Situation	Strategies	Expected outcome
Social-ecological impacts		
Limited knowledge about SSF	Research on fishers' practices, perceptions and knowledge	Better address impacts of traditional/subsistence fisheries Support enabling environmental and fisheries policies
Diverse perceptions of social-ecological impacts	Environmental education (capacity development) and participatory monitoring	Enhanced knowledge and abilities to respond to diverse changes
Social-ecological impacts are complex and too dynamic to comprehend	Development of cross-scale, multi-parameter SSF-specific frameworks and assessments	Comprehensive understanding of vulnerability and adaptive capacity Better understanding of resilience
Monitoring		
Need for frameworks and methods to embrace social-ecological system dynamic and learning-by-doing perspective	Participatory monitoring and evaluation of SSF in different contexts and regions Monitoring that is geared more to decisions than just measuring	Knowledge and learning as basis for supporting shared experiences and networking Support for more robust analyses, such as scenario analysis and multi-criteria analysis
Science remains the most highly valued knowledge system	Incorporate local, traditional and other types of knowledge, where possible integrated with science	More diverse and adaptive sets of knowledge mobilized in multiple contexts via diverse stakeholders
Stewardship		
Misfit between fishery systems dynamics (ecosystems, livelihoods) and institutions	Engaging fishers in design of MPA and fishery management objectives and implementation of planning	Higher compliance in fishery and MPA management Greater genuine ownership of the factors favouring self-organization
Need more opportunity for communication and shared learning and action	Engage stakeholders in multiple activities and use fisher network dynamics in stewardship	Collaborative learning, communication and knowledge sharing become more dynamic Achieved sustainable goals from collaborative work and learning
Conflicts raised by asymmetries and management failures	Design rapid and low-cost negotiation and conflict management mechanisms	Improved communication, collaboration and compliance with good governance
Participation and engagement of fisherfolk reduces competition with other sectors	Explore ecosystem stewardship as a formal and legal duty Enable institutional learning for adaptive co-management and resilience thinking	To embody resilient and sustainable pathway as a societal objective Increased participation and robust governance

Many of the lessons overlap and add nuances to the main point. We do not refer to the individual articles, but challenge the reader to discover where the points resonate. We offer

a very simplistic summary of an SSF situation, search for strategies that authors have suggested to enhance stewardship and sketch the desired outcome, that is, “what sustainable stewardship looks like”, as we have said before. Some of the strategies may be transformational or incremental depending on the situation in the particular SSF or set of scenarios at the start. It is a broad-brush picture we paint.

The impacts section illustrated how SSF dynamics are cross-scale and multi-level. The mainstream academic literature may perpetually claim that SSF are not well known, and that they are so situation-specific in their dynamics that they are only good for story-telling rather than scientific analysis. This, however, is a reductionist perspective. An emerging and rich literature, with many contributions from TBTI participants, is tackling SSF in a more comprehensive and transdisciplinary manner [3-7]. However, we are still working on our conceptual frameworks and do not know enough in most cases to definitively apply them to SSF. Colleagues, for example, are working on well-being, interactive governance, livelihood and fisherfolk organizations [8-13].

Perspectives on social-ecological impacts, tied to the other two components, showed that SSF dynamics occur on multiple spatial, temporal, jurisdictional and institutional scales. They are culturally and socially linked to specific resource users and fishing techniques. Small-scale commercial and recreational fisheries are often different in the impacts they experience and how they respond to changes. Environmental and fishery policies that neglect scale and fishery type characteristics may reduce SSF system resilience and exacerbate loss of livelihood diversity. This negative outcome must be addressed to create enabling policy environments for SSF stewardship.

Variation in SSF can be better addressed when research is properly designed, taking into consideration fishers’ knowledge, perceptions and practices. A priority for better understanding impacts is to engage resource users and others along SSF value chains in constructing robust but adaptive conceptual frameworks. Collectively, the expected outcomes should facilitate improved monitoring and better design of stewardship interventions via knowledge mobilization and collaboration [14]. Asymmetries in access to information can affect how fisherfolk perceive impacts and manage change in ecosystems. This affects their abilities to respond and manage change in pursuit of resilient and sustainable outcomes as stewards.

Capacity building (or capacity development) and participatory monitoring can help fishers to become more familiar with other knowledge systems and to learn about impacts that are not encompassed by their local experience. As stressed by Junior McDonald, one of the fishers contributing to this e-book, some challenges faced by SSF surpass fishers’ abilities to fully understand how they are likely to be impacted by unexpected and new changes. Take ocean acidification in the context of climate change or increasing invasive alien species as examples. On the other hand, NGOs and scientists alike often underestimate the innovation and adaptive capacity latent in fisherfolk social networks. All parties have something to learn. This leads us to realize that SSF will be better addressed if we all work together on understanding change. We all benefit from the outcomes of enhanced knowledge and capacity.

Monitoring must encompass both positive and negative changes, recognizing that a positive change in one situation may be perceived as negative in another. We have come a long way

from thinking of monitoring as mainly bio-physical, and what you do to stakeholders rather than with them. The authors have clearly broadened our view of monitoring to include socio-economic and governance indicators and to be as practically participatory as possible in the situation. This extends to evaluation. Much more needs to be done to improve monitoring methodologies to improve outcomes.

Monitoring is not just a conduit for data-gathering and feeding information systems. It bridges knowledge, fostering collective action and shared learning. It is not an easy task. It challenges our perception about what positions should be played by whom. As stewards we realize that almost every stakeholder can contribute to generating information and knowledge, sharing their knowledge and allowing us to learn from it.

Working together needs a focus on “how to?” in terms of methods and approaches. As stated at the start of this book, we seek approaches where dynamic and complex SSF can be understood and monitored in ways that promote sustainable and resilient fisheries livelihoods. Thus providing practical incentives for sustaining stewardship. The section on monitoring gives us guidance on how to achieve desirable outcomes.

SocMon is striving globally to provide a comprehensive approach through which site-based socio-economic data and knowledge can be incorporated into decision-making. It ties into the previous section on impacts, which suggested that more specific and locally based information contributes significantly to understanding local identities and to measuring specific actual or perceived impacts. Continued data gathering and the development of strategies to support learning and decision-making are required. The remaining perspectives in the monitoring section of this e-book reinforce the finding that participation in monitoring is a crucial step in improving the quality and consistency of information [15]. Participation is essential for enhancing stewardship.

Some of the practical experiences in this e-book describe the development of participatory methods to monitor, to plan and to evaluate fishery social-ecological systems and decide on the preferred courses of action for enhancing stewardship. Properly designed methods can provide a platform of collaboration for expanding capacity development. They can provide multiple opportunities for shared learning and practical collaboration with outcomes that contribute to good governance. As fisherfolk become included in decision-making processes through monitoring. We expect that, besides fostering resilient sustainable development pathways, inclusion will enhance stewardship by rewarding fisherfolk for self-organization as an outcome.

The third section explored enhancing stewardship in more depth than the previous two. We introduced, in the introduction to this book, a definition of ecosystem stewardship from Chapin and collaborators’ [16] referred to the strategies human societies develop in order to address sustainable pathways such as: i) to reduce risks and vulnerabilities; ii) to foster resilience; and iii) to embrace opportunities and transform from undesirable trajectories. Continuing from the monitoring section, we add a fourth pathway, which is to support fisher’s self-reliance and self-organization.

Authors in both the monitoring and stewardship sections stress the importance of building and implementing an agenda or strategic direction in order to support and to guide the efforts aimed at achieving any sustainable pathway. By considering the ability to make

informed choices under duress, we take into account the challenges faced by stakeholders in promoting ecosystem stewardship. Conflicts affect how SSF will be considered in a governance arena, especially in EAF where comparison to other economic sectors is inevitable. Fishery stakeholders that are self-organizing, and that can manage conflicts, stand a better chance of succeeding as stewards.

Authors in this volume propose that conflict management is potentially supportive of enhanced stewardship. They suggest that strategies of education and outreach lead to improved communication, collaboration and empowerment, and that these may ultimately reduce the asymmetries or inequities at the root of conflicts and diverging objectives where consensus is expected. Adaptive management also helps to reduce conflict given its strategic flexibility, and in turn conflicts encourage adaptation [17-20].

Another perspective saw stewardship as reflecting a sense of duty, either informal or legal. Social agency was presented as the ability of social groups to participate and to be mobilized into collective action to make a difference. The capacity, within social agency, for good and responsible leadership is at the heart of groups making optimal choices in times of constantly changing situations [21]. Stewards are often change agents.

Change agents demonstrate how the power of being communicative and networked can be crucial in enhancing stewardship. The last chapters describe how different networked organizations could play strategic roles in taking into consideration all that we discussed before. Network-designed organizations (e.g. the Caribbean Network of Fisherfolk Organizations) have high potential to improve the communication flow, learning and action that are essential ingredients of successful stewardship. Network organizational or institutional design for good governance can enhance stewardship.

Some situations may call for completely new institutional arrangements. SSF-specific institutional arrangements for stewardship can provide a high sense of belonging to decision-making processes [22]. An example is transforming from conventional fisheries management to collaborative adaptive management that embraces stewardship [9, 23, 24]. We see evidence from the authors that fisherfolk and many other stakeholders are committed to enhancing stewardship in SSF. They want a better future; a future where fisheries livelihoods can be truly sustainable inter-generationally. By this, we also mean that livelihoods are supportive of healthy and productive ecosystems.

CONCLUSION

Stewardship is a collective effort to make possible positive sustainable futures. This book is optimistic about this possibility for SSF, rising above the image of the global fisheries crisis. The potential for success is enormous based on the few experiences shared in this volume. We hope that the contents can motivate people to share more experiences and to communicate their perspectives. Let us keep in touch and follow each other's next steps, share our successful stories and (net)work together to find ways for overcoming constraints.

Stewardship is an adaptive concept. Strategies to enhance stewardship will be dynamic. These strategies need to be innovative and participatory, changing as social-ecological systems change. We are excited to share the authors' contributions in these pages as one of the outputs from TBTI WG4. Authors and readers alike are invited to join in enhancing the

stewardship. As stressed much in this book, networks are important. The editors and members of WG4 see this book as an invitation for further networking and learning together to find paths for enhancing stewardship and creating resilient small-scale fisheries social-ecological systems. Welcome aboard!

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