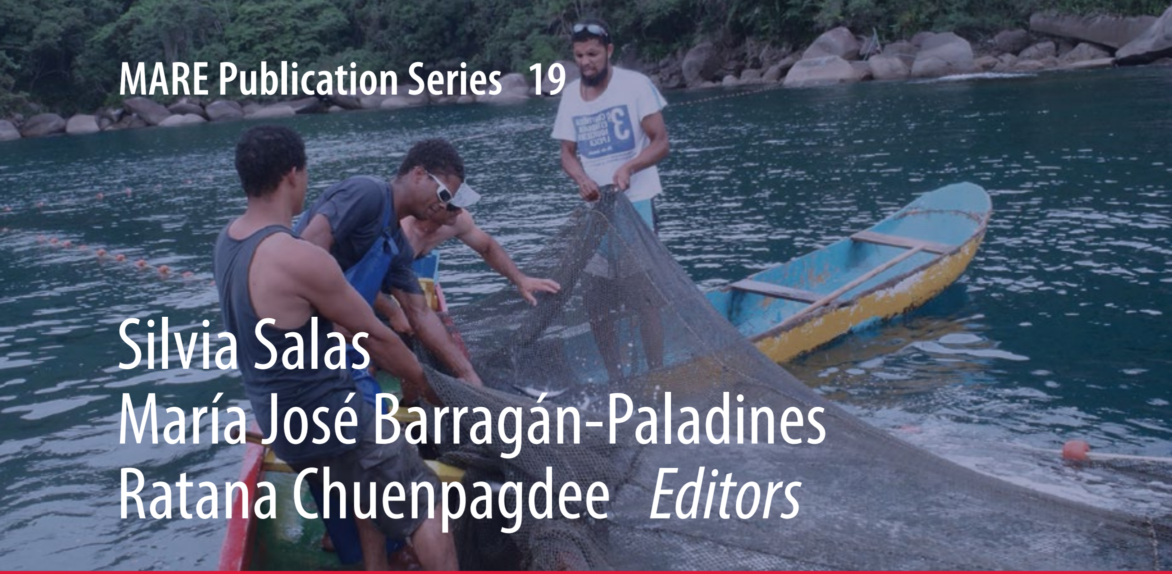


MARE Publication Series 19

Silvia Salas
María José Barragán-Paladines
Ratana Chuenpagdee *Editors*

# Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean

Centre for Maritime MARE Research

Springer

# MARE Publication Series

Volume 19

The MARE Publication Series is an initiative of the Centre for Maritime Research (MARE). MARE is an interdisciplinary social-science network devoted to studying the use and management of marine resources. It is based jointly at the University of Amsterdam and Wageningen University (www.marecentre.nl).

The MARE Publication Series addresses topics of contemporary relevance in the wide field of 'people and the sea'. It has a global scope and includes contributions from a wide range of social science disciplines as well as from applied sciences. Topics range from fisheries, to integrated management, coastal tourism, and environmental conservation. The series was previously hosted by Amsterdam University Press and joined Springer in 2011.

The MARE Publication Series is complemented by the Journal of Maritime Studies (MAST) and the biennial People and the Sea Conferences in Amsterdam.

More information about this series at http://www.springer.com/series/10413

Silvia Salas • María José Barragán-Paladines
Ratana Chuenpagdee
Editors

# Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean

Springer

*Editors*
Silvia Salas
Marine Resources Department
Cinvestav Mérida
Mérida, Yucatán, Mexico

Ratana Chuenpagdee
Department of Geography
Memorial University of Newfoundland
St. John's, NL, Canada

María José Barragán-Paladines
Development and Knowledge Sociology-
Social Science Department
Leibniz Centre for Tropical Marine
Research (ZMT)
Bremen, Germany

Too Big To Ignore (TBTI; toobigtoignore.net) is a global research network and knowledge mobilization partnership, funded by the Social Sciences and Humanities Research Council of Canada, and supported by 15 partner organizations and over 400 members from around the world. The network aims at elevating the profile of small-scale fisheries, arguing against their marginalization in national and international policies, and developing research and governance capacity to address global fisheries challenges.

ISSN 2212-6260 ISSN 2212-6279 (electronic)
MARE Publication Series
ISBN 978-3-319-76077-3 ISBN 978-3-319-76078-0 (eBook)
https://doi.org/10.1007/978-3-319-76078-0

Library of Congress Control Number: 2018939180



Cover illustration: Hard-working circle net fishermen, Trindade, Brazil, December 2010, Courtesy of Patrick McConney, The University of West Indies

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Foreword

In June 2014, a remarkable world event took place during the 31st Session of the Committee on Fisheries (COFI) at the FAO Headquarters. FAO member states formally endorsed the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines). The SSF Guidelines are now in place and initiatives are being pursued to begin their implementation.

When my esteemed colleague Dr. Silvia Salas kindly invited me to read the book that she was coauthoring and coediting with Dr. M. Jose Barragán-Paladines and Dr. Ratana Chuenpagdee – within the frame of the activities in support of the SSF Guidelines being carried out by Too Big to Ignore: Global Partnership for Small-Scale Fisheries Research (TBTI) – I could not help but experience some flashbacks related to my past work connected with small-scale fisheries in the Latin America and Caribbean (LAC) region. I also thought back to two world events that were necessary steps in the full adoption of the SSF Guidelines. I remembered the high level of involvement of governments, fishers' organizations, and other stakeholders in the region during the deliberations related to small-scale fisheries that took place at the FAO World Fisheries Conference on Fisheries Management and Development in Rome in 1984. This early momentum occurred in a context of the recent adoption of the Law of the Sea Convention (UNCLOS 1982), and during the 1995 adoption by member countries of the FAO Code of Conduct for Responsible Fisheries in the context of the recommendations of United Nations Conference on Environment and Development (UNCED 1992). Identical commitment was shown by key LAC actors during the process that led to the adoption of the SSF Guidelines. This involvement and commitment should be considered an encouraging factor when looking forward to the implementation of the SSF Guidelines in countries across the region.

LAC small-scale fisheries are characterized by highly diverse ecosystems, fisheries, fishing gears, types of fishers' organizations, and fisheries management approaches. Despite this diversity, the activity presents to a varying degree of technological, economic, social, and cultural features that give a common identity to small-scale fisheries at regional, national, and local levels in Latin America and the Caribbean.

The role historically played by small-scale fisheries (both marine and inland) in the LAC region is being increasingly considered by governments and other stakeholders as a strategic social and economic priority. In many countries in the region, small-scale fisheries make a significant contribution to the generation of employment, incomes, and foreign exchange earnings, as well as being a major source of national food supply and a cornerstone of regional food security. This contribution is especially important in the context of rural development, particularly to the food security and livelihoods of poor and isolated riparian and marine coastal communities.

The evolution of small-scale fisheries in the region in recent decades has very often been strongly influenced by external factors, such as macroeconomic policies, national economic crises, increasing international demand for fish and fish products, and the need to meet international product safety, quality, and environmental standards, among others. Large segments of the subsector showed resilience and adapted rapidly to cope with these new circumstances, thus largely succeeding in maintaining its important role in the economic and societal well-being of countries in the region.

However, in the present day, the consequences of several persistent factors make small-scale fisheries of the region vulnerable and may threaten their future sustainability. One of these factors is the continuous growth in international demand for fish and fish products that pose additional pressure over already fully exploited or overexploited fisheries resources and their ecosystems. This heightened exploitation occurs in the absence of adequate or specific fisheries policies, governance systems, and management approaches in the region. The vulnerability of the region's small-scale fisheries may also increase due to the increased frequency of natural disasters and climate change-related phenomena, which, in the absence of appropriate preparedness or mitigation and adaptation policies, threaten the sustainability of small-scale fisheries across the region. Current efforts involving both academia and ad hoc fisheries research institutions are directed to addressing such vulnerabilities.

Academia and research institutions, together with regional organizations, Civil Society Organizations (CSOs), and Non-governmental Organizations (NGOs), act as one of the three key pillars in the implementation of the SSF Guidelines. These actors have a mission to interface supportively between the other two pillars, namely governments who serve as the crucial implementing party, and fishers and their communities as the main drivers in implementation strategies. Existing and future research at various levels of social, economic, bioecological, and geographic contexts can contribute valuable inputs to improving small-scale fisheries policy formation in a collaborative interaction with the other key stakeholders. This collaboration can, in turn, lead to improved governance systems and management approaches with potential to fill the significant gaps between present realities and the changes needed in the LAC region to ensure the implementation of the SSF Guidelines.

The chapters of this book, prepared by authors from many different countries, offer invaluable theory, empirical knowledge, and methodological innovations related to the sustainability of small-scale fisheries. These case studies span a wide geographical extent of the region, while still often presenting issues and analysis at regional, subregional, national, and local perspectives as relevant. From a thematic point of view, the studies included in this volume present information, analysis, and findings from several perspectives, such as the economic and social conditions surrounding small-scale fisheries operations, critical issues surrounding the vulnerability and risk facing small-scale fisheries, different assessment and management approaches, and issues related to governance for sustainability. The insights uncovered by the book are surely of interest to a wide audience of stakeholders and will be instrumental in enhancing the science-policy interface in many countries of the region. Most of the research currently being conducted in the region on small-scale fisheries is slowly being refocused and expanded in order to address these questions and global priorities. The findings and methods presented in this book through the lens of specific contexts of small-scale fisheries in the region could serve as inputs to help stimulate that process.

There are not many forums in the LAC region for fishery researchers to present their work and findings among a community of practice, or to exchange experiences and establish collaboration with their colleagues in the region. This book aims to serve as a starting point to make the research being conducted on LAC known to a wide audience both within and beyond the region, while also stimulating collaboration and further research among scholars across the world working on the implementation of the SSF guidelines.

This book perfectly embodies the role that the SSF Guidelines urge the academic and research community to play in the regional context of LAC. The studies included in the volume present multiple approaches to small-scale fisheries governance that are in line with what is enshrined in the document's principles. In this regard, the book may constitute a baseline for future research to be conducted in several fields in order to help define the gaps that need to be filled and provide options for how ongoing research can work alongside other key actors to advance the implementation of the SSF Guidelines in the LAC region.

Former Senior Fishery Officer of FAO
and International Consultant

Angel Alberto Gumy

# Series Editor's Preface

Much of the world's food supply comes from the sea and is made available by millions of people who harvest, process, and market its products. An overwhelming majority of these people operate in the small-scale fisheries sector. At the same time, we know that marine resources and environments are under threat from overfishing, industrial pollution, and climate change. These compounding threats create great challenges for fisheries stakeholders, policymakers, civil society organizations, and academia worldwide.

The MARE Book Series by Springer includes edited volumes and monographs focusing on people and their manifold relations with the sea, as manifested in different parts of the globe. As the editors of the series, we are happy to include another important study in our portfolio. This volume is yet another contribution of the Too Big to Ignore (TBTI) research partnership that showcases its focus on applied scholarship about small-scale fisheries.

Latin America and the Caribbean, the region from which all the case studies in this volume originate, display many of the features of small-scale fisheries elsewhere, notably enormous ecological, social, and cultural diversity and complexity. However, these fisheries are neglected by policymakers, which hinder their sustainability and viability and reduce their potential to play an even more important role in job creation and food supply. It is difficult for people within the sector to break out of the poverty trap that exists in the region.

With the advent of the UN Sustainable Development Goals (SDGs) and the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication, which were endorsed by FAO member states in 2014, small-scale fisheries are now in focus as never before. In pursuit of the implementation of these important international instruments, the research community has a vital contribution to make regarding small-scale fisheries. This book, and the other publications of the MARE Series produced in collaboration with TBTI, should also be seen in this context.

This new book, much like other publications in the MARE Series, provides crucial insights into the realities and prospects of small-scale fisheries, which are essential for effective policy and governance outcomes. We are extremely pleased that the editors Silvia Salas, María José Barragán-Paladines, and Ratana Chuenpagdee have chosen the MARE Book Series as a venue for their findings. This book deserves widespread attention in the Latin America and Caribbean region and beyond.

Tromsø and Amsterdam

Svein Jentoft and Maarten Bavinck
MARE Series editors

# Acknowledgments

*Viability and Sustainability of Small-Scale Fisheries in Latin America and the Caribbean* speaks to contemporary issues concerning small-scale fisheries, such as current and potential market demands, social capital and their contribution to stewardship, management schemes, and governance, among others. The chapters included in this volume look at the complexity of the human-natural systems interlinked with small-scale fisheries and identify strategies to build capacity in coastal communities. Special attention is paid to the conditions and factors that either increase or decrease the weaknesses and vulnerability of this sector, in terms of livelihoods access, governance arrangements, adaptation mechanisms, and resilience strategies. The book thus presents some of the emerging challenges and threats that fishing communities and fishers are facing in the region. It is worth noting that this book fills a significant gap in up-to-date information on small-scale fisheries in the region, with many case studies closing the knowledge gaps in small-scale fisheries systems in certain areas and countries while elaborating on their current challenges, opportunities, and experiences. The book also enhances the visibility of small-scale fisheries both by assessing their current status in the region and revealing future trends expected to affect the sector. Importantly, by applying an integrative perspective and bringing together fisheries-related cases from the Atlantic, Pacific, and Caribbean subregions, as well as the Amazon River basin, the book offers ways to improve small-scale fisheries governance in the region with lessons that can be drawn for furthering the sustainability of small-scale fisheries worldwide.

The volume targets individuals, organizations, and institutions interested in small-scale fisheries issues. It is particularly relevant to managers, practitioners, and intergovernmental organizations, as well as fisheries stakeholders and civil society organizations in the Latin America and Caribbean region. This book has been shaped by a shared vision among the editors and authors around the importance of this sector to Latin America and the Caribbean, as well as the common desire to contribute to improving the viability and sustainability of small-scale fisheries in the region. We hope the book can help inspire new thinking and trigger the interest of the reader to take actions that may lead to viable and sustainable small-scale fisheries and coastal communities.

We are grateful for the funding support of TBTI, provided by the Social Sciences and Humanities Research Council of Canada (grant number 895-2011-1011), and the Memorial University of Newfoundland, St. John's. Staff at TBTI headquarters in St. John's, particularly Vesna Kereži (TBTI Project Manager), have been tremendous in their support of the book production. Brennan Lowery has kindly helped us with the language editing. S. Salas acknowledges financial support from Fondos Mixtos-Conacyt (247043), which enabled her to participate in the meetings about the book. We also would like to thank all contributors of this volume for their positive response to the call for contributions, and for their commitment to producing high-quality, research-based case studies. We are indebted to the reviewers of the book proposal and the chapters, who generously and voluntarily dedicated part of their busy schedules to provide thoughtful and useful comments that greatly improved the overall quality of the chapters and thus of the entire volume. Finally, we appreciate the support of the MARE Publication Series editors, Professors Maarten Bavinck and Svein Jentoft, and the help of Springer staff Joseph Daniel and Fritz Schmuhl for their guidance and assistance in this publication.

Mérida, Mexico — Silvia Salas
Bremen, Germany — María José Barragán-Paladines
St. John's, Canada — Ratana Chuenpagdee
October 2017

The main focus of most technical publications on fisheries theory and practice has been on the offshore industrial fishery, but this book is concerned with our understanding of near-shore harvests and communities. While smaller in scale, inshore fisheries are more complex ecologically, and cannot be successfully managed without understanding their socioeconomic context which is of immediate relevance. Therefore, the successful management of small-scale, inshore fisheries requires the integration of fisheries within the economy of coastal communities, implying a need to understand diverse topics such as bioeconomics, ecological and environmental protection, and user rights and responsibilities. The book illustrates the complexity, diversity, and dynamics of small-scale fisheries in the Latin American and Caribbean region, and presents experiences, tools, and approaches to lead toward sustainable and viable fisheries. The reader of this compilation of essays on inshore fisheries will gain a new understanding of the range of actions, approaches, and information needed for their successful management.

John F. Caddy
International Fisheries Expert

This book provides a detailed description and analysis of the complexities and heterogeneities of small-scale fisheries in the Latin America and Caribbean (LAC) region. It also enhances the traditional knowledge and resilience of fishing communities to cope with current challenges stemming from changing ecosystems patterns, extreme climate events, market fluctuations, and governance regimes. The reported richness of diversity of ecosystems, species, fishing methods and gears, community involvement in the governance of their fisheries, information availability, and methods of fisheries analysis all play an important role in achieving sustainable and viable small-scale fisheries in the future. This book, prepared by the Too Big To Ignore project, constitutes a very valuable resource for policy makers, fisheries scientists, nongovernmental organizations, civil society organizations, and fishing communities interested in putting in place sound small-scale fisheries management strategies, research, and actions to contribute to the sustainability of small-scale fisheries and food security in the LAC region.

Juan Carlos Seijo, Professor of Fisheries Bioeconomics
Marist University of Mérida

# Contents

# Part I
# Introduction

# Chapter 1
# Big Questions About Sustainability and Viability in Small-Scale Fisheries

**Ratana Chuenpagdee, Silvia Salas, and María José Barragán-Paladines**

**Abstract** Like elsewhere around the world, small-scale fisheries in Latin America and the Caribbean are highly diverse and complex, thus posing great challenges to governance. Coupled with these characteristics are the various changes that small-scale fisheries are exposed to, including climate-induced changes, environmental variability, and market fluctuation. Several tools and approaches have been used to manage small-scale fisheries in the region and lessons from their application provide a strong basis for the discussion about what needs to be done in light of these changing conditions. The focus on the viability and sustainability of small-scale fisheries, which is the topic of the book, aligns with the objectives of the international instruments such as *The Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries* and the Sustainable Development Goals. The chapter provides the rationale for the examination of viability and sustainability in small-scale fisheries in Latin America and the Caribbean and introduces the case studies covered in the book.

**Keywords** Small-scale fisheries · Viability · Sustainability · Governance · SSF Guidelines · Sustainable Development Goals · Latin America and the Caribbean

---

R. Chuenpagdee (✉)
Department of Geography, Memorial University of Newfoundland, St. John's, Canada
e-mail: ratanac@mun.ca

S. Salas
Marine Resources Department, CINVESTAV Mérida, Mérida, Yucatán, México
e-mail: ssalas@cinvestav.mx

M. J. Barragán-Paladines
Development and Knowledge Sociology-Social Science Department, Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany
e-mail: mariaj.barraganp@leibniz-zmt.de



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_1

## 1.1 Introduction

According to the Sea Around Us Project, small-scale fisheries in Latin America and the Caribbean contribute about 11% to the global small-scale fisheries catch and about 12% of total market value (Pauly and Zeller 2016). These figures may seem low in comparison with other regions, like Asia and Oceania (52%) and Europe (13%). However, 74% of all catches in Latin America and the Caribbean come from small-scale fisheries, which is higher than other regions (70% in Asia and Oceania and 24% in Europe). In other words, small-scale fisheries in the Latin America and Caribbean region are the predominant sector and thus require much greater policy and research attention in order to foster and secure their viability and sustainability.

A large body of literature has been written about numerous aspects of fisheries in the Latin America and Caribbean region, with a growing contribution of research and discussion focusing specifically on small-scale fisheries. Because some of these studies are written in Spanish, French, and Portuguese, they have not been cited as highly as those in English (Table 1.1). Also, as shown in Fig. 1.1, when compared to ecology and economics (in English and other languages), less is known about the social aspects of small-scale fisheries, such as their contribution to viable livelihoods, food security, poverty alleviation, and sources and conditions of their vulnerability. Research into these questions can complement the strong foundation of natural science knowledge, thus leading to a more comprehensive understanding about fisheries systems. This interdisciplinary approach is called for in the United Nations Food and Agriculture Organization (FAO) *Code of Conduct for Responsible Fisheries* (FAO 1995).

The importance of a holistic and integrated approach to governing fisheries is also one of the key principles promoted in the *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty*

**Table 1.1** Search results for literature in scientific journals: ISI Web of Knowledge, SCOPUS, Google Scholar, and Latindex

| Source of search | Search keywords | # of hits | Language |
|---|---|---|---|
| ISI Web of Sciences apps.webofknowledge.com | "Small-scale fisheries" | 2072 | English |
| | "Latin America" + "small-scale fisheries" | 22 | |
| SCOPUS www.scopus.com | "Small-scale fisheries" | 2113 | English |
| | "Latin America" + "small-scale fisheries" | 198 | |
| Google Scholar scholar.google.com | "Small-scale fisheries" | 20,100 | English, Spanish, Portuguese, and French |
| | "Latin America" + "small-scale fisheries" | 2440 | English, Spanish, Portuguese, and French |
| Latindex http://www.latindex.org | "Fisheries" | 33 | Spanish and Portuguese |

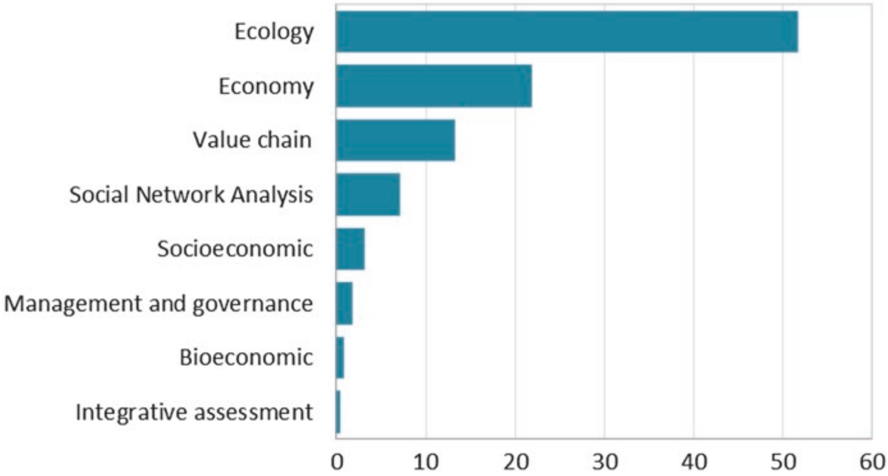



**Fig. 1.1** Main research topics on small-scale fisheries in the Latin America and Caribbean region between 1950 and 2015. (Sources: ISI Web of Knowledge, SCOPUS, Google Scholar and LatIndex)

*Eradication* (SSF Guidelines) (FAO 2015). The adoption of the SSF Guidelines in 2014, 25 years after the *Code of Conduct for Responsible Fisheries* was passed, marks an important moment in the global discourse on fisheries governance. Unlike other international instruments, the SSF Guidelines were developed through a 'bottom-up' process, with fisheries-related civil society organizations (CSOs) playing a critical role in initiating the discussion, producing drafts of the guidelines, and conducting consultation to solicit inputs from fishers and fishers' organizations in various locations around the world.

The SSF Guidelines contain several principles that speak to the importance of small-scale fisheries and the need to promote a sustainable and viable future for this sector. These principles center around fundamental elements like human rights and dignity, nondiscrimination, and equity and equality, with an emphasis on gender. They also refer to major governance principles such as transparency and accountability, consultation and participation, rule of law, and a holistic and integrated approach. The SSF Guidelines also promote the examination of diverse values and the contribution of small-scale fisheries to culture, social responsibility, feasibility, social and economic viability, and social, economic, and environmental sustainability. The discussion about the SSF Guidelines and the deliberation about these principles, along with the recognized research gaps stated above, inspired the creation of this edited volume.

As suggested by Jentoft (2014), the implementation of the SSF Guidelines will require commitment and effort from all stakeholders. Recent research conducted by Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research (TBTI; toobigtoignore.net) covers various aspects of small-scale fisheries and contributes to supporting the implementation of the SSF Guidelines. For instance, through more than 30 case studies around the world, Jentoft and Chuenpagdee (2015) offer lessons about issues affecting small-scale fisheries governance and highlight how several countries are moving away from hierarchical governance models to participatory and co-governance, while some are in a hybrid form or in transition. In Jentoft et al. (2017), another 30 case studies directly examine challenges and opportunities in the implementation of the SSF Guidelines. Finally, Johnson et al. (2017) bring the discussion to another level with the focus on values and well-being of small-scale fisheries, mainly with examples from Asia. These three volumes speak to the need to broaden the research scope and policy perspectives to recognize the existing contribution of small-scale fisheries and foster their potential to address global concerns related to ecosystem health, food security, and poverty alleviation.

The current volume adds to this discourse by focusing on the viability and sustainability of small-scale fisheries and fishing communities, using case studies in the Latin America and Caribbean region as illustrations. It begins with the observation that the high diversity, complexity, and dynamics of small-scale fisheries, along with the wide range of spatial distribution and jurisdiction, pose significant challenges to understanding the necessary conditions for viable and sustainable fisheries in the region. These characteristics can be found within many countries and across the region overall. For example, several ecosystem types exist in Latin America and the Caribbean, from the volcanic environments in Galapagos Islands to tropical rainforests in the Amazonian River basin. The coastal regions of the Atlantic, Pacific, and Caribbean are also diverse in geophysical characteristics, habitats, and biodiversity, giving rise to a variety of demersal, pelagic, and benthic fisheries with different species compositions (Salas et al. 2007, 2011). Similarly, the Latin America and Caribbean region is highly diverse and complex in terms of languages, historical and cultural attributes, economic and social contexts, and institutional and governance arrangements (Orensanz et al. 2005; Alcalá-Moya 2011). All of these features make small-scale fisheries difficult to govern, as also suggested by Salas et al. (2011) in an early volume of country-level studies that focused on challenges in the assessment and management of coastal fisheries in the region. Current global trends (e.g., market changes, climate change, etc.) impose a greater challenge that must be addressed to understand and govern small-scale fisheries in the region, and in order to identify factors that can lead to viable and sustainable fisheries (Defeo et al. 2013; Crona et al. 2015).

## 1.2 The Emphasis on Sustainability and Viability

Sustainability has long been on the policy and research agenda. However, sustainability in the context of small-scale fisheries is a recent topic providing a major foundation for the SSF Guidelines and has been discussed at various venues. The United Nations Sustainable Development Goals (SDGs) include concerns about sustainable fisheries in Goal 14, which aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development (UN 2017). Specific reference to small-scale fisheries is made in Target 14b under this goal, which speaks to the need to provide access for small-scale fishers to marine resources and markets (UNEP 2016). The global indicator for this target is the progress that countries make in their application of governance frameworks (e.g., legal, regulatory, policy, and institutional), in ways that recognize and protect access rights for small-scale fisheries (UN 2017). In effect, SDG 14 and specifically Target 14b present a unique opportunity to combine thinking around sustainability and viability, rather than looking at these two topics separately. In this view, one can argue that for small-scale fisheries to be sustainable, small-scale fishing communities must have viable livelihoods. Likewise, for small-scale fishing communities to be viable, fisheries need to be sustainable.

Making small-scale fishing communities viable while maintaining sustainable fisheries aligns with the objectives of the SSF Guidelines. In discussing responsible fisheries and sustainable development, the SSF Guidelines include various domains that promote community viability such as social development, employment and decent work, and value chain, post-harvest and trade. However, achieving both the sustainability and viability of small-scale fisheries is a big challenge. Programs, practices, and policies to promote their sustainability and viability are currently developed mostly based on sets of quantitative criteria or indicators. Few metrics are available to evaluate viability, except in the context of financial performance (Schuhbauer and Sumaila 2015a). Within TBTI, a research cluster on economic viability has been working on developing and testing an indicator-based framework to assess viability from both economic and social perspectives (Schuhbauer and Sumaila 2015b). However, a framework to look at the interplay between viability and sustainability is currently not available. This book aims to take a step in that direction.

## 1.3 About This Book

The overall aim of this book is to examine the extent to which small-scale fisheries performance can be improved along the entire fish chain (i.e., pre-harvest, harvest, and post-harvest). By incorporating conditions and challenges, markets and socioeconomic attributes, and governance systems into the analysis of the case studies, this volume reflects on how such improvements can lead to increased viability and help to secure the sustainability of fishing communities and resources. The book presents and synthesizes findings and lessons learned from the case studies, along the wide range of spatial distribution and jurisdictional characteristics of fisheries in the region. These learnings are intended as a basis for policy formulation and the development of management strategies that can help foster the implementation of the SSF Guidelines and the achievement of the SDGs.

Specifically, the main questions concerning the sustainability and viability of small-scale fisheries raised in the book revolve around the following issues:

1. The diversity and significance of issues, challenges, and threats faced by small-scale fisheries in the Latin America and Caribbean region
2. The conditions and factors in different small-scale fisheries contexts that foster or inhibit viability and sustainability

3. The role and adaptive capacity of communities and fisherfolks in reducing vulnerability and securing sustainable livelihoods
4. The role of appropriate institutional and legal frameworks, policy interventions, and alternative governance models in promoting viability and sustainability

The book consists of 23 chapters, 20 of which are case studies related to 15 countries and Small Island Developing States (SIDS) in the Latin America and Caribbean region (Fig. 1.2). These 20 case studies cover a variety of ecosystems (e.g., marine, coastal, and freshwater) in the Pacific, Atlantic, Caribbean, and Gulf of Mexico, as well as the Amazonian River Basin. The diversity of the case studies is reflected in both bioecological and socioeconomic contexts, including a couple of examples from indigenous small-scale fisheries. While the majority of the case studies are specific to small-scale fisheries in certain locations, a few chapters present comparative case studies and broader analyses.

The book is organized into six parts. The first and last parts are the introduction and conclusion. The four main parts consist of collections of case studies related to (1) issues, challenges, and threats; (2) monitoring, management, and conservation; (3) socioeconomics, markets, and livelihoods; and (4) communities, stewardship, and governance. In addition to this chapter, *Part I* includes Chap. 2 (Leis et al. [a]), which presents a regional overview of the status, challenges, and potentials of small-scale fisheries of all countries in the Latin America and Caribbean region using national-level data and statistics, literature, and the TBTI information system (ISSF 2017).

*Part II* contains four chapters that illustrate issues and threats that add to the vulnerability of small-scale fisheries and demonstrate how communities cope with these stresses. Chap. 3 (Marín) presents an example from central-southern Chile, describing how small-scale fishing communities deal with coastal disasters. Chapter 4 (Castellanos-Galindo and Zapata) tells the story of small-scale fishing communities on the Pacific Coast of Colombia, looking at what happened in the past that threatened their viability and sustainability, and discussing the challenges that lie ahead. In Chap. 5, Salas et al. discuss the adaptive strategies of small-scale fishers in the Yucatán coast of Mexico as the communities are exposed to risks and resource use competition. Also in the Gulf of Mexico, Chap. 6 (Tolentino-Arévalo et al.) offers insights about how coastal fishing communities in Tabasco state, Mexico, cope and adapt to climate change while dealing with the oil industry.

*Part III* focuses on the roles of management, including monitoring and assessment, and how stakeholders are involved in promoting conservation and sustainability. This section begins with a description of how small-scale fishers can participate in conservation and stewardship by taking part in data collection and knowledge production about fisheries (Chap. 7; Fulton et al.). Fujita et al. (Chap. 8) present the situation in Belize in which new initiatives are introduced to deal with the risk of overfishing and overcapitalization in fisheries. In Chap. 9, a pre- and post-analysis is presented by Ramírez-Luna and Chuenpagdee to look at the origin and implementation of a management system called "exclusive fishing zone" and how it affects small-scale fisheries. Chapter 10 (Lopes et al.) offers an account of


**Fig. 1.2** The Latin America and Caribbean countries and states; blue denotes the 15 countries and states included in the case studies. (Source: M. Agapito, TBTI)

how Amazonian small-scale fisheries are managed, along with the key management challenges in this fishery. Finally, Galindo-Cortes et al. (Chap. 11) propose a shift from stock assessment to fisheries management and governance to achieve viability and sustainability goals.

Moving to options and opportunities for small-scale fisheries in enhancing viability and securing sustainability, *Part IV* presents examples of the interconnectivity between socioeconomic, market, livelihoods, viability, and sustainability. Beginning with Chap. 12, Edwards et al. introduce the Socioeconomic Monitoring Initiative for Coastal Management (SocMon) as a framework to assess the socio-ecological dynamics of small-scale fisheries and illustrate its applicability in Brazil, Jamaica, and the Grenadines Islands. Gill et al. (Chap. 13) present another comparative case study, this time looking at St. Kitts and Nevis, Honduras, and Barbados to analyze values associated with reef-related fisheries in these contexts. Similarly, Benítez and Flores-Nava (Chap. 14) discuss the contribution of small-scale fisheries to food security and family income in Chile, Colombia, and Peru. Next, Chap. 15 shifts the focus to the post-harvest part of the fish chain, which is often not discussed. However, as argued by Pedroza-Gutiérrez (Chap. 15), the way the supply chain is organized can help improve viability. The last two chapters in this part focus on dynamics. Naranjo-Madrigal and Bystrom (Chap. 16) analyze the dynamics of fishing efforts in Costa Rica and explore the linkages between social and ecological systems. In Chap. 17, González presents a rich description of the social dynamics in the Nicaraguan Miskito Coast, illustrating how indigenous lobster divers cope with external market pressure and the consequences on the resources.

The last set of case studies (*Part V*) speaks to the key elements for viability and sustainability related to community, stewardship, and governance. Chapter 18 (Seixas et al.) describes a collaborative governance system employed in Brazil and discusses the advantages and challenges associated with its implementation. Also in Brazil, Leis et al. [b] (Chap. 19) present a case for involving fishers in conservation and stewardship efforts, using the top-down establishment of a marine protected area as an example. Turner et al. (Chap. 20) offer another illustration of how stewardship initiatives affect governance perceptions among coral reef fishers in Barbados, Belize, Honduras, and St. Kitts and Nevis. Chapter 21 returns to Brazil with a study by Mattos and Wojciechowski, who analyze the existing institutions and legal framework used to govern small-scale fisheries and their implications on sustainable development. Finally, Barragán-Paladines (Chap. 22) brings the discussion about governance to the meta-level, examining how principles like *Buen Vivir* (i.e., good way of living) affect the viability and sustainability of small-scale fishing people in Ecuador and the Galapagos Islands.

In the conclusion section of the book (*Part VI*), Salas et al. (Chap. 23) summarize experiences and lessons from the case studies presented in the book, highlighting examples of the challenges facing small-scale fisheries in different countries in the Latin America and Caribbean region. It also shows how these challenges affect their viability and sustainability and how these difficulties have been addressed. Based on these insights, the chapter concludes with key interventions, tools, and approaches that would be desired to improve governance for viable and sustainable future of small-scale fisheries in the Latin America and Caribbean region.

The 20 case studies illustrate the diversity, complexity, and dynamics of small-scale fisheries in many countries and SIDS in the Latin America and Caribbean region. Some studies incorporate the complexity of natural, social, and cultural assets, arguing for the rights of small-scale fishers, including indigenous groups, for access to resources and markets. Other cases deal with the normative and formal instruments used to govern small-scale fisheries, showing both success stories and challenges. In some instances, the sources of vulnerability and the barriers to viability and sustainability are made explicit, with examples of external pressures, such as market fluctuation, related to environmental conditions and climate variability and postharvest situations. Many chapters recognize the important roles that the governance systems (including process, structure, institutional arrangements, and regulatory and legal frameworks) play in promoting viability and securing sustainability for small-scale fisheries.

The contributions of the 20 case studies and the two synthesis chapters illustrate the importance of an in-depth understanding of the entire small-scale fisheries systems from ecological, economic, social, and governance perspectives. These case studies also highlight the importance of contextualizing this understanding in terms of the threats and challenges affecting their viability and exploring opportunities for improving their conditions. The lessons and experiences presented in this volume provide options and alternatives that are worthy of inclusion in the formulation of policies and intervention for sustainable small-scale fisheries. They also help pave the way for the implementation of the SSF Guidelines in the Latin America and Caribbean region and in promoting the achievement of the SDGs, not only in the context of SDG14 but also regarding other goals such as alleviating poverty (SDG1), ending hunger (SDG2), good health and well-being (SDG3), and gender equality (SDG5), to name a few. As illustrated here, fisheries policies and practices need to be holistically conceived and integrative in order to promote the livelihoods and well-being of small-scale fisheries systems while protecting the health of resources and the aquatic environment.

The small-scale fisheries sector in Latin America and the Caribbean is far from homogenous. In fact, there are a broad range of similarities and differences within the small-scale fisheries in this region which, when compared to small-scale fisheries in other regions of the world, appear to be even more complex. These diverse experiences at both the regional and global scales offer to us a great opportunity to share and exchange lessons and perspectives that may be useful for fostering a broader conversation about the future of the world's small-scale fisheries.

**Acknowledgments** Both this chapter and the book itself are the product of the Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research (TBTI), funded through partnership grant # 895-2011-1011 by the Canadian Social Sciences and Humanities Research Council (SSHRC). We also thank Eva Coronado for the literature review and acknowledge FOMIX (2014-C17-247043) for providing financial support to Silvia Salas for her travel to Canada while she was working on the book.

## References

Alcalá-Moya G (ed) (2011) Pescadores en América Latina y el Caribe: espacio, población, producción y política, volúmenes I y II. Universidad Nacional Autónoma de México, Facultad de Ciencias-Unidad Multidisciplinaria de Docencia e Investigación-SISAL, Yucatán, México

Crona BI, Van Holta T, Petersson M, Daw TM, Buchary E (2015) Using social–ecological syndromes to understand impacts of international seafood trade on small-scale fisheries. Glob Environ Chang 35:162–175

Defeo O, Castrejón M, Ortega L, Kuhn AM, Gutiérrez NL, Castilla JC (2013) Impacts of climate variability on Latin American small-scale fisheries. Ecol Soc 18(4):30. https://doi.org/10.5751/ES-05971-180430
FAO (2015) Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. Rome, United Nations Food and Agriculture Organization, FAO
FAO (Food and Agriculture Organization of the United Nations) (1995) Code of conduct for responsible fisheries. FAO, Rome
ISSF. (2017). Information system on small-scale fisheries. Issfcloud.toobigtoignore.net. Accessed 31 Aug 2017
Jentoft S (2014) Walking the talk: implementing the international voluntary guidelines for securing sustainable small-scale fisheries. Mar Stud 13:16
Jentoft S, Chuenpagdee R (eds) (2015) Interactive governance for small-scale fisheries: Global reflections. MARE Publication series 13. Springer, Cham
Jentoft S, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) (2017) The small-scale fisheries guidelines: Global implementation. MARE Publication series 14. Springer, Cham
Johnson DS, Acott TG, Stacey N, Urquhart J (eds) (2017) Social wellbeing and the values of small-scale fisheries. MARE Publication series 17. Springer, Cham
Orensanz JM, Parma AM, Jerez G, Barahona N, Montecinos M, Elías I (2005) What are the key elements for the sustainability of 'S-fisheries'? Insights from South America. Bull Mar Sci 76:527–556
Pauly D, Zeller D (eds) (2016) Global atlas of marine fisheries – a critical appraisal of catches and ecosystem impacts. Island Press, Washington D.C.
Salas S, Chuenpagdee R, Seijo JC, Charles A (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fish Res 87(1):5–16
Salas S, Chuenpagdee R, Seijo JC, Charles A (2011) Coastal fisheries of Latin America and the Caribbean. FAO fisheries and aquaculture technical paper 544. FAO, Rome
Schuhbauer A, Sumaila UR (2015a) Economic viability and small-scale fisheries: a review. Ecol Econ 124:69–75
Schuhbauer A, Sumaila UR (2015b) Assessing the economic viability of small-scale fisheries: an indicator-based framework. University of British Columbia, Fisheries Economic Research Unit, and Too Big To Ignore, Vancouver
Schuhbauer, A, Sumaila UR (2016) Economic viability and small-scale fisheries - A review. Ecological Economics, 124(C):69–75
UN (2017). Sustainable Development Goals. Sustainable development knowledge platform, Department of Economic and Social Affairs, United Nations. https://sustainabledevelopment.un.org/. Accessed 15 Sept 2017
UNEP (2016) GEO-6 regional assessment for Latin America and the Caribbean. United Nations Environment Programme, Nairobi

**Ratana Chuenpagdee** is a professor at the Department of Geography, Memorial University of Newfoundland, St. John's, Canada. She held the position of a Canada Research Chair in Natural Resource Sustainability and Community Development at Memorial University from 2006 to 2016. Her research emphasizes interdisciplinary approaches to coastal, fisheries, and ocean governance, focusing particularly on small-scale fisheries, marine protected areas, community-based management, and food security. She has worked in several countries including Cambodia, Malawi, Mexico, Spain, Thailand, and Canada. Dr. Chuenpagdee is a director of the Too Big To Ignore (TBTI) Global Partnership for Small-Scale Fisheries Research and one of the editors of the 2017 book 'The Small-Scale Fisheries Guidelines: Global implementation'.

**Silvia Salas** is a professor at the Marine Resources Department at Cinvestav Unidad Merida, Mexico. Her background is in Marine Science (Cinvestav, MSc) and Resource Management and Environmental Studies (University of British Columbia, Canada, PhD). She has competence in fisheries bio-economics and management, fleet dynamics and fishing strategies, vulnerability, and risk perception with an emphasis on small-scale fisheries. She has participated as a consultant in several FAO workshops and has collaborated as a member of the advisory committee of the WECAF Region (FAO). Currently she is the representative of Latin America in the IIFET Board Committee and represents Mexico in NAAFE Board Committee. She is also one of the collaborators in the TBTI partnership.

**María José Barragán-Paladines** obtained a PhD in Geography at Memorial University of Newfoundland in St. John's, Canada. Her undergraduate and master's research at the Technical University of Munich (TUM) focused on Marine Protected Areas (MPAs) and marine wildlife management. Her PhD research employed the interactive governance approach, with a specific focus on MPAs, examining the governability of the Galapagos Marine Reserve. She collaborates with TBTI and is currently a post-doctoral researcher in the "Development and Knowledge Sociology" at the Leibniz Centre for Tropical Marine Research in Bremen, Germany. Her research interests include small-scale fisheries sustainability, fishing community viability, food security from the marine perspective, and marine resource governance.

# Chapter 2
# Overview of Small-Scale Fisheries in Latin America and the Caribbean: Challenges and Prospects

**Mirella de Oliveira Leis, María José Barragán-Paladines, Alicia Saldaña, David Bishop, Jae Hong Jin, Vesna Kereži, Melinda Agapito, and Ratana Chuenpagdee**

**Abstract** The importance of small-scale fisheries in Latin America and the Caribbean has been widely recognized in terms of income, livelihoods, and food security for more than two million people. The highly diverse ecosystems and multiple species found within this region determine the variety of fishing techniques, gears, and target species, as discussed in this chapter. These diverse and complex characteristics pose challenges to the region's governing systems, which may lack the technical and financial resources to cope with the numerous resulting management and governance challenges. These pressures are further exacerbated when fisheries assessment and monitoring are poorly conducted, adding uncertainty in relation to the status of the ecosystem and fish stocks. Small-scale fisheries activities thus have become vulnerable in the face of various challenges in Latin America and the Caribbean. Current efforts to enhance small-scale fisheries viability and sustainability in Latin America and the Caribbean include the adoption of innovative management approaches that focus on the entire ecosystems rather than on single species and that acknowledge the concerns of local stakeholders in decision-making through strategies such as collaboration with the government in co-management arrangements. Although many of these co-management arrangements

M. de Oliveira Leis (✉) · A. Saldaña · D. Bishop · J. H. Jin · V. Kereži
M. Agapito · R. Chuenpagdee
Too Big To Ignore Global Partnership for Small-Scale Fisheries Research, Memorial University of Newfoundland, St. John's, NL, Canada
e-mail: mirella.deoliveiraleis@mun.ca; asaldanamill@mun.ca; d.bishop@mun.ca; toobigtoignore@mun.ca; mta557@mun.ca; ratanac@mun.ca

M. J. Barragán-Paladines
Development and Knowledge Sociology-Social Science Department, Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany
e-mail: mariaj.barraganp@leibniz-zmt.de

 
S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_2

in the region are still nascent, this chapter highlights that fishers and their organizations play a significant role in responsible resource governance through exercising ecosystem stewardship.

**Keywords** Latin America and the Caribbean · Small-scale fisheries · Governance · Viability · Sustainability · Environmental stewardship

## 2.1 Introduction

Small-scale fisheries in the Latin America and Caribbean region can be traced back to pre-colonization periods (i.e., before the fifteenth century) (Diegues 2008; Bray 2012; Rostworowski 2015). At the time, the inhabitants of the Americas relied heavily on fishing resources for subsistence. Historically, the development of fishing practices and knowledge about resources and fishing grounds were passed on from elders to younger generations by different strategies, some of which are still present in some communities (De Madariaga 1969). After colonization, the monetary value attributed to fish and its trade triggered the shift from a subsistence-based to commercial fishery. This change opened space for fishing enterprises that actively searched to expand their fishing effort in the region, particularly during the 1980s (Allsopp 1985; Tassara 1994; Salas et al. 2007). This expansion coincided with liberal political agendas combined with neoliberal practices such as financialization, deregulation, and privatization, among other drivers of change (Pinkerton 2017). In the same vein, nation states made a major push to develop industrial fisheries and increase fishing fleets, arguing that such development would generate jobs and help secure food availability for coastal communities (Chuenpagdee et al. 2011).

According to FAO (2016), almost 90% of all motorized fishing vessels in the Latin America and Caribbean region are considered small scale, or less than 12 m in length. Despite the recognition that there is no single agreed-upon definition of small-scale fisheries (FAO 2015), and that the criteria used in Latin America and the Caribbean to define small-scale fisheries vary remarkably across countries, small-scale fisheries are generally characterized by a small number of fishing crew (3–5 fishers), are largely community-based, operate in nearshore areas, use low levels of fishing technology, and have limited capital investment (Salas et al. 2007). Further, they typically target multiple species and use a large diversity of gears and fishing techniques that vary spatially and temporally as determined by the dynamics of resource availability (Salas et al. 2007). Small-scale fisheries in the region are deeply linked to the history and culture of local fishing communities and have a strong influence on the regional economy through the generation of employment, income, and livelihoods.

More than a third of total landings and almost half of the economic value of fish landed in Latin America and the Caribbean come from small-scale fisheries (Pauly and Zeller 2015). However, the contributions of the Latin American and Caribbean countries to overall small-scale fisheries catches vary significantly. For instance, the highest landings come from Latin American countries (i.e., Chile, Mexico, Peru, Brazil, and Argentina) (Pauly and Zeller 2015), whereas some Caribbean countries account for the highest landed value per tonne of fish produced (e.g., Anguilla, Bahamas, British Virgin Islands, US Virgin Islands, Turks and Caicos) (Salas et al. 2007; Pauly and Zeller 2015). This reflects different catch strategies, with the Caribbean fisheries targeting a relatively low volume of high value benthic resources (e.g., spiny lobster *Panulirus argus*, queen conch *Strombus gigas*, and different species of shrimp), which are mostly destined for export and tourism (Mahon 2008). The Latin American fisheries, on the other hand, in spite of their high diversity (Baldeo 2011; Herrera et al. 2011; Herrera-Ulloa et al. 2011; Valle et al. 2011), primarily target demersal fish species (i.e., Brazil and Argentina) or small pelagic species (i.e., Chile, Mexico, and Peru) in a comparatively high volume that generates high revenue despite a lower value per tonne (Salas et al. 2011).

The diversity and complexity of small-scale fisheries in Latin America and the Caribbean mean that management approaches and overall fisheries governance may differ according to the national context. While some regional cooperation and scaling up of the governing system are already happening in the region, other approaches may need to be considered to support the implementation of the *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*, further on referred to as the SSF Guidelines (FAO 2015). From that perspective, this chapter provides an overview of small-scale fisheries in the region, emphasizing key characteristics that include the diverse systems of fisheries governance. However, this overview is not exhaustive in light of several important differences that can be observed within the region. The description of small-scale fisheries in Latin America and the Caribbean is then followed by a discussion of the challenges they face in the region and conditions that are favorable for achieving the viability and sustainability of small-scale fisheries in pursuit of the implementation of the SSF Guidelines.

## 2.2 Data Sources

We relied on three main data sources for information about small-scale fisheries in Latin America and the Caribbean. First, we conducted a comprehensive literature review of peer-reviewed publications, books, and monographs on topics related to small-scale fisheries. Second, we used publicly available databases maintained by the Food and Agriculture Organization of the United Nations (FAO), such as the Country Fishery Profile and the FAO Global Statistics, the *Sea Around Us* Project for large-scale and small-scale fisheries catches and values (Pauly and Zeller 2015), and the Information System on Small-Scale Fisheries (ISSF) (Chuenpagdee and Devillers 2015; Chuenpagdee et al. 2017). The latter was produced by the Too Big To Ignore Global Partnership for Small-Scale Fisheries Research (TBTI). ISSF data used in the analysis (downloaded in November 2016) include 44 small-scale fisheries profiles covering 15 countries in the region as well as 289 publications from 33 countries. The database also includes information on fisheries subsidies, which were revealed in a PhD thesis (Schuhbauer et al. 2017). Finally, we consulted various sources of government documents and gray literature available from government agencies in the region (e.g., Brazilian Ministry of Fisheries and Aquaculture, Chilean *Servicio Nacional de Pesca, Ministerio de Economia, Fomento y Turismo*) and from regional organizations, research institutions, civil society organizations, and fishery bodies like the *Organización del Sector Pesquero y Acuícola del Istmo Centroamericano* (OSPESCA), the Caribbean Regional Fisheries Mechanism (CRFM), and the Western Central Atlantic Fishery Commission (WECAFC), among others.

## 2.3 Characteristics of Small-Scale Fisheries in Latin America and the Caribbean

### *2.3.1 Diverse Ecosystems*

The Latin America and Caribbean region is one of the world's richest regions in terms of biodiversity abundance and endemism rates (Olson and Dinerstein 1998; Olson et al. 2002). Brazil, Colombia, Ecuador, Mexico, and Peru are among the top ten most biodiverse countries in the world (Bovarnick et al. 2010), together accounting for 60–70% of all known life on Earth (UNEP 2016). With the Caribbean Sea in the northeast, the Atlantic Ocean to the east, and the Pacific Ocean to the west, the Latin America and Caribbean region includes FAO Major Fishing Areas 31 (Western Central Atlantic), 41 (Southwest Atlantic), 77 (Eastern Central Pacific), and 87 (Southeast Pacific) (FAO 2017). The area also encompasses ten Large Marine Ecosystems (LMEs), namely, the California Current, Gulf of California, Gulf of Mexico, Pacific Central-American, Caribbean Sea, Humboldt Current, Patagonian Shelf, South Brazil Shelf, East Brazil Shelf, and North Brazil Shelf (Brown 2017). This broad geography results in very diverse coastal, marine, and inland ecosystems, which include coral reefs, seagrass beds, mangroves, sandy beaches, tidal flats, lagoons, estuaries, salt marshes, large river basins, and wetlands (Seeliger and Kjerfve 2001; UNEP 2010, 2016). The diversity of ecosystems and species is reflected in the number of species caught by small-scale fisheries in each country, with Brazil leading the region at 251 species (Fig. 2.1).

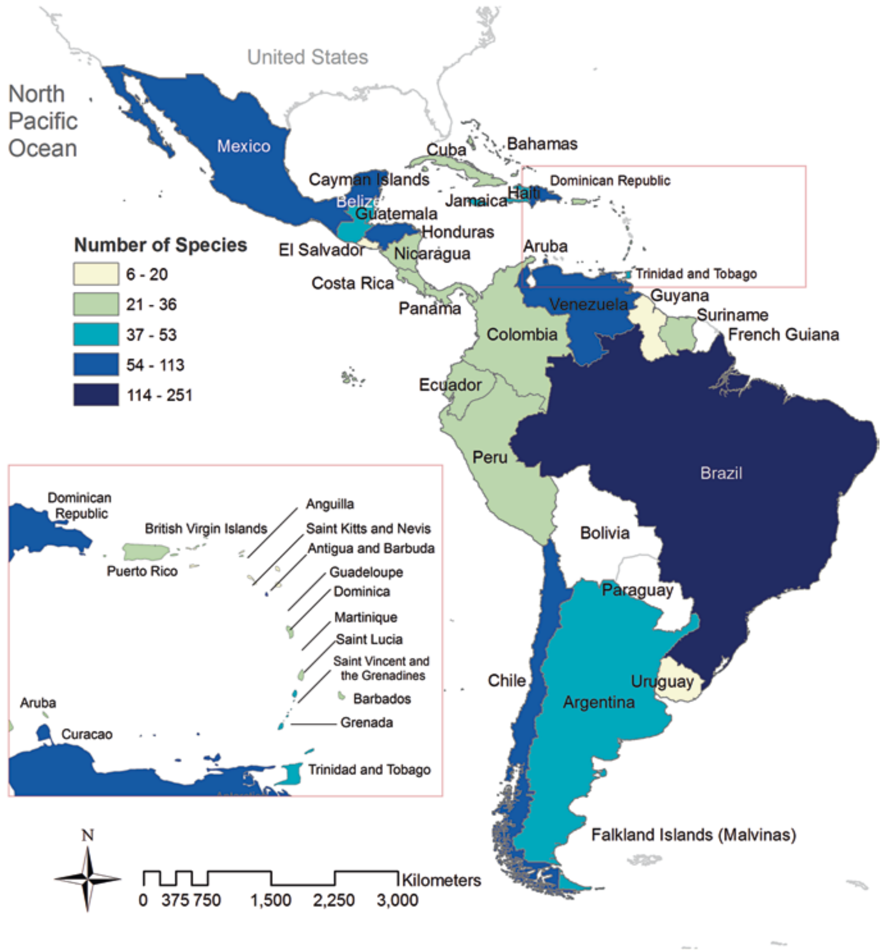



**Fig. 2.1** Total number of species caught by small-scale fisheries in each country of the Latin America and Caribbean region (Source: *Sea Around Us* Project; Pauly and Zeller 2015)

### *2.3.2 Diversity of Target Species and Gears*

With the diverse ecosystems in which small-scale fisheries in Latin America and the Caribbean take place, including both marine and freshwater habitats, the sector encompasses a wide spectrum of species and fishing practices (Macchi et al. 2014). A great variety of species is targeted in the region, including mollusks (e.g., bivalve, gastropod, cephalopods), crustaceans, echinoderms, and demersal and pelagic fishes. For instance, Elías et al. (2011) report 64 species caught in Argentina, Mohammed et al. (2011) report close to 40 species and groups of species for Trinidad and Tobago, and Fernández et al. (2011) found that more than 120 species are caught on both the Pacific and Atlantic coasts of Mexico. Despite the diversity of species targeted in the region, some species or group of species support the main landings in different subregions, with fishing gears varying according to species targeted. The main species targeted by small-scale fisheries on the Caribbean coast in terms of economic value include benthic resources like the spiny lobster (*Panulirus argus*) and queen conch (*Strombus gigas*), which are caught mainly using traps and diving techniques. Another important group of species that is caught heavily at the local scale in the Caribbean are large pelagics such as tuna-like species, as well as dolphinfish, wahoo, and reef fish (Mahon 2008; Fanning et al. 2013). In the Guianas-Brazil region, different species of shrimp constitute the main target (*P. brasiliensis*, *Penaeus subtilis*, *P. notialis*, *P. schmitti*, and *Xiphopenaeus kroyeri*) (Phillips et al. 2011). In South America, the focus is on small pelagic species (e.g., anchovy, sardine) or demersal fish species (e.g., croaker, hake), which have been prominent for several decades (Salas et al. 2011; Pauly and Zeller 2015). Specifically, small pelagic fishes are the predominant target in Peru and Chile, where they are caught using purse seines, while demersal fishes are the main target in Uruguay and Brazil, where they are harvested using trawls (Baldeo 2011; Pauly and Zeller 2015). Diving is also a common fishing method, performed using hookah gear (Herrera et al. 2011). According to the ISSF database, the most common fishing gears reported for Latin America and the Caribbean are hooks and lines, gillnets, surrounding nets, and traps (Chuenpagdee et al. 2017).

### *2.3.3 Catches and Values of Marine Fisheries*

The small-scale fisheries sector in Latin America and the Caribbean constitutes almost one third of the total marine catch in the region (FAO 2016). According to the *Sea Around Us* project, catches from marine waters are estimated at about 4.1 million tonnes in the region (Pauly and Zeller 2015). In some countries, small-scale fisheries represent the majority of the national fisheries catch. For instance, there are about 20 countries and island states in Latin America and the Caribbean where small-scale fisheries provide more than 90% of the total national catch.

Even though overall small-scale fisheries catches are smaller than industrial fisheries, especially considering the catch of one single species – the world's largest fishery, Peruvian anchoveta (*Engraulis ringens*), with an annual catch of over 95 million tonnes (Pauly and Zeller 2015; Majluf et al. 2017) – the landed value of small-scale fisheries catches is estimated to be about $8 billion USD, or 54% of the total landed value (Pauly and Zeller 2015). This implies that the value per tonne of small-scale fisheries is more than twice that of large-scale fisheries (about $3,131 per tonne vs. $1470) (Pauly and Zeller 2015). This figure highlights the importance of small-scale fisheries to the social and economic development in the region.

*Latin America* Chile, Mexico, Peru, Brazil, and Argentina are the top five countries in the Latin America subregion in terms of absolute marine catch and landed value (Fig. 2.2). However, small-scale fisheries are more dominant in French

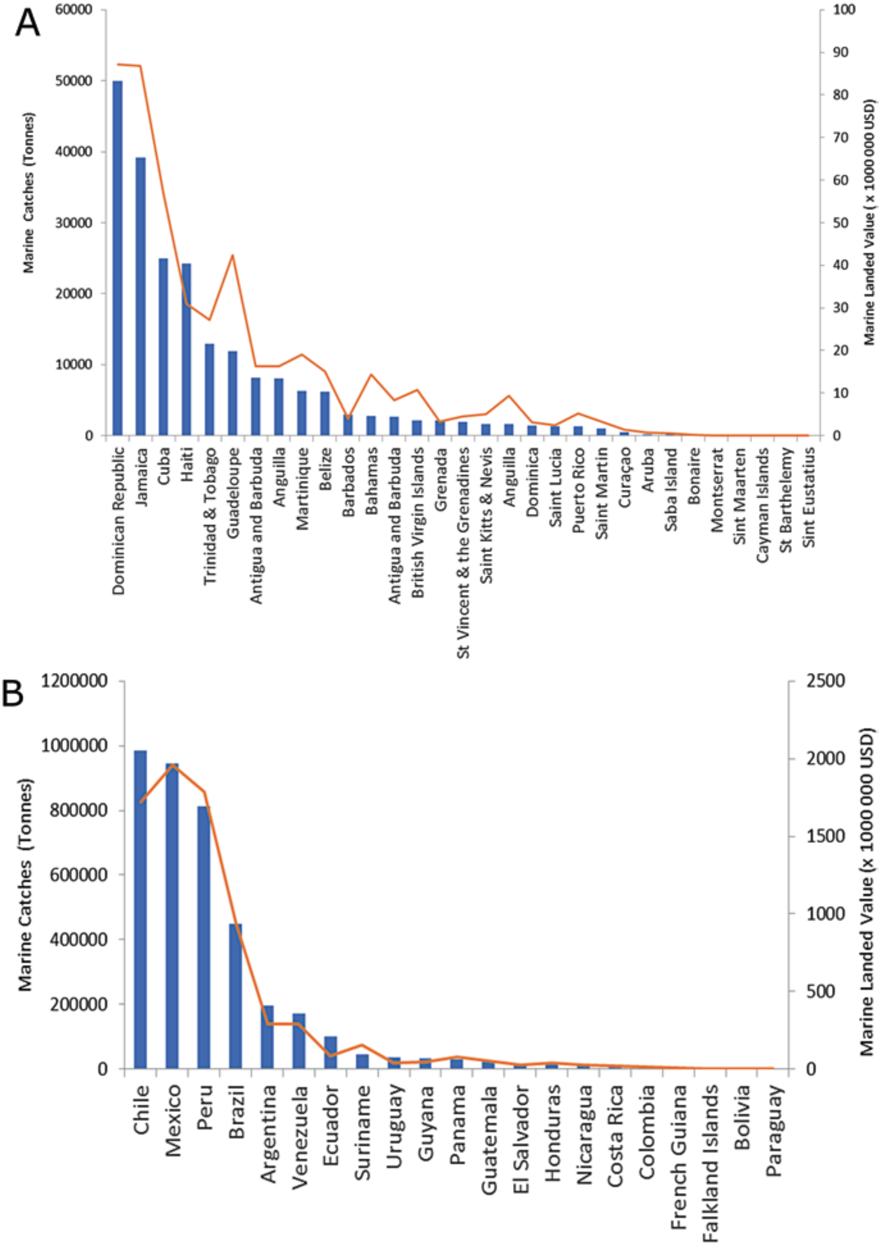



**Fig. 2.2** Small-scale fisheries marine catch and landed value for the Caribbean (**a**) and for Latin America (**b**) (Source: *Sea Around Us* Project 2017, Pauly and Zeller 2015)

Guiana, Venezuela, Honduras, and Suriname, representing more than 75% of total catch and landed value, including industrial fisheries. Suriname, French Guiana, and Honduras represent the highest value per tonne in the subregion, with landings valued at more than $2,800 per tonne in these countries (Pauly and Zeller 2015; Sea Around Us database 2017).

*The Caribbean* includes many countries in which fisheries catches and landed value come almost entirely from small-scale fisheries. In three specific cases (Haiti, Montserrat, and Jamaica), all catches are small-scale (Pauly and Zeller 2015; Sea Around Us database 2017). The Dominican Republic and Jamaica lead the subregion with the largest marine catches and landed values, catching about 40,000 tonnes worth over $80 million USD. However, in terms of value per tonne, Anguilla, Bahamas, and the British Virgin Islands rank highest in the subregion, valued at over $5,000 USD per tonne (Pauly and Zeller 2015; Sea Around Us database 2017).

### *2.3.4 Inland Fisheries*

Inland fisheries play a very strong role in Latin America and the Caribbean. These fisheries take place in the Usumacinta river system in Mexico; the large river systems of the Amazon, Orinoco, and La Plata; and important secondary river systems such as the Essequibo in Guyana, the São Francisco in Brazil, and the Magdalena in Colombia. Fishing also occurs in lakes such as Lake Nicaragua, the Andean lakes of Argentina and Chile, and Lake Titicaca, as well as several reservoirs in Brazil and Venezuela and the Pantanal wetlands of the upper Paraguay River (FAO 2011). However, information about this sector is currently insufficient for effective management (Béné and Neiland 2003; Miao et al. 2010; Cooke et al. 2014; Youn et al. 2014).

South America accounts for one of the largest rivers in the world in terms of volume of water discharge, the Amazon river. Brazil leads the region in terms of inland landings, with about 235,527 tonne/year, followed by Mexico (123,688 tonnes) and Venezuela (43,681 tonnes), as shown in Fig. 2.3 (FAO 2009). The importance of inland small-scale fisheries to local economies in the Brazilian and the Bolivian Amazon river basin is enormous. In Brazil, inland small-scale fisheries employ more than 200,000 people and serve as a revenue source worth about $200 million USD per year for riparian communities, with over 200 fish species being targeted for human consumption in the Brazilian Solimões-Amazon river basin (Fischer et al. 1992; Barthem and Fabré 2004). A high level of complexity and diversity in Brazilian inland small-scale fisheries activity is reflected in catch composition, type of fishing ground, and fishing gear used (Lopes et al. 2016).

In the Bolivian Amazon, indigenous fisheries targeting the "paiche" (*Arapaima gigas*) have become commercially significant, accounting for about 80% of the catch in that region (Macnaughton et al. 2015). In the Caribbean, only four countries report their inland catches, of which Cuba encompasses the largest share with 1,680 tonnes, followed by the Dominican Republic (842 tonnes), Haiti (600 tonnes), and

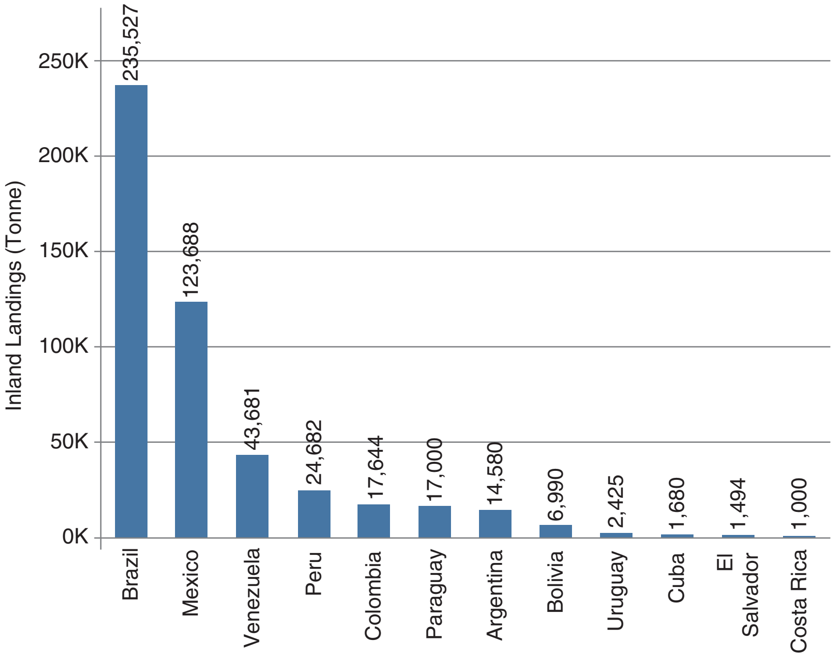



**Fig. 2.3** Inland landings, in tonnes, for the top 12 countries in Latin America and the Caribbean (Source: FAOSTAT; FAO 2009)

Jamaica (400 tonnes) (FAO 2009). Inland production in Cuba, the Dominican Republic, and Jamaica is mainly driven by stocking schemes in reservoirs, with Cuba having had a much larger inland fisheries production in the 1990s (16,000 tonnes) when funding for stocking was abundant (FAO 2011). Inland fisheries are particularly important to landlocked countries, where they constitute an important source of animal protein and the only domestic source of fisheries products (FAO 2011). The two landlocked countries in the region, Paraguay and Bolivia, land 17,000 and 6,990 tonnes of fish, respectively (FAO 2009).

### *2.3.5 Social and Cultural Diversity, Employment, and Livelihoods*

It is estimated that roughly 2 million people are either directly or indirectly linked to small-scale fisheries in Latin America and the Caribbean (Salas et al. 2011). This sector greatly contributes to the alleviation of poverty and malnutrition, as well as the food security of the region (Hanazaki et al. 2013). The region also encompasses an extensive social and cultural diversity, expressed by the myriad of languages, cultural identities, spiritual attributes, and historical features present in Latin

America and the Caribbean, which have shaped the tight relationship that exists between fishing people and aquatic environments (Diegues 2008). In fact, both past and current social and natural dimensions implicit in fishing practices are balancing the role that small-scale fishers play in enhancing the sense of care for the marine environment and the responsible use of shared fishing resources (Medeiros et al. 2014).

Given the diverse sociocultural context, a homogenous approach for addressing the poverty and social marginalization of fishers in the region is unlikely to be found (Gasalla and de Castro 2016). Such an approach would be further limited by the ethnic, cultural, religious, and spiritual differences in the fishing traditions that occur across Latin America and the Caribbean. These large subregional variations show the deeply embedded ancestral connections between fishers, their territories, and the seas surrounding them. The multiple meanings and stories that are intermingled within those rapports also form part of the self-identities of local coastal communities, both in indigenous communities and in areas with predominant European influence (Lafer 2014).

An additional transcendental dimension associated with small-scale fisheries in the Latin American and Caribbean context is the traditional knowledge that is associated with this activity. It has been said that the production and transmission of fishing knowledge have led to the diversification of fishing techniques, gears, and fishing grounds, as exhibited by the fishing communities at large (Galván-Tudela 1988, 1990; Pascual-Fernández 1991). These varied sources and forms of knowledge have enabled fishers in the region to adapt to seasonal fluctuations in conditions such as changing riverine water levels, coastal geomorphology dynamics, seasonal abundance, species composition, and distribution and even to dynamic cultural and spiritual practices associated with the act of fishing.

### *2.3.6 The Importance of Fish as Food*

Fish has been highlighted as a food source of high nutritional value and an important source of protein and micronutrients (Béné et al. 2015, 2016). From the standpoint of fishing communities, the local availability of fish determines the patterns of animal protein consumption more so than direct economic dependency on fisheries (Bezerra da Costa et al. 2014). Thus, fish consumption within the Latin American and Caribbean context varies remarkably across the region, ranging from high fish consumption indices in Caribbean countries to relatively low figures for most of South America except a handful of countries like Chile (Villanueva-Benitez and Flores-Nava, Chap. 14, this volume). Per capita fish consumption has also been generally low in certain parts of Central America (FAO 2013). On average, fish and seafood consumption in Latin America and the Caribbean, based on food supply data, is 15 kg/capita/year (FAO 2013). This number shows that, despite the significant average of apparent fish and seafood consumption in this region, it still ranks rather low compared to the global average of apparent fish and seafood consumption (19.7 kg/capita/year) and much lower than high-consuming countries in Asia, Oceania, and Europe. Maldives, Iceland, Kiribati, Hong Kong, and Malaysia, for instance, consume over 50 kg of fish and seafood per capita per year; in Latin America and the Caribbean, per capita fish and seafood consumption ranges from as low as 1.3 kg/capita/year in Guatemala to about 53 kg/capita/year in Antigua and Barbuda (FAO 2013).

A variety of factors affect fish and seafood consumption patterns, such as access, availability, and affordability of fish as food. In the case of Latin America and the Caribbean, lower apparent fish and seafood consumption in certain countries in Central America (e.g., Guatemala with 1.3 kg/capita/year, the lowest in the region, and Honduras, with about 4 kg/capita/year) and South America (e.g., Argentina and Uruguay with about 7 kg/capita/year each) can be partly explained by the high availability of other animal protein sources (FAO 2013). Cultural factors also play a role in influencing consumer preferences toward food. In some cases, food taboos or food prohibitions are observed in regions such as riverine communities in the Amazon and along the Atlantic Forest coast in Brazil (Begossi et al. 2004).

Overall, per capita usage of fish and seafood for human consumption at the global scale is likely to increase significantly in the next decade. Global per capita fish consumption reached a record high in 2014 of almost 20 kg/capita/year, with Latin America and the Caribbean playing an important role in this growth (e.g., Brazil, Peru, Chile, and Mexico). This increase was due to a wide array of factors occurring in developing countries such as rising living standards, population growth, rapid urbanization, the growing recognition of fish as healthy and nutritious food, and technological developments in food processing, packaging, and distribution (FAO 2016). However, this increasing trend in fish and seafood consumption may not be reflected at a local scale in some cases. In Puruba Beach, southeastern coast of Brazil, a small-scale fisheries community experienced a reduction in fish consumption and in the diversity of species eaten, followed by an increased reliance on external food sources, reflecting dietary changes over time (MacCord and Begossi 2006). Additionally, authors like Golden et al. (2017) have raised an issue about the availability, accessibility, and affordability of fish as food, and its resulting importance to food security, in fishing communities where aquaculture has been strongly promoted. It remains largely unclear to what extent aquaculture activities mitigate the food insecurity of fishing communities in Latin America and the Caribbean (Hellebrandt et al. 2014).

### *2.3.7 Distribution of Subsidies*

Globally, the majority of subsidies (about 84%) go to support large-scale fisheries (Schuhbauer et al. 2017) and are mainly destined for subsidizing fuel costs and enhancing capacity (Sumaila et al. 2010). Schuhbauer et al. (2017) have analyzed fisheries subsidies in 81 countries which together represent 98% of global subsidies allocated to fisheries in 2009, or $35 billion USD. The share of subsidies allocated

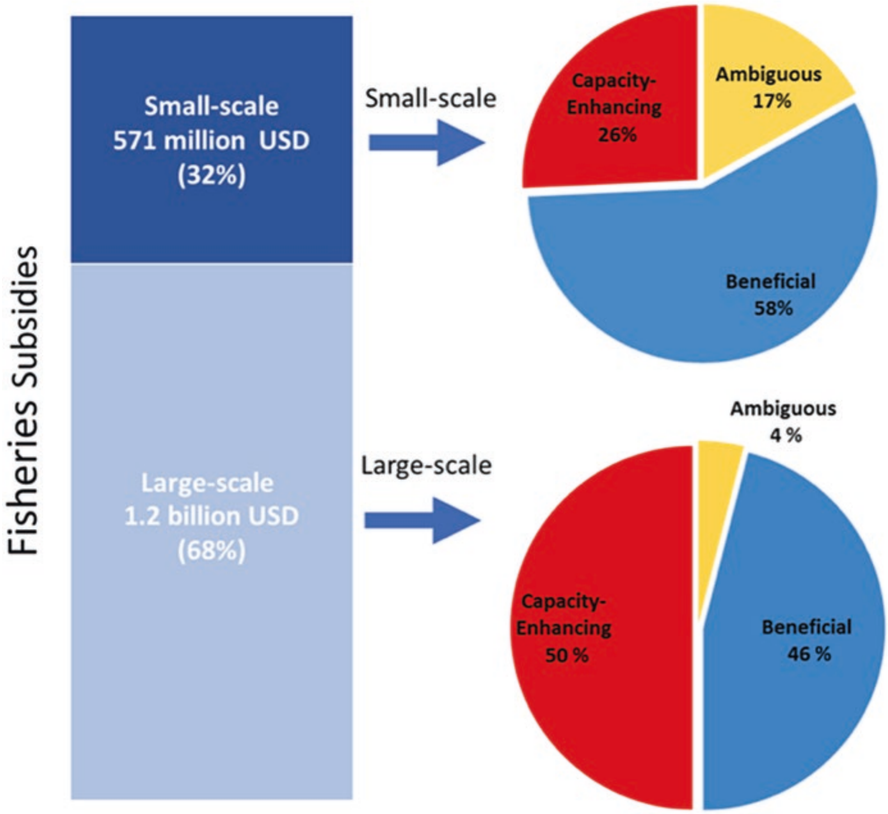



**Fig. 2.4** Proportion of fisheries subsidies allocated to small-scale fisheries and large-scale fisheries in Latin America and the Caribbean and the share designated to capacity-enhancing, ambiguous, and beneficial subsidies for each (Source: Chuenpagdee and Devillers 2015; ISSF database 2016; Schuhbauer et al. 2017)

to small-scale fisheries in Latin America and the Caribbean is much higher than the global average, with about 32% allocated to small-scale fishers (Fig. 2.4; Schuhbauer et al. 2017; ISSF database 2017, Chuenpagdee and Devillers 2015). These small-scale fisheries subsidies are divided into three categories as follows: beneficial (57.7%), capacity-enhancing (25.7%), and ambiguous (16.6%) (Schuhbauer et al. 2017). Schuhbauer et al. (2017) define the fisheries subsidy categories as follows: (1) beneficial subsidies go to fund fisheries management, fisheries research and development, and marine protected areas; (2) capacity-enhancing subsidies support boat construction, renewal and modernization, development programs, port development, infrastructure for marketing and storage, tax exemptions, and fishing access agreements; and (3) ambiguous subsidies go to fisher assistance, vessel buyback, and rural fisheries community development programs.

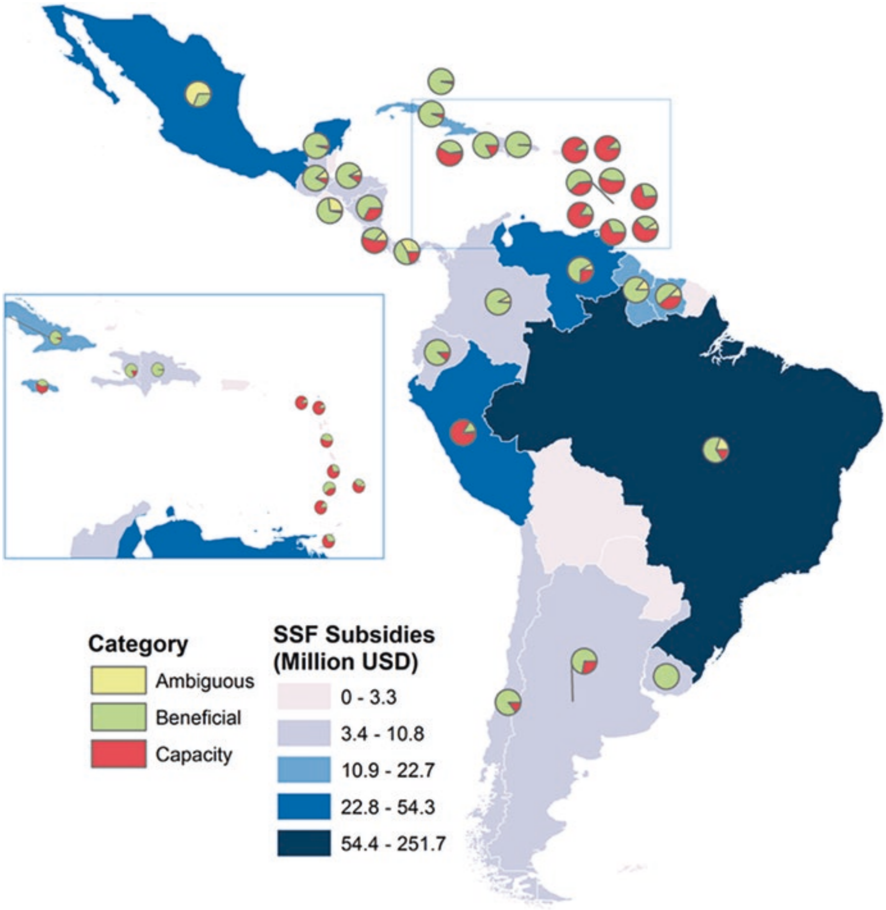



**Fig. 2.5** Subsidies allocated to small-scale fisheries in the Latin America and Caribbean region in million USD and the share of capacity-enhancing, ambiguous, and beneficial subsidies per country (Data source: Schuhbauer et al. 2017; ISSF database 2016, Chuenpagdee and Devillers 2015)

There are remarkable differences in subsidy category allocations throughout the region. The capacity-enhancing subsidies are primarily concentrated in the Caribbean, whereas in Latin American countries, priority is given to the beneficial subsidies, followed by ambiguous subsidies (Fig. 2.5). The capacity-enhancing subsidies in the Caribbean are highest in St. Kitts and Nevis, where they are mostly allocated to fisheries development projects, followed by Antigua and Barbuda and Grenada, which mostly have similar subsidies (Schuhbauer et al. 2017). Historically, public policies on fisheries subsidies have aimed at increasing fish catches through capacity enhancement, especially between the 1960s and 1980s, until these measures led to overexploitation and declines in catches, as in the case of Brazil (Abdallah and Sumaila 2007). The ambiguous subsidies are mostly used in Mexico

(69%), Panama (33%), El Salvador (27%), and Brazil (19%), where a relatively large share of the total subsidies to small-scale fisheries are destined toward fisher assistance, vessel buyback, and rural fisher community development programs (Schuhbauer et al. 2017). According to Schuhbauer et al. (2017), beneficial subsidies represent more than 80% of the total subsidies allocated to small-scale fisheries in Guyana, Chile, Cuba, Ecuador, Guatemala, Haiti, and Honduras. They are especially significant in Colombia, where 90% of designated beneficial subsidies support marine protected areas and fisheries management, and in Uruguay, where almost all small-scale fisheries subsidies are also dedicated to this end.

## 2.4 Fisheries Governance Systems

While top-down governance modes still dominate in the region, according to the data in ISSF, co-management regimes are gaining ground in several Latin American and Caribbean countries in recent decades (Chuenpagdee and Devillers 2015; ISSF database 2016). Since the late 1980s, co-management regimes for small-scale fisheries in Latin America and the Caribbean have been informed by the commons theory (Ostrom 1990; Ostrom et al. 1999) and were proposed as part of the solution to resource conflicts and crises (Jentoft et al. 1998). This approach has been considered a hybrid system that combines centralized and decentralized formats, as well as community and state institutions (Singleton 2000), in a system of fisheries governance that requires active community participation (Noble 2000).

Devolution and sharing of government power with local stakeholders in fisheries resource management usually requires an enabling environment for collective action, with an important role in co-management activities played by small-scale fishers' associations and cooperatives. Fishers' cooperatives are of the utmost importance for the viability and sustainability of small-scale fisheries, not only in Latin America and the Caribbean but worldwide (Pomeroy 1995; Le Sann 1997). The capacity of small-scale fisheries communities to take collective action, in conjunction with government support, in particular has been demonstrated as fundamentally important to achieving fisheries sustainability in developing countries (Kosamu 2015). In Brazil, Kalikoski et al. (2009) state that small-scale fisheries cooperatives have been a strong ally in successful community-based initiatives, where co-management arrangements usually take place inside marine protected areas that allow for sustainable resource use, with fishers participating as part of the MPA council, or in fishing fora (McConney and Medeiros 2014). In the Baja California peninsula, social organizations for small-scale fisheries include more than 200 fishing cooperatives, which have contributed to reducing the transaction costs of fishing activities as well as increasing access to fishing permits and markets (Ramirez-Sanchez et al. 2011). This form of small-scale fisher self-organization has also been described as a means to bringing non-monetary benefits to fishers in some situations such as promoting empowerment and providing leadership as a unified effort to protect small-scale fisheries livelihoods in Latin America (Pollnac 1988).

In Mexico, the cases of the lobster (Méndez-Medina et al. 2015) and abalone fishery (Searcy-Bernal et al. 2010) illustrate a supportive dynamic between fishers' cooperatives and government. Another example of a highly effective small-scale fishing cooperative is from the Punta Allen fishery, located in the Sian Ka'an Biosphere Reserve in the state of Quintana Roo, Mexico (Sosa-Cordero et al. 2008; Cunningham 2013). According to Cunningham (2013), the partnership between the government and the fishers' cooperative has fostered greater community accountability and has enabled the fishing community to be an effective steward of the resource. This positive environment has brought economic and social prosperity to the fishing community from the 1960s to date. It has recently been reported that small-scale fishers in the Punta Allen lobster fishery perceive the co-management regulations to be highly effective, and the success of this co-management arrangement could be partly due to an equal distribution of fishing incomes and benefits among fishers (Villanueva-Poot et al. 2017).

In the Caribbean, local user organizations are few, and have not played an active role in resource governance or fostering co-management in practice due to cultural and historical barriers to social cohesion and collective action (Brown and Pomeroy 1999; Mahon 2008). However, some successful cases can be found in the Caribbean in terms of fishing cooperatives and support to co-management regimes, for example, in Belize and Barbados (Brown and Pomeroy 1999). In Belize, the organizational strength of fishing cooperatives has been a major factor in the success of the conch and lobster fisheries (Brown and Pomeroy 1999). For this reason, Belizean fishing cooperatives have often been identified as the most successful in the Caribbean (McConney and Medeiros 2014). In this case, territorial use rights are only allocated to "native" Belizeans, who share communal property of conch and lobster resources and receive government support. The fishing cooperatives are responsible for controlling the fish chain of the conch and lobster fishery, and adopted co-management elements such as collaborative patrolling and participatory decision-making (Brown and Pomeroy 1999). In Barbados, there has been a recent trend toward cooperatives and associations focused on empowerment and participation in decision-making, with about six fishers' organizations currently operating under the Barbados National Union of Fisherfolk Organizations (BARNUFO; McConney and Medeiros 2014). Today in the CARICOM region, the Caribbean Regional Fisheries Mechanism (CRFM) plays a fundamental role in fostering both the formal and informal organizations of fishers at the regional and national levels (McConney and Medeiros 2014). One of the main outputs has been the creation of the Caribbean Network of Fisherfolk Organizations (CNFO) at the regional level, which aims at strengthening and facilitating networks among fishers' organizations (McConney and Medeiros 2014).

Territorial Use Rights in Fisheries (TURFs) have proven to be a successful tool for small-scale fisheries management in Chile. In 1995, the Chilean TURFs were launched under the new Fishing Act of 1991 (Subpesca 1995). Through the TURF model, fishing rights are allocated to fisher associations (i.e., unions and cooperatives) that could be operationalized under the term "Management and Exploitation Areas of Benthic Resources" (MEABR). TURFs have shown to play an important role, not only in providing social and economic benefits to coastal communities but also in marine resource conservation (Gelcich et al. 2012). However, challenges remain in terms of increased costs associated with surveillance and addressing poaching, which further compromises the already variable and uncertain financial returns (Gelcich et al. 2016). These challenges could be overcome through several strategies, including the development of restocking activities, support for enforcement, combining TURFs with MPAs, and marketing and commercialization (Gelcich et al. 2016). On a positive note, fishers perceive the main outcome of Chilean TURFs to be a contribution to territorial empowerment, as well as encouraging innovation and stewardship (Gelcich et al. 2016).

## 2.5 Challenges Facing Latin American and the Caribbean Small-Scale Fisheries

As in the rest of the world, small-scale fisheries in Latin America and the Caribbean face multiple challenges. These mostly stem from the high ecological and social diversity of these fisheries systems, which add to their complexity in terms of assessment and governance. These challenges increase when coupled with the limited financial and logistic capacity of management authorities and the lack of political will to properly assess and manage the fisheries. This situation generates high uncertainty for the future state of fisheries resources and threatens the ability of fishing communities to sustain their livelihoods. The ability of small-scale fishers to respond and adapt to changes is thus impaired by the limited effectiveness of governing institutions, as well as by unsolved conflicts between users of the coastal and marine environments (Orensanz et al. 2005; Defeo et al. 2013). The following are some of the key issues that require attention from key governing actors.

### *2.5.1 Limited Research Scope*

Despite some major advancements in research and information availability, the Latin America and Caribbean region still has limited financial support to conduct research (Salas et al. 2011). According to Salas et al. (2007), the region lacks sufficient research efforts, resources and knowledge production intended to foster an integrative and comprehensive understanding of small-scale fisheries as part of complex ecological, sociocultural, and economic systems. As will be later discussed, however, some positive changes have occurred which can help strengthen the viability and sustainability of small-scale fisheries in the region.

As reported in the ISSF database (Chuenpagdee and Devillers 2015), a strong area of current research is governance, with an emphasis on participation and representation in decision-making. Some attention has also been given to addressing the effectiveness of different policies, tools, and instruments for resource management, as well as the appropriateness of rules and regulations and associated enforcement and compliance (Chuenpagdee et al. 2017). Ecological research on topics such as fish biology and populations receives similar attention when compared to sociocultural research, which focuses largely on livelihood dependency, alternative employment, and job diversification (Chuenpagdee et al. 2017). Economic research, on the other hand, is far less emphasized in the region.

### 2.5.2 Weak Governance Structures and Interactions

The lack of sound data is exacerbated by poor capacity for the surveillance and enforcement of management regulations (Chuenpagdee et al. 2011). Some of the biggest governance challenges in Latin America and the Caribbean are the lack of sound governance structures coupled with inadequate inter-institutional coordination (Gerhardinger et al. 2011), a high level of corruption (Transparency International 2016), the absence of professional motivation from managers (Gerhardinger et al. 2011), and poor public participation (Salas et al. 2007). All these difficulties, intermingled within a pessimistic working environment (Gerhardinger et al. 2011), contribute to an uncertain future for small-scale fisheries in the region.

### 2.5.3 Competing Uses of Coastal Space

Challenges and threats toward small-scale fisheries do not only stem from a problematic institutional environment and weak governance structures. They also emerge from daily-life practices within coexisting conflictive scenarios that are prompted by the diversity of interactions taking place among the multiple users of the marine environments. According to Bennett et al. (2015), the term "ocean grabbing" – defined as the dispossession of coastal and ocean territories from the use, control, or access by small-scale fishers – is a representation of such power imbalances. Currently, it is being heavily promoted by a neoliberal policy agenda that privileges the maximization of profits in the short term. This is illustrated by the shrimp small-scale fishery case in the São Paulo coast, Southeast Brazil, where fishers have had access to their territories prohibited or limited by the implementation of a set of coastal zoning policies that favor port, oil and gas, and infrastructure projects (Gasalla and Gandini 2016).

The competing uses of coastal and ocean territories and the dispossession of these resources from small-scale fishers are fundamentally relevant to the rapid development pattern currently underway in Latin America and the Caribbean. These conflictive scenarios are illustrated by the permanent competing claims and interests between small-scale fisheries communities and coastal area developers such as tourism enterprises that take place in most of the Caribbean countries, as well as by oil extraction conflicts (e.g., Mexico, Venezuela, Brazil), salt mining disputes (e.g., Mexico, Cuba, Martinique, Guadeloupe), and conflicts over other non-fuel minerals (e.g., Venezuela, Mexico, Guyana) (Herrera et al. 2011; Barragán-Paladines and Chuenpagdee 2015; Lopes et al. 2015). Conflicts can even occur between small-scale fishers and actors promoting conservation and coastal areas protection. In those cases, the exclusion and marginalization of fishers occur through measures that limit their access to coastal areas and fishing grounds and thus access to their livelihoods.

Under the same logic, the establishment of no-take areas without the involvement and participation of local stakeholders can also be perceived by community members as a means to restrain small-scale fishers from accessing the resources they depend on. Such practices have had significant implications and negative impacts on fishing communities' viability in Latin America and the Caribbean through increased marginalization and isolation (Lopes et al. 2015; Gasalla and de Castro 2016). Another critical source of stress to small-scale fisheries is the urbanization trend experienced along coastal regions. With more than 80% of the human population in the region living in urban areas (FAO 2016), an increasing tourism industry, and growing infrastructure development, it is likely that small-scale fisheries communities would be further impeded from sustaining their livelihoods and maintaining their connection with the marine environments. Conflicts over resource use are also common in the Caribbean, where fisheries and tourism coexist. A perception of tourism as having negative impacts on marine resources was found in the Bahamas, in which tourism is linked to the overharvesting of fisheries resources (i.e., queen conch, spiny lobster, Nassau grouper), despite recognition of neutral to positive effects of tourism on household's quality of life (Hayes et al. 2015).

### *2.5.4 Overfishing and Ecosystem Degradation*

As a worldwide issue, overfishing and the associated degradation of the marine environment are of major concern in Latin America and the Caribbean. Of the 49 fish stocks in the region for which data were available through FAO (2005) and analyzed by Boyd (2010), about 30% of them are moderately to fully exploited, and thus close to their maximum sustainable limits, with a further 12% being considered fully exploited to overexploited (Boyd 2010). A decline in catches has been observed throughout the region, including by small-scale fishers in El Salvador, where major environmental degradation and reduced catches have led to impacts on their livelihoods (Campbell 2015). In the Caribbean, many fisheries are under stress from overfishing and ecosystem degradation, especially reef fish, coastal pelagic (e.g., ballyhoo, jacks, clupeids), and deep water demersal (e.g., snapper, grouper) species, on which small-scale fishers rely for their livelihoods, as well as the valuable export-oriented conch and lobster (Brown and Pomeroy 1999). Additionally, coral reef ecosystems in the Caribbean have been threatened by *Sargassum* outbreaks, which were first recorded in the early 1990s (Bouchon et al. 1992) and now represent a growing concern in the region (Johnson et al. 2013; Louime et al. 2017). The occurrence of this macroalgae has largely increased in density, extent, and frequency in the region and has been mainly attributed to climate change, with resulting environmental, economic, and health impacts (Louime et al. 2017).

In order to illustrate the overfishing effect, Freire and Pauly (2010) have identified the “fishing down the marine food web” phenomena in the east Brazil Large Marine Ecosystem, which suffered one of the highest trophic level declines in the world. Additionally, it has been shown that a critical aspect of the total fish catch (such as discards and unreported, illegal fishing) remains largely unknown (Zeller et al. 2017). The global fisheries catch reconstruction by *Sea Around Us* has revealed that the decline in catches is more severe worldwide than previously thought, and that discards account for about 10% of total annual catches, with small-scale fisheries contributing to only 7% of that in comparison to industrial fisheries, which contribute to the remainder majority (Zeller et al. 2017). In Latin America and the Caribbean, catch reconstruction data show a similar trend, with catch estimates accounting for discards and previously unreported catches differing from official catch data in the region; these discrepancies seriously compromise the total catch values and thus the entire status of the fishing resource (Pauly and Zeller 2015).

### *2.5.5 Erosion of Social and Cultural Assets*

Cultural, spiritual, and traditional practices in small-scale fisheries are fundamental to the development and structure that define fishing communities of the region. The loss or erosion of these institutions can contribute to the disappearance of social bonding and the dislocation of the impacted communities. Under the current trend of exclusion of fishers from traditional fishing grounds by conservation practices (e.g., protected areas), urban and industrial development, as well as by global phenomena (e.g., climate change effects on the marine resources availability), small-scale fishing communities in Latin America and the Caribbean are subjected to compounding vulnerability from these and other stressors (Defeo et al. 2013; Faraco et al. 2016). In the absence of sufficient capacity and assets to face those challenges properly, small-scale fishers’ ability to respond to changes is impaired by these multiple factors, which in turn threaten their standard of living and the viability of coastal communities (Defeo et al. 2013).

## 2.6 Factors Supporting Viability and Sustainability

### *2.6.1 Environmental Stewardship*

The intention by small-scale fishers to take care of natural resources out of a sense of responsibility may turn them into stewards of environmental conservation (McConney et al. 2014; Medeiros et al. 2014; Gasalla and de Castro 2016). This requires a strong connection and interdependence between fishers and the natural environment, such as the cases observed in many traditional communities in Brazil, where resource users are well aware of the importance of the marine ecosystem they rely on for their livelihoods and are thus willing to protect it (Diegues 2008).The concept of ecosystem stewardship has been attributed to a "steward" who has the responsibility and accountability for taking care of common pool resources or public property as a custodian, while ensuring its proper and wise use for the continuance of the natural resource (Medeiros et al. 2014). The cases featured in the special issues on stewardship in Latin America and the Caribbean (McConney et al. 2014; Medeiros et al. 2014; Villasante and Österblom 2015; Gasalla and de Castro 2016) demonstrate that the development of a genuine interest in sustaining fisheries resources for generations to come is possible through responsible use and accountability for management. Several chapters in this volume present case studies addressing these issues.

Medeiros et al. (2014) state that the idea of environmental stewardship in small-scale fisheries would enhance not only the conservation of the marine realm but would also promote the well-being of fishing communities and the maintenance of fishing livelihoods. This concept also encompasses the need for stakeholder participation in managing, monitoring, and enforcing commonly agreed-upon rules and regulations for wise fisheries resource management. Thus, in order to be effective stewards of the environment, the main considerations are the acknowledgment of existing local/traditional practices, the devolution of power from governing bodies to resource users, and structural mechanisms in place to allow for effective participation of resource users in governance (Orensanz et al. 2005; Chuenpagdee et al. 2011; Medeiros et al. 2014; Fulton et al., Chap. 7, this volume). The need to enhance and strengthen stewardship has been widely endorsed in the Latin American and Caribbean context (Salas et al. 2007, 2011; Chuenpagdee et al. 2011; McConney et al. 2014; Medeiros et al. 2014; Gasalla and de Castro 2016). In fact, a high potential for collaboration and institutional innovation related to environmental stewardship in small-scale fisheries has been acknowledged and endorsed in this region (McConney et al. 2014; Medeiros et al. 2014; Villasante and Österblom 2015; Gasalla and de Castro 2016).

### *2.6.2 Cooperation and Partnership*

It has been argued that the local fishers' associations and cooperatives, despite the challenges they face, could still play an important role in the Latin American and Caribbean small-scale fishing sector (Jentoft 1986). These organizations encourage cooperation among community members, inspire leadership, and contribute to strengthening small-scale fishers' voices at higher governance levels in cases across the world (Pinkerton 1989; Amarasinghe and Bavinck 2017). The region has many successful examples of alternative approaches to collaborative resource management that engage these critical stakeholder groups. Some illustrations of such cases are the Vigia Chico spiny lobster cooperative in Quintana Roo, Mexico (Sosa-Cordero et al. 2008; Méndez-Medina et al. 2015), the TURFs and bottom-up approaches to marine conservation in Chile (Gelcich et al. 2015), and the co-management schemes for small-scale fisheries in Uruguay and Brazil (Trimble and Berkes 2015). The adoption of co-management approaches and their success in Latin America and the Caribbean are thought to result from trust, cooperation, leadership, and community cohesion (Gutiérrez et al. 2011; Villasante and Österblom 2015). All of these conditions are considered enabling factors that are presumably strengthened through fishers' associations and cooperatives. The sustainability of small-scale fisheries could presumably be achieved through increased cooperation within communities, along with government assistance and legitimization and support from partnerships with NGOs and other organizations at the local level.

### *2.6.3 Women in Small-Scale Fisheries*

The role of women in small-scale fisheries in Latin America and the Caribbean is extensive, with female participation in fishing activities throughout the value chain. Illustrations of the highly valuable role of women in fisheries in this region include, for instance, the Piriápolis fishery in Uruguay (Trimble and Johnson 2013). In this region, fishers' wives and other women perform shore-based work mostly related to preharvest fishing activity, such as the preparation of long lines (known as *alistar*) and the baiting of the hooks, as well as postharvest activities such as the disentangling of the fish caught from gillnets upon the boats' arrival (Trimble and Johnson 2013).

In several countries in the region, women are active fishers, gathering shellfish species (like clam *Anomalocardia brasiliana*) in tropical estuaries of Northeast Brazil (e.g., Goiana River estuary and Canal de Santa Cruz estuary in Pernambuco State). These clam fisherwomen account for about 80% of all the people involved in this activity (Silva-Cavalcanti and Costa 2009). Additionally, in the Corumbau Marine Extractive Reserve, located in Bahia State, northeast Brazil, women's involvement in the activity is an important asset that adds significant economic value to fisheries products due to various postharvest activities such as fish and octopus cleaning and shrimp salting, as well as the production of handicrafts for additional income (Di Ciommo and Schiavetti 2012). In El Salvador, as in many of the countries in the region, women are commonly involved in postharvest activities such as cleaning, eviscerating, and processing the catch (Gammage 2004). In the Caribbean, women's role in small-scale fisheries has been poorly documented, despite their important contribution to small-scale fisheries (McConney et al. 2011; McConney and Medeiros 2014). Women's representation and leadership in fishers' organizations is lacking in the Caribbean region, with few exceptions such as the active "Women in Fishing Association" in Trinidad and Tobago (McConney and Medeiros 2014), and the recently created Gender in Fisheries Team (GIFT) that advocates for gender equality in CRFM member states. According to the examples cited above, the inclusion of gender is needed throughout the region as a key component to understanding fishing communities and economies, given that women participate in and often dominate many aspects of the fisheries production chain (Kleiber et al. 2015).

### 2.6.4 Alternative Governance Models

Successful cases of alternative governance models in the region include, first, the group-based rights to fish awarded to small-scale fishers in Mexico (Méndez-Medina et al. 2015) and, second, the individual-based rights to fish that were given to small-scale fishers in Chile and Peru (FAO 2000; Castilla and Gelcich 2008). One of the reasons for this success is the pre-existing community-based and co-management governance systems which, interestingly, are also encountered in other countries of the region (Pomeroy et al. 2004; McCay et al. 2014). It has been found that leadership and a sense of empowerment among fishers, as well as transparency in decision-making processes, are key success factors at implementing fishery use rights and making co-management arrangements possible (Sosa-Cordero et al. 2008).

The co-management governance model that has emerged around the region has proven to be highly appropriate to building a supportive environment for the ecosystem approach to fisheries (EAF), which has been recognized globally as a strategic perspective that could enhance fisheries governance (Garcia et al. 2003). This approach goes beyond the single-species management focus including non-target species at the ecosystem level in dealing with fisheries management (Hall and Mainprize 2004). In the Latin American and Caribbean context, this would also mean that additional dimensions (e.g., historical, cultural, social, and economic) surrounding small-scale fisheries should be recognized and integrated in the policies and practices governing this sector (Garcia et al. 2003; Salas et al. 2007; Seijo et al. 2011; Jentoft and Chuenpagdee 2015).

The EAF also provides a comprehensive understanding of fisheries systems through a broad array of tools and strategies employed in fisheries assessment. It contributes to the advancement of the operational aspects of fisheries management, such as the establishment of monitoring programs, the engagement of fishers in data gathering, and the expansion of data collection areas (Salas et al. 2007). By increasing the involvement of fishers in the management process, conflicts between users could be better understood and successful and fair processes for the allocation of fishing rights (Barbados, Mexico, and Cuba) could be achieved (Salas et al. 2007). Moreover, the increased attention to a transdisciplinary approach in addressing small-scale fisheries issues (Salas et al. 2007; Chapman et al. 2008; Marín and Berkes 2010; Ratner and Allison 2012; Chuenpagdee and Jentoft 2015; McConney et al. 2015) has been seen as a real advancement in examining the complexities implicit within this sector. Although highly recognized and endorsed for fisheries management in the region, EAF has not yet been fully implemented (Fanning et al.

2011). However, there have been attempts at the regional level in the Caribbean, where EAF has been incorporated as part of the Caribbean Large Marine Ecosystem (CLME) project (Fanning et al. 2011) and, according to McConney and Medeiros (2014), has been endorsed through the Caribbean Regional Fisheries Mechanism (CRFM).

### *2.6.5 Small-Scale Fisheries Guidelines*

Given the complexity of small-scale fisheries worldwide, and in particular in the Latin America and Caribbean region, the SSF Guidelines offer a substantial opportunity for achieving sustainable small-scale fisheries. This international policy instrument offers a comprehensive set of principles to guide sustainable and equitable fisheries governance, such as concerns for human rights in fisheries, responsible fisheries, a supportive implementation environment, and capacity development (FAO 2015). The greatest challenge concerns the implementation of the SSF Guidelines, given that it requires national and international joint initiatives and strong collaborative practices to hone communication and negotiation skills in order to first recognize the importance of small-scale fisheries and, second, to incorporate them into the priorities of public policies and practice. However, this is not an easy task, although some efforts have begun to lead in this direction. In many cases, substantial changes regarding power and social relations, institutional functioning, attitudes, and financial instruments are required in order to implement the SSF Guidelines. Successful implementation of the SSF Guidelines also asks for specific policy mechanisms at the national level (see Nisa 2017; Saavedra-Díaz and Jentoft 2017).

Some actions have been taken toward implementation, as in the case of Brazil, where some of the guiding principles of the SSF Guidelines are already part of public policies, such as participatory research and empowering women in alignment with the SSF Guidelines (Mattos et al. 2017). Nonetheless, the state-driven fisheries agency still needs to make several adjustments in order to facilitate implementation, such as changes in human resources, institutional capacities, information-sharing infrastructure, knowledge-based action, and surveillance mechanisms (Mattos et al. 2017). In cases like Belize, Mexico, and Nicaragua, where some resources are shared with other countries, finding synergies between the SSF Guidelines and other national or international normative instruments is of high relevance in order to uphold the rights of small-scale fishers, including indigenous people (González 2017). In the case of Costa Rica, the implementation of the SSF Guidelines may rest upon non-state actors, like small-scale fishing cooperatives (Sabau 2017). The implementation of the SSF Guidelines is fundamental to the enhancement and promotion of the contribution of small-scale fisheries to Latin America and the Caribbean in alignment with global efforts for fisheries sustainability and to secure the well-being of fishing communities (FAO 2015).

## 2.7 Concluding Remarks

The richness of ecosystems and species in Latin America and the Caribbean has enabled a high diversity of fishing practices and techniques passed down by generations, allowing small-scale fishers to thrive in this ever-changing environment. The ties between the social and natural environment and the long historical tradition of small-scale fisheries have also cemented the activity as an essential part of traditional livelihoods and a major source of income and food for coastal and riverine communities. In this context, the concept of environmental stewardship has been widely acknowledged in the Latin America and Caribbean region, with communities expressing a sense of ownership and responsibility toward the marine environment and fisheries resources. Strengthening the connectivity between people and nature can be seen as a means to achieve better fisheries governance, for example, through promoting a willingness to protect the ecosystem and increasing the participation of resource users in managing and monitoring the aquatic environment.

Cooperatives and fishers' organizations have long played a key role in increasing the participation and accountability of resource users in fisheries sustainability to a certain extent in the region. In line with the goal of devolving power from government to local stakeholders in the management of common pool resources, the top-down governance mode has given way to co-management for the most part in Latin America and the Caribbean. However, this process has been slow, taking many different forms and encompassing an array of levels of participation throughout the region, from pure consultation to delegated power and community control (Arnstein 1969). In the Caribbean, for instance, emerging co-management approaches are relatively new and still mostly consultative rather than collaborative, thus revealing a need to build capacity for more effective, legitimate, and transparent interactions between few local resource user organizations and government institutions (Mahon 2008). In addition, the holistic and integrative approaches to fisheries assessment and ecosystem understanding through initiatives such as the ecosystem approach to fisheries or ecosystem-based management have been heavily promoted (Fanning et al. 2011). The interactive governance framework has also been applied to examine interactions that take place between social, natural, and governing systems as a way to enhance the overall governability (Kooiman et al. 2005; Chuenpagdee and Jentoft 2009).

Despite positive advancements in management and governance in the Latin America and Caribbean region, challenges remain in terms of the lack of knowledge and understanding of small-scale fisheries and governance challenges due to poor institutional structure, limited capacity, and unclear interactions, among other barriers. Enhancing and advancing knowledge about small-scale fisheries require capacity building, not only among fishers at the local level but also at the levels at which researchers, policy makers, managers, practitioners, and administrators operate. It is therefore essential to recognize the importance of small-scale fisheries both in terms of numbers and the intangible contributions that they make to the well-being and sustainability of coastal communities in the region. We cannot discuss small-scale fisheries only in terms of stocks, catches, and profitability but also in terms of culture, history, and ways of life. Efforts to enhance the visibility and viability of small-scale fisheries in Latin America and the Caribbean would likely lead to the sustainability of fisheries in the region.

**Acknowledgments** Funding for the research is provided by the Canadian Social Sciences and Humanities Research Council (SSHRC) to "Too Big To Ignore Global Partnership for Small-Scale Fisheries Research" partnership grant (grant number 895-2011-1011) and Memorial University of Newfoundland. We thank the reviewers for the comments and acknowledge the editorial help of Brennan Lowery.

## References

Abdallah PR, Sumaila UR (2007) An historical account of Brazilian public policy on fisheries subsidies. Mar Policy 31(4):444–450

Allsopp WHL (1985) Fishery development experiences. Fishing New Books, Farnham

Amarasinghe O, Bavinck M (2017) Furthering the implementation of the small-scale fisheries guidelines: strengthening fisheries cooperatives in Sri Lanka. In: Jentoft S, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) The small-scale fisheries guidelines: Global implementation, MARE publication series, vol 14. Springer, Dordrecht, pp 379–399

Arnstein SR (1969) A ladder of citizen participation. J Am Plan Assoc 35(4):216–224

Baldeo R (2011) Coastal fisheries of Grenada. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper No. 544. FAO, Rome, pp 219–229

Barragán-Paladines MJ, Chuenpagdee R (2015) The status of artisanal fishing in El Salvador governability assessment of the Galapagos marine reserve. Maritime Stud 14(13). https://doi.org/10.1186/s40152-015-0031-z

Barthem RB, Fabré NN (2004) Biologia e diversidade dos recursos pesqueiros na Amazônia. In: Ruffino ML (ed) A pesca e os recursos pesqueiros na Amazônia brasileira. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis IBAMA, Brasília, pp 17–62

Begossi A, Hanazaki N, Ramos RM (2004) Food chain and the reasons for fish food taboos among Amazonian and Atlantic forest fishers (Brazil). Ecol Appl 14(5):1334–1343

Béné C, Neiland AE (2003) Valuing Africa's inland fisheries: overview of current methodologies with an emphasis on livelihood analysis. NAGA WorldFish Center Q 26:18–21

Béné C, Barange M, Subasinghe R, Pinstrup-Andersen P, Merino G, Hemre GI, Williams M (2015) Feeding 9 billion by 2050 – putting fish back on the menu. Food Security 7:261–274

Béné C, Arthur R, Norbury H, Allison EH, Beveridge M, Bush S (2016) Contribution of fisheries and aquaculture to food security and poverty reduction: assessing the current evidence. World Dev 79:177–196. https://doi.org/10.1016/j.worlddev.2015.11.007

Bennett NJ, Govan H, Satterfield T (2015) Ocean grabbing. Mar Policy 57(July 2015):61–68

Bezerra da Costa MK, Melo CD, Lopes PFM (2014) Fisheries productivity and its effects on the consumption of animal protein and food sharing of fishers' and non-fishers' families. Ecol Food Nutr 53(4):453–470

Bouchon C, Bouchon-Navarro Y, Louis M (1992) A first record of a Sargassum (Phaeophyta, Algae) outbreak in a Caribbean coral reef ecosystem. Proceedings of the 41st Gulf and Caribbean Fisheries Institute, pp 171–188

Bovarnick A, Alpizar F, Schnell C (eds) (2010) The importance of biodiversity and ecosystems in economic growth and equity in Latin America and the Caribbean: an economic valuation of ecosystems, United Nations Development Programme

Boyd C (2010) Fisheries sector. In: Bovarnick A, Alpízar F, Schnell C (eds) The importance of biodiversity and ecosystems in economic growth and equity in Latin America and the Caribbean: an economic valuation of ecosystems. United Nations Development Programme, Washington, pp 83–126

Bray T (2012) Ritual commensality between human and non-human persons: investigating native ontologies in the late pre-Columbian Andean world. eTOPOI J Ancient Stud special volume 2:197–212. Creative commons attribution 3.0 license: http://creativecommons.org/licenses/by/3.0. Accessed 15 June 2017

Brown BE (2017) Large marine ecosystem fisheries management with particular reference to Latin America and the Caribbean Sea. Environ Dev 22(2017):111–119

Brown DN, Pomeroy RS (1999) Co-management of Caribbean community (CARICOM) fisheries. Mar Policy 23(6):549–570

Campbell M (2015) The status of artisanal fishing in El Salvador. Mar Policy 52:33–37

Castilla JC, Gelcich S (2008) The management of the loco (*Concholepas concholepas*) as a driver for self-governance of small-scale benthic fisheries in Chile. FAO Fisheries technical paper, no. 604. FAO, Rome

Chapman B, Jackson-Smith D, Petrzelka P (2008) Comparative institutions and management resiliency in Latin American small-scale fisheries. Soc Sci J 45(2008):312–329

Chuenpagdee R, Devillers R (2015) Information system on small-scale fisheries. Too Big To Ignore – Global partnership for small-scale fisheries research. www.issf.toobigtoignore.net. Accessed 20 July 2017

Chuenpagdee R, Jentoft S (2009) Governability assessment for fisheries and coastal systems: a reality check. Hum Ecol 37(1):109–120

Chuenpagdee R, Jentoft S (2015) Exploring challenges in small-scale fisheries governance. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries: Global reflections, MARE Publication series, vol 13. Springer, Dordrecht, pp 3–16

Chuenpagdee R, Salas S, Charles A, Seijo JC (2011) Assessing and managing coastal fisheries of Latin America and the Caribbean: underlying patterns and trends. In: Salas S, Chuenpagdee R, Seijo JC, Charles A (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper 544. FAO, Rome

Chuenpagdee R, Rocklin D, Bishop D, Hynes M, Greene R, Lorenzi MR, Devillers R (2017) The global information system on small-scale fisheries (ISSF): a crowdsourced knowledge platform. Mar Policy. https://doi.org/10.1016/j.marpol.2017.06.018

Cooke SJ, Arlinghaus R, Bartley DM, Beard TD, Cowx IG, Esssington TE, Jensen OP, Lynch A, Taylor WW, Watson R (2014) Where the waters meet: sharing ideas and experiences between inland and marine realms to promote sustainable fisheries management. Can J Fish Aquat Sci 71:1593–1601

Cunningham E (2013) Catch shares in action: Mexican Vigía Chico cooperative spiny lobster territorial use rights for fishing program. Environmental Defense Fund. http://fisherysolutioncenter.edf.org/sites/catchshares.edf.org/files/Mexican_Vigia_Chico_Spiny_Lobster_TURF.pdf. Accessed 15 June 2017

De Madariaga JJ (1969) La caza y la pesca al descubrirse América. Editorial Prensa Española, Madrid

Defeo O, Castrejon M, Ortega L, Kuhn A, Gutierrez NL, Castilla JC (2013) Impacts of climate variability on Latin American small-scale fisheries. Ecol Soc 18:30

Di Ciommo RC, Schiavetti A (2012) Women participation in the management of a marine protected area in Brazil. Ocean & Coastal Manage 62(June 2012):15–23

Diegues AC (2008) Marine Protected Areas and artisanal fisheries in Brazil, SAMUDRA Monograph. International Collective in Support of Fishworkers (ICSF), Chennai

Elías I, Carozza C, Di Giácomo EE, Isla MS, Orensanz JML, Parma AM, Pereiro RC, Perier MR, Perrotta RG, Ré ME, Ruarte C (2011) Coastal fisheries of Argentina. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper. No. 544. FAO, Rome, pp 13–48

Fanning L, Mahon R, McConney P (eds) (2011) Towards marine ecosystem-based management in the wider Caribbean, MARE publication series, vol 6. Amsterdam University Press, Amsterdam
Fanning L, Mahon R, McConney P (2013) Applying the large marine ecosystem (LME) governance framework in the wider Caribbean region. Mar Policy 42:99–110
FAO (2005) Review of the state of world marine fishery resources, FAO Fisheries technical paper. no. 457. 235p. FAO, Rome
FAO (2009) FishStat Plus. Capture fisheries data, 1950–2007. FAO, Rome. www.fao.org/fishery/statistics/software/fishstat/en. Accessed 15 June 2017
FAO (2011) Review of the state of the world fishery resources: Inland fisheries, FAO fisheries and aquaculture circular no. 942, rev. 2. FAO, Rome
FAO (2013) FAOSTAT Consumption of fish and fishery products – World apparent consumption statistics based on food balance sheets. http://www.fao.org/fishery/statistics/global-consumption/en. Accessed 15 June 2017
FAO (2015) Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. FAO, Rome
FAO (2016) The state of world fisheries and aquaculture (SOFIA) 2016, Contributing to food security and nutrition for all. FAO, Rome
FAO (2017) FAO major fishing areas. http://www.fao.org/fishery/area/search/en. Accessed 30 Aug 2017
FAO (Food and Agriculture Organization of the United Nations) (2000) Use of property rights in fisheries management, FAO fisheries technical paper 404/1. FAO, Rome
Faraco LFD, Andriguetto Filho JM, Daw T, Lana PC, Teixeira CF (2016) Vulnerability among fishers in southern Brazil and its relation to marine protected areas in a scenario of declining fisheries. Desenvolvimento e Meio Ambiente 38:51–76
Fernández JI, Álvarez-Torres P, Arreguín-Sánchez F, López-Lemus LG, Ponce G, Díaz-de-León A, Arcos-Huitrón E, del Monte-Luna P (2011) Coastal fisheries of Mexico. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and aquaculture technical paper. No. 544. FAO, Rome, pp 231–284
Fischer CFA, Chagas ALGA, Dornelles LDC (1992) Pesca de águas interiores. Coleção Meio Ambiente, Série Estudos de Pesca 1(29). IBAMA, Brasília
Freire KMF, Pauly D (2010) Fishing down Brazilian marine food webs, with emphasis on the East Brazil Large Marine Ecosystem. Fish Res 105(1):57–62
Galván-Tudela A (1988) La antropología de la pesca: Problemas, teorías, y conceptos. Revista Canaria de Filosofía y Ciencia Social 2:11–33. Universidad de La Laguna, La Laguna
Galván-Tudela A (1990) Estrategias económicas, innovaciones tecnológicas y territorialidad: Estudio antropológico social de las poblaciones pesqueras de Muxía, Fisterra, Lira, Muros y A Garda (Galicia). Memorias de Cátedra, Universidad de La Laguna. Unpublished
Gammage S (2004) The tattered net of statistics. In: Kumar KG (ed) Gender agenda – women in fisheries: A collection of articles from SAMUDRA Report. International Collective in Support of Fishworkers (ICSF), Chennai, pp 36–40
Garcia SM, Zerbi A, Aliaume C, Do Chi T, Lasserre G (2003) The ecosystem approach to fisheries: issues, terminology, principles, institutional foundations, implementation and outlook. FAO technical consultation on the ecosystem-based fisheries management (2002, Reykjavík, Iceland). FAO fisheries technical paper no. 443. FAO, Rome
Gasalla MA, de Castro F (2016) Enhancing stewardship in Latin America and Caribbean small-scale fisheries: challenges and opportunities. Maritime Stud 15:15
Gasalla MA, Gandini FC (2016) The loss of fishing territories in coastal areas: the case of seabob-shrimp small-scale fisheries in São Paulo, Brazil. Maritime Stud 15:9. https://doi.org/10.1186/s40152-016-0044-2
Gelcich S, Fernandez M, Godoy N, Canepa A, Prado L, Castilla JC (2012) Territorial user rights for fisheries as ancillary instruments for marine coastal conservation in Chile. Conserv Biol 26(6):1005–1015

Gelcich S, Peralta L, Donlan CJ, Godoy N, Ortiz V, Tapia-Lewin S, Vargas C, Kein A, Castilla JC, Fernandez M, Godoy F (2015) Alternative strategies for scaling up marine coastal biodiversity conservation in Chile. Maritime Stud 14(5). https://doi.org/10.1186/s40152-015-0022-0
Gelcich S, Cinner J, Donlan CJ, Tapia-Lewin S, Godoy N, Castilla JC (2016) Fishers' perceptions on the Chilean coastal TURF system after two decades: problems, benefits, and emerging needs. Bull Mar Sci 92(1). https://doi.org/10.5343/bms.2015.1082
Gerhardinger LC, Godoy EAS, Jones PJS, Sales G, Ferreira BP (2011) Marine protected dramas: the flaws of the Brazilian national system of marine protected areas. Environ Manag 47:630–643
Golden CD, Seto KL, Dey MM, Chen OL, Gephart JA, Myers SS, Smith M, Vaitla B, Allison EH (2017) Does aquaculture support the needs of nutritionally vulnerable nations? Front Mar Sci 4(159). https://doi.org/10.3389/fmars.2017.00159
González M (2017) Beyond the small-scale fisheries guidelines: tenure rights and informed consent in indigenous fisheries of Nicaragua. In: Jentoft S, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) The small-scale fisheries guidelines: Global implementation, MARE publication series, vol 14. Springer, Dordrecht
Gutiérrez N, Hilborn R, Defeo O (2011) Leadership, social capital and incentives promote successful fisheries. Nature 470:386–389
Hall SJ, Mainprize B (2004) Towards ecosystem-based fisheries management. Fish Fish 5(1):1–20
Hanazaki N, Berkes F, Seixas CS, Peroni N (2013) Livelihood diversity, food security and resilience among the caiçara of coastal Brazil. Hum Ecol 41(1):153–164
Hayes MC, Peterson MN, Heinen-Kay JL, Langerhans RB (2015) Tourism-related drivers of support for protection of fisheries resources on Andros Island, The Bahamas. Ocean & Coastal Manage 106(2015):118–123
Hellebrandt D, Allison EH, Delaporte A (2014) Food security and artisanal fisheries: critical analysis of initiatives in Latin America. Desenvolvimento e Melo Ambiente 32:7–27
Herrera A, Betancourt L, Silva M, Lamelas P, Melo A (2011) Coastal fisheries of the Dominican Republic. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 175–217
Herrera-Ulloa A, Villalobos-Chacón L, Palacios-Villegas J, Viquez-Portuguéz R, Oro-Marcos G (2011) Coastal fisheries of Costa Rica. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 137–153
Jentoft S (1986) Fisheries co-operatives: lessons drawn from international experiences. Can J Dev Stud 7(2):197–209
Jentoft S, Chuenpagdee R (eds) (2015) Interactive governance for small-scale fisheries: Global reflections, MARE Publication series. Springer, Dordrecht
Jentoft S, McCay BJ, Wilson DC (1998) Social theory and fisheries co-management. Mar Policy 22(4–5):423–436
Johnson DSK, Franks JS, Moreno P, Sanchez-Rubio G (2013) The Sargassum invasion of the Eastern Caribbean and dynamics of the Equatorial North Atlantic. Proceedings of the 65th Gulf and Caribbean Fisheries Institute, November 5–9. GCFI, Santa Marta, Colombia
Kalikoski DC, Seixas CS, Almudi T (2009) Gestão compartilhada ecomunitária da pesca no Brasil: Avanços e desafios. Ambiente & Sociedade XII(1):151–172
Kleiber D, Harris LM, Vincent ACJ (2015) Gender and small-scale fisheries: a case for counting women and beyond. Fish Fish 16(4):547–562
Kooiman J, Bavinck M, Jentoft S, Pullin R (eds) (2005) Fish for life: interactive governance for fisheries. University of Amsterdam Press, Amsterdam
Kosamu IBM (2015) Conditions for sustainability of small-scale fisheries in developing countries. Fish Res 161(2015):365–373
Lafer C (2014) A política externa do Brasil para a América Latina. II Simpósio Internacional Pensar e Repensar a América Latina. PROLAM, University of São Paulo, 17–21 October 2014, São Paulo, Brazil

Le Sann A (1997) Del Norte al Sur Pescar para vivir. CISP, Santa Fé de Bogotá

Lopes P, Pacheco S, Clauzet M, Silvano RAM, Begossi A (2015) Fisheries, tourism, and marine protected areas: conflicting or synergistic interactions? Ecosyst Serv 16:333–340

Lopes GCS, Catarino MF, Lima AC, Freitas CEC (2016) Small-scale fisheries in the Amazon basin: general patterns and diversity of fish landings in five sub-basins. Boletim do Instituto de Pesca São Paulo 42(4):889–900

Louime C, Fortune J, Gervais G (2017) Sargassum invasion of coastal environments: a growing concern. Am J Environ Sci 13(1):58–64

Macchi GJ, Saborido-Rey F, Murua H, Claramunt G, Chaves PT (2014) Advances in fisheries research in Ibero-America. Fish Res 160(2014):1–7

MacCord PL, Begossi A (2006) Dietary changes over time in a caiçara community from the Brazilian Atlantic forest. Ecol Soc 11(2):38. http://www.ecologyandsociety.org/vol11/iss2/art38/. Accessed 15 June 2017

MacNaughton A, Carvajal-Vallejos FM, Argote A, Rainville TK, Van Damme PA, Carolsfeld J (2015) "Paiche reigns!" species introduction and indigenous fisheries in the Bolivian Amazon. Maritime Stud 14(11). https://doi.org/10.1186/s40152-015-0030-0

Mahon R (2008) Assessing governability of fisheries using the interactive governance approach: preliminary examples from the Caribbean. J Transdiscipl Environ Stud 7(1):1–11. ISSN:1602-2297

Majluf P, De la Puente S, Christensen V (2017) The little fish that can feed the world. Fish Fish 18(4):772–777

Marín A, Berkes F (2010) Network approach for understanding small-scale fisheries governance: the case of the Chilean coastal co-management system. Mar Policy 34(5):851–858

Mattos SMG, Wojciechowski MJ, Macnaughton AE, da Silva GHG, Maia AMLR, Carolsfeld J (2017) Implementing the small-scale fisheries guidelines: lessons from Brazilian clam fisheries. In: Jentoft S, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) The small-scale fisheries guidelines: Global implementation, MARE publication series, vol 14. Springer, Dordrecht, pp 473–494

McCay BJ, Micheli F, Ponce-Díaz G, Murray G, Shester G, Ramirez-Sancheza S, Weismang W (2014) Cooperatives, concessions, and co-management on the Pacific coast of Mexico. Mar Policy 44(February 2014):49–59

McConney P, Medeiros R (2014) Strengthening organizations and collective action in small-scale fisheries: lessons learned from Brazil and the Caribbean. In: Kalikoski DC, Franz N (eds) Strengthening organizations and collective action in fisheries A way forward in implementing the international guidelines for securing sustainable small-scale fisheries, FAO fisheries and aquaculture proceedings, vol 34. FAO, Rome

McConney P, Nicholls V, Simmons B (2011) Gender in Caribbean fisheries: it's the women's turn. Unpublished paper presented at the Institute for Gender and Development Studies Biennial Symposium: contemporary issues in Caribbean research on gender and feminism. UWI Cave Hill Campus, 24–25 February 2011

McConney P, Medeiros R, Pena M (eds) (2014) Enhancing stewardship in small-scale fisheries: practices and perspectives. Too Big To Ignore (TBTI) and Centre for Resource Management and Environmental Studies, The University of the West Indies, Cave Hill campus, Barbados. CERMES technical report no. 73. CERMES, Cave Hill

McConney P, Charlery JD, Pena M, Phillips T, Van Anrooy R, Poulaln F, Bahrl T (2015) Disaster risk management and climate change adaptation in the CARICOM and wider Caribbean region; formulating a strategy, action plan and programme for fisheries and aquaculture. FAO, Rome

Medeiros RP, Serafini TZ, McConney P (2014) Enhancing ecosystem stewardship in small-scale fisheries: prospects for Latin America and the Caribbean. Desenvolvimento e Meio Ambiente 32:181–191

Méndez-Medina C, Schmook B, McCandless SR (2015) The Punta Allen cooperative as an emblematic example of a sustainable small-scale fishery in the Mexican Caribbean. Maritime Stud 14(12). https://doi.org/10.1186/s40152-015-0026-9

Miao W, Silva SD, Davy B (eds) (2010). Inland fisheries resource enhancement and conservation in Asia (no. 2010/22). RAP Publication, Bangkok

Mohammed E, Ferreira L, Soomai S, Martin L, Shing CA, C. (2011) Coastal fisheries of Trinidad and Tobago. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 315–356

Nisa ZA (2017) Building capacity for implementing the small-scale fisheries guidelines: examples from the Pacific and the Caribbean Small Island developing states. In: Jentoft IS, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) The small-scale fisheries guidelines: Global implementation, MARE publication series, vol 14. Springer, Dordrecht

Noble BF (2000) Institutional criteria for co-management. Mar Policy 24:69–77

Olson DM, Dinerstein E (1998) The global 200: a representation approach to conserving the Earth's most biologically valuable ecoregions. Conserv Biol 12(3):502–515

Olson DM, Dinerstein ED, Wikramanayake ND, Burgess GVN, Powell EC, Underwood JA, D'Amico I, Itoua HE, Strand JC, Morrison CJ, Loucks TF, Allnutt TH (2002) The global 200: priority ecoregions for global conservation. Ann Mo Bot Gard 89:199–224

Orensanz JM, Parma AM, Jerez G, Barahona N, Montecinos M, Elías I (2005) What are the key elements for the sustainability of 'small-scale fisheries'? Insights from South America. Bull Mar Sci 76:527–556

Ostrom E (1990) Governing the commons: the evolution of institutions for collective actions. Cambridge University Press, Cambridge

Ostrom E, Burger J, Field CB, Norgaard RB, Policansky D (1999) Revisiting the commons: local lessons, global challenges. Science 284(5412):278–282

Pascual-Fernández J (1991) Entre el mar y la tierra. In: Los pescadores artesanales canarios. Dirección General de Cooperación Cultura. Editorial Interinsular Canaria, Ministerio de Cultura

Pauly D, Zeller D (eds) (2015). Sea Around Us concepts, design and data. www.seaaroundus.org. Accessed Jul 20 2017

Phillips T, Chakalall B, Romahlo L (2011) Management of the shrimp and groundfish fisheries of the North Brazil shelf: an ecosystem approach. In: Fanning L, Mahon R, McConney P (eds) Towards marine ecosystem-based management in the Wider Caribbean, MARE publication series, vol 6. Amsterdam University Press, Amsterdam

Pinkerton E (ed) (1989) Cooperative management of local fisheries: new directions for improved management and community development. University of British Columbia Press, Vancouver

Pinkerton E (2017) Hegemony and resistance: disturbing patterns and hopeful signs in the impact of neoliberal policies on small-scale fisheries around the world. Mar Policy 80:1–9

Pollnac RB (1988) Evaluating the potential of fishermen's organizations in developing countries. ICMRD, University of Rhode Island, Kingston

Pomeroy RS (1995) Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia. Ocean & Coastal Manage 27(3):143–162

Pomeroy RS, McConney P, Mahon R (2004) Comparative analysis of coastal resource co-management in the Caribbean. Ocean & Coastal Manage 47(9–10):429–447

Ramirez-Sanchez S, McCay BJ, Johnson T, Weisman W (2011) Surgimiento, formación, y persistencia de organizaciones sociales para la pesca ribereña de la península de Baja California: Un enfoque antropológico. Región y Sociedad XXIII(51):71–100

Ratner BD, Allison EH (2012) Wealth, rights, and resilience: an agenda for governance reform in small-scale fisheries. Dev Policy Rev 30(4):371–398

Rostworowski M (2015) Recursos naturales renovables y pesca, siglos VXI-XVII: curacas y sucesiones, costa norte (Obras completas IV). Instituto de Estudios Peruanos, Lima

Saavedra-Díaz LM, Jentoft S (2017) The role of the small-scale fisheries guidelines in reclaiming human rights for small-scale fishing people in Colombia. In: Jentoft S, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) The small-scale fisheries guidelines: Global implementation, MARE Publication series, vol 14. Springer, Dordrecht

Sabau G (2017) Costa Rica: a champion of the small-scale fisheries guidelines. In: Jentoft S, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) The small-scale fisheries guidelines: Global implementation, MARE Publication series, vol 14. Springer, Dordrecht

Salas S, Chuenpagdee R, Seijo JC, Charles A (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fish Res 87:5–16

Salas S, Chuenpagdee R, Seijo JC, Charles A (2011) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and aquaculture technical paper 544. FAO, Rome

Schuhbauer A, Chuenpagdee R, Cheung WWL, Greer K, Sumaila RU (2017) How subsidies affect the economic viability of small-scale fisheries. Mar Policy 82(August 2017):114–121

Searcy-Bernal R, Ramade-Villanueva MR, Altamira B (2010) Current status of abalone fisheries and culture in Mexico. J Shellfish Res 29(3):573–576

Seeliger U, Kjerfve B (eds) (2001) Coastal and marine ecosystems of Latin America, Ecological studies, vol 144. Springer, Berlin

Seijo JC, Charles A, Chuenpagdee R, Salas S (2011) Toward sustainability for coastal fisheries of Latin America and the Caribbean: effective governance and healthy ecosystems. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 403–421

Silva-Cavalcanti JS, Costa MF (2009) Fisheries in protected and non-protected areas: is it different? The case of *Anomalocardia brasiliana* at tropical estuaries of Northeast Brazil. J Coastal Res special issue no. 56:1454–1458. Proceedings of the 10th International Coastal Symposium ICS 2009, Vol. II

Singleton S (2000) Co-operation or capture? The paradox of co-management and community participation in natural resource management and environmental policy-making. Environ Politics 9(2):1–21. https://doi.org/10.1080/09644010008414522

Sosa-Cordero E, Liceaga-Correa MLA, Seijo JC (2008) The Punta Allen lobster fishery: current status and recent trends. In: Townsend R, Shotton R, Uchida H (eds) *Case studies in fisheries self-governance*, FAO fisheries technical paper 504. FAO, Rome

Subpesca (Subsecretaría de Pesca y Acuicultura) (1995) D.S. N° 355–1995 Reglamento sobre Áreas de Manejo y Explotación de Recursos Bentónicos (Actualizado Abril 2010). http://www.subpesca.cl/portal/615/w3-propertyvalue-38114.html. Accessed 20 Jul 2017

Sumaila UR, Khan AS, Dyck AJ, Watson R, Munro G, Tydemers P, Pauly D (2010) A bottom-up re-estimation of global fisheries subsidies. J Bioecon 12(3):201–225

Tassara E (ed) (1994) Pesca artesanal, acuicultura, y ambiente: Experiencia y perspectivas de desarrollo. Memorias del Seminario Internacional Las Políticas de Desarrollo de la Pesca Artesanal en América Latina y el Caribe. Ministerio del Ambiente, Comisión Europea, y la Oficina Cooperación Italiana en Colombia. EcoEdiciones, Bogotá

Transparency International (2016). Corruption Perceptions Index 2016. https://www.transparency.org/news/feature/corruption_perceptions_index_2016. Accessed 20 Jul 2017

Trimble M, Berkes F (2015) Towards adaptive co-management of small-scale fisheries in Uruguay and Brazil: lessons from using Ostrom's design principles. Maritime Stud 14(14). https://doi.org/10.1186/s40152-015-0032-y

Trimble M, Johnson D (2013) Artisanal fishing as an undesirable way of life? The implications for governance of fishers' well-being aspirations in coastal Uruguay and southeastern Brazil. Mar Policy 37:37–44

UNEP (2016) GEO-6 regional assessment for Latin America and the Caribbean. United Nations Environment Programme, Nairobi

UNEP (United Nations Environment Programme) (2010) State of biodiversity in Latin America and the Caribbean. United Nations Development Programme, Nairobi

Valle SV, Sosa M, Puga R, Font L, Duthit R (2011) Coastal fisheries of Cuba. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 155–174

Villanueva-Poot R, Seijo JC, Headley M, Arce AM, Sosa-Cordero E, Lluch-Cota DB (2017) Distributional performance of a territorial use rights and co-managed small-scale fishery. Fish Res 194(2017):135–145

Villasante S, Österblom H (2015) The role of cooperation for improved stewardship of marine social-ecological systems in Latin America. Ecol Soc 20(1):8. https://doi.org/10.5751/ES-05949-200108

Youn SJ, Taylor WW, Lynhc AJ, Cowx IG, Beard TD, Bartley D, We F (2014) Inland capture fishery contributions to global food security and threats to their future. Glob Food Sec 3:142–148

Zeller D, Cashion T, Palomares M, Pauly D (2017) Global marine fisheries discards: a synthesis of reconstructed data. Fish Fish 00:1–10. https://doi.org/10.1111/faf.12233

**Mirella de Oliveira Leis** is a Research Fellow with Too Big To Ignore Global Partnership for Small-Scale Fisheries Research, based at Memorial University of Newfoundland, St. John's, Newfoundland, Canada. Ms. Leis holds a BSc degree in Oceanography from the Federal University of Paraná in Brazil (2008–2012) and an MSc degree in Geography from Memorial University of Newfoundland, Canada (2013–2016). She has been awarded the distinction of Fellow of the School of Graduate Studies as a recognition of outstanding achievement in a graduate program in 2016. Her research focuses on small-scale fisheries, marine conservation, and marine protected area governance.

**María José Barragán-Paladines** obtained a PhD in Geography at Memorial University of Newfoundland in St. John's, Canada. Her undergraduate and Master's research at the Technical University of Munich (TUM) focused on marine protected areas (MPAs) and marine wildlife management. Her PhD research employed the interactive governance approach, with a specific focus on MPAs, examining the governability of the Galapagos Marine Reserve. She collaborates with TBTI and is currently a post-doctoral researcher at the Development and Knowledge Sociology-Social Science Department at the Leibniz Centre for Tropical Marine Research in Bremen, Germany. Her research interests include small-scale fisheries sustainability, fishing community viability, food security from the marine perspective, and marine resource governance.

**Alicia Saldaña** is currently a MSc student in Geography at Memorial University of Newfoundland in St. John's, Canada, where she works with Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research. She holds a BSc in Fisheries Biology at Facultad de Ciencias del Mar, Universidad Autónoma de Sinaloa, and a MSc in Marine Biology at Centro de Investigación y de Estudios Avanzados del IPN. Along her career, she has been involved on different studies related to small-scale fisheries including ecologic indicators, fishing fleet dynamics, and socioeconomic aspects in both the Pacific coast and the Yucatan Peninsula coast.

**David Bishop** obtained his masters' degree in Marine Studies (Fisheries Resource Management) from the Fisheries and Marine Institute of Memorial University of Newfoundland in 2015. Prior to his masters', he graduated with a BSc, majoring in Geography and minoring in Biology. During that time, his studies focused on topics such as marine biology and resource management. Most recently, he worked as a research assistant of the Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research project, focusing primarily on their information system on small-scale fisheries.

**Jae Hong Jin** holds a master's degree in Anthropology from Seoul National University in Korea. He has been part of several ethnographic research projects in Korea and has co-authored two books on the relationships of religious services and its clients. Most recently, he has worked as a research assistant of the Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research project, focusing primarily on the regional synthesis of small-scale fisheries data.

**Vesna Kereži** is the project manager of the Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research project. She holds a MSc in the Human Dimensions of Wildlife Management from Memorial University of Newfoundland, Canada. In the past, she studied human-wildlife interactions with a focus on socio–cultural aspects of these interactions. Her interests lie in natural resource management, human dimensions of fisheries, and knowledge mobilization and transformation.

**Melinda Agapito** is a research fellow of the Too Big To Ignore (TBTI) project. She obtained a PhD in Geography at Memorial University of Newfoundland in St. John's, Canada. Her PhD focused on developing a conservation decision-making method to help identify conservation areas. Her research interests include food security and conservation and she has experience with the conservation and fisheries settings in the Philippines and Northwest Atlantic (Canada). She currently works on small-scale fisheries research focusing on food security and ecological impacts of fishing gears.

**Ratana Chuenpagdee** is professor at the Department of Geography, Memorial University of Newfoundland, St. John's, Canada. She held the position of Canada Research Chair in Natural Resource Sustainability and Community Development at Memorial University from 2006 to 2016. Her research emphasizes interdisciplinary approaches to coastal, fisheries, and ocean governance, focusing particularly on small-scale fisheries, marine protected areas, community-based management, and food security. She has worked in several countries including Cambodia, Malawi, Mexico, Spain, Thailand, and Canada. Dr. Chuenpagdee is a director of the Too Big To Ignore (TBTI) Global Partnership for Small-Scale Fisheries Research and co-edited the book *Interactive Governance for Small-Scale Fisheries: Global Reflections* (2015), with Professor Svein Jentoft.

# Part II
# Issues, Challenges and Threats

# Chapter 3
# Adaptive Capacity to Coastal Disasters: Challenges and Lessons from Small-Scale Fishing Communities in Central-Southern Chile

**Andrés Marín**

**Abstract** More frequent and severe coastal disasters represent major threats to small-scale fisheries and challenge their viability and potential as an engine of sustainable development. Hurricanes and storm surges and alluviums and tsunamis, among other fast and unexpected events, often drive multiple and overlapping social and environmental impacts. They also influence changes to which fishing communities must respond and adapt, such as threats to life, material devastation, natural resource loss, and ecosystem transformations. Based on empirical case studies and secondary sources, this chapter examines the successes and failures of small-scale fishing communities in the central-southern Chile since the massive February 2010 earthquake and tsunami. This study draws lessons about the key factors of adaptive capacity among coastal resource user communities. The analysis reinforces the importance of social capital and networks, local ecological knowledge, and livelihood agility, as well as stresses several opportunities and drawbacks that need to be observed on the way to pursue more sustainable small-scale fisheries. A better understanding of what makes a difference for fishing communities in response to natural hazards and other external perturbations can inform the design of more equitable and effective fisheries and coastal management policies, along with strategies in Chile and elsewhere.

**Keywords** Artisanal · Benthic · Chile · Coastal Areas · Co-management · Ecosystem services · Hazards · Livelihoods · Post-disaster · Recovery

A. Marín (✉)
CEDER – Centro de Estudios del Desarrollo Regional y Políticas Públicas,
Núcleo de Investigación Desarrollo Local, Regional y Gobernanza Medioambiental,
Universidad de Los Lagos, Osorno, Chile
e-mail: andres.marin@ulagos.cl



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_3

## 3.1 Introduction

An increase in frequent and severe coastal disasters forecasted for the twenty-first century represents major threats to small-scale fisheries and challenges their viability and potential as an engine of human sustainable development.[1] Hurricanes, storm surges, alluviums, and tsunamis, among other extreme and unexpected events, often drive dramatic social and environmental changes to which coastal resource-dependent communities must respond, adapt, and cope. Disasters trigger multiple overlapping impacts on people and the environment, which unfold in the short, mid, and long term, and demand different kinds of responses. Not only can they threaten the lives of coastal inhabitants and destroy the infrastructure and technology on which their livelihoods rely, but they can also drive permanent environmental changes such as loss of habitat for valuable species or the modification of the availability of ecosystem services. For coastal peoples, addressing these abrupt difficulties normally implies the compounded challenge of surviving, recovering, and adapting while, at the same time, dealing with ongoing vulnerabilities and uncertainties (Pomeroy et al. 2006). Persistent unfavorable conditions faced by small-scale fishing communities, such as poverty, lack of financial capital, and exclusion from decision-making (Andrew et al. 2007), can be even further deteriorated in the face of environmental change and disasters.

Until a few decades ago, coastal disasters and other environmental changes were not explicitly considered as growing threats to the sustainability of small-scale fisheries (McGoodwin 1990; Berkes et al. 2001; Charles 2001).[2] Since 2004, after the tsunami in the Indian Ocean and the typhoon in the Philippines, researchers from various disciplines started paying more attention to small-scale fisheries's vulnerability to extreme coastal events and the challenges faced in the aftermath (Adger et al. 2005; Pomeroy et al. 2006; Westlund et al. 2007). More recently, several studies have investigated post-disaster challenges of small-scale fisheries in Japan after the 2011 Tohoku tsunami (De Silva and Yamao 2007; Wilhelm and Delaney 2013). However, in Latin America and the Caribbean, despite the wide socioeconomic relevance of small-scale fisheries (Salas et al. 2011) and the high levels of exposure to risks and hazards, there are only a few studies addressing the many faces of post-disaster adversities affecting them. In this chapter, I contribute to filling this gap by

[1] Marine environments and the sustainability of the world's fisheries are being threatened by multiple drivers (e.g., overfishing, pollution, and climate change; see Boonstra et al. (2015). The collapse of exploited fish species, e.g., Acheson and Gardner (2014), would imply a major *disaster* affecting global food security and human subsistence (Rice and Garcia 2011). Without ignoring these threats to marine resources themselves, this chapter, however, is concerned about the abrupt *disasters* particularly affecting small-scale fisheries and coastal people's livelihoods. Examples are provided above as follows.

[2] Fishing has been commonly considered an intrinsically high-risk profession due to adverse working environments and possible technological failures (McGoodwin 1990; Smith 1998). But this account does not necessarily include climate change and extreme disasters as factors that threat the sustainability of coastal fishing communities.

describing and analyzing successful and failed examples of small-scale fishing communities in central-southern Chile since the massive February 2010 earthquake and tsunami and discussing key factors in the adaptive capacity of coastal resource users. The analysis is based on three studies published in coauthorship with several colleagues (Marín et al. 2010, 2014, 2015), my doctoral thesis (Marín 2015), secondary data, and complementary unpublished information.

The empirical studies referred to above provided three snapshots covering different spatial and temporal scales of the post-disaster process. Here I elaborate on those findings and draw lessons about adaptive capacity in small-scale fisheries to respond to different interrelated impacts after a natural disaster. The guiding questions are: *How do fishing communities survive and respond in the short term to an unexpected earthquake and tsunami? What are the factors of fishers' mid-long-term recovery strategies after the devastation of their livelihoods? How do small-scale fisheries adapt and respond to permanent disaster-driven environmental changes*? As explained in more detail in the methods section, the analysis is based on grassroots data collected from fishers' leaders in three Chilean administrative regions on a follow-up assessment of fisher organizations in Bio-Bío (the most affected region) and an in-depth case study covering the Tubul-Raqui coastal wetland.

The impact of coastal disasters – and associated social, economic, and environmental changes – on the sustainability of small-scale fisheries is too big to ignore. A better understanding of what makes a difference for fishing communities in responding to disasters and other external perturbations is necessary to inform the design of more equitable and effective fisheries and coastal management policies and strategies. This chapter is based entirely on the Chilean 2010 earthquake and tsunami experience. However, my hope is that the underlying questions addressed and the provisional answers offered can also be relevant to approach small-scale fisheries adaptation in other countries and/or in response to other extreme coastal events.

### *3.1.1 Adaptive Capacity in Small-Scale Fisheries*

Within scientific and political discourses, it is broadly assumed and expected that small-scale fisheries and their communities have the capacity to adapt to current as well as future social and environmental changes, including those generated by disasters and extreme climate events (FAO 2015). In a sense, adaptive capacity is conceived as a way to bridge the gap between the potential of small-scale fisheries development and the adversity to which they are permanently exposed. Adaptive capacity is a broad concept used to describe "the ability of a system to adjust to change, moderate the effects, and cope with a disturbance" (Cutter et al. 2003, p. 600). Adger (2006) defines adaptive capacity as "the ability of a system to evolve in order to accommodate environmental hazards or policy change and to expand the range of variability with which it can cope" (p. 270). For McClanahan et al. (2008), adaptive capacity "indicates society's potential to cope with perturbations and take advantage of new opportunities, whether due to climate impacts, conservation interventions, or other changes to the social-ecological system" (pp. 53–54).

When a system performs concrete adaptations in relation to its internal or external environment, it is due to its inherent capacity to change in order to persist. This idea mostly refers to social systems in which adaptation could be conceived as a deliberate action (McCarthy 2014). Scholars have explored multiple sources of adaptive capacity of natural resource-dependent communities, especially those within fishing communities. These studies have addressed financial and technological issues (Tompkins and Adger 2004; Badjeck et al. 2010), occupational and productive features (Allison and Ellis 2001; Kraan 2009), institutional characteristics (Dolšak and Ostrom 2003; Armitage 2005), cultural and cognitive dimensions (Marshall and Marshall 2007; Boonstra and Hanh 2014), and social capital and network aspects (Bodin et al. 2006; Eriksson et al. 2017).

Social capital, in general, refers to the (in)existence of collaborative networks – in a context of trust, shared norms, and reciprocity – which can be expected to have positive effects for people and the environment (Coleman 1988; Krishna 2002). The studies summarized here, and others (Grafton 2005; Bodin and Prell 2011; Crona et al. 2017), emphasize and reinforce the role of social capital and networks – both within and among local communities and groups and between their organizations, the state, and other private and civil society actors[3] – as expressions of adaptive capacity in small-scale fisheries. However, our results discussed in this chapter highlight the need to take a broader perspective and pay attention to multiple and complementary factors of adaptive capacity.

The remaining of the chapter is divilded into four sections. Section 3.2 presents an overall characterization of Chilean small-scale fisheries, a description of the great 2010 earthquake and tsunami, and a summary of the methods and tools used to collect and analyze data. In Sect. 3.3, the main research findings are presented and discussed with emphasis on the adaptations and responses to different disaster impacts from a longitudinal perspective. Finally, in Sect. 3.4, I reflect and identify challenges and lessons toward sustainable small-scale fisheries and coastal management in the face of more severe disasters and other environmental changes.

## 3.2 Research Setting and Methodological Approach

### *3.2.1 Artisanal and Small-Scale Fisheries in Chile*

Chile represents a unique setting to illustrate and investigate the relationship between fishing communities and the untamed nature of coastal environments. Due to its geographical location and unique extension, the country has been endowed with an abundance of marine resources and is among the world's greatest ten fish

[3] These three types of network-based social capital are formally referred to as bonding (i.e., intra-group/community relationships), bridging (i.e., horizontal relationships between different groups/communities), and linking social capital (i.e., relationships between local groups/communities and actors in higher levels of political, economic, or social hierarchy); see Woolcock (2001), Grafton (2005), and Marín and Berkes (2010).

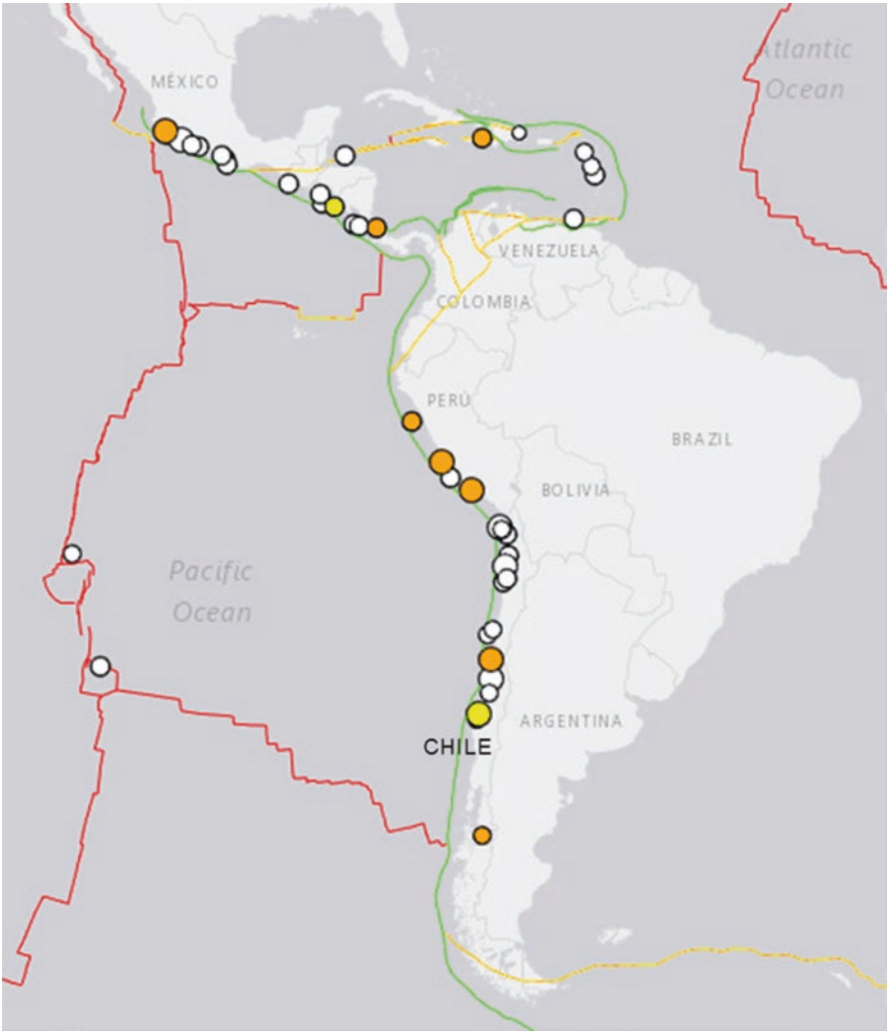



**Fig. 3.1** Tsunami events in Latin America and the Caribbean between 1985 and 2015. Size of circles = magnitude of earthquakes (the larger, the greater). Color of circles = no. of fatalities; white, no deaths/unknown; orange, few deaths (1–50); purple, some deaths (51–100); yellow, many deaths (101–1000). Lines indicate plate boundaries. Source: Adapted from NCEI (2016)

producers (FAO 2014). At the same time, Chile is challenged by conditions for multiple and extreme coastal disasters, as the world's 11th most exposed country to environmental risks and hazards (Welle and Birkmann 2015). As illustrated in Fig. 3.1, the country has suffered extensively from the most damaging tsunamis in Latin America and the Caribbean in recent decades (NCEI 2016). In Chile, as in Thailand, Indonesia, Japan, and the Philippines, small-scale fisheries and associated communities are among the most vulnerable populations and are highly exposed to tsunamis and other coastal disasters.

Chile was the eighth largest fish-producing country in the world in 2012, with more than 2.6 million tons of marine captures (3.2% of total global catch) and the sixth main exporter of fish and other marine products in the same year (FAO 2014). Behind these aggregated figures, highly different fishing sectors and socioeconomic realities must be differentiated. This differentiation is important to contextualize the fisheries we will examine and clarify the terminology used in the chapter.

Chilean fisheries are segmented by law into three large sectors, which each makes different contributions to gross national product (ODEPA 2014): the industrial sector (30%), the aquaculture sector (32%), and the artisanal sector (38%).[4] The artisanal fishery sector,[5] in particular, has great social and economic importance and provides a direct source of employment for more than half of the country's fishing workers, roughly 86,000 people (ODEPA 2014). Nevertheless, unlike the common use of the term "artisanal" in the literature (Johnson 2006), in Chile "artisanal fisheries" are neither a synonym for nor a subset of small-scale fisheries.

According to Chilean regulations, the artisanal fishery sector is a broad category referring to the fishing extractive activity carried on by natural persons who work as artisanal fishers on a personal, direct, and regular basis, either as fishers, vessel owners, shellfish divers, or seaweed gleaners.[6] Artisanal fishing vessels are defined as boats and launches that are up to 18 m long and have up to 80 $m^3$ of storage capacity. A careful examination of the regulations reveals various (sometimes overlapping) sub-sectors, depending on the type of vessels (e.g., four categories exist for vessels from less than 8 and up to 18 m long), navigation, and fishing technology employed (e.g., from no technology at all to GPS, sonar, and purse seiners) and the resources extracted (e.g., out of 67 species of fish, 30 of mollusks, 23 of crustaceans, and 13 of seaweed).

In this context, Chilean small-scale fisheries (as referred to here) consist mainly of a sub-sector of artisanal fisheries including male and female boat owners, fishers, and hookah divers operating from boats of up to 12 meter long (equipped with 10–45 hp off board engines and air compressors) and also inshore and nearshore gatherers and gleaners operating either with or without vessels (see Fig. 3.2). The sub-sector targets multiple marine resources (e.g., fish, marine invertebrates, and seaweed), such as reef fish (e.g., vieja negra/*Graus nigra*, pejeperro or sheephead/*Semicossyphus darwini*, and acha/*Medialuna ancietae*), mollusks (e.g., loco/*Concholepas concholepas*, navajuela/*Tagelus dombeii*, and huepo/*Ensis*

[4] The contribution of the artisanal sector is overrepresented, as it includes seaweed landings, a highly heavy and low-price resource. Excluding seaweed, the artisanal sector represents only 26% of the national catch.

[5] "Artisanal" is the label employed in Chile for designating the diverse nonindustrial extractive activities of fishing people. In strict terms, the label is misleading as technology has been long adopted by most fishers (e.g., hookah diving, fiberglass motorboats, and iron launches), and a majority employs gear developed elsewhere and purchased in the market (e.g., nets and longlines).

[6] Note that these are mutually nonexclusive categories; hence one person can be registered and carry on two or more of these activities as long as it is within one administrative region.

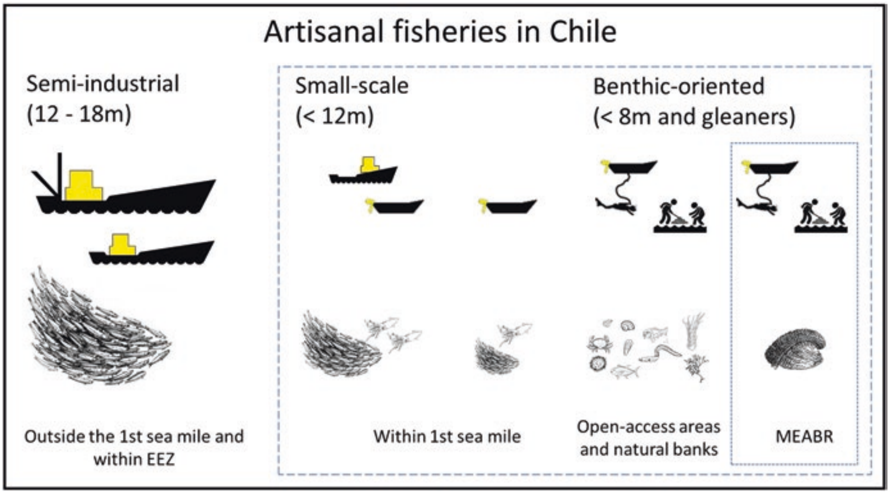



**Fig. 3.2** Chilean small-scale fisheries in context (Source: elaborated by the author based on the Fisheries and Aquaculture Law; vessel images: courtesy of Verónica Ortiz)

*macha*), crustaceans (e.g., jaiba limón/*Cancer porter* and jaiba peluda/*Cancer setosus*), and seaweed (e.g., luga negra/*Sarcothalia crispata* and huiro negro/*Lessonia nigrescens*; see Godoy et al. 2010). The term benthic-oriented sub-sector (*subsector bentónico*) is commonly used in Chile to refer to small-scale fisheries targeting mostly bottom-dwelling marine organisms.

Small-scale fisheries in Chile are associated with self-established local organizations such as fishing unions and cooperatives (Payne and Castilla 1994) and *caletas*, or coves in English (Castilla et al. 1998). Fisher organizations are headed by elected leaders and traditionally perform productive and social functions (e.g., resource management and group support) and also represent their members' interests and demands before the state and other market and social actors. *Caleta* is a term referring to landing and mooring sites as well as the fishing villages that develop around the fishing activity in rural areas (Aburto et al. 2009). *Caleta* facilities normally include port infrastructure consistent in stowage for equipment and gear, office/meeting rooms, and fish vending stalls. With support from the state, some fisher organizations have improved their *caletas* to take advantage of tourism by, for instance, starting restaurants, museums, or seafood or handicraft stalls. In exceptional cases, fisher organizations have gone even further and implemented small-scale aquaculture or processing plant projects.

A key feature defining Chilean small-scale fisheries organizations covered in our studies is their potential participation in the Management and Exploitation Areas for Benthic Resources (known in the literature as MEABR). These areas were established by law in the 1990s to halt overexploitation trends and to foster the sustainable use of benthic resources (Castilla 1994; Gelcich et al. 2010). The MEABR is a form of co-management system in which the state transfers exclusive territorial user rights to organized fisher organizations over a portion of coastal seabed and the resources therein. The opportunity to apply for and obtain a MEABR was an important driver of the organization of fishers through the creation of unions and cooperatives, as well as for the collective management of resources (Payne and Castilla 1994; Gelcich et al. 2005). The MEABR system has also led to the establishment of more permanent and formalized relationships between resource users and the state and other social and market actors (Schumann 2007; Marín and Berkes 2010), as it represents a key pillar in strengthening small-scale fisheries and coastal management processes in Chile (Gelcich et al. 2010).

It is important to stress that the main focus of this chapter is the small-scale fisheries sub-sector, which is characterized by small boats and crew, basic technology, and multispecies focus. However, when assessing wide-scale tsunami threats to life and impacts, reference to the broader "artisanal" sector is necessary and unavoidable because fine-grained data is unavailable or hard to collect. Similarly, when discussing livelihood issues related to co-management, the analysis refers mainly to benthic-oriented small-scale fisheries organizations participating in the MEABR system. Figure 3.2 presents a general guidance to understanding Chilean artisanal and small-scale fisheries, based on how (much), what, and where they are allowed to fish.

### *3.2.2 The Massive 2010 Coastal Disaster in Central-Southern Chile*

At dawn on Saturday, February 27, 2010, an Mw 8.8 earthquake befell south-central Chile and became the world's sixth largest instrumentally recorded earthquake. The epicenter was located in the Pacific Ocean (35°54′32″S 72°43′59″W) at a depth of 30.1 km (see Fig. 3.3). The quake lasted up to 4 min and affected six Chilean administrative regions, namely, Valparaíso, Santiago (Metropolitan), O'Higgins, Maule, Bio-Bío, and Araucanía, in an area inhabited by more than 13 million inhabitants corresponding to nearly 80% of the national population. The massive tectonic event had a great impact on people's lives, housing, and public infrastructure, with a total death toll of 525 and a total economic loss calculated to be around USD $30 billion.

However, the catastrophe did not end there for coastal populations. The epicenter and the rupture zone, located under the sea, generated a tsunami that hit approximately 600 km of Chile's coastline (33° 36′S – 38° 28′S) and also the Juan Fernández Archipelago located 700 km off the continent. Major tsunami waves hit the coast in the following 14 min to 2 h and devastated coastal cities, villages, and fishing *caletas* in an area that accounts for around 27% of the artisanal workforce and 47% of the national artisanal catch (Marín et al. 2010). It was estimated that about 80,000 permanent inhabitants in the area were small-scale fishers and their families. Due to the summer season and holiday period, thousands of tourists and visitors were also within the area and were affected by the earthquake when the disaster happened. In addition to the immediate material destruction and the abrupt shock that the survivors experienced, the coastal areas were suddenly exposed to the tsunami threat.

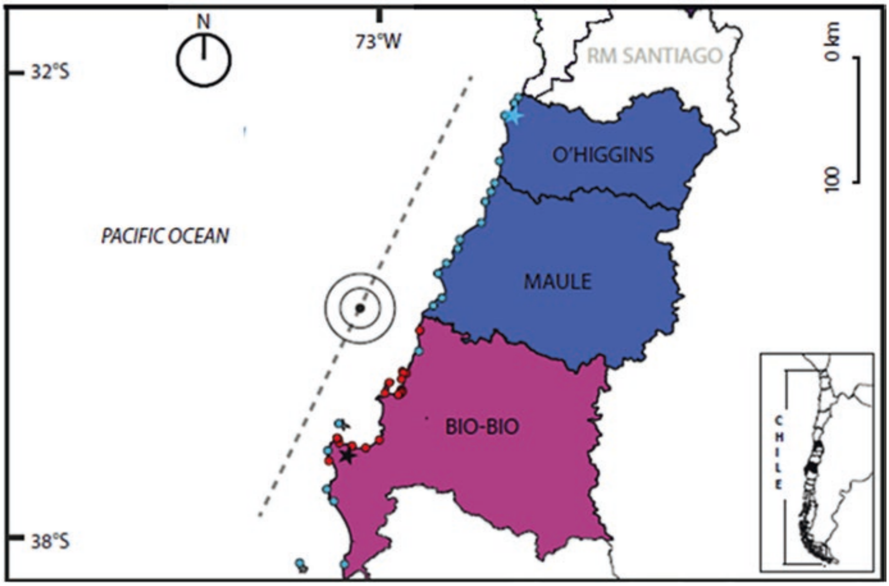



**Fig. 3.3** Reference map of the coastal zone impacted by the 2010 tsunami. Concentric circles show the earthquake epicenter, and the dotted line marks the coastline with the highest tsunami impacts. Circles represent the fishing caletas/organizations studied. The black star indicates the location of the Tubul-Raqui coastal wetland. Source: Adapted from Marín (2015)

In addition to the life-threatening earthquake and tsunami and the associated material devastation of public and private fishing infrastructure and assets, the 2010 event generated permanent topographic and environmental changes in rocky coasts, sandy beaches, dunes, and river mouths (Farías et al. 2010; Vargas et al. 2011; Jaramillo et al. 2012). Massive earthquakes like the one in Chile – and in other places as well – tend to trigger coastal uplift and subsidence phenomena that change both coastal landscapes and social-ecological relationships (Castilla et al. 2010). The uplift of the land (vis-à-vis the receding of the sea) was particularly evident in estuaries and wetlands, where hydrological balances were modified, affecting highly productive ecosystems which local communities depend on.

### *3.2.3 Methods and Analytical Approach*

The research presented in this chapter is an unintended example of an adaptive or iterative research design (Yin 2013). Unforeseeable natural events, personal experiences, and interactions with research subjects resulted in shifts and redefinitions of research goals, questions, and methods. The studies draw on mixed methods and techniques to collect and analyze different sets of empirical data. Qualitative methods were used to learn at the grassroots level how the individuals describe their problems, their actions, and the networks that are relevant to them. Participatory and rapid rural appraisal techniques, including in-depth interviews, workshops, and observation, were employed. Consulted informants include fishers, fishers' representatives, scientists, fishery technicians and consultants, as well as public sector officials. Their discourses play an important role throughout the research process. For instance, participant perspectives permitted a preliminary understanding of the research context and inform the design of quantitative instruments, allowed for descriptive and comparative analyses to be conducted, and supported the interpretation of quantitative data and analyses.

Quantitative methods were also employed in all the case studies to survey a broad and representative collection of informants from different sectors and settings. Semi-structured questionnaires were applied with fishers' leaders, coastal resource user groups, and public sector representatives. These instruments are particularly useful for obtaining relational data, for example, about the existing and meaningful relationships among actors (e.g., for the analysis of social capital and networks; see below). Also, Likert scales of response were used to quantify perceptions such as increasing or decreasing trends in the availability of ecosystem services (Sect. 3.3) or the extent of tsunami damage and impacts suffered (Sect. 3.2). The quantitative data obtained allowed for statistical (Sect. 3.1) and other advanced analyses (e.g., QCA in Sect. 3.2; see Ragin 2008) leading to generalizable conclusions.

Overall, the three case studies discussed here cover nearly 80 small-scale fisheries organizations in central-southern Chile (Fig. 3.3) and are based on more than 40 interviews and 10 workshops and the application of ca. 300 semi-structured questionnaires. The analysis of collected data was performed using specialized computer software packages, including QCA version 1.1–3 in the study presented in Sect. 3.2 and SigmaPlot version 13.0 and MS Excel in the research outlined in Sects. 3.1 and 3.3.

In terms of the analytical approaches adopted, a central theme in our research is the empirical examination of social relationships through social network analysis (Bodin and Prell 2011). Networks here represent a key hypothesized source of fisher organizations and community adaptive capacity. The study of social networks has been motivated by the argument that the different positions occupied by actors within the social structure are related to the mobilization of information, resources, and opportunities along these networks. The analysis of social networks proceeds by describing the patterns of social relations using formal methods and metrics such as centrality and the assessment of whether the positions of individuals in the network are correlated with or cause certain outcome of interest. The (non)existence of social networks and the levels of social capital they give rise to have been considered the "glue," "lubricant," and "pipelines" within and across scales, which people and groups rely on to develop (Woolcock 2001; Krishna 2002) and adapt to change (Pelling and High 2005; Bodin and Crona 2008). Social network analysis concepts and metrics were used particularly in Sect. 3.2 as a way to measure small-scale fisheries organizations' social capital before and after the 2010 coastal disaster. Also, non-systematic assessment and analysis of social capital, as a factor of tsunami evacuation, were included in the study addressed in Sect. 3.1. Further conceptual and operational details can be found in the original sources referenced above (Marín et al. 2010, 2015).

Ecosystem services (ES) refer to the multiple benefits people obtain from nature (Millennium Assessment 2005) and represent the lens through which we studied permanent environmental changes and their impact on local communities (Marín et al. 2012). This concept provides the basis for the research synthesized in Sect. 3.3. In particular, the ES framework developed by the Millennium Ecosystem Assessment addresses the consequences of ecosystem change for human well-being, highlighting the mutual interactions and dependencies between society and ecosystems (Carpenter et al. 2012). Authors have highlighted that the well-being and livelihoods of different social groups rely on the access to specific natural resources and services that are meaningful to, and sometimes coproduced by, them (Daw et al. 2011). In turn, the availability and access to resources can be determined by direct and indirect social, economic, political, and environmental drivers of change. Few studies have used the ES framework to assess change after abrupt transformations in social-ecological systems related to natural disasters. We apply the framework to describe and analyze the case of rapid and permanent disaster-driven ecosystem transformations and the consequences on and transformations of coastal people's livelihoods (see Sect. 3.3).

## 3.3 Adaptive Capacity in Chilean Small-Scale Fisheries to the 2010 Earthquake and Tsunami Impacts

### *3.3.1 Responding to and Surviving an Unexpected Earthquake and Tsunami*

Before February 2010, the last massive tsunami in Chile hit in 1960, triggered by the world's biggest instrumentally recorded earthquake in modern history, which registered Mw 9.8 (USGS 2016). The threat of tsunamis and the experience of Chileans with their effects had been somehow dormant in peoples' consciousness and stored in elders' memories and stories for a long time. Although the high probability of a massive earthquake in the seismic gap between the cities of Constitución and Concepción was predicted and discussed by experts (Ruegg et al. 2009), only a few people had access to this information by the end of summer 2009/2010. In that context, the event unveiled dramatic weaknesses and lack of preparedness throughout state institutions to respond to a national crisis of this magnitude. In addition to the complete failure of telecommunication systems and the total electricity blackout, the uncoordinated response from the authorities led to the absence of official tsunami warnings at all levels (Madariaga et al. 2010).[7]

In the face of the tsunami and despite the absence of timely evacuation warnings, coastal communities in Chile showed the capacity to respond quickly to the disaster and thus to survive. Based on fieldwork and data collected soon after the disaster,

[7] In April 2016, a 6-year trial to allocate faults and responsibilities associated with the absence of tsunami alert and the fatal consequences was conditionally suspended. The six defendants, including civil authorities, public servants, and former members of the Navy, accepted to pay compensation to the victims' families.

we found that less than 5% of casualties attributed to the tsunami in the impact zone (8 out of 181) were individuals identified as fishers or members of fishers' households (Marín et al. 2010). In less than 15 min, many fishing villages and *caletas* completely self-evacuated to safe areas without any formal procedure or guidance (Moussard 2011; Soulé 2014).

The successful response of fishing communities in Chile to the coming tsunami can be explained by a combination of factors (Marín et al. 2010). First, coastal people were able to interpret the natural warning signals during and after the earthquake. Both the strength of the tremor and the anomalies in the sea level raised the alert of coastal dwellers. Second, these signals were properly interpreted by recalling the stories about past tsunamis told by elders. An illustration is the story told about the nine tsunamis that hit the Chilean coasts in the twentieth century, with the 1960 tsunami that hit Valdivia being the most remembered since it claimed more than 2200 victims and radically transformed the coastal landscape. These experiences became part of the coastal oral tradition that has been transferred across generations. Third, the evacuation alert that was maintained at the local level was promptly transmitted among neighbors. In that context, social relationships expanded and reached a sort of informal warning system. For example, these interactions were critical in convincing people with doubts to evacuate and in enabling support for residents with reduced mobility. Furthermore, in some cases, these informal networks saved the lives of inexperienced visitors who were in high-risk areas and were alerted by coastal residents.

In sum, the outstanding response and survival capacity of small-scale fishing communities can be explained by the existence of experience-based ecological knowledge, the bonding social capital, and the appropriate and opportune assessment of natural warnings. The timely activation of these latent sociocultural assets in the face of an abrupt threatening shock suggests the existence of a natural hazard-associated subculture among the coastal fishing communities. Similar responses were reported in northern Chile during the September 2015 earthquake/tsunami (Contreras-López et al. 2016; Aránguiz et al. 2016). These findings highlight the value of social capital and local knowledge in relation to hazard preparedness and responsiveness and stress the need to integrate contextual and behavioral approaches in disaster management and rehabilitation policies (Box 3.1).

**Box 3.1: Tsunami Impacts on Artisanal and Small-Scale Fishing Capacity in Central-Southern Chile (Adapted from Marín et al. 2010)**

The 2010 tsunami caused the immediate devastation of vessels, equipment, and infrastructure in more than 100 *caletas* along central-southern Chile and implied the loss of up to 60% of fishing capacity (Marín et al. 2010). Widespread destruction of fishing assets was also reported in the Juan Fernández Archipelago (Contreras and Winckler 2013). On the continent, specific impacts were observed depending on particular characteristics of the activities carried on in the three regions affected, as summarized below:

(continued)

**Box 3.1** (continued)

- O'Higgins: fisheries in the region are intensive at a small-scale level, such as inshore seaweed gleaning. Main target species here are luga/*Mazzaella laminarioides*, chasca/*Gelidium* spp., and cochayuyo or bull kelp/*Durvillaea antarctica.* The activity is spatially based on *rucos*, namely, coastal seasonal settlements made of light and/or recycled materials. Critical losses in the region included these temporary shelters, diving suites, and ready-to-sell products recently harvested.[8]
- Maule: the region concentrates a large number of small-scale fishers using outboard engine boats (up to 8–10 m) and also larger board engine *lanchas* (between 12 and 18 m). The former mostly target demersal species (e.g., *merluza* or Chilean hake/*Merluccius gayi*), and the latter catch pelagic species (e.g., *reineta* or southern Ray's bream/*Brama australis*, *bacalao* or Patagonian toothfish/*Dissostichus eleginoides*, *congrios* or cusk eels/*Genypterus* spp., and *Chilean albacora* or *pez espada*/*Xiphias gladius*). In this area, critical damages affecting fishing materials were vessels, engines, and fishing nets.
- Bio-Bío: the region is one of the most important and diverse fishing zones in Chile. It concentrates an important labor-intensive pelagic fleet (up to 18 m and 50 gross tons) that captures more than 60% of the national artisanal fleet catch (e.g., *sardina común* or pilchard/*Sardinops sagax*, *anchoveta* or anchovy/*Engraulis ringens*, *jurel* or jack mackerel/*Trachurus symmetricus*). Also, small-scale fishers and divers in the region extract about 45% of the national catch of benthic invertebrates (e.g., *loco*/*Concholepas concholepas*, *navajuela*/*Tagelus dombeii*, and *huepo*/*Ensis macha*). In this region, massive damages affected all categories of vessels (particularly small boats), fishing nets, longlines, and diving equipment.

In addition to the impacts on fishing gear and equipment, basic port infrastructure and services suffered severe damages (e.g., destruction of docks, dams, landing platforms, and cranes) that were reported all along the coast. Moreover, in many *caletas*, *small-scale fisheries* organizations lost their offices, storage lockers, stores, and restaurants or small-scale aquaculture projects. Small-scale fishing communities were probably the most affected coastal group with more than 24,000 fisher households' livelihoods directly or indirectly threatened.

[8] For seaweed gatherers in Central Chile, summer is the most profitable season. They normally store and dry the produce in low areas between the narrow beaches and steep coastal cliffs before transporting it for selling. The February 2010 tsunami swept away 3 months of hard work.

### 3.3.2 Recovering Fisheries Livelihoods in the Aftermath of the Disaster

For many resource-dependent communities, including those reliant on small-scale fisheries, recovering from abrupt devastating events generally implies a compounding challenge. This complex scenario not only requires recovering from what has been lost but also addressing pre-existent and persistent problems, vulnerabilities, and slow-paced changes and uncertainties (Pomeroy et al. 2006). An old research question in disaster and social-ecological studies concerns the factors explaining and predicting individual and collective capacity to respond to and recover from extreme perturbations (Diamond 2005; Gunderson 2010; Aldrich 2012). In fact, some scholars have drawn on the *resilience* concept to stress internal or intrinsic factors leading to more or less capacity to adapt to change (Walker et al. 2004; Adger et al. 2005), whereas others have referred to *vulnerability* to highlight external or contextual factors determining people's exposure to disasters and their possibilities to respond and recover (Blaikie et al. 2014; Adger 2006). More recently, authors have developed integrative approaches to account for both internal and external factors of recovery (Berkes 2007; Turner 2010; Maru et al. 2014).

One factor of this "recovery" in the aftermath of the disaster was illustrated by the variety of international aid programs, both public and private and national and international, that provided fishers with new or repaired vessels and equipment to resume their activity.[9] However, even though in 2011 the impacted small-scale fisheries already started to show symptoms of recovery (Fig. 3.4), more subtle and long-term impacts at the grassroots level could still be observed. In the Bio-Bío region, for instance, fishers' leaders and SERNAPESCA (National Fishery Service) officers described an altered scenario of fisher organizations' performance in the region after the tsunami (Marín et al. 2015).

After extreme perturbation, it is reasonable to think that people will attempt recovering and bouncing back to the former stage. However, evidence shows that they will often navigate different trajectories (Masten and Obradović 2008). This situation was illustrated by Bio-Bío's case, as described in Box 3.2. Our findings reflect the unequal adaptive capacity of small-scale fisheries organizations to recover from the 2010 tsunami (Marín et al. 2015). Interestingly, the different levels of recovery performed by small-scale fisheries organizations were not correlated with the level of restoration of fishing vessels and equipment (i.e., enabled by the direct transfer of material and financial resources from external agencies). This suggests that there are more complex explanatory factors of post-disaster livelihood recovery for small-scale fishing groups.

[9] These include government funding and co-funding programs (e.g., FIP/FAP, Volvamos a la Mar), civil society and private initiatives (e.g., Un bote para Chile, Mar de Esperanza), and international NGOs (e.g., Red Cross, Caritas).

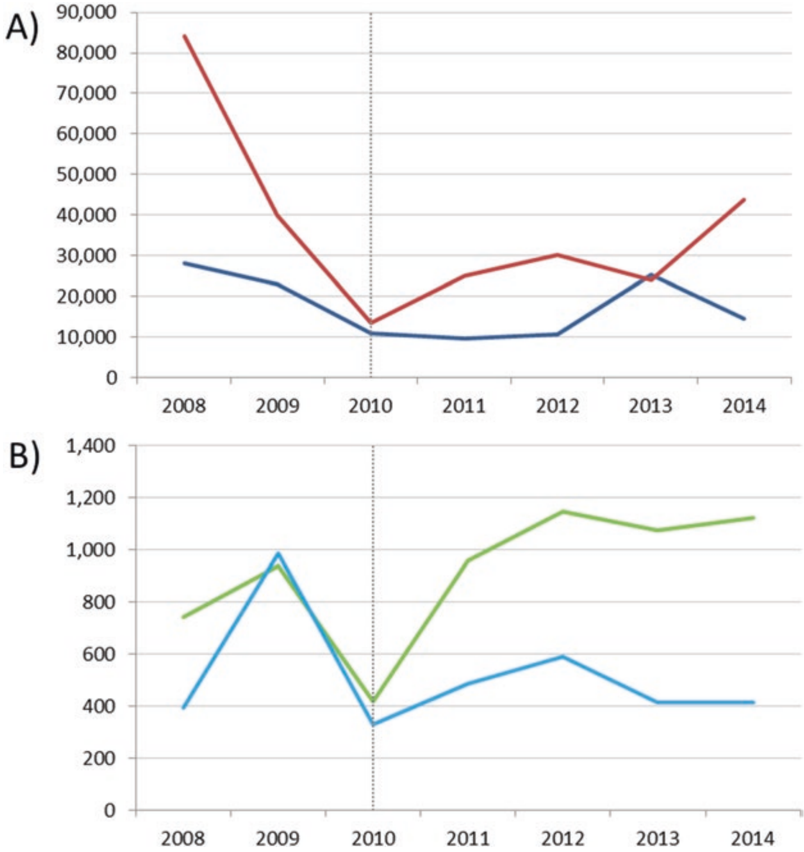



**Fig. 3.4** Annual landings of small-scale fisheries target resources in Bio-Bío (tons). (**a**) Red = shellfish; blue = seaweed. (**b**) Green = crustaceans; light blue = other resources (e.g., sea urchins). Dotted lines highlight the year of the disaster. Source: SERNAPESCA (2015)

Disaster research has frequently looked for singular factors explaining post-disaster recoveries, frequently focusing either on communities' internal capacities or on external constraints. In our study (Marín et al. 2015), we explore whether and how the interplay between internal and external factors – namely, pre-/post-linking social capital and levels of damage and isolation, respectively – can better explain post-disaster recovery trajectories. Results showed that the level and strength of linkages existing in social capital assets are critical in determining the post-disaster recovery trajectories of small-scale fisheries organizations. Maintaining or increasing levels of social capital is indispensable for positive trajectories to occur, while a common denominator for less desirable post-disaster recovery trajectories is a low or reduced level of social capital. When widespread destruction affects livelihoods at the local level, communities are more likely to satisfy their needs if they can obtain resources and support from other places. In fact, the ability of the

**Box 3.2: Post-disaster Recovery Trajectories of Small-Scale Fisheries Organizations in Bio-Bío (Adapted from Marín et al. 2015)**

A common expectation after a disaster is for a community to rebuild, recover, or return to the normal status (Leitch and Bohensky 2014). This is generally referred to as the capacity of a system to "bounce back" to a previous state, but this can be problematic when applied to resource-dependent communities (Manyena 2006). Depending on the extent of the damage and/or the state before the disaster, returning to a previous condition might be impossible or even undesirable (Zanuttigh 2014; Pomeroy et al. 2006). In addition, without ignoring the harmful side of disasters, authors have highlighted that there are opportunities beyond a return to the normal. Disasters can also open windows of opportunity for positive transformation (Blaikie et al. 2014; Olsson and Galaz 2012).

In the Bio-Bío region, preliminary fieldwork and in situ observations suggested that small-scale fisheries organizations impacted by the tsunami were not undergoing a similar fate in the midterm. While some had been able to respond and adapt to the new conditions, many were still having a hard time trying to recover their livelihoods. To capture these differences, we used the term "post-disaster trajectories" (Marín et al. 2015). This concept is operationalized as a five-category semantic scale that reflects different trends in collectively performed productive activities in relation to resource use, management, and commercialization: (1) innovation, organizations have taken the opportunity to do new/different things (e.g., diversified livelihoods); (2) normalization, organizations have managed to recover a similar condition they had before (e.g., bounce back); (3) recovering, organizations are still striving to move toward normalization (e.g., but have not found their way through yet); (4) stagnation, organizations have lacked continuity and dynamism in their efforts to recover (e.g., lacking capacity, resources, and guidance to do it); and (5) recession, organizations have lost the capacities and qualities they had before (e.g., risking their fishing livelihoods and resource management/stewardship capacity). The five trajectories describe stages within a continuum ranging from more to less desirable pathways into long-term recovery and development, as shown in Fig. 3.5.

communities to leverage those resources is more likely when diverse and strong trustful relationships in higher-level organizations (i.e., high level of linking social capital) are built and maintained.

A different finding after the analysis highlighted the role of external factors (i.e., those that are beyond the control of fishers) in determining recovery trajectories. Two external factors that were assessed, namely, the amount of damage suffered and the geographical isolation of small-scale fishing *caletas*/organizations, deeply affect the importance of supportive and collaborative relationships and shape the specific

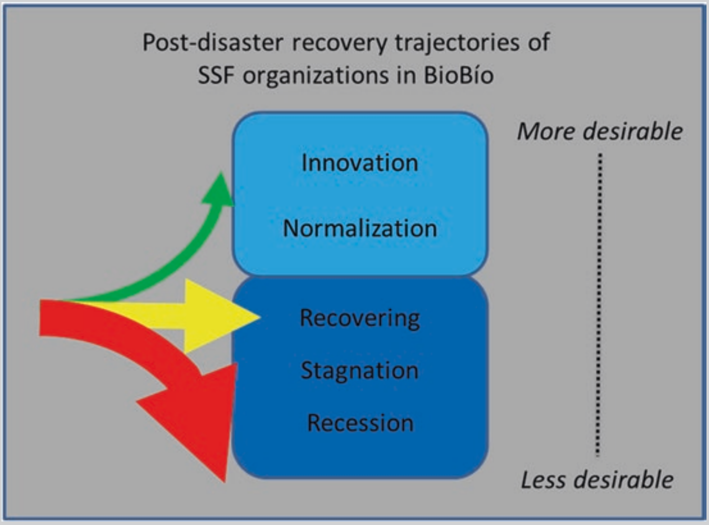



**Fig. 3.5** Post-disaster recovery trajectories observed among small-scale fisheries organizations in Bio-Bío after the 2010 earthquake and tsunami (based on Marín et al. 2015). Four years after the tsunami, out of 21 organizations studied, 11 were going through less desirable trajectories (red), 7 were striving with adversity (yellow), and only 3 had expressed positive adaptive capacities and were navigating into a potentially more sustainable future (green)

vulnerability contexts of small-scale fishing communities. Both the level of damage and the level of isolation are related with associated transaction costs (see Dahlman 1979) and represent potential obstacles to the access and flow of resources and information between the local level and higher levels. Obtaining critical assets for recovery (e.g., financial, human, knowledge) from regional, national, and international actors is less probable in the absence of strong and trustworthy relationships.

Key lessons from this finding include the observation that external factors, such as damage and isolation, are particularly relevant for defining post-disaster recovery trajectories. Individually, neither damage nor isolation can by themselves hamper highly connected organizations from recovering. At the same time, any of these factors can hamper the recovery of organizations that remain disconnected. Interestingly, the study was not able to determine whether small-scale fisheries organizations with high levels of linking social capital would have been able to recover under conditions of high damage and high isolation. The capacity of local users to steer better responses through their social networks is important, but should not be overestimated. Concurrent factors, such as the amount of damage and geographical isolation, can amplify or reduce the importance of supportive and collaborative relationships (Marín et al. 2015).

### 3.3.3 Shifting Livelihoods in Response to Ecosystem Change and Resource Loss

In some places, in addition to the threat to human lives and the devastation of material assets, extreme disaster events can cause permanent environmental changes (Szczucinski et al. 2006; Cochard et al. 2008). Tubul-Raqui, in the Gulf of Arauco, is one of the major coastal wetlands of Chile and of the western South American coast (Valdovinos et al. 2010). The social and ecological importance of the wetland is derived from its biodiversity and the provision of multiple ecosystem services that support local and traditional livelihoods. The February 2010 earthquake generated a ~ 1.6 m coastal uplift in and around the Gulf of Arauco (Castilla et al. 2010), altering the hydrological balance, drying most channels, and reducing salt-freshwater interaction in the wetland (see Box 3.3).

**Box 3.3: Ecosystem Transformations Forcing Livelihood Adaptations in Tubul-Raqui Coastal Wetland**

Based on the discourse of participants in the research, we categorized and prioritized provisioning, regulation, support, and cultural ecosystem services that are relevant to communities' well-being all around the Tubul-Raqui wetland (Marín et al. 2012). Freshwater (e.g., for human and cattle consumption), biodiversity (e.g., avifauna), and aesthetic (e.g., landscape beauty and potential for tourism) services and values obtained from the wetland were highlighted by all communities, independently of their location. At the same time, informants expressed sharp differences in their prioritization of key provisioning services, suggesting three resource user groups and their respective livelihood systems:

- Coastal users, including mostly coastal fishers from *caleta* Tubul nearby the river mouth, who depend on diving in the Gulf of Arauco and seaweed (i.e., *pelillo*/*Gracilaria* sp.) cultivation/gathering in the wetland
- Transition users, represented mainly by rural dwellers from Santa Clara and *caleta* Las Peñas (about. 8 km inland from Tubul) whose mixed livelihoods include both diving, seaweed gleaning, and small-scale agriculture
- Inland users, mainly small- and medium-scale farmers from several adjacent localities (e.g., Aguapié and Raqui) who engage in agriculture and livestock activity (e.g., dairy products) in a 2–3 km fringe between the cultivated wetland plain and adjacent forested hills

As a consequence of the 2010 earthquake and the associated coastal uplift, the availability and abundance of key ecosystem services sustaining local livelihoods dramatically changed, with positive and negative impacts on local livelihoods (Marín et al. 2012). Overall, the drying of vast wetland areas was associated with reduced aesthetic values and presence of migratory bird species, as well as diminished opportunities for tourism. Other impacts were felt

(continued)

**Box 3.3** (continued)


**Fig. 3.6** Disaster-driven adaptation in *Caleta* Las Peñas. After the disaster (in the summer of 2011), local residents installed a soccer court on the dry riverbed, exactly where they traditionally used to fish, navigate, and swim (goals are emphasized for illustrative purposes). Before the disaster: picture courtesy of Carolina Vargas. After the disaster: picture by the author, adapted from Marín et al. (2012)

differently along the wetland. For inland communities, for instance, farmland areas increased and improved as a consequence of reduced saltwater intrusions and increased availability of fodder, generating opportunities for farmers to increase productivity. However, for coastal and transition communities, environmental changes generated highly negative impacts. These refer mostly to the total loss of *pelillo* and the habitat necessary for its growth, as well as the loss of depth in the rivers, which made navigation and connectivity unfeasible.

Along with changes in the wetland ecosystem, people's perception of personal and collective well-being significantly decreased among coastal fishing communities, as compared to pre-disaster times (Marín et al. 2012). The post-disaster triggered multiple responses and adaptations among fishing communities to recover affected livelihoods and well-being. One example of those adaptations is presented in Fig. 3.6.

The 2010 coastal disaster abruptly modified the ecosystems and the stability of the social-ecological system. One of the most dramatic changes for small-scale fishing communities was the total loss of *pelillo* (*Gracilaria* sp.) and its habitat within the wetland (Valdovinos et al. 2010; Vargas et al. 2011). This valuable agar-producing seaweed was fundamental for the local economy and the social organization of fishers, gleaners, and other members of the community (Alveal 1988). Small-scale fishing communities in *caletas* Tubul and Las Peñas lost a major source of livelihood and suffered significant impacts on their well-being (Marín et al. 2014).

Two years after the disaster, fishing households were somehow able to cope with the compounded challenges they faced. According to our study, the responses and adaptations observed were very heterogeneous, as shown in Fig. 3.7, including intensification, reduction, reconversion, and diversification of economic activities. These multiple adaptations heavily rely on the pre-existing flexible livelihood

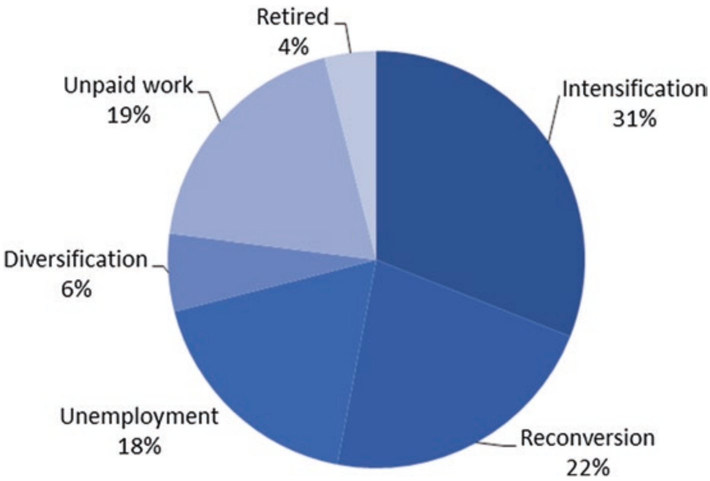



**Fig. 3.7** Post-disaster livelihood shifts in Tubul-Raqui (Adapted from Marín et al. 2014)

systems, allowing for adjustments in a pluri-activity matrix rather than forcing radical transformations. Nevertheless, the most frequent response among affected resource users was the intensification strategy, namely, focusing on other extractive activities already carried on before the disaster. Most of these cases represent fishers and divers who, once seaweed resources were lost, were forced to intensify shellfish exploitation from the Gulf. Similarly, many women and elders who were previously engaged in seaweed gleaning and processing lost their source of income and had to dedicate their activities to the household or retire.

In Tubul-Raqui, small-scale fisheries's adaptive capacities triggered by pre-existing livelihood portfolios generated intensification in the exploitation of less impacted or enhanced ecosystem services which could be reducing resilience. The small-scale fisheries organization that was traditionally prominent in the *pelillo* business did fund-raising to implement a seaweed processing plant (that would add value to resources from other places), in an unsuccessful attempt to diversify. Moreover, some leaders tried to engage their members in a *pelillo* replanting experiment in a sheltered nearby bay, but there was a scant interest (TL Personal communication, July 15, 2011). Results show that, after the disaster and associated ecosystem transformation, there have been few attempts to create untested new beginnings in the Tubul-Raqui wetland from which user groups could evolve to a more innovative livelihood system after the shift.

In response to resource loss and ecosystem change in the Tubul-Raqui wetland, small-scale fisheries' adaptive capacity was enabled and determined by the livelihood portfolios of people prior to the abrupt shift (Adger et al. 2002; Marschke and Berkes 2006). Considering the benthic resource overexploitation threat underlined in the study, the question that arises is whether the activated responses were conducive to adaptive or maladaptive results in the long term. In this case, coastal communities seem to have the capacity to cope with abrupt changes and increased vulnerability in the short term. However, in Tubul-Raqui, the resulting responses may not be adaptive or sustainable in the long term.

In the Tubul-Raqui case study, we did not measure social capital and networks in a systematic way. Nevertheless, field observation and unpublished information suggest that the limited capacity of the local community to reduce post-disaster threats on resource availability might be explained by the existing relational patterns among key stakeholders. First, we learned about a long-standing resentment and latent tensions between members of the "Asociación Gremial" (owners of the 12 ha *pelillo* aquaculture concession in the wetland) and other fishers' organizations. The former were blamed for the enclosure of the wetland and the appropriation of its seaweed resources. Hence, after the disaster, interpersonal relationships and bonding social capital among resource users in the *caleta* were somehow eroded.

Second, local informants criticized the proliferation of new fisher and gleaners' associations (*agrupaciones*) after the earthquake/tsunami, which were created with the sole purpose of becoming qualified recipients of national and international aid projects and programs (DM Personal communication, May 30, 2011.). Before the earthquake/tsunami, there were five fisher and gleaner organizations established in Tubul; after the event, 37 local associations were registered. Conflicts of interest and rivalry among emerging and experienced leaders, as well as among opportunistic and more traditional resource users, rapidly increased. The diminished capacity to act collectively, for instance, to regulate exploitation and halt overfishing, can be associated with these low levels of bridging social capital and weak horizontal networks.

Interestingly, the way linking social capital and vertical relationships have developed also seems to play a role. For example, the creation of new fisher associations described above was fostered and supported by the local government (Salinas-Martinez 2012), apparently without consulting existing fisher representatives or foreseeing the negative impacts on local social cohesion and organization in the midterm. In addition, in Tubul and also in other *caletas*, a common perception is that, after the disaster, paternalistic ways of interaction were deepened between fisher organizations and external public, private, and civil society actors. Fishers and other local recipients of external aid and support got used to receiving benefits without any contribution on their behalf, which inevitably led to increased dependency and disempowerment of communities and their organizations.

## 3.4 Lessons and Challenges

Social networks and social capital have been regarded as key conditions for social resilience and adaptive capacity of natural resource users in the face of unprecedented global environmental change (Pelling and High 2005). Lessons learned from our studies reinforce the positive role of social networks and social capital as vehicles for accessing and mobilizing valuable resources and information as expressions of adaptive capacity to coastal disasters in small-scale fisheries. In the context of short-term post-disaster responses, bonding social capital within fishing communities, along with other sociocultural assets, was found to be a central trigger of immediate and effective tsunami evacuation, which indicates a well-established adaptive capacity to extreme and unexpected coastal hazards. In the midterm, higher levels of linking social capital appeared as a fundamental condition for more desirable post-disaster recovery trajectories of fisher organizations, reflecting the importance of cross-scale networks of support for recuperating fishing livelihoods and exploring new opportunities.

Building broad and strong social networks and building social capital were found to be necessary conditions of small-scale fishers' organizations and coastal communities' response and adaptive capacity in the face of environmental disasters. However, the research also indicates that these are not enough. Social capital and networks are displayed in concurrency with other key factors, such as local ecological knowledge and livelihood flexibility. The lessons highlighted here suggest a careful and nuanced approach to the study of social networks and social capital as potential answers to the challenges and problems affecting small-scale fisheries. Moreover, our research highlights the fact that the expected benefits of social networks and social capital are contingent and depend, to a great extent, on external factors. In particular, high levels of linking social capital were found to explain fisher organizations' mid- to long-term adaptive capacity, even under the contexts of high geographical isolation or high disaster impacts. However, our findings do not support the conclusion that social capital can lead to more desirable outcomes at any degree of vulnerability, for instance, in cases of both high isolation and high devastation. There are reasons to consider that the positive paybacks from large and diverse supportive networks can be incremental until a certain limit in which adaptive capacity is surpassed by contextual constraints. A better understanding of such limits is particularly relevant in a context of increased uncertainty associated with global environmental change.

Findings indicate that it is crucial to differentiate the types of social capital (e.g., bonding, bridging, and linking) as potentially relevant for leading to certain specific outcomes, but not for all outcomes. Each type of social capital refers to relationships within and across system boundaries and scales of organization, which enable the flow of different resources and information that are functional to particular goals. For instance, linking social capital can be important to obtain support from distant and powerful actors for livelihood recovery, but it is less likely to help in surviving sudden hazards when communication systems are collapsed. The different types of social capital are context-specific and connected to particular outcomes. However, one may hypothesize that the overall role of networks on complex and dynamic social-ecological processes emerges from bonding, bridging, and linking relationships simultaneously. For instance, Grafton (2005) discussed how the three types of social capital are connected to different dimensions of fisheries governance in the face of change and uncertainty. Further studies to test such hypothesis will be necessary, for instance, to explore how the three types work together and how interdependent they are for enhancing or reducing resource users' adaptive capacity.

It is important to treat social capital and networks as relative concepts about social reality, rather than normative values, which illuminate not only the positions of the most advantaged actors within a system but also of its most vulnerable actors. Social capital has been defined as a metaphor of the relative advantage of some individuals and actors over others (Burt 2002), and therefore social capital studies have a high probability to describe evolving landscapes of social inequity. While usually the use of social capital in research and policy discourses is being criticized for presenting and fostering an idealized image of social life, the network approach to social capital is more analytically rigorous. The studies presented above characterize both successful stories about the winners (i.e., those with improved capacity to recover, innovate, and diversify) and failed accounts of the losers (those with reduced coping capacities and increased levels of exposure) in the face of disasters and environmental change. By exploring the causal rationale among social capital and other concomitant factors of enhanced/reduced adaptive capacity of small-scale fishing communities, it is possible to identify underlying mechanisms that can be modified and reshaped to create more resilient and less vulnerable coastal social-ecological systems.

The potentials and limitations of adaptive capacity to coastal disasters in small-scale fisheries relate directly to the debate between resilience and vulnerability approaches to understand society-nature interactions. In our research, some risks associated with overemphasizing these two perspectives can be identified. By only looking at the resilience of small-scale fisheries and coastal communities (or any given social-ecological system) and putting high expectations on the adaptive capacity of actors (i.e., their agency), recovery and development policies may fall into some kind of laissez-faire situation. If people are assumed to have the right capacities to overcome different shocks, then the role and responsibility of the state and the rest of society in supporting small-scale and traditional livelihood systems could be downplayed, entrusting their fate to their autonomous performance. On the contrary, by only looking at local users' vulnerability and justifying their unfavorable performance and conditions based on external determinants (i.e., structural constraints), post-disaster and development programs may be influenced by *paternalistic* visions. If communities are considered to lack the capacities to respond to adversity and move forward, then the only way to overcome permanent threats is by being subject to state and external intervention, thus undermining individual and collective capacities to organize and innovate.

Some scholars have highlighted the need to move toward more integrated theoretical frameworks and to account for the interplay among human agency, structural constraints, and environmental conditions in the production of more or less sustainable futures (Adger 2006; McLaughlin and Dietz 2008; Turner 2010). A reasonable approach, supported by our research, is to regard resource users neither as passive "observers" of their vulnerability nor as fully autonomous agents of their resilience, but a contingent combination of both. Ultimately, in my vision, the consolidation of small-scale fisheries as a sustainable engine of human development, in a context of increasing social and environmental complexity and uncertainty, relies on deliberate societal efforts to build resilience and to reduce vulnerability.

**Acknowledgments** This work would have not been possible without the contribution of more than 300 informants, including fishery workers, coastal dwellers, public sector officers, researchers, and professionals, who kindly and selflessly agreed to share their perceptions, experiences, and information. ¡Muchas gracias a todos y todas! I wish to express my gratitude to my supervisors and coauthors Beatrice Crona, Örjan Bodin, and Stefan Gelcich, for their support, guidance, and insightful discussions throughout the process. I am especially thankful to Dr. Juan C. Castilla for encouragement and inspiration to do research and pursue my doctoral project and to my other coauthors, Gonzalo Araya, Gonzalo Olea, and Gonzalo Espíndola, for the opportunity to work together. The original studies were partly funded by Project CAPES FB-0002. I also thank the support of FONDECYT 11171068 and 1140672 and MUSELS/ICM MINECON.

## References

Aburto J, Thiel M, Stotz W (2009) Allocation of effort in artisanal fisheries: the importance of migration and temporary fishing camps. Ocean Coast Manag 52(12):646–654

Acheson J, Gardner R (2014) Fishing failure and success in the Gulf of Maine: lobster and groundfish management. Maritime Stud 13(1):8

Adger WN (2006) Vulnerability. Glob Environ Chang 16(3):268–281

Adger WN, Kelly PM, Winkels A, Huy LQ, Locke C (2002) Migration, remittances, livelihood trajectories, and social resilience. AMBIO J Hum Environ 31(4):358–366

Adger WN, Hughes TP, Folke C, Carpenter SR, Rockström J (2005) Social-ecological resilience to coastal disasters. Science 309(5737):1036–1039

Aldrich DP (2012) Building resilience: social capital in post-disaster recovery. University of Chicago Press, Chicago

Allison EH, Ellis F (2001) The livelihoods approach and management of small-scale fisheries. Mar Policy 25(5):377–388

Alveal K (1988) Gracilaria de Tubul: Historia y significado de un recurso. Gayana (Botánica) 45:119–140

Andrew NL, Béné C, Hall SJ, Allison EH, Heck S, Ratner BD (2007) Diagnosis and management of small-scale fisheries in developing countries. Fish Fish 8(3):227–240

Aránguiz R, González G, González J, Catalán PA, Cienfuegos R, Yagi Y, Ryo Okuwaki R, Urra L, Contreras K, Del Rio I, Rojas C (2016) The 16 September 2015 Chile tsunami from the post-tsunami survey and numerical modeling perspectives. Pure Appl Geophys 173(2):333–348

Armitage D (2005) Adaptive capacity and community-based natural resource management. Environ Manage 35(6):703–715

Badjeck MC, Allison EH, Halls AS, Dulvy NK (2010) Impacts of climate variability and change on fishery-based livelihoods. Mar Policy 34(3):375–383

Berkes F (2007) Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. Nat Hazards 41(2):283–295

Berkes F, Mahon R, McConney P, Pollnac R, Pomeroy R (2001) Managing small-scale fisheries: alternative directions and methods. International Development Research Centre, Ottawa

Blaikie P, Cannon T, Davis I, Wisner B (2014) At risk: natural hazards, people's vulnerability and disasters. Routledge, London

Bodin Ö, Crona BI (2008) Management of natural resources at the community level: exploring the role of social capital and leadership in a rural fishing community. World Dev 36(12):2763–2779

Bodin Ö, Prell C (2011) Social networks and natural resource management: uncovering the social fabric of environmental governance. Cambridge University Press, Cambridge

Bodin Ö, Crona B, Ernstson H (2006) Social networks in natural resource management: what is there to learn from a structural perspective. Ecol Soc 11(2):r2

Boonstra WJ, Hanh TTH (2014) Adaptation to climate change as social–ecological trap: a case study of fishing and aquaculture in the Tam Giang Lagoon, Vietnam. Environ Dev Sustain 17(6):1527–1544

Boonstra WJ, Ottosen KM, Ferreira ASA, Richter A, Rogers LA, Pedersen MW, Kokkalis A, Bardarson H, Bonanomi S, Butler W, Diekert FK, Fouzai N, Holma M, Holt RE, Kvile KØ, Malanski E, Macdonald JI, Nieminen E, Romagnoni G, Snickars M, Weigel B, Woods P, Yletyinen J, Whittington JD (2015) What are the major global threats and impacts in marine environments? Investigating the contours of a shared perception among marine scientists from the bottom-up. Mar Policy 60:197–201

Burt RS (2002) The social capital of structural holes. The new economic sociology: developments in an emerging field. In: Guillén MF, Collins R, England P, Meyer M (eds) The new economic sociology. Russell Sage Foundation, New York, pp 148–190
Carpenter S, Arrow K, Barrett S, Biggs R, Brock W, Crépin AS, Engström G, Folke C, Hugues TP, Kautsky N, Li CZ, McCarney G, Meng K, Mäler KG, Polasky S, Scheffer M, Shogren J, Sterner T, Vincent JR, Walker B, Xepapadeas A, de Zeeuw A (2012) General resilience to cope with extreme events. Sustainability 4(12):3248–3259
Castilla JC (1994) The Chilean small-scale benthic shellfisheries and the institutionalization of new management practices. Ecol Int Bull 21:47–63
Castilla JC, Manriquez P, Alvarado J, Rosson A, Pino C, Espoz C, Soto R, Oliva D, Defeo O (1998) Artisanal "caletas" as units of production and co-managers of benthic invertebrates in Chile. Can Spec Publ Fish Aquat Sci 125:407–413
Castilla JC, Manríquez PH, Camaño A (2010) Effects of rocky shore coseismic uplift and the 2010 Chilean megaearthquake on intertidal biomarker species. Mar Ecol Prog Ser 418:17–23
Charles AT (2001) Sustainable fishery systems. Blackwell Science, Oxford
Cochard R, Ranamukhaarachchi SL, Shivakoti GP, Shipin OV, Edwards PJ, Seeland KT (2008) The 2004 tsunami in Aceh and Southern Thailand: a review on coastal ecosystems, wave hazards and vulnerability. Perspect Plant Ecol Evol Syst 10(1):3–40
Coleman JS (1988) Social capital in the creation of human capital. Am J Sociol 94(1988):S95
Contreras M, Winckler P (2013) Pérdidas de vidas, viviendas, infraestructura y embarcaciones por el tsunami del 27 de Febrero de 2010 en la costa central de Chile. Obras y Proyectos 14:6–19
Contreras-López M, Winckler P, Sepúlveda I, Andaur-Álvarez A, Cortés-Molina F, Guerrero CJ, Mizobe CE, Igualt F, Breuer W, Beyá JF, Vergara H, Vergara H (2016) Field survey of the 2015 Chile tsunami with emphasis on coastal wetland and conservation areas. Pure Appl Geophys 173(2):349–367
Crona B, Gelcich S, Bodin Ö (2017) The importance of interplay between leadership and social capital in shaping outcomes of rights-based fisheries governance. World Dev 91:70–83
Cutter SL, Boruff BJ, Shirley WL (2003) Social vulnerability to environmental hazards. Soc Sci Q 84(2):242–261
Dahlman CJ (1979) The problem of externality. J Law Econ 22(1):141–162
Daw T, Brown K, Rosendo S, Pomeroy R (2011) Applying the ecosystem services concept to poverty alleviation: The need to disaggregate human well-being. Environ Conserv 38(04):370–379
De Silva DAM, Yamao M (2007) Effects of the tsunami on fisheries and coastal livelihood: a case study of tsunami-ravaged southern Sri Lanka. Disasters 31(4):386–404
Diamond J (2005) Collapse: how societies choose to fail or succeed. Penguin, New York
Dolšak N, Ostrom E (eds) (2003) The commons in the new millennium: Challenges and adaptation. The MIT Press, Cambridge
Eriksson H, Albert J, Albert S, Warren R, Pakoa K, Andrew N (2017) The role of fish and fisheries in recovering from natural hazards: Lessons learned from Vanuatu, Environ Sci Policy 76: 50–58. https://doi.org/10.1016/j.envsci.2017.06.012.
FAO (2015) Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty alleviation. FAO, Rome
FAO (Food and Agricultural Organization of the United Nations) (2014) The state of world fisheries and aquaculture: opportunities and challenges. FAO, Rome
Farías M, Vargas G, Tassara A, Carretier S, Baize S, Melnick D, Bataille K (2010) Land level changes produced by the Mw 8.8 2010 Chilean earthquake. Science 329(5994):916
Gelcich S, Edwards-Jones G, Kaiser MJ (2005) Importance of attitudinal differences among artisanal fishers toward co-management and conservation of marine resources. Conserv Biol 19(3):865–875
Gelcich S, Hughes TP, Olsson P, Folke C, Defeo O, Fernandez M, Foale S, Gunderson LH, Rodríguez-Sickert C, Scheffer M, Steneck RS, Castilla JC (2010) Navigating transformations in governance of Chilean marine coastal resources. Proc Natl Acad Sci USA 107(39):16794–16799
Godoy N, Gelcich S, Vásquez JA, Castilla JC (2010) Spearfishing to depletion: evidence from temperate reef fishes in Chile. Ecol Appl 20(6):1504–1511

Grafton RQ (2005) Social capital and fisheries governance. Ocean Coast Manag 48(9):753–766
Gunderson L (2010) Ecological and human community resilience in response to natural disasters. Ecol Soc 15(2):18
Jaramillo E, Dugan JE, Hubbard DM, Melnick D, Manzano M, Duarte C, Campos C, Sanchez R (2012) Ecological implications of extreme events: Footprints of the 2010 earthquake along the Chilean coast. PLoS One 7(5):e35348. https://doi.org/10.1371/journal.pone.0035348
Johnson DS (2006) Category, narrative, and value in the governance of small-scale fisheries. Mar Policy 30(6):747–756
Kraan M (2009). Creating space for fishermen's livelihoods: Anlo-Ewe beach seine fishermen's negotiations for livelihood space within multiple governance structures in Ghana (Doctoral dissertation). Leiden University
Krishna A (2002) Active social capital: tracing the roots of development and democracy. Columbia University Press, New York
Leitch AM, Bohensky EL (2014) Return to "a new normal": discourses of resilience to natural disasters in Australian newspapers 2006–2010. Glob Environ Chang 26:14–26
Madariaga R, Métois M, Vigny C, Campos J (2010) Central Chile finally breaks. Science 328(5975):181–182
Manyena SB (2006) The concept of resilience revisited. Disasters 30(4):434–450
Marín A (2015) Adaptive capacity for social and environmental change: the role of networks in Chile's small-scale fisheries. Stockholm Resilience Centre, Stockholm University, Stockholm
Marín A, Berkes F (2010) Network approach for understanding small-scale fisheries governance: the case of the Chilean coastal co-management system. Mar Policy 34:851–858
Marín A, Gelcich S, Araya G, Olea G, Espíndola M, Castilla JC (2010) The 2010 tsunami in Chile: devastation and survival of coastal small-scale fishing communities. Mar Policy 34:1381–1384
Marín A, Gelcich S, Castilla JC, Berkes F (2012) Exploring social capital in Chile's coastal benthic comanagement system using a network approach. Ecol Soc 17(1):13. https://doi.org/10.5751/ES-04562-170113
Marín A, Gelcich S, Castilla JC (2014) Ecosystem services and abrupt transformations in a coastal wetland social-ecological system: Tubul-Raqui after the 2010 earthquake in Chile. Ecol Soc 19(1):22
Marín A, Bodin Ö, Gelcich S, Crona B (2015) Social capital in post-disaster recovery trajectories: insights from a longitudinal study of tsunami-impacted small-scale fisher organizations in Chile. Glob Environ Chang 35:450–462
Marschke MJ, Berkes F (2006) Exploring strategies that build livelihood resilience: a case from Cambodia. Ecol Soc 11(1):42
Marshall NA, Marshall PA (2007) Conceptualizing and operationalizing social resilience within commercial fisheries in northern Australia. Ecol Soc 12(1):1
Maru YT, Stafford Smith M, Sparrow A, Pinho PF, Dube OP (2014) A linked vulnerability and resilience framework for adaptation pathways in remote disadvantaged communities. Glob Environ Chang 28:337–350
Masten AS, Obradović J (2008) Disaster preparation and recovery: lessons from research on resilience in human development. Ecol Soc 13(1):9
McCarthy JF (2014) Using community led development approaches to address vulnerability after disaster: caught in a sad romance. Glob Environ Chang 27:144–155
McClanahan TR, Cinner JE, Maina J, Graham NAJ, Daw TM, Stead SM, Wamukota A, Brown K, Ateweberhan M, Venus V, Polunin NVC (2008) Conservation action in a changing climate. Conserv Lett 1(2):53–59
McGoodwin JR (1990) Crisis in the world's fisheries: people, problems, and policies. Stanford University Press, Stanford
McLaughlin P, Dietz T (2008) Structure, agency and environment: Toward an integrated perspective on vulnerability. Glob Environ Chang 18(1):99–111
Millennium Assessment (2005) Millennium ecosystem assessment. Synthesis report. Island Press, Washington, DC

Moussard M (2011) Prácticas y conocimientos territoriales, determinantes de la sobrevivencia ante situaciones de riesgo en la Caleta El Morro de Talcahuano (unpublished thesis). Universidad de Concepción, Chile
NCEI (2016) Natural hazards viewer. http://maps.ngdc.noaa.gov/viewers/hazards/. Accessed 5 April 2016
Oficina de Estudios y Políticas Agrarias (ODEPA) (2014) Sector pesquero: Evolución de sus desembarques, uso y exportación en las últimas décadas. Oficina de Estudios y Políticas Agrarias, Ministerio de Agricultura, Chile. http://www.odepa.cl/wpcontent/files_mf/1392915533Sectorpesca201402.pdf. Accessed 15 April 2016
Olsson P, Galaz V (2012) Social-ecological innovation and transformation. In: Nicholls A, Murdock A (eds) Social innovation: blurring boundaries to reconfigure markets. Palgrave Macmillan, Basingstoke, pp 223–247
Payne H, Castilla JC (1994) Socio-biological assessment of common property resources management: small-scale fishing unions in central Chile. Out of the Shell 4(3):10–14
Pelling M, High C (2005) Understanding adaptation: what can social capital offer assessments of adaptive capacity? Glob Environ Chang 15(4):308–319
Pomeroy RS, Ratner BD, Hall SJ, Pimoljinda J, Vivekanandan V (2006) Coping with disaster: rehabilitating coastal livelihoods and communities. Mar Policy 30(6):786–793
Ragin CC (2008) Redesigning social inquiry: fuzzy sets and beyond. University of Chicago Press, Chicago
Rice JC, Garcia SM (2011) Fisheries, food security, climate change, and biodiversity: characteristics of the sector and perspectives on emerging issues. ICES J Mar Sci 68(6):1343–1353
Ruegg JC, Rudloff A, Vigny C, Madariaga R, De Chabalier JB, Campos J, Kausel E, Barrientos S, Dimitrov D (2009) Interseismic strain accumulation measured by GPS in the seismic gap between Constitución and Concepción in Chile. Phys Earth Planet Inter 175(1):78–85
Salas S, Chuenpagdee R, Charles AT, Seijo JC (2011) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and Aquaculture technical paper 544. FAO, Rome
Salinas-Martinez L (2012) Informe pesca artesanal comuna de Arauco periodo 2009-2012. Municipalidad de Arauco. Oficina Pesca Artesanal y Acuicultura
Schumann S (2007) Co-management and "consciousness": Fishers' assimilation of management principles in Chile. Mar Policy 31(2):101–111
SERNAPESCA (Servicio Nacional de Pesca y Acuicultura) (2015) Desembarque artesanal por especie y región, anuarios estadísticos 2009-2015. https://www.sernapesca.cl/index.php?option=com_remository&Itemid=246&func=selec&id=2. Accessed 5 April 2016
Smith ME (1998) Fisheries risk in modern context. Maritime Anthropol Stud 1:29–48
Soulé B (2014) Post-crisis analysis of an ineffective tsunami alert: the 2010 earthquake in Maule, Chile. Disasters 38(2):375–397
Szczucinski W, Chaimanee N, Niedzielski P, Rachlewicz G, Saisuttichai D, Tepsuwan T (2006) Environmental and geological impacts of the 26 December 2004 tsunami in coastal zone of Thailand-overview of short and long-term effects. Pol J Environ Stud 15(5):793–810
Tompkins EL, Adger W (2004) Does adaptive management of natural resources enhance resilience to climate change? Ecol Soc 9(2):10
Turner BL (2010) Vulnerability and resilience: coalescing or paralleling approaches for sustainability science? Glob Environ Chang 20(4):570–576
USGS (U.S. Geological Survey) (2016) Largest earthquakes in the world since 1900. U.S. Geological Survey – National Earthquake Information Center. http://earthquake.usgs.gov/earthquakes/world/10_largest_world.php. Accessed 8 May 2016
Valdovinos C, Muñoz MD, Sandoval N, Vásquez D, Olmos V (2010) Natural disasters and biodiversity: The case of Tubul-Raqui coastal wetland. Sociedad Hoy 19:33–51
Vargas G, Farías M, Carretier S, Tassara A, Baize S, Melnick D (2011) Coastal uplift and tsunami effects associated to the 2010 Mw8.8 Maule earthquake in Central Chile. Andean Geol 38(1):219–238

Walker B, Holling CS, Carpenter SR, Kinzig A (2004) Resilience, adaptability and transformability in social-ecological systems. Ecol Soc 9(2):9

Welle T, Birkmann J (2015) World Risk Index 2015. In Word risk report. Bündnis Entwicklung Hilft and UNU-EHS, Berlin, pp. 40–49x

Westlund L, Poulain F, Bage H, van Anrooy R (2007) Disaster response and risk management in the fisheries sector. FAO, Rome

Wilhelm J, Delaney A (2013) No homes, no boats, no rafts: Miyagi coastal people in the aftermath of disaster. In: Gill T, Slater DH, Steger B (eds) Japan copes with calamity. Peter Lang, Bern, pp 99–124

Woolcock M (2001) The place of social capital in understanding social and economic outcomes. Can J Policy Res 2(1):11–17

Yin RK (2013) Case study research: design and methods. Sage, Thousand Oaks

Zanuttigh B (2014) Features common to different hydrometeorological events and knowledge integration. In: Hydrometeorological hazards: interfacing science and policy, Wiley, pp 49–81

**Andrés Marín** is an associated researcher at the *Centro de Estudios del Desarrollo Regional y Políticas Pública* (CEDER), Universidad de Los Lagos, Chile. He holds a Master's of Natural Resource Management from the University of Manitoba (Canada) and a PhD in Sustainability Sciences from Stockholm University (Sweden). His research focuses on studying social and environmental changes in socio-ecological systems, with a particular interest in small- and medium-scale resource users and coastal areas. More specific interests include social networks and social capital in environmental governance and disaster resilience/vulnerability studies.

# Chapter 4
# Small-Scale Fisheries on the Pacific Coast of Colombia: Historical Context, Current Situation, and Future Challenges

**Gustavo A. Castellanos-Galindo and Luis Alonso Zapata Padilla**

**Abstract** Small-scale fisheries in the Colombian Pacific are not very significant in a global context but make a large contribution to total national fish landings, play a pivotal role in sustaining the livelihoods of coastal communities, and supply the demand for fish protein at the local and national levels. This importance is likely to rise in the coming years given the estimated increase of national fish consumption, the regional infrastructure development plans, and the predicted increase in coastal accessibility if the peace agreement between the Colombian government and FARC is successfully implemented and the region is pacified. This chapter aims to explain how artisanal fisheries have developed in the Colombian Pacific coast over the last 30 years, explaining the different types of fisheries, their current situation, and the advances and challenges facing sustainable management. Signs of overexploitation of some fisheries resources appeared as early as the 1990s (e.g., white shrimps, mangrove cockles). Updated stock assessments of these resources are needed, together with other target fisheries currently under pressure. Ecosystem-based fisheries management actions, like the establishment of MPAs and the introduction of fishing gear that reduces bycatch, have resulted in increased awareness of the importance of sustainable fisheries management and biodiversity conservation. Current challenges include further increasing this level of awareness about sustainable fishing practices, and overcoming the frequent disconnect between fisheries governmental, private, and other societal sectors. Advances in these areas could lead to more sustainable fishing practices that could be used to face the predicted scenarios of increased fish and shellfish national demand.

G. A. Castellanos-Galindo (✉)
World Wildlife Fund - WWF Colombia, Programa Marino Costero, Cali, Colombia

Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany

L. A. Zapata Padilla
World Wildlife Fund - WWF Colombia, Programa Marino Costero, Cali, Colombia
e-mail: lazapata@wwf.org.co

 
S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_4

**Keywords** Fisheries management · Mangrove fisheries · Fisheries governance · Afro-Colombians · Colombian Pacific

## 4.1 The Pacific Lowlands of Colombia: Environmental Features and Sociopolitical History

### *4.1.1 Environmental Features*

The Pacific coast of Colombia extends for approximately 1300 km (Correa and Morton 2010). The continental shelf can be as narrow as 10–15 km wide in the northern region (approximately 400 km from Punta Ardita to Cabo Corrientes, see Fig. 4.1) and widens in the south to about 65 km (Martínez and López-Ramos 2011). The coast in the northern portion (Baudo Range) is dominated by rocky shores and cliffs and, to a minor extent, by sandy beaches and small mangrove patches that develop around river deltas. In contrast, the southern coast (roughly 650 km) until the border with Ecuador is dominated by alluvial plains and a system of around 60 barrier islands backed by extensive mangrove forests (Martínez et al. 1995). Some of these mangrove forests, which cover roughly 200,000 ha, are considered to be among the most structurally well-developed mangroves in the Neotropics (e.g., tree heights up to 45 m; West 1956; Castellanos-Galindo et al. 2015). Three important deltas develop in the southern coast (San Juan, Patía, and Mira), discharging a significant amount of sediments in the surrounding coastal area (Restrepo and López 2008).

Climatic conditions in the Colombian Pacific coast are dominated by the presence of the Intertropical Convergence Zone (ITCZ), which largely determines the precipitation regime in this area. Mean rainfall values are considered extremely high, possibly the highest in the American continent, ranging from up to 10 m per year$^{-1}$ in the central coast (Buenaventura and San Juan Delta) and decreasing to the north and south near the borders with Panama and Ecuador, respectively (Correa and Morton 2010). The tidal regime in the Colombian Pacific is predominantly macro- and meso-tidal, with spring tide amplitude greatest in the central zone (Buenaventura) reaching >4 m. In the south (Tumaco), spring tide amplitudes are 3.5 m (Correa and Morton 2010). Due to the extremely high precipitation, the surface salinity in the Colombian Pacific coast is the lowest (29–31) in the whole Tropical Eastern Pacific region (Fiedler and Talley 2006). Most estuarine systems in the Colombian Pacific rarely exceed 30, even during the dry season.

The bathymetry and dominant ecosystems along the Colombian Pacific coast have determined to a large extent the type of artisanal fishery that has developed and how far offshore they operate. In the southern coast, a larger continental shelf as wide as 50 km at its widest point enables artisanal fishers to venture further from shore (e.g., near Gorgona Island). These fishers can also target important resources that are only present in mangrove nursery habitats, such as white shrimp, mangrove

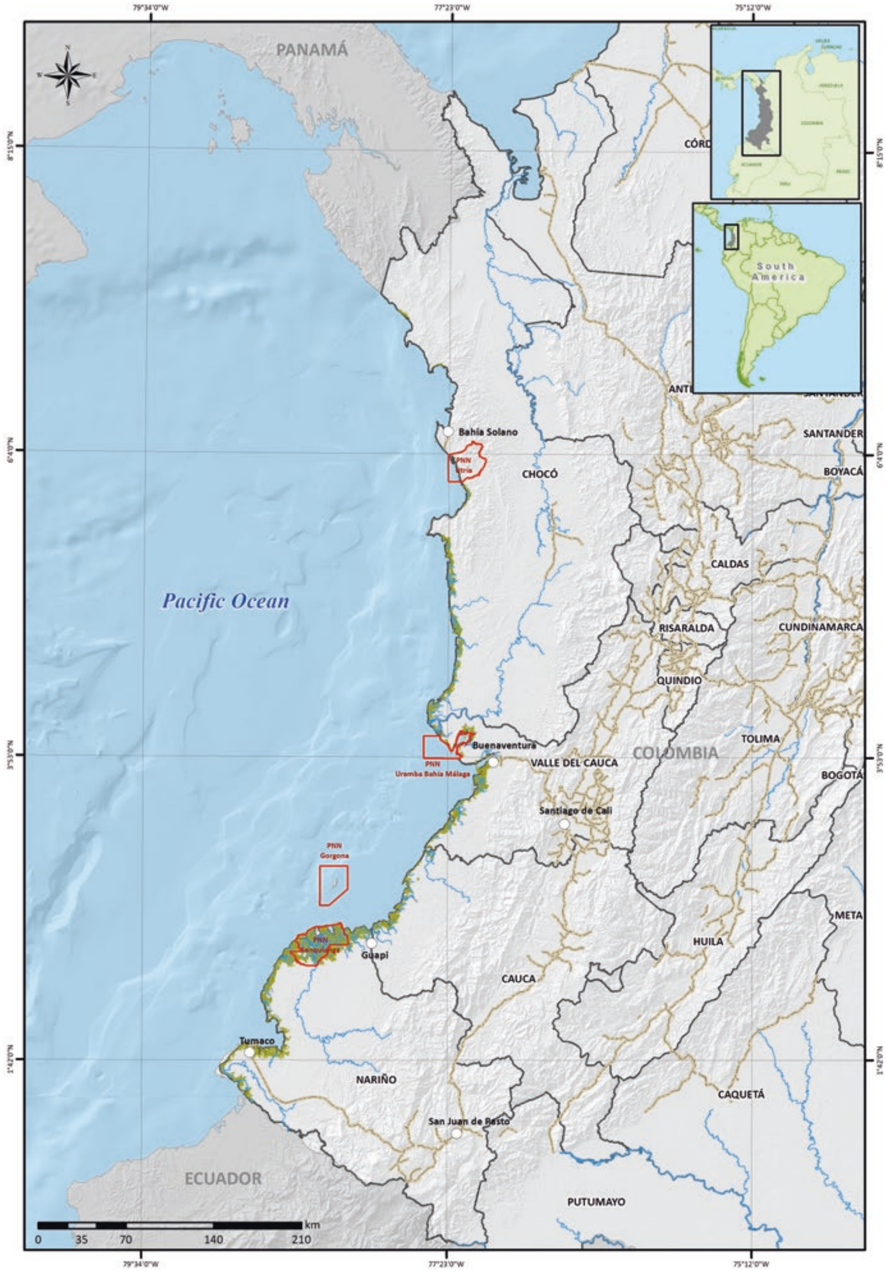



**Fig. 4.1** Map of the Colombian Pacific coast showing mangrove areas (in green), principal coastal cities, National Parks (red polygons), provinces, and principal rivers

cockles, and estuarine fishes. In contrast, artisanal fishers operate closer to shore along the very narrow continental shelf of the northern coast, especially the fleet that targets demersal and benthic resources (e.g., the artisanal bottom-longline fleet). Due to the lack of extensive mangrove areas in the northern part of the Pacific coast, there is no substantial fishery for white shrimp or mangrove cockles, and most fishes targeted by the artisanal fleet do not depend on mangroves as nursery habitat.

### *4.1.2 Sociopolitical Context*

The Colombian Pacific lowlands have historically been politically and economically marginalized. As a result, this region has been considered one of the poorest areas in the country according to conventional metrics, with 65% of the population unable to meet their basic needs and an illiteracy rate above 30% (Castiblanco et al. 2015). In contrast, the Pacific lowlands have provided a wealth of resources, including timber, gold, and vegetable ivory – *tagua* – to the rest of the country for decades (Leal and van Ausdal 2013). In recent times, gold mining activities and illicit crop cultivation primarily have reemerged with the presence of guerrilla and paramilitary forces (Wade 2002). These activities have intensified the armed conflict that has been waged across the country for more than 50 years. Criminal groups are now a feature in the control and commercialization of illegal mining activities.

Human population density in the Colombian Pacific has historically been very low (Etter et al. 2006), when compared to the rest of the country and to other areas in northwestern South America (Fig. 4.2). The way in which the country was colonized, with most major cities located in the Andes, has led to an extremely centralized administration that ignores the most isolated regions. Exacerbating this challenge is the fact that the severe environmental conditions in the Pacific such as high humidity and precipitation may be responsible for the low numbers of people inhabiting this region. The lack of a parallel coastal road is a major challenge of the Colombian Pacific region compared to other coastal areas in South American countries. This general lack of coastal infrastructure has in some way prevented massive deforestation of the rainforests and mangroves and preserved many coastal fishery resources in this region. Currently, only two roads connect the cities located in the Colombian Andes to the most populated coastal cities – Buenaventura, with 369,753 inhabitants and Tumaco, with 171,281 inhabitants (see Fig. 4.1). Other coastal settlements are small (<10,000 inhabitants) and interspersed along the 1300 km coastline, with many located near river deltas (see Fig. 4.3). Most of these villages are only accessible by boat, and some intermediate cities such as Bahía Solano and Guapi can be reached via light aircraft. Basic goods (e.g., most vegetables, cooking oil, etc.) delivered to most of these remote towns arrive from Buenaventura on vessels (*barcos de cabotaje*) that can take up to 48 h to arrive.

Livelihoods in most coastal villages depend on a combination of fishing and agriculture. In some areas, timber extraction also constitutes an important source of

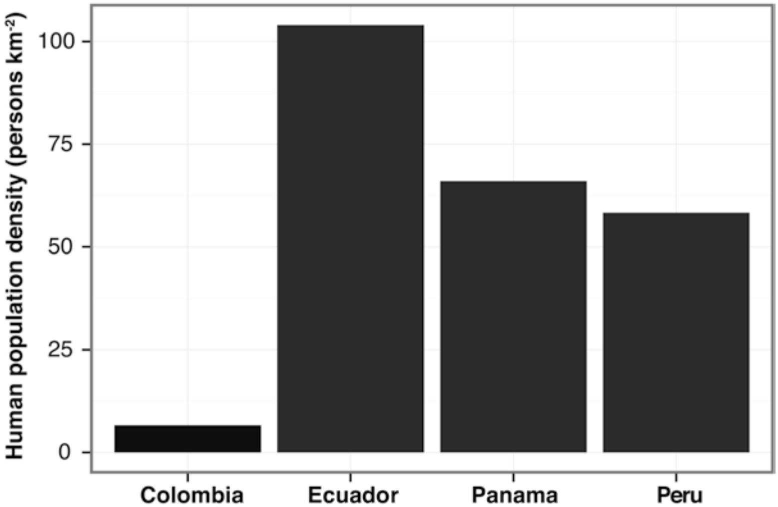



**Fig. 4.2** Human population density (persons km$^{-2}$) in the coastal area of the Colombian Pacific, Panama, Ecuador, and Peru. Data correspond to the provinces with coasts in the Pacific Ocean of each country. Data were extracted from the corresponding national authorities in charge of population censuses

**Fig. 4.3** Typical small village (ca. 600 inhabitants) at the mouth of a river and surrounded by mangrove forest in the Colombian Pacific coast (Jurubirá, northern Colombia, GA Castellanos-Galindo, WWF Colombia)

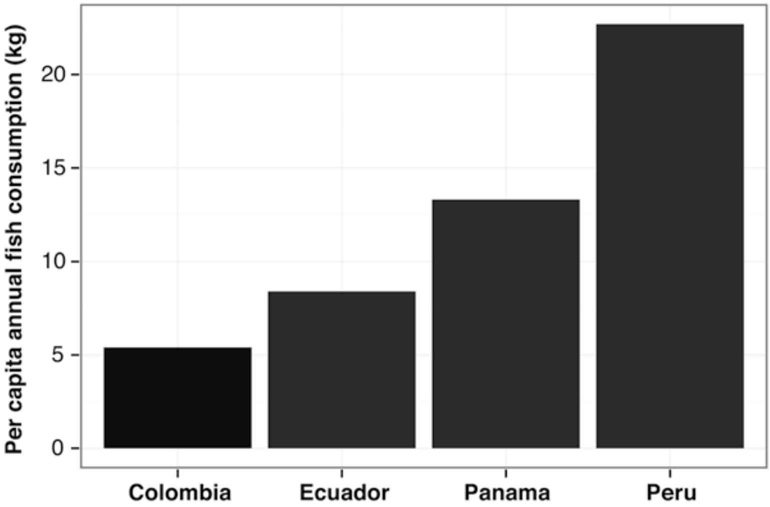



**Fig. 4.4** Fish consumption per capita per year in Colombia and adjacent countries in the Eastern Pacific in 2011 (source FAO; http://www.fao.org/fishery/statistics/global-consumption/en)

income. Fishing and agriculture have historically been practiced on a seasonal basis by Afro-Colombians and indigenous people. Fish is the main animal protein source for coastal villages, while fish consumption in the rest of the country (and the Colombian average) is extremely low when compared to neighboring countries such as Peru (Fig. 4.4).

Through a transitory article in the new Colombian constitution of 1991, Colombia granted significant territorial land rights to Afro-Colombian communities in the Colombian Pacific. This process led to the passing of Law 70 in 1993. Currently there are 162 collective titles that correspond to 5.2 million hectares, benefiting around 635,000 families (Leal 2008; PNUD 2012). Many of these collective titles are located near coastal areas in the Colombian Pacific coast. Law 70 has granted Afro-Colombian communities the right to make decisions in their territories, including those regarding the management of natural resources. This management has sometimes been facilitated by national and regional environmental agencies and NGOs leading to participatory ecosystem management plans (e.g., mangroves) and the creation of regional marine management areas (*distritos regionales de manejo integrado*), where certain traditional, mainly artisanal, extractive practices (e.g., collection of mangrove cockles, artisanal fishing by locals) are allowed.

While Law 70 has certainly helped Afro-Colombians in their struggle to recognize their territorial rights, the presence of different economic interests, legal and illegal actors, and high levels of corruption create a complex sociopolitical context on the Colombian Pacific that prevents significant improvements in the quality of life of its inhabitants.

## 4.2 The Origin and Evolution of Artisanal Fisheries in the Colombian Pacific

An understanding of the current dynamics, social context, and challenges of artisanal fisheries in the Colombian Pacific can be gained when looking at the history of human occupation along the coast over the last 2000 years. In contrast to the long history of dependence and tradition of exploitation of marine fisheries resources by other indigenous coastal cultures in South America, such as the Inca Empire in Peru (Marcus et al. 1999), indigenous cultures that settled in the Colombian and Panamanian Pacific coast seemed to have established in small settlements and exploited resources mainly associated with intertidal habitats in the extensive coastal estuarine mangroves (Cooke and Ranere 1999). It does not appear that pelagic resources were targeted by these indigenous cultures. These differences in ancient fisheries resource use may simply reflect the differences in relative abundance of resources, given that fisheries productivity is extremely high on the Peruvian coast and relatively modest on the Colombian Pacific coast (Pennington et al. 2006).

### *4.2.1 Indigenous People and Afro-Colombians*

Currently, very few indigenous settlements are found in coastal areas of Colombia, with most located in the upper basins of the rivers that drain into the Pacific. Many of these indigenous people now depend on scarce bush meat resources and freshwater fish as animal protein sources. Marine fishery resources are rarely harvested by indigenous people in this area, with some villagers taking seasonal trips to the coast to collect intertidal mollusks and reef fishes on the rock-dominated northern Colombian coast in areas such as the Gulf of Tribugá.

Starting in 1520, Africans were brought to Colombia by Spanish colonialists and forced to work primarily in gold mines due to the decline in indigenous labor. However, the Pacific lowlands of the country were only effectively settled by the Spanish and their African slaves in the seventeenth century. By the end of the eighteenth century, African slaves outnumbered the indigenous population in this region (Wade 2002). Slavery was abolished in Colombia in 1851, and freed slaves gradually migrated from the mining centers to settle in areas near the coast, displacing indigenous communities that now largely inhabit the upper river basins. The origins of the Africans that were brought to the Pacific lowlands include coastal cultures of West Africa (today's Senegal, Gambia, Liberia, Benin, Equatorial Guinea, and Angola) and areas of Central Africa such as the Congo (de Granda 1971). The first African communities were established in small villages in the lower reaches of principal rivers and continued activities centered in a combination of small-scale mining combined with agriculture and fishing.

The presence of Africans (now Afro-Colombians) in the Pacific coastal region of Colombia can be considered relatively recent (< 200 years) when compared to the significant presence of indigenous people in other areas of South America like Peru (> 2000 years; Marcus et al. 1999). Most likely, the exploitation of coastal fisheries resources has not been as intense as in other areas of the Pacific such as Ecuador and Peru due to this relatively recent occupation of the coast by Afro-Colombians and the apparently scarce presence of indigenous people on the Colombian Pacific coast prior to their arrival.

### *4.2.2 Legal Definition of Artisanal Fisheries in Colombia*

In the Law 13 1990 and Decree 2256 of 1991 passed by the Colombian Congress, a commercial artisanal fishery is defined as one that is performed by individuals or fishing cooperatives with gears and methods characteristic of a small-scale production activity. This definition is problematic, as it does not clearly distinguish a "commercial artisanal" from an industrial commercial fishery. Aside from this issue, artisanal fishers in the Colombian Pacific use generally small boats (3–15 m in length) made of wood or fiberglass and equipped with relatively small engines (0.5 – 40 hp) and which hold a small storage capacity (0.5–1.5 tons). The most common fishing methods are gill nets, bottom longlines, and simple handlines.

### *4.2.3 Principal Resources Targeted by Artisanal Fisheries*

Artisanal fisheries in the Colombian Pacific coast are considered multi-specific, regardless of the fishing gear used. There are sharp differences between the gears used on the northern coast, spanning from Cabo Corrientes to the Panamanian border, and those used on the southern coast from Cabo Corrientes to the Ecuadorian border (see Fig. 4.1). These differences, as explained above, are mainly due to the different ecosystems present in the northern (rocky shores) and southern portions of the coast (mangrove-dominated). Coastal artisanal fisheries in the north most often target resources associated with rocky bottoms like snappers (Lutjanidae) and groupers (Epinephelidae). In contrast, catches in the south are usually dominated by estuarine species like croakers (Sciaenidae), catfishes (Ariidae), and snooks (Centropomidae). In recent years, fishing gear restrictions have been introduced in the north coast as a result of participatory processes with artisanal fishers and environmental and fisheries authorities. These processes have led to the banning of gill nets in most of the northern coast in the area spanning from the Gulf of Tribugá to the Panamanian border. Gill nets are identified by fishers as a nonselective and destructive fishing gear in comparison to hook and lines and bottom longlines. The permanent conflicts between the harvesters using hook and lines and bottom longlines, who constitute the majority of fishers in the area, and the few fishers using gill nets led to the prohibition of gill nets in this area.

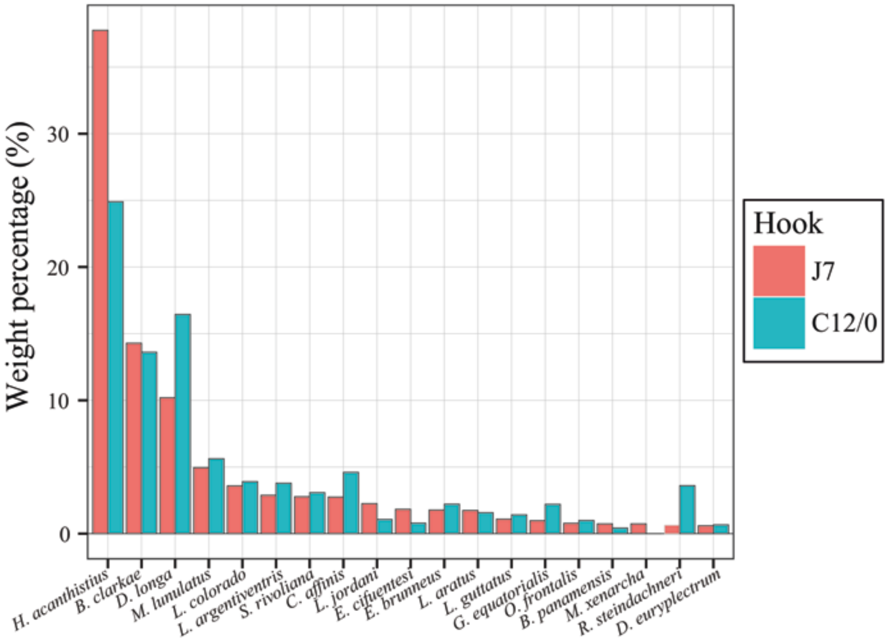



**Fig. 4.5** Principal species targeted by the bottom longline fishery (J hooks and C12/0 hooks) at two localities of the Colombian Pacific (Bazán and Jurubirá; taken from Bycatch project, WWF Colombia)

#### 4.2.3.1 Demersal Species

Artisanal bottom longlines are a common fishing gear used throughout the Pacific coast of Colombia, and certain localities are known for the prevalence of this fishing gear, such as Bazán in Nariño and the communities of Charambirá, Jurubirá, and Bahía Solano in Chocó. The most economically important targeted species for this fishing gear are the rooster hind (*Hyporthodus acanthistius*) and the Pacific bearded brotula (*Brotula clarkae*). Twelve other species are considered common and represent 86% of the total number of individuals in the catches obtained with this fishing gear (Zapata et al. 2012). Of these 12 species, only 2 species of snappers and 1 grouper are considered of high commercial value (*Lutjanus argentiventris*, *Lutjanus colorado*, and *Epinephelus analogus*), and four species are consumed or sold locally (*Caulolatilus affinis*, *Mustelus lunulatus*, *Diplectrum euryplectrum*, and *Bagre panamensis*). The remaining species belong to the order Anguilliformes (mainly the spotted-tail moray *Gymnothorax equatorialis*) and are either used as bait by this fishery or discarded as bycatch (Gómez et al. 2014) (Fig. 4.5).

Over the last 10 years, the World Wildlife Fund (WWF) has helped to transform the artisanal longline fishing fleet operating in different countries of the Tropical Eastern Pacific with the aim of reducing the bycatch of sea turtles via the exchange of J hooks for circle hooks (Andraka et al. 2013). On the Pacific coast of Colombia, this initiative has succeeded within the artisanal bottom longline fishing fleet that targets demersal species in different localities along the coast, focusing predominantly on Bazán in the south and Jurubirá in the north (Caicedo Pantoja et al. 2012). Apart from minimizing sea turtle mortality, the use of circle hooks (C/12) in this bottom longline fleet has resulted in an increase in the capture size of most of the demersal species targeted and a decrease in the amount of discarded bycatch of demersal species, including at least four species of eels (Anguilliformes).

#### 4.2.3.2 Pelagic Species

Pelagic species are targeted using hook and line (droplines) and trolling in the northern region (Chocó Department) and mostly with gill nets in the central and southern parts of the coast (Cabo Corrientes to the Ecuadorian border). The most important pelagic species targeted in the northern region are the yellowfin tuna (*Thunnus albacares*) and a variety of jacks (Carangidae) that include the almaco jack (*Seriola rivoliana*), the green jack (*Caranx caballus*), and the bigeye trevally (*Caranx sexfasciatus*). The mean landings of these four species alone were approximately 400 tons per year in the northern region, spanning from Bahía Solano to Juradó, from 2011 to 2014 (Marviva 2014). In the southern and central part of the Colombian Pacific coast, the artisanal fishing fleet that targets pelagic species predominantly uses gill nets of different mesh sizes. The use of gill nets is regulated by the Colombian fishing authority, *Autoridad Nacional de Acuicultura y Pesca* – AUNAP. Only gill nets ≥2 ¾″ mesh size are allowed, but a considerable amount of illegal gill net fishing persists along the coast given weak enforcement and the relatively low cost of smaller mesh size gears in the market.

In the two largest settlements and coastal ports, Buenaventura and Tumaco, as well as other medium-sized towns such as Guapi, an artisanal fleet locally called *viento y marea* (wind and tide) is active. This fleet, which developed during the last 20 years, can move farther away from the coast and stay more days at the sea and uses gill nets with mesh sizes ranging from 3″ to 6″. Small boats (10–15 m long, 3 m wide, using two 15 hp. outboard engines) operate in this fleet year-round with an average time at sea of 9 days. Most of the catch is landed in Buenaventura. Among the most important pelagic species targeted are the Pacific sierra (*Scomberomorus sierra*), corvinas (*Cynoscion* spp.), Pacific crevalle jack (*Caranx caninus*), and spadefishes (Ephippidae). Other demersal species, especially snappers (Lutjanidae), are also targeted by this fleet. This type of fishery is regarded as highly profitable with a relatively high catch per unit effort (measured in kilograms of fish per fishing trip). This fishery is unregulated, and it is unknown if the increasing fishing effort of this fleet is causing adverse effects on the populations of the targeted species (Baos 2013). Conflicts between local and *viento y marea* fishers operating in local fishing territories in different towns along the Pacific coast are being increasingly recognized as a major problem for fisheries sustainability (Saavedra-Díaz et al. 2015).

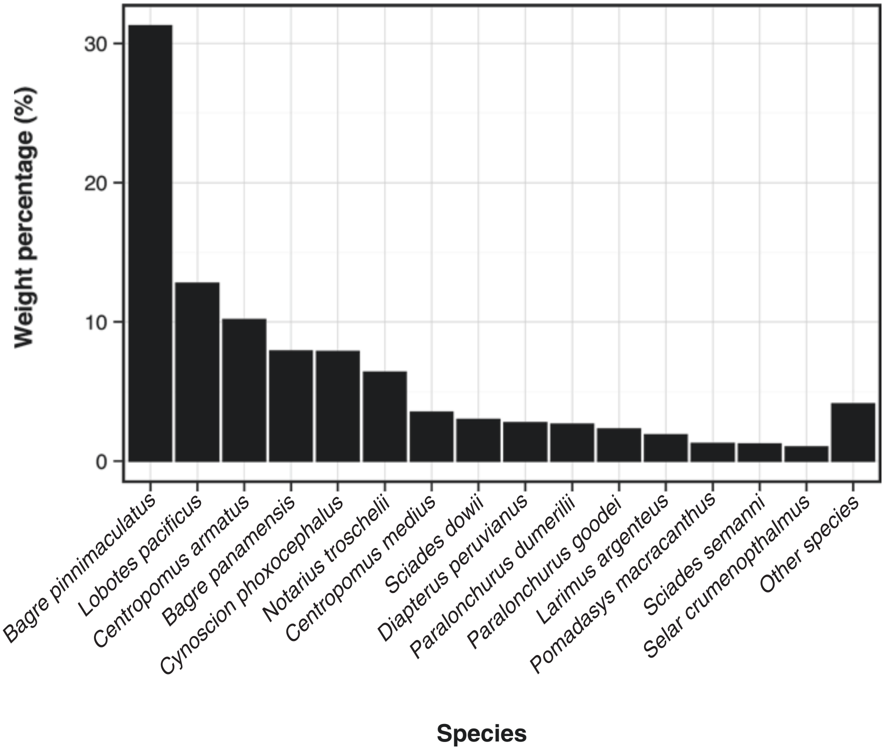



**Fig. 4.6** Principal species targeted by the gill net fishery (3½″–4½″ mesh size) at one locality in the southern part of the Colombian Pacific (Iscuandé; taken from Uribe-Casteñeda 2015)

A more coastal artisanal fleet using gill nets ranging in mesh sizes from 3″ to 6″ targets estuarine-related fish species on the mangrove-dominated coast of the southern Pacific (Fig. 4.6). The principal species that are landed by this fishery are jacks (*C. caninus*, Carangidae), catfishes (*Bagre panamensis*, *Notarius troschelii*, *B. pinnimaculatus*; Ariidae), Pacific sierra (*S. sierra*), corvinas (*Cynoscion phoxocephalus*; Sciaenidae), and snooks (*Centropomus armatus*; Centropomidae) (Uribe-Castañeda 2015). The catch is usually landed at small villages where a small fishing cooperative receives the product and then transports it to Buenaventura by boat. As in other countries in Latin America, especially the Pacific region of Panama (Carvajal-Contreras et al. 2008), some of the catch remains in the villages for local consumption and to be processed by women into dry salted fish, which is commercialized in the villages located in the upper reaches of the coastal rivers in the Pacific. This activity and the amount of fish that is commercialized in this form are usually overlooked in the national fisheries statistics (personal observation from authors).

#### 4.2.3.3 Mangrove Cockles

Mangrove cockles (*Anadara* spp.) are harvested artisanally on the west coast of the American continent from Mexico to Peru and are considered the most commercially important mollusks in the whole Tropical Eastern Pacific region (MacKenzie 2001). In many countries, such as Costa Rica, this resource is considered overexploited (Stern-Pirlot and Wolff 2006). These cockles are usually buried (first 50 cm) in the intertidal area of mangrove swamps among the prop roots of mangrove trees (MacKenzie 2001). Cockles have been traditionally harvested by Afro-Colombians (mainly women and children) on the Colombian Pacific mangrove-dominated coast and the northern Ecuadorian coast. However, harvesting of mangrove cockles by women in other countries of the region such as Peru or southern Ecuador is rare, being a predominantly male-dominated activity.

Cockles are usually commercialized locally, and there is no significant market for them in the interior of Colombia. Therefore, commercialization only occurs in Buenaventura and Tumaco and, to a minor degree, in Cali, where inhabitants of the Colombian Pacific coast have immigrated in recent years. Demand for mangrove cockles in Ecuador and Peru, in contrast, is very high and is a driver of the intense exploitation of this species on the southern coast of the Colombian Pacific, where it is harvested for export to these countries (Gil-Agudelo et al. 2011; Zapata Padilla and Caicedo Pantoja 2011). The minimum legal harvest size for this species in Colombia is 50 mm, compared to 45 mm in Ecuador and Peru. This situation exacerbates the already complex management measures needed for this resource, and it would be desirable that the three countries agree on a common minimum legal harvest size.

Mangrove cockles are of high socioeconomic importance on the Colombian Pacific coast (González Cuesta 2004; Zapata Padilla and Caicedo Pantoja 2011). Market forces, namely, demand from neighboring countries, are the most pressing threats to the sustainability of this fishery. The vast and relatively undisturbed mangrove areas on the southern Colombian Pacific coast still support important quantities of this resource that urgently need to be better and more effectively managed.

#### 4.2.3.4 White Shrimp and Other Penaeidae

The artisanal fishery for white shrimp (mainly *Penaeus occidentalis*) developed and boomed in the central and southern Colombian Pacific coast in the early 1980s. Before that, white shrimp was mainly exploited by an industrial fleet using trawl nets. The development of the artisanal fishery for white shrimp was triggered by the introduction of monofilament gill nets and the easy acquisition of engines by artisanal fishers. Currently, gillnetting for white shrimps is a widespread artisanal activity on the central and southern coast of the Colombian Pacific. The resource is now considered overexploited (Barreto Reyes et al. 2014), with most of the catch being provided by the artisanal fleet and a small percentage provided by a declining industrial fleet.

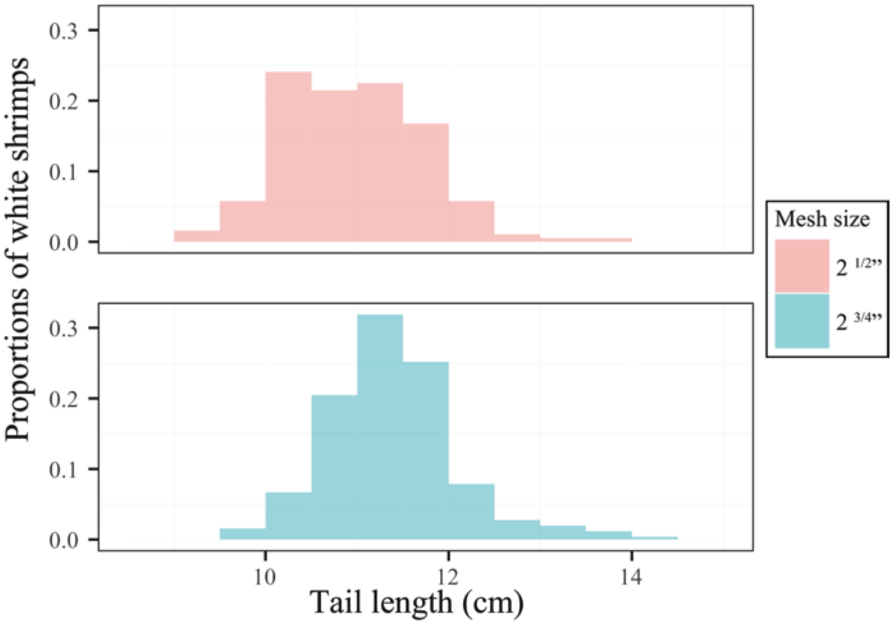



**Fig. 4.7** Size structure of white shrimps (*Penaeus occidentalis*) caught by the artisanal fleet with legal (2¾″, n = 255) vs illegal (2½″, n = 190) gillnets at one locality in the southern part of the Colombian Pacific (Iscuandé, March 2015; taken from Uribe-Castañeda 2015)

Regulations such as the minimum mesh size of 2 ¾″ in gill nets and a ban on the extraction of this resource during January and February of each year have been implemented by the fisheries authority (AUNAP) to halt overexploitation. Mesh size restrictions in gill nets are poorly enforced, and many artisanal fishers still use gill nets of ≤2 ½″ in mesh size. The impact of mesh size restrictions on shrimp stock replenishment has never been fully tested in the artisanal fleet targeting this resource. Ongoing evaluation of gear size selectivity in a location on the mangrove-dominated southern coast (Iscuandé) will provide tools to evaluate the performance and benefit of mesh size restrictions in this fishery. Preliminary results showed significant differences (two-sample Kolmogorov-Smirnov test; $D = 0.2468$, $p < 0.0001$) in shrimp size frequency distributions captured with legal (2 ¾″ mesh size) and illegal (2 ½″) gill nets, with mean tail lengths 0.4 cm higher for shrimp captured with legal gill nets (see Fig. 4.7).

Better awareness-raising processes and control of commercialization could prove effective for improving management practices. On the other hand, there are recent positive experiences that should be built on, such as the acceptance of the seasonal closure by artisanal fishers as they became aware of the decline of this resource. The ban has also been enforced in the principal cities where shrimp is commercialized, such as Cali, Popayan, Pasto, and Quibdó. Further efforts should aim at providing alternative sources of income to fishers during the ban and providing scientific evidence of the effectiveness of the ban and other regulations on the replenishment of shrimp stocks.

Other Penaeidae that are targeted by an artisanal bottom trawling fleet (locally called *changa*) operating in several towns of the southern coast include the Pacific sea bob or *tití* (*Xiphopenaeus riveti*), the titi shrimp or *pomada* (*Potrachypene precipua*), and the carabali shrimp or *tigre* (*Trachypenaeus byrdi*). This type of fishery has been banned on the entire Colombian Pacific coast since 2004 (INCODER resolution 00695 of 2004). In spite of this prohibition, *changa* fleets are relatively common in many coastal villages, and in some communities, such as El Cuerval in Iscuandé, they represent the principal fishing method employed by fishers and their principal source of income. The principal problem posed by this fishery is the large amount of bycatch it produces, consisting mainly of the juveniles of at least 30 estuarine fish species and many invertebrates (Fig. 4.8).

## 4.3 Estimating Fisheries Removals in Artisanal Fisheries of the Colombian Pacific

According to Wielgus et al. (2010), in 2005 and 2006, artisanal shrimp landings corresponded to 48% and 31% of total reported shrimp landings in the Colombian Pacific, respectively. Wielgus et al. (2010) reported that between 1950 and 2006, the true marine fisheries catches from the Pacific coast of Colombia might have been 1.3 higher than what the country reported to the FAO. This study commented on the lack of data on bycatch of artisanal shrimp fisheries in Colombia (both Pacific and Caribbean) and also calculated that 29% of total removals by artisanal fisheries were used for subsistence and not reported in official statistics. They calculated that in the years 1989, 2005, and 2006, 69% of fish landings (excluding tuna and Pacific anchoveta) were attributed to artisanal fisheries. In 2013, 75% of the fish landed in the Colombian Pacific (excluding the landings from the industrial tuna fishery) was landed by the artisanal fisheries sector (SEPEC 2013).

To calculate true fishery removals, Wielgus et al. (2010) used a study performed in the northern Colombian Pacific in the Gulf of Tribugá (Tobón-López et al. 2008), in order to derive the most common fish families captured by the artisanal fishery on the whole coast. The artisanal fishery on the northern coast, as explained before, is different from the south in terms of both catches and species composition. Landings on the southern coast are considerably higher than in the north, and important fish families that are mostly used for subsistence in the south (e.g., Ariidae, sea catfishes) are rarely seen in the landings of the northern coast. Therefore, we believe that the true marine fisheries catch in the Pacific coast of Colombia estimated by Wielgus et al. (2010), placed at 1.3 higher than official reported landings, is a very conservative value and that actual landings could be at least two or three times higher than what is officially reported. Additionally, a simple comparison of the landings reported by the fisheries authorities (*Sistema del Servicio Estadístico*

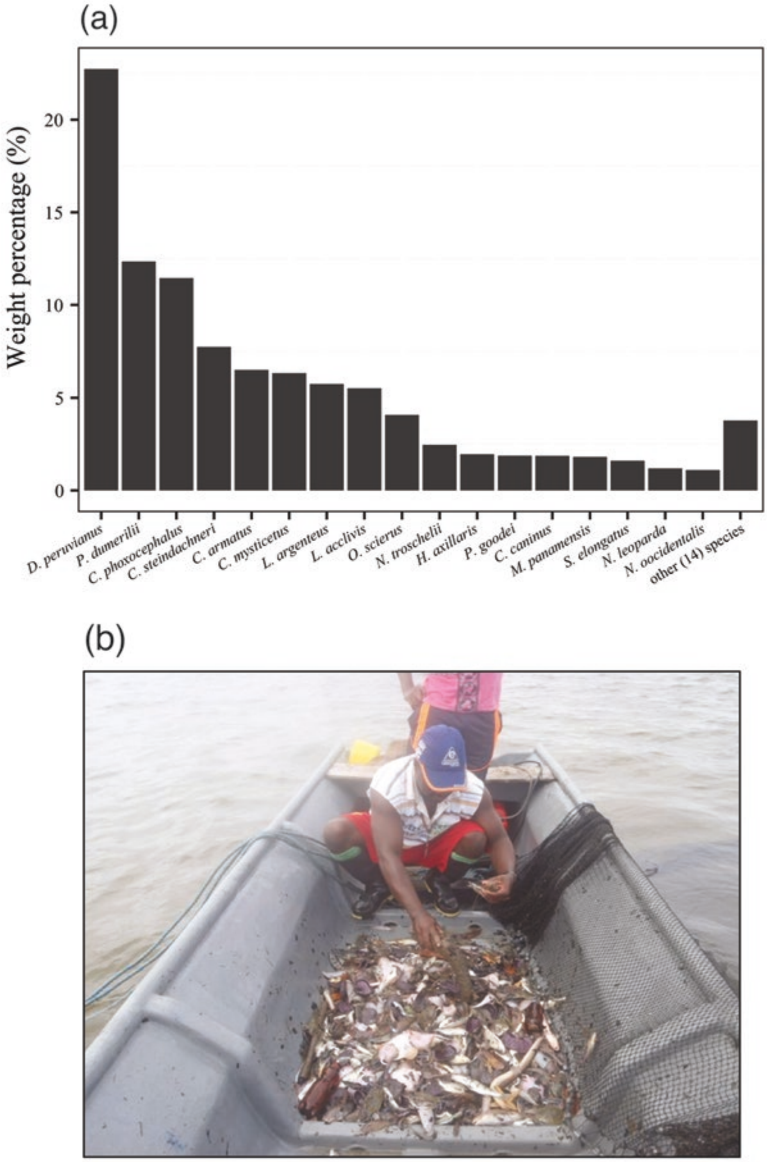



**Fig. 4.8** (**a**) Principal fish species caught as bycatch by the artisanal trawl fishery (locally called *changa*) at one locality in the southern part of the Colombian Pacific (Cuerval, Iscuandé; taken from Uribe-Castañeda 2015) and (**b**) typical catch of an artisanal trawl in Iscuandé (Rodrigo Baos, WWF Colombia)

*Pesquero Colombiano* – SEPEC) in Bahía Solano on the northern coast during March 2013–February 2014 and those by a participatory monitoring project in the same area (Marviva 2014) reveals that the true fisheries catches in this area are five times greater than what was officially reported (233 vs 1025 tons). A further reassessment of artisanal fishery removals will need to account for the larger and more representative fisheries taking place on the central and southern Colombian Pacific coast but also for the weaknesses in the way official landings statistics are taken throughout the coast.

## 4.4 Current Sustainability of Artisanal Fisheries in the Colombian Pacific

Some artisanal fisheries in the Colombian Pacific are considered overexploited. Particularly, the white shrimp (*Penaeus occidentalis*) and the mangrove cockle (*Anadara tuberculosa*) are considered overexploited by different authors (Mora-Lara 1988; Borda and Cruz 2004). Starting in the 1980s, the artisanal fishery for white shrimp boomed as a result of the introduction of gill nets. The low cost of this fishing gear allowed artisanal fishers to easily obtain nets with small mesh sizes (< 2 ¾″, which is the minimum allowed by the fishing authority). Gill nets with mesh size 2 ½″ are the most common gear used to target white shrimp in the southern Colombian Pacific coast. Poor enforcement and the lack of awareness throughout the coast are partly responsible for this situation. Another cause for the use of illegal nets is the lack of control of commercialization of such small-size nets. This last argument is a common claim from artisanal fishers to justify using these gears.

Mangrove cockles in many different areas of the Tropical Eastern Pacific are considered overexploited, in countries such as Costa Rica, Panama, Ecuador, and Colombia (Borda and Cruz 2004; Stern-Pirlot and Wolff 2006; Flores and Mora 2011; Orensanz et al. 2013). Although also considered overexploited in the Colombian Pacific, the status of mangrove cockles stocks seems to be less critical than in other countries due to (1) the relatively intact and large coverage of mangrove areas especially along the southern portion of the coast, (2) the low human population density directly related to pressure on this resource, and (3) the very low national commercial demand for this product. Nevertheless, several other pressures indicate that the condition of mangrove cockle stocks in Colombia will change in the near future. Increasing demand for mangrove cockles in Ecuador and Peru is likely to be supplied by cockles targeted in Colombia (Alava et al. 2015). Therefore, adequate and effective measures to enforce current regulations and quotas for this resource are needed. There are significant challenges in getting accurate estimates of the total harvest of this species in Colombia, especially because many of the cockles harvested in Colombia and later sold in Ecuadorian and Peruvian markets are neither accounted for in fishery landings statistics nor in export registers of Colombia.

The Colombian fisheries authority (AUNAP) has been developing different initiatives to help artisanal fishers sustainably manage resources in the Colombian Pacific. These initiatives include changing fishing gears that have been legally banned in the past, such as artisanal motorized trawls, locally called *changas*, and gill nets with small mesh sizes <2 ¾, for other supposedly more sustainable fishing gears. However, at the same time, the fisheries authority subsidizes fishers by giving them boats and fishing gears at different localities along the coast, an intervention which creates overcapacity in this fishery sector. Other national bodies such as the Agriculture Ministry, *Unidad de Reparación de Victimas*, and *Instituto Colombiano de Desarrollo Rural* (INCODER) also subsidize fishers in this form. Such a strategy can be extremely risky as it increases fishing effort and consequently pressure on fisheries resources which are currently poorly understood.

## 4.5 Challenges and Opportunities in Managing the Multi-Species Artisanal Fisheries of the Colombian Pacific

Small-scale artisanal fisheries in the Colombian Pacific coast are slowly gaining recognition at local and national levels. This momentum must be viewed as an opportunity to make important advances in the management of fisheries resources and improvements in the well-being of the coastal communities that depend on these resources. To take advantage of this opportunity, better synchronization between different stakeholders is needed. Efforts from AUNAP must recognize local initiatives that have successfully operated, sometimes for many years, in different regions along the coast. Sustainability efforts led by NGOs working with communities also need to be coordinated in order not to mislead locals when looking for appropriate fisheries management strategies. Acknowledging the importance that fishers' local ecological knowledge (LEK) can play in managing fisheries resources is fundamental, not only to understand traditional sustainable use of resources by communities but also to gain social support when implementing regulations and/or agreements. An example of recognizing this LEK was the *Conversatorio* for Citizen Action (Beardon 2008), where traditionally marginalized mangrove cockle harvesters were able to raise their voice and propose alternatives for sustainably managing cockle stocks with the people traditionally in charge of setting policies and regulations. Ultimately, the national government will need to promote a clear fisheries agenda with policies that are not influenced by political interests and subject to change according to the political party in power at any given time. This clear agenda will in turn create trust among stakeholders benefiting the collective construction of sustainability measures and governance in the artisanal fisheries sector of the Colombian Pacific coast.

Recent examples on the northern coast to declare exclusive artisanal fishing zones (ZEPA) show that the artisanal fisheries sector is being recognized at the national level. However, there are still uncertainties regarding the usefulness of such established agreements and regulations if they are not properly accompanied by ongoing monitoring and enforcement. Our understanding of the dynamics of most multi-specific artisanal fisheries on the Colombian Pacific coast is still very limited, and more research is urgently needed. Understanding these dynamics should be the focus of stakeholders working in these newly created exclusive artisanal fishing zones.

A critical factor that could be amenable to sustainable management of fisheries resources on the Colombian Pacific coast is the relatively low human population density and the low demand for fisheries products within the country in general. This relative “advantage” must be put into context, taking into account the likely increase in human population density and concomitant demand for fisheries products as infrastructure development advances and the previous restrictions, associated with the armed conflict, on moving along the Pacific coast are lifted. Due to the open-access characteristic of small-scale fisheries, overcapacity is often present (Purcell and Pomeroy 2015). This symptom is not as acute in the Pacific coast as in other areas. However, the pace of exploitation is increasing, which is to some extent fostered by subsidies provided by government agencies such as AUNAP, INCODER, *Comité de Reparación de Victimas*, and others. These subsidies may create perverse incentives, especially considering that sustainable exploitation rates are unknown for most resources. Rethinking such strategies and identifying exploitation thresholds for the primary resources targeted by artisanal fisheries should be prioritized.

Eco-certification schemes like the Marine Stewardship Council, the world’s largest fisheries certification label, could potentially be a market-based alternative for supporting the sustainable management of artisanal fisheries in the Colombian Pacific. Although these certification schemes have been criticized due to their weak standards to evaluate the sustainability of a fishery, and the underrepresentation of small-scale fisheries in their certified fisheries (Jacquet et al. 2010a, b; Sampson et al. 2015), they may prove valuable when accompanied with other management strategies to reduce pressure on some resources. Important steps in this regard, which have been supported by various NGOs, have been made on the northern Colombian coast, especially with the artisanal tuna fisheries. A recently launched fishery improvement project (FIP) called *Standard de Responsabilidad Ambiental* intends to certify fisheries products coming from sustainable fisheries. In this way, artisanal fishers stand to benefit from higher prices for fish that are harvested in a sustainable manner, while the fish companies selling these fish receive an eco-certification that can help them enter exclusive markets. The challenge of this initiative is to develop a transparent and reliable assessment of what constitutes a sustainable fishery on a coast where very little is known about the stocks targeted by artisanal fishers. Additionally, a lack of integration of such initiatives with national fisheries and environmental authorities could be a major source of failure for these eco-certification schemes, and such integration should be sought in combination with greater articulation with potential markets for these sustainable seafood products.

## 4.6 Conclusion and Outlook

Artisanal fisheries in the Colombian Pacific coast have been extremely important in sustaining the livelihoods of a vulnerable part of the Colombian population, consisting mainly of Afro-Colombians, and supplying the demand for fish protein at the local and national level. This importance is likely to increase in the coming years given the projected increase in fish consumption at the national level, the infrastructure development planned for the region, and the predicted increase in tourism and accessibility if the current peace agreement is successfully implemented and the region is pacified.

There are many implications of human population increase for the conservation of fisheries resources on the Colombian Pacific coast. Implementing multiple management actions under this scenario will be an urgent task. There is no single measure that could help to halt the overexploitation and degradation of critical coastal ecosystems, such as mangroves, that sustain fisheries productivity along many parts of the coast. Instead, the combination of different co-management actions and appropriate enforcement measures could help stakeholders foresee and adapt to current and future demands. It is thought that the success of fisheries co-management is greatly improved by the presence of strong community leaders and social cohesion (Pretty 2003; Gutierrez et al. 2011). These attributes have been greatly fortified by the implementation of Law 70 and by processes facilitated by diverse groups such as the *Conversatorio* for Citizen Action (Beardon 2008). The recent establishment of community-based protected areas (e.g. *Distrito Nacional de Manejo Integrado Cabo Manglares Bajo Mira y Frontera* and *Distrito Regional de Manejo Integrado El Encanto de los Manglares del Bajo Baudó*), accompanied by national and regional environmental agencies, gives hope that synergy between policy makers and local stakeholders can lead to sustainably managed fisheries resources on the Colombian Pacific coast. These efforts will need strong technical support reflected in sound management plans that are effectively implemented. Additionally, overcoming the frequent disconnect between governmental, private, and other civil society sectors when making decisions will greatly enhance conservation and management outcomes and directly benefit coastal people, ecosystems, and resources.

**Acknowledgments** WWF Colombia activities in the Colombian Pacific have been possible due to the support from the Walton Family Foundation, WWF Netherlands, WWF US (Project No. 4138), WWF UK, AUNAP, Rufford Small Grants Foundation, the Conservation Leadership Programme, Colombian National Parks, several Afro-Colombian councils and fishers' organizations, and Corponariño, among others. Many artisanal fishers have been involved in different processes facilitated by WWF along the Colombian Pacific coast, to whom we owe our utmost gratitude. We thank the many consultants working for WWF on the Pacific coast of Colombia. Comments by Mary Lou Higgins, Director of WWF Colombia, are greatly appreciated. GC-G is supported by a fellowship from the Alexander von Humboldt Foundation.

## References


Alava JJ, Lindop A, Jacquet J (2015) Marine fisheries catch reconstructions for continental Ecuador: 1950-2010. Working paper #2015-34. University of British Columbia Fisheries Centre, Vancouver

Andraka S, Mug M, Hall M, Pons M, Pacheco L, Parrales M, Rendón L, Parga ML, Mituhasi T, Segura A, Ortega D, Villagrán E, Pérez S, de Paz C, Siu S, Gadea V, Caicedo J, Zapata LA, Martínez J, Guerrero P, Valqui M, Voguel N (2013) Circle hooks: developing better fishing practices in the artisanal longline fisheries in the Eastern Pacific Ocean. Biol Conserv 160:214–223

Baos R (2013) Caracterización de arte de pesca artesanal de las embarcaciones denominadas viento y marea en el área de influencia de Buenaventura. WWF Colombia technical report, Bogotá

Barreto Reyes CG, Borda Rodríguez CA, Álvarez-León LR (2014) Análisis bioeconómico de las pesquerías de camarón blanco del Pacífico colombiano. Luna Azul 39:153–164

Beardon H (2008) Building hope from chaos: culture, politics, and the protection of the Colombian Pacific mangroves. WWF UK, London

Borda C, Cruz R (2004) Pesca artesanal de bivalvos (*Anadara tuberculosa* y *A. similis*) y su relación con eventos ambientales Pacífico colombiano. Rev Investig Mar 25:197–208

Caicedo Pantoja JA, Zapata Padilla LA, Castellanos-Galindo GA, Goméz LS (2012) Implementation of a sea turtle bycatch reduction program through the use of circle hooks in artisanal bottom longline fisheries in the Colombian Pacific. Bull Mar Sci 88:814–815

Carvajal-Contreras DR, Cooke R, Jiménez M (2008) Taphonomy at two contiguous coastal rockshelters in Panama: preliminary observations focusing on fishing and curing fish. Quat Int 180:90–106

Castellanos-Galindo GA, Cantera J, Saint-Paul U, Ferrol-Schulte D (2015) Threats to mangrove social-ecological systems in the most luxuriant coastal forests of the Neotropics. Biodivers Conserv 24:701–704

Castiblanco C, Etter E, Ramirez A (2015) Impacts of oil palm expansion in Colombia: what do socioeconomic indicators show? Land Use Policy 44:31–43

Cooke RG, Ranere AJ (1999) Pre-Columbian fishing on the Pacific coast of Panama. In: Blake M (ed) Pacific Latin America in prehistory: the evolution of Archaic and formative cultures. Washington State University Press, Seattle, pp 103–121

Correa I, Morton R (2010) Pacific coast of Colombia. In: Bird ECF (ed) Encyclopedia of the world's coastal landforms. Springer, Dordrecht, pp 193–197

de Granda G (1971) Onomástica y procedencia africana de esclavos negros en las minas del sur de la Gobernación de Popayán (Siglo XVIII). Rev Españ Antropol Am 6:381–422

Etter A, McAlpine C, Wilson K, Phinn S, Possingham H (2006) Regional patterns of agricultural land use and deforestation in Colombia. Agric Ecosyst Environ 114:369−386

Fiedler PC, Talley LD (2006) Hydrography of the eastern tropical Pacific: a review. Prog Oceanogr 69:143–180

Flores L, Mora E (2011) Evaluando variaciones en la talla de *Anadara tuberculosa* y *Anadara similis* en el Archipiélago of Jambelí: Hay indicios de sobrepesca? Rev Cienc Mar Limnol 5:33–49

Gil-Agudelo DL, Espinosa S, Delgado MF, Gualteros W, Lucero CH, Cantera J (2011) La pesquería tradicional de piangua en el Pacífico colombiano, entre la subsistencia y el comercio. In: Díaz JM, Vieira C, Melo G (eds) Diagnóstico de las principales pesquerías del Pacífico Colombiano. Fundación Marviva, Bogotá, pp 50–79

Gómez S, Caicedo JA, Zapata LA (2014) Captura de peces no comerciales con espinel experimental de fondo en Isla Gorgona, Colombia, y su área de influencia. Rev Biol Trop 62(Suppl 1):391–405

González Cuesta AE (2004) Modernización, conflicto armado y territorio: El caso de la Asociación de Concheras de Nariño, Asconar, Municipio de Tumaco. Maguaré 18:103–123

Gutierrez NL, Hilborn R, Defeo O (2011) Leadership, social capital and incentives promote successful fisheries. Nature 470:386–389

Jacquet JL, Pauly D, Ainley D, Holt S, Dayton P, Jackson J (2010a) Seafood stewardship in crisis. Nature 467:28–29

Jacquet J, Hocevar J, Lai S, Majluf P, Pelletier N, Pitcher T, Sala E, Sumalia R, Pauly D (2010b) Conserving wild fish in a sea of market-based efforts. Oryx 44:46–56

Leal C (2008) Disputas por tagua y minas: Recursos naturales y propiedad territorial en el Pacífico colombiano, 1870-1930. Rev Colomb Antropol 44:513–409

Leal C, van Ausdal S (2013) Landscapes of freedom and inequality: environmental histories of the Pacific and Caribbean coasts of Colombia. desiguALdades.net working paper series 58, desiguALdades.net International Research Network on Interdependent inequalities in Latin America, Berlin

MacKenzie CL (2001) The fisheries for mangrove cockle, *Anadara* spp., from Mexico to Peru, with descriptions of their habitats and biology, the fishermen's lives, and the effects of shrimp farming. Mar Fish Rev 63:1–39

Marcus J, Sommer JD, Glew CP (1999) Fish and mammals in the economy of an ancient Peruvian kingdom. Proc Natl Acad Sci 96:6564–6570

Martínez JO, López-Ramos E (2011) High-resolution seismic stratigraphy of the late Neogene of the central sector of the Colombian Pacific continental shelf: a seismic expression of an active continental margin. J South Am Earth Sci 31:28–44

Martínez JO, González JL, Pilkey OH, Neal WJ (1995) Tropical barrier islands of Colombia's Pacific coast. J Coast Res 11:432–453

Marviva (2014) Monitoreo pesquero participativo en la zona exclusiva de pesca artesanal (ZEPA), Marzo de 2011 – Febrero 2014. Marviva, Bogotá

Mora-Lara CO (1988) Análisis de la pesca de langostino, Penaeus (*Litopenaeus*) *occidentalis*, Street, efectuada por la flota camaronera de Buenaventura y el trasmallo "electrónico". Trianea 1:193–207

Orensanz JMC, Parma AM, Burotto AM, Guerrero LE, Cordero SS, Sepúlveda E, Granda CT (2013) Part I: Latin American rights-based fisheries targeting sedentary resources. In: Orensanz JM, Seijo JC (eds) Rights-based management in Latin American fisheries, FAO Fisheries and aquaculture technical paper no. 582. FAO, Rome, pp 1–69

Pennington JT, Mahoney KL, Kuwahara VS, Kolber DD, Calienes R, Chavez FP (2006) Primary production in the eastern tropical Pacific: a review. Prog Oceanogr 69:285–317

PNUD (Programa de las Naciones Unidas para el Desarrollo) (2012) Colección Cuadernos INDH 2011, Afrocolombianos: Sus territorios y condiciones de vida. PNUD, Bogotá

Pretty J (2003) Social capital and the collective management of resources. Science 302:1912–1914

Purcell SW, Pomeroy RS (2015) Driving small-scale fisheries in developing countries. Front Mar Sci 2:44. https://doi.org/10.3389/fmars.2015.00044

Restrepo JD, López SA (2008) Morphodynamics of the Pacific and Caribbean deltas of Colombia, South America. J South Am Earth Sci 25:1–21

Saavedra-Díaz LM, Rosenberg AA, Martín-López B (2015) Social perceptions of Colombian small-scale marine fisheries conflicts: Insights for management. Mar Policy 56:61–70

Sampson GS, Sanchirico JN, Roheim CA, Bush SR, Taylor E, Allison EH, Anderson JL, Ban NC, Fujita R, Jupiter S, Wilson JR (2015) Secure sustainable seafood from developing countries. Science 348:504–506

SEPEC (Sistema del Servicio Estadístico Pesquero Colombiano) (2013) Boletín Estadístico. *Autoridad Nacional de Acuicultura y Pesca* (AUNAP)-Universidad del Magdalena, Convenio de cooperación No. 0058 de 2013

Stern-Pirlot A, Wolff M (2006) Population dynamics and fisheries potential of *Anadara tuberculosa* (Bivalvia: Arcidea) along the Pacific coast of Costa Rica. Rev Biol Trop 54:87–99

Tobón-López A, Rubio EA, Giraldo A (2008) Análisis taxonómico de la ictiofauna del Golfo de Tribugá, Pacífico colombiano. Lat Am J Aquat Res 36:93–104

Uribe-Castañeda N (2015) Informe técnico de la pesca de camarón y fauna asociada en Iscuandé, Nariño. Technical report. WWF Colombia, Bogotá

Wade P (2002) The Colombian Pacific in perspective. J Lat Am Caribb Anthropol 7:2–33

West RC (1956) Mangrove swamps of the Pacific coast of Colombia. Ann Assoc Am Geogr 46:98–12

Wielgus J, Zeller D, Caicedo-Herrera D, Sumaila R (2010) Estimation of fisheries removals and primary economic impact of the small-scale and industrial marine fisheries in Colombia. Mar Policy 34:506–513

Zapata Padilla LA, Caicedo Pantoja JA (2011) La actividad extractiva de piangua (*Anadara tuberculosa*) en el Parque Nacional Natural Sanquianga, Nariño Colombia. In: Díaz JM, Vieira C, Melo G (eds) Diagnóstico de las principales pesquerías del Pacífico Colombiano. Fundación Marviva, Bogotá, pp 81–90

Zapata LA, Caicedo JA, Rojas P, Goméz S, Castellano-Galindo G, Lora AM, Baos R, Cuadros L (2012) Disminución del impacto por captura incidental de tortugas marinas con el uso de anzuelos curvos. Informe de País (Colombia año fiscal 2011-2012). Technical report. WWF Colombia, Bogotá

**Gustavo A. Castellanos-Galindo** is currently a postdoctoral fellow at the Resource Management working group of the Leibniz Centre for Tropical Marine Research in Bremen, Germany. He completed his Masters and PhD at the University of Bremen and has carried out research in different countries of Latin America for more than 10 years in topics ranging from fish community ecology and biogeography to marine conservation. Gustavo has been a consultant of WWF-Colombia for 9 years and is currently focused on understanding the complexities of mangrove fisheries in the eastern Pacific Ocean.

**Luis Alonso Zapata Padilla** is the current Marine and Coastal Program Coordinator of WWF in Colombia and Panamá. Luis has a Master's degree in Biological Sciences and 25 years of experience working in fisheries and marine conservation. He has worked for the National Institute of Fisheries and Aquaculture (INPA) in Colombia and the National Park Service (*Parques Nacionales Naturales de Colombia*). Luis is currently involved in projects related to the sustainability of Colombian artisanal and industrial fisheries and is also involved in supporting the creation of new MPAs that protect key marine ecosystems in Colombia and Panama.

# Chapter 5
# Cooperation, Competition, and Attitude Toward Risk of Small-Scale Fishers as Adaptive Strategies: The Case of Yucatán, Mexico

**Silvia Salas, Oswaldo Huchim-Lara, Citlalli Guevara-Cruz, and Walter Chin**

**Abstract** There is a worldwide recognition of the challenges that fishing communities face with respect to changing environments, market integration, and different sources of uncertainty. In this context, to be able to implement policies oriented to increase adaptive capacity in fishing communities and improve fisheries governance, it is important to understand the factors underlying fishers' attitudes, the decisions they make, and the strategies they develop to face uncertain conditions. We present two case studies from the Yucatán coast in Mexico that reveal the complex and challenging realities of marine resource use in fishing communities and highlight why it is necessary to enhance adaptive capacity for good governance in small-scale fisheries. In both cases, we observed risk-averse and risk-prone attitudes in fishers' operations in response to changing conditions. In one case, cooperative actions were observed in the community, but those arrangements have been changing in response to increasing uncertainty in catches, the participation of newcomers, and unreliable surveillance. We argue that the decrease in resource abundance, lack of social capital, and weak institutions can increase overall uncertainty and prompt diverse responses from fishers to compensate for such conditions. We contend that strengthening the adaptive capacity of people in fishing communities can be

S. Salas (✉)
Marine Resources Department, Cinvestav Mérida, Mérida, Yucatán, Mexico
e-mail: ssalas@cinvestav.mx

O. Huchim-Lara
Universidad Marista de Mérida, Mérida, Mexico
e-mail: rhuchim@marista.edu.mx

C. Guevara-Cruz
Centro de Estudios Tecnológicos del Mar, Mérida, Mexico

W. Chin
University of California, Los Angeles, CA, USA



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_5

promoted through cooperation among community members, scientists, and public institutions as the first step toward improving fisheries governance.

**Keywords** Adaptive capacity · Cooperation · Risk · Safety · Governance · Uncertainty

## 5.1 Introduction

Small-scale fisheries in Mexico are facing risky conditions such as illegal fishing, social conflicts, fluctuating markets, changes in the environment, and changes in resource availability, all of which place fishers in vulnerable situations (Manuel-Navarrete et al. 2011; Pedroza and Salas 2011; Bennett et al. 2014; Huchim-Lara et al. 2015). Accordingly, fisheries policies are expected to diversify the approaches they utilize in dealing with fisheries by moving beyond a singular focus on stock assessment. It is necessary for policies to integrate different visions concerning what small-scale fisheries involve, including perceptions and attitudes of fishers toward risk and uncertainty and the strategies they develop to face these conditions (Cinner et al. 2011; Fulton et al. 2011; Salas et al. 2011).

Some authors have argued that, under uncertain scenarios, proactive strategies based on cooperative actions can facilitate the adaptive capacity of fishing communities and improve fisheries governance (Fabricius et al. 2007; Basurto et al. 2013; Ovando et al. 2013; Salas et al. 2015). The adaptive capacity of fishers needs to be built under the premise that diversity of contexts implicit in small-scale fishing communities should be recognized (Bodin and Norberg 2005; Amarsinghe and Bavinck 2011; Seijo and Salas 2014). It is important to explore the driving factors that generate a sense of vulnerability among different groups to learn about their circumstances and identify and develop alternative strategies for dealing with these stressors. At the international level, several actions have been taken, for instance, the Intergovernmental Panel on Climate Change (IPCC), the WorldFish Center (WFC), and the Food and Agriculture Organization (FAO) have held workshops for identifying and discussing critical issues faced by people who depend on fisheries and aquaculture and deal with uncertainty and the impact of different factors, including climate change (Cochrane et al. 2009; Badjeck et al. 2011; IPCC 2014).

We contend that valuable insights about strategies to increase adaptive capacity in fishing communities can be found by understanding (1) how small-scale fishers respond to changes in resource abundance, (2) how they interact within social networks, and (3) how policy interventions influence their ability for adaptation. In that sense, examples of case studies and lessons learned could contribute to better policies to strengthen fishing communities and the sustainability of fishing resources.

Using two case studies from Mexico, we explore what kind of decisions fishers make when dealing with risk and uncertainty and what factors play an important role as incentives for this decision-making. We divide the chapter in three sections: (a) a short review of issues regarding vulnerability in small-scale fisheries and cooperation processes to set the stage for discussion, (b) two case studies that expose the issues addressed, and (c) lessons learned from the case studies that provide insights regarding the required conditions or actions that could help to improve small-scale fisheries governance in an environment of risk and uncertainty.

## 5.2 Vulnerability and Adaptive Capacity

Several authors have called attention to potential threats facing fishing communities, with special emphasis on environmental changes and the adaptive capacity of fishers to respond to environmental and sociological changes (Badjeck et al. 2011; IPCC 2014). Among the threats, acidification, sea level rise, rainfall, hurricanes, and red tides have been documented as growing threats (Pielke and Landea 1998; Badjeck et al. 2011; Amarsinghe and Bavinck 2011; Salas et al. 2011; IPCC 2014). In addition, these threats are considered to have increased in severity in the last decades. Badjeck et al. (2011) present a wide vision of the potential and extended effects of climate change and environmental factor variability in which the impact of these stressors on aquatic ecosystems can affect resource productivity, which in turn can have an impact on economic activities and hence have a direct or indirect effect over resources' users.

Changes in the availability of resources can provide an incentive for fishers to search for alternative target species and alternative activities or even move to other areas (Fabricius et al. 2007; Johnson and Welch 2009; Manuel-Navarrete et al. 2011). Another important aspect in this scenario is occupational health and safety, which can be threatened as fishers dare to expose themselves to riskier conditions when resource availability is reduced by going further and deeper in the search for income improvement or at least to maintain their livelihoods (Huchim-Lara et al. 2015).

Under conditions of risk and uncertainty, fishers need to adjust in response to actual and potential threats, by evaluating the potential cost of recovery (Pielke and Landea 1998). In this context, we posit that adaptations from fishers and government bodies are necessary, as well as understanding such adaptations, to be able to adjust to the dynamics of these socio-ecological systems (Manuel-Navarrete et al. 2011; Salas et al. 2011). It is also relevant to state clearly what the "real costs" of adaptation are (ecological, social, or economic) and who bears them. It is also important to learn how fishers respond under different circumstances. Different responses may be observed based on fishers' present or current experiences or given their future expectations (Salas and Gaertner 2004).

Fishers can express different attitudes at the individual or community level, and their attitudes toward risk can change over time and under different conditions. In this context, three types of risk takers can be identified in fishing communities (Seijo et al. 1998; Salas et al. 2011):

(a) Risk-averse: people who base their decisions on previous experiences, perceive threatening conditions, or have limited resources to handle threats or risks (social, economic, personal support)

(b) Risk-neutral: people who have had limited exposure to risky conditions, hence may have a lower sense of vulnerability
(c) Risk-prone: people who perceive a high probability on achieving expected benefits, need to accomplish a goal, and have confidence about the availability of supporting resources

In order for fishers to attain their goals while dealing with different constrains and based on the resources available (human, economic network, etc.), they develop different types of strategies, which can be reactive or proactive under different conditions (Salas et al. 2011). Among the proactive strategies, cooperation is a commonly observed action that is taken to deal with vulnerability and risk.

## 5.3 Cooperation Processes: Incentives and Constrains

Humans perceive the potential benefits of cooperation, but it seems that it is only under certain conditions that individuals become motivated to fully participate in collective action (Gatewood 1984; Guttman 1996; Rutan 1998; Basurto et al. 2013). Cases that involve cooperation occur when actors obtain mutual benefit by some common or matching interests (Salas and Gaertner 2004; Cinner et al. 2011; Ovando et al. 2013). Fishers can cooperate for a variety of reasons, including to reduce risks, to increase benefits, or for altruistic reasons (Ovando et al. 2013; Salas et al. 2015; Huang and Vuong 2016). It has been reported that, under stressful or vulnerable conditions, there could be incentives for acting collectively (Salas and Gaertner 2004). Conversely, it has also been shown that human behavior can change in the face of resource scarcity (i.e., limited catch quota, limited access to food, limited space), which leads people to competitiveness (Cinner et al. 2011; Leibbrandt et al. 2013).

One common form of cooperation that has been observed in small-scale fisheries is the sharing of information and catches among fishers (Gatewood 1984; Rutan 1998; Salas and Gaertner 2004). Pooling effort to face complex situations has been observed in the case of small-scale fishers in Yucatán, who cooperate by combining seine nets among groups of friends to fish small pelagic species, a strategy that was undertaken because the length of the nets used as single units did not permit them to be operated by only one boat (Blondin et al. 1981).

It is also important to note that changes in the conditions of the fishery or fishers' personal circumstances can contribute to changes in their cooperative efforts. For example, while Alaskan seiners share information about their fishing grounds on a regular basis, it is difficult to negotiate when quotas are allocated because each fisher wants to keep his/her individual quota (Gatewood 1984). Similarly, fishers in Yucatán, Mexico, share catches regularly during the windy season (when demersal fish species and octopus are harvested), but they do not share the lobster catch, which is the most profitable resource in their area (Salas and Gaertner 2004). One important factor involved in the notion of cooperation is the size of human groups, which appears to be an important attribute for the patterns of interaction and communication between fishers. This aspect has been shown to be relevant when, for instance, the fewer the people in the group, the more information is shared (Guttman 1996; Basurto et al. 2013).

Common norms, values, local forces, and a sense of community can certainly contribute to creating social networks to support collective action (Salas et al. 2011; Basurto et al. 2013; Leibbrandt et al. 2013). In this context, leadership plays an important role in the creation of social networks among small-scale fishers (Rutan 1998; Bodin and Crona 2009). Transparency and mutual trust are required to maintain the cooperative spirit and sustain the agreements that are usually made among relatives, colleagues, and friends. These conditions can, by extension, enable cooperative actions for the management of resources and hence contribute to improving fisheries governance.

## 5.4 Empirical Cases of Small-Scale Fisheries in Yucatán: The Context

Our methodological approach was based on mixed methods, in which we analyzed two case studies that involve fishers from two fishing communities located on the Yucatán coast of Mexico – Dzilam de Bravo (DB) and Río Lagartos (RL) – which are represented with dots in Fig. 5.1.

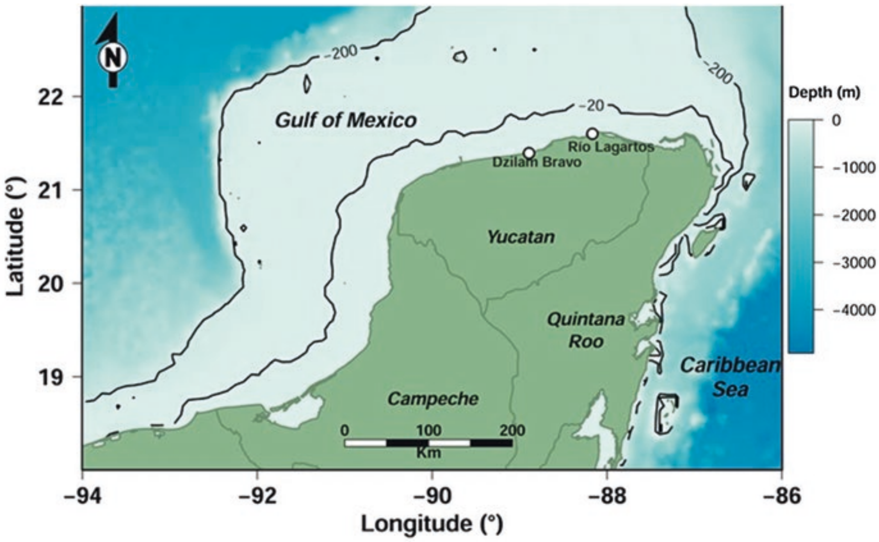



**Fig. 5.1** Location of the two fishing communities presented as case studies (Source: Torres-Irineo Design)

### 5.4.1 The Communities

Dzilam de Bravo is a small community of 2463 inhabitants on the Yucatán coast of Mexico (Fig. 5.1) where small-scale fishing is one of the main economic activities. The National Institute of Statistics and Geography (INEGI, Spanish acronym, 2010) reports a total of 650 fishers and 326 fishing boats operating in the area. Fishing is practiced by two groups: fishers organized in fishing cooperatives in the port and private sector permit holders who have the means to fish and to trade fish products independently.

Río Lagartos is a town located on the east coast of Yucatán state situated 230 km from the state capital of Mérida. This area is located within the Río Lagartos Biosphere Reserve, a natural protected area that comprises a large area of mangrove habitat and a large diversity of birds. The town comprises a total of 3272 people, 16% of whom are illiterate (INEGI 2010). The main economic activities in the community include fishing, ranching, and tourism. Like in Dzilam de Bravo, there are both fishers organized in fishing cooperatives and working for private owners.

### 5.4.2 Fisheries and Management

Fisheries in both communities are entirely small scale. The boats are made of fiberglass (9–11 m), and fishing trips are carried out on a daily basis using Global Positioning System (GPS) to search for fishing grounds. A high diversity of species is captured, but the main target species include demersal fishes (groupers, snappers), octopus, lobster, and more recently sea cucumber. The *hookah* system is used to catch lobster and sea cucumber. Since this system pumps air directly down to divers, it allows divers to search larger areas and remain underwater for long periods of time. For demersal fishes, hook and line is used, and octopus is captured with a traditional fishing method called *jimbas* that includes two bamboo sticks that have lines with crabs used as bait. Except for sea cucumber, target species are also captured by a semi-industrial fleet that operates in deeper waters.

The management regulations for primary species (lobster, grouper, and octopus) include seasonal closures, minimum legal size, gear restrictions, and, in the case of octopus, a catch quota shared with two other states (Campeche and Quintana Roo). In the case of the sea cucumber fishery, government agencies have been inconsistent in enforcing regulations since it was opened. The close season has not established regular periods each year as depicted in Table 5.1. The biological or technical support for such adjustments is not clear, for instance, the open season had varied between months and time from 4 months to 10 days; in 2016 the fishing season lasted only 10 days and coincided with the breeding period of one of the two sea cucumber species.

**Table 5.1** Management regulations and catches associated with the sea cucumber fishery in Yucatán from 2007 to 2014 (SAGARPA Yucatán statistical data)

| Year | Fishing season (months/days) | Months of the year | Fishing permits | Catch (t) all species |
|---|---|---|---|---|
| 2001 | 4 | Jul–Oct | | 34.3 |
| 2010 | 4 | Jul–Oct | 215 | 2613.7 |
| 2011 | 2 | Apr–May | 290 | 2033.6 |
| 2012 | 2 | Feb–March | 303 | 1584.6 |
| 2013 | 3 | Apr–May and Nov–Dec | 569 | 2762.4 |
| 2014 | 2 | Feb–Apr | 429 | 3682.4 |
| 2015 | 2 | Apr–May | 429 | 600 |
| 2016 | 10 days | Jun | 560 | 1616 |
| Total | 19 months, 10 days | | | |

## 5.5 Methodological Approach

The two case studies examined in this chapter explore the duality of competition and cooperation in a coastal community in the first case and risk associated with fishing methods and incentives to target high-value species in the second. In examining these case studies, we explore several questions, including (a) How are fishers adapting to changing conditions? (b) What are the incentives for fishers to cooperate or to compete? (c) What are the sources of risk and uncertainty in diving fisheries and what kind of strategies have fishers developed to deal with such conditions?

We used direct and indirect sources of information and a mixed method approach to data analysis for these case studies. In the first case, we used data from logbooks provided by one of the two fishing cooperatives existing in Dzilam de Bravo, which contained daily catch records from each boat for each individual fisherman, by species, including data from 2007 to 2012. In addition, we interviewed fishers and spent time in the community in 2013 to undertake participatory research. From the logbooks, we observed patterns of cooperative actions among some fishers, who share catches when arriving to deck on the same day. This agreement indicates that these fishers share their catches regardless of who brought more in a day, which we defined as individual cooperation (occurring between two and more fishers). We also identified another form of cooperation that occurred when fishers provided fish product to children or other members of the community to give support to these community members, which we defined as a cooperation process at the community level.

In the second case study, we explored the strategies of divers facing different sources of uncertainty at the operational level. In this case, the analysis was based on data from logbooks from one of the two fishing cooperatives in Río Lagartos, which included data on daily catch by species by fisher and boat. From these records, we could select fishers with different performance while diving, which we determined based on their trip yields. Hence, three categories were defined, including high, medium, and low performance. One of each group was followed during daily fishing journeys each month for the lobster season, which lasted 8 months. With the help of micro diving computers and onboard observers, we recorded ascent speed, fishing time, and water temperature in each diving immersion during the trip. We also used records from the logbooks of the hyperbaric chamber where fishers get treatment for diving accidents, which helped to match information on cases of decompression.

In both communities, previous experience in the study area facilitated the researcher's interaction with fishers and other community members. Based on the results of the case studies, we analyze and discuss the response of fishers to different conditions of risk and uncertainty with a specific focus on adaptive strategies.

## 5.6 Learning from the Case Studies

### *Case Study 1 – Two Sides of a Coin: Cooperation and Competition in Dzilam de Bravo*

### *5.6.1 Coopera.tive Processes*

Previous studies have provided evidence of cooperation among fishers in Dzilam de Bravo (Salas and Gaertner 2004). These references show interesting aspects of cooperation, providing details about who shares their catch with whom while showing how these practices help fishers face adverse environmental conditions (e.g., windy season). In the present case study, the permanence of the reported type of cooperation in the same community was analyzed, while other forms of cooperation were also explored. Information gathered was linked to both the individual and community level. Below we describe in detail the cooperative agreements and the incentives linked to these processes.

*Individual Cooperation Format*

**Fisher to Fisher** This type of cooperation includes instances where two or more fishers pool their daily catches and share it in equal parts, regardless of who caught more or less in their respective journey. In the case study, the cooperation teams included two or three skippers. Salas and Gaertner (2004) indicated risk-averse attitudes of fishers toward bad environmental conditions, such as during the windy season from November to February, when more fishers worked in teams. That study showed that bad weather motivates the fishers to work in teams, which ensures a greater probability of each fisher receiving some catch under risky weather conditions. In the present study, fishers mentioned a concern regarding diminishing catches from day 1 to the next due to a decline in resource availability. Hence, by sharing their catches, fishers ensure the maintenance of a daily income regardless of environmental conditions. The crew of each vessel is usually made up of two or three fishermen for the daily fishing trips; however, these findings showed that fishers generally cooperate with relatives and friends, in addition to owners of other vessels when fishing in teams.

From daily catch records, we identified several teams and observed that the number of teams had been decreasing through time: from 14 (2007) to 34 (2008), to 33 (2009), and finally to 4 in 2010. However, individual cooperation in the case of catch sharing among fishers showed that at least two teams (*Polluelo-Tigrillo* and *Lobo-Chunga*) have been operating in the community for at least a decade and have maintained their cooperation arrangements to work together during this time.

Findings also showed a decrease in catches, which confirmed what fishers had indicated during interviews. Under the current economic difficulties facing households, fishers did not increase the number of teams only during windy seasons as reported by Salas and Gaertner (2004) but instead integrated existing teams during the seasonal closure of fisheries for high-value species (e.g., octopus, sea cucumber, and lobster). In either case (windy season or limited resource access), the strategy seems more risk-averse than risk-prone, since fishers attempt to maintain an average catch from their fishing journeys to sustain an average income.

In our analysis, we compared the incomes of fishers who participated in cooperative practices to those of fishers who did not. We found that teams were more common from January to May, a period that corresponds to the windy season and to the closed seasons of the most important species in the area (octopus and lobster), as indicated by fishers. It was clear that participating in teams resulted in higher incomes for fishers. For example, the income per trip obtained by fishers working in cooperation was between USD $40 and $60 per trip, compared to $24 to $40 per trip obtained by fishers who did not cooperate (Fig. 5.2). The higher income difference is evident in the first period of the year, when more teams operate.

*Community Cooperation Format*

**Fisher to** *Gaviota* In this type of system, fishers give fish products to different members of the community, who are referred to locally as *gaviotas* (seagulls) at the landing site. These people, who are mostly children who go to landing sites after school or during the summer holidays, frequent the landing site to request fish products to fishers in exchange of cleaning the boats or eviscerate the fish (Fig. 5.3). *Gaviotas* can sell the fish products at the fishing cooperative or to a permit holder. The products sold to the local fishers' cooperative have been recorded for several years in their logbooks, allowing a good measure of the volume and income derived for the *gaviotas*. Based on the logbook records, we calculated that the production given by fishers to the *gaviotas* annually was 1.8% of the total catch obtained by the cooperative. Fish hunting at deck by people has also been observed in other communities in Yucatán, but catch records about how much they collect are not available.

*Gaviota* **to** *Gaviota* Some of the *gaviotas* are siblings or relatives, and, in many cases, they share the benefits of this activity by pooling the fish products regardless

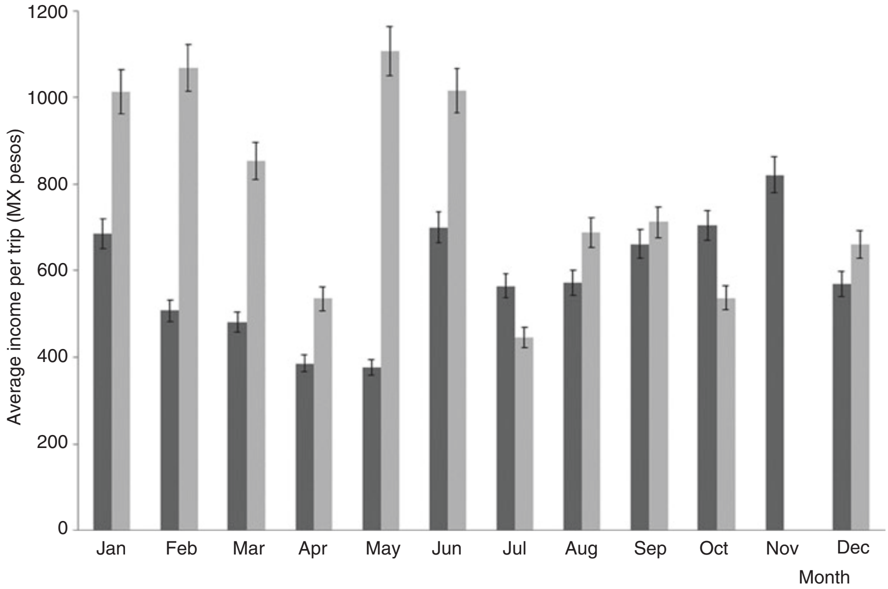



**Fig. 5.2** Income per trip in Dzilam de Bravo for both fishers working in cooperation (black bars, equivalent to \$24–40 Dlls per month) and fishers who do not take part of cooperative practices (gray bars, equivalent to \$40–60 Dlls per month)

**Fig. 5.3** Children (*gaviotas*) helping fishers at arrival after the fishing journey in Dzilam de Bravo, Yucatán, Mexico (Pictures: Silvia Salas)

of who collected the most individually. We noted an interesting fact: a young man we encountered who buys this product from children and resells it in Merida was himself a *gaviota* one decade ago. Currently he is a middleman and even helps children from a rural town (Dzilam Gonzalez, which is 12 km away from Dzilam de Bravo) to commute between communities for fish hunting and buys the products from them.

When fishers were asked “why do fishers share their catches with the *gaviotas*?” they indicated that the *gaviotas* are part of their own community (i.e., Dzilam de Bravo) or of some neighboring community (i.e., Dzilam Gonzales) where the fishers themselves usually get shelter from hurricanes. In both cases the fishers said they knew that the benefit of the fish sharing provided the *gaviota* households with food and money. Additionally, a fisher stated that “they help kids to contribute with their community and because in some cases the kids have no direct support from their parents” (Carlos Perez, personnel communication, April 18, 2013). When interviewed, some *gaviotas* said that the money they get (on average between USD $20 and $50 per month) can be shared at home to purchase food and buy school supplies.

*Competition: The Other Side of the Coin*

Since 2007, government agencies (state and federal) started the assessments of sea cucumber (*Isostichopus badionotus*, *Holothuria floridana*), to identify its potential viability for commercial exploitation. Since 2013, a legal “pilot commercial fishing” activity of sea cucumber was developed in the states of Yucatán and Campeche. However, despite the “exploratory” nature of this new fishery, fishers in at least three or four communities caught high volumes of sea cucumber (1199.9 t in 2013 and 2649.2 in 2014), which went far beyond the expected level of exploitation (Fig. 5.4). The high commercial value of the product and limited surveillance

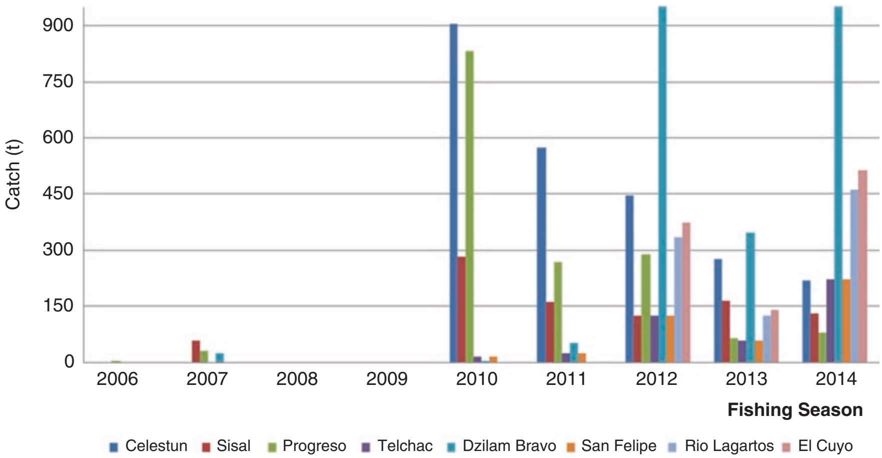



**Fig. 5.4** Catch trend of sea cucumber fishery in communities in Yucatán, Mexico (Data source: SAGARPA Yucatán)

catalyzed illegal fishing activities in the area. The advent of this new fishery has modified local social arrangements. A "gold rush" (to get access to a very profitable species) among the fishers seems to operate in the area, with increased competition among local and external fishers, as well as changes in conditions that are modifying the existing cooperative arrangements among community members.

Figure 5.4 shows that the highest catches were concentrated in Sisal, Celestun, and Progreso (the first two located in the northeastern and the last one in the central coast of Yucatán) at the beginning of the sea cucumber extraction period (2010–2014). Dzilam de Bravo reached the highest records of sea cucumber catch later between 2012 and 2014. Other communities (i.e., San Felipe, Río Lagartos, and El Cuyo) obtained sea cucumber catch quotas as well. However, the presence of fishers from nine different communities in the same fishing area generated conflict between fishing communities and within the communities themselves.

As a side effect of the sea cucumber fishery, newcomers were attracted either to fish or help in other fishing-related activities (as divers, cooks, boat helpers, and gut cleaners). The highest earning wages are earned by divers and cooks. However, community members' expectations about the spillover benefits from the fishery were not reached. The first reason for this is because few local cooks were hired, since the sea cucumber buyers brought their own personnel (during the first seasons, there were foreign buyers, mainly Chinese, but in the last season, there were also local buyers). Additionally, sea cucumber permit holders brought divers from other communities who were willing to accept lower wages.

Increasing competition with locals modified local arrangements in Dzilam de Bravo, including cooperative processes. This triggered the development of illegal fishing and trade, and thus favored corruption, leaving local fishers feeling threatened and invaded. The catch share practice formerly maintained with *gaviotas* changed: fishers were no longer willing to share their catches of sea cucumber consistently, as they had done a few years prior.

Government agencies have not shown clear initiatives to deal with the problems caused by the sea cucumber fishery, instead leaving "small windows" open to allow continued fishing activities "outside of the rules" as a strategy to reduce tension in the short term. An example of this was the short fishing season of 2016, which lasted only 16 days. The "gold rush" for market incentives has generated competition between local fishers and newcomers from neighboring fishing communities and even from other states. The mentality associated with the fishery has generated issues of poaching, corruption, work-related accidents (decompression sickness because of diving), and clashes between fishers. An increase in diving accidents and associated safety risks has become a major concern in the region. Private, profit-oriented decompression chamber businesses were installed in the fishing communities or close to them, whose owners were aware of the risks as well as the opportunities for profit. We present more information regarding these issues in the second case study.

### *5.6.2 Case Study 2: Perception of Risk and Divers' Safety in Río Lagartos*

Small-scale fisheries comprise one of the riskiest occupations around the world. Diving is one of the riskiest fishing methods, with the potential for severe or fatal impact on fishers' health and, by extension, on the wider fishing communities (Huchim-Lara et al. 2015; Chin et al. 2016).

In Yucatán, lobster and sea cucumber are caught by diving practices that use a *hookah* system. This system is widely used in the Caribbean area and other regions around the world to catch different sessile marine species. Examples include the sea cucumber fishery in the Galapagos Islands, the lobster fishery in Honduras, and the sea urchin fishery in California and among Thailand fishermen (Gold et al. 2000; Dunford et al. 2002; Westin et al. 2005; Huchim-Lara et al. 2015). The flexibility of this fishing method enables fishers to extend the length of time they can spend in search for their best catch but at the same time creates health-related risks for divers. In Yucatán, between 2003 and 2012, around 1000 divers were treated in decompression chambers for decompression sickness, equating roughly 200 cases per year (IMSS 2013).

The lobster (*Panulirus argus*) has been one of the most profitable fisheries in Yucatán since the 1980s and today is the third most economically significant fishery in the region (Huchim-Lara et al. 2015). Five fishing cooperatives on the eastern coast of Yucatán hold fishing permits and concessions where they catch lobster. After the sea cucumber fishery became a very profitable commercial fishery, the number of newcomers, especially those interested in sea cucumber, increased, as did the number of diving-related accidents (Huchim-Lara et al. 2016). Inexperienced divers entering the sea cucumber fishery suffered more accidents than those with more expertise. For instance, during the 2014–2015 lobster fishing season (which lasted 8 months), 116 cases of decompression accidents were reported, compared to 152 cases of decompression sickness reported between March and April in 2015 (a 1-month season). Currently, this fishery is at its maximum catch limits (DOF 2012). However, newcomers have not stopped entering, while illegal fishing has increased and decompression accidents are more common than before.

Despite high rates of decompression sickness and carbon monoxide poisoning among *hookah* divers, these illnesses are sometimes disregarded or not considered because of lack of knowledge (CDC 2010; Huchim-Lara et al. 2015; Chin et al. 2016; Huchim-Lara et al. 2016). In this context, it is important to understand the fishing strategies developed by divers, which can vary depending on divers' skills, the species they catch, as well as the conditions of the sea while diving (e.g., temperature, waves, etc.).

Depth and dive duration are crucial variables to consider when diving: the deeper the dive, the less time can be spent at the bottom. The speed of ascent can also increase the probability of decompression as the nitrogen bubbles cannot be eliminated properly. Our findings regarding the fishing operations of divers for both sea cucumber and lobster show that the average speed of ascent of divers was 20.28 FSW/

min, which is 5% above the speed recommended by the US Navy Regulations (30 FSW/min). Additionally, 24% of all divers exceeded the no-decompression limit, as fishers spent more time underwater than what is allowed for a specific depth, especially in the case of sea cucumber divers.

A common pattern observed among lobster divers was diving in a "yo-yo pattern," in which they go up and down to drop the catch into the boat or to get a hook in case they lose it while fishing (Fig. 5.5a). This is a risky practice since it exposes the divers to the risk of arterial gas embolism due to their frequent ascents. In the case of sea cucumber, divers spend more time at the bottom in each single dive (Fig. 5.5b). In both cases, these diving patterns can lead to a high risk of decompression.

The strategies developed by divers respond to the conditions they must face to obtain these resources. When targeted resources become scarce, the pressure to move farther or spend more time underwater increases the risk of injury. Understanding the diving patterns of fishers and spreading awareness about related risks are crucial to encouraging safer strategies.

Additional findings based on divers' response to personal interviews show that the pollution caused by the *hookah* compressor has a significant impact on divers' health, producing effects ranging from *cutis marmorata* (skin bends) to dizziness or even the appearance of symptoms that are like the effects of decompression sickness. The carbon monoxide measures in the air contained in the *hookah* systems were tested in seven boats, revealing that the air breathed by divers reached an average of 41.67 parts per million (ppm) of CO (ranging between 8 ppm and 150 ppm). These levels are far above the average recommended by international standards, such as (1) 3 ppm by the Health and Safety Executive (HSE) agency, (2) 35 ppm by the Occupational Safety Health Association (OSHA), and (3) 10 ppm by the Diving Safe Practices Manual (DSPM).

One group of fishers allowed us to modify their *hookah* systems to reduce air pollution. An air intake separation device was installed in the *hookah* system to stop pollutants entering the air contained in the system. We tested the air quality before and after the modification of the compressors and observed a reduction of up to 80% of the CO levels from the compressed air contained in the tank (Fig. 5.6). After the modification of compressors among the divers who participated, we have been told that several other fishers have also started making their own modifications to their *hookah* systems once they observed the benefits of the reduced CO levels.

Along the entire process of modifying the *hookah* systems, the owners of the systems were present. An important aspect of this intervention focused on the interactions between the research team and fishers. The development of trust between fishers and researchers, which was crucial to the research and the *hookah* modifications specifically, was mainly due to personal rapport developed over many years. Several of the fishers who took part in this intervention have been cooperating with the research group for at least 2 years in the assessment of diving patterns. We found that building trust is a critical step to promote cooperation between resource users and scientists, which also opens a window for other kinds of interaction in terms of the implementation of public policies.

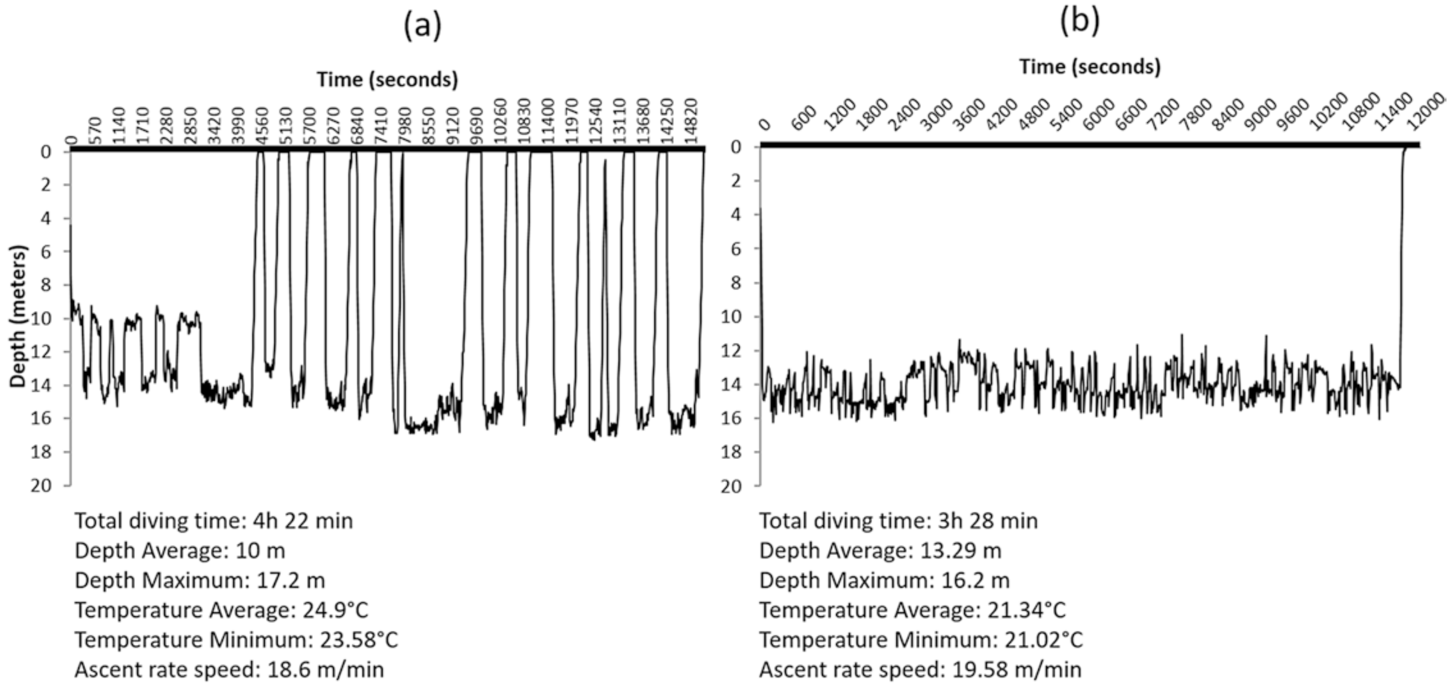



**Fig. 5.5** Example of diving patterns recorded with microcomputers in Río Lagartos, Yucatán, Mexico, for (**a**) lobster fishery (**b**) and sea cucumber fishery

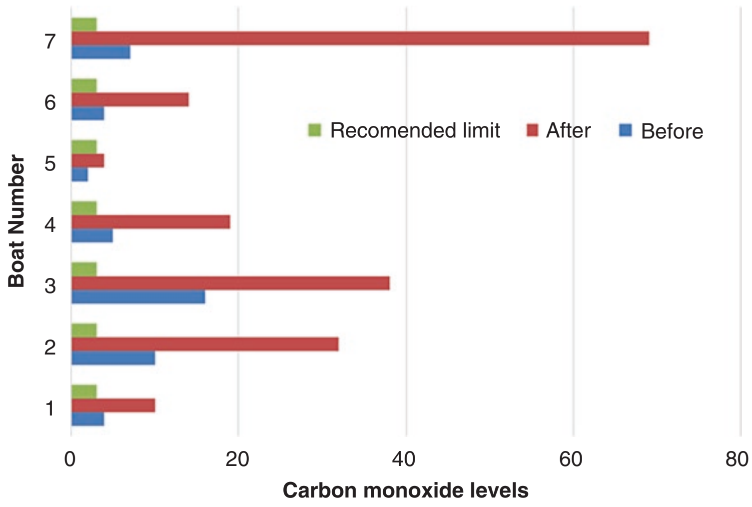



**Fig. 5.6** Concentration of CO in *hookah* systems before and after the intervention (Source: Modified from Chin et al. 2016)

Overall, this case study showed that fishers' attitudes toward risk can change depending on the context, individual goals, and changing circumstances that affect behavior. Divers in Río Lagartos have developed different fishing strategies to reach their goals, while they appear to adopt a risk-prone mentality under changing conditions or catch reductions. The lack of care regarding time and depth of dives increases the probability of decompression, which occurs more commonly in the sea cucumber fishery than for lobster. Despite these conditions, it was evident that divers need to learn more about the risk they face, implying the need for a management intervention, to improve the safety of diving practices. In this regard, cooperation among fishers, researchers, and managers can help to build capacity in fishing communities.

## 5.7 Discussion and Conclusions

Across the two case studies, we observed risk-averse and risk-prone strategies of fishers, which illustrate how fishers adapt under conditions of uncertainty either by cooperating or competing. We also observed changes in the cooperative agreements when economic incentives modified institutional arrangements in fisheries policies and in the community. One insight we gleaned from this study is that networking seems to be an important social asset, as observed by Bodin and Norberg (2005). Additionally, fishers' tendency to share catches and help each other within the fishing community gives fishers and other members of the community a sense of belonging, which creates strong social bonds. The cooperation of fishers with researchers in the second case also shows the importance of building trust.

### *5.7.1 Cooperation and Competition Adaptive Strategies*

The two case studies illustrate how fishers adapt under conditions of uncertainty, either by cooperating to reduce risk while fishing or changing their fishing strategies to earn higher incomes from profitable high-risk fisheries. Risk-averse attitudes are evident in the first case, while more risk-prone tendencies are observed in the second (Seijo et al. 1998). In both cases, fishers developed responses to the risk of reduced income from fishing by shifting operations to maintain an acceptable income in situations where access to target fish could be reduced given changes in environmental conditions, regulations, or resource availability (Salas and Gaertner 2004; Salas et al. 2011; Bennett et al. 2015).

In the Dzilam de Bravo case, cooperation between fishers and the *gaviotas* as a means of contributing fish and income to their own community seems to suggest an altruistic attitude on the part of fishers. However, our findings also showed that fishers' support of children from neighboring communities did not correspond to an altruistic attitude but instead illustrated the interest of the fishers in ensuring access to these neighboring communities as shelter when storms came. With the increased number of newcomers, a reduction in cooperative strategies among fishers was observed. Nevertheless, fishers still give fish products to *gaviotas*, though preference is given to locals and profitable species are not shared anymore.

Regarding issues of competition, the findings show that fisheries policymakers only responded to pressure from fishers and entrepreneurs with stopgap measures, such as short-term pulses to reduce tension, by opening small windows to fish sea cucumber. Governmental intervention exacerbated these conflicts, leading to unequal benefits felt by different users (Chuenpagdee and Jentoft 2015). Under these conditions, long-term successful management strategies are almost impossible to achieve. In this case, competition led to social clashes and the modification of existing cooperative arrangements that had been built up through time in Dzilam de Bravo. This situation can weaken the system and delay community capacity building.

The weak institutional management system has also contributed to increase illegal fishing even by fishers with limited diving experience, which increases the risk of decompression. Shorter fishing seasons have become an incentive to accelerate a "grab the most" kind of behavior that encourages divers to maintain or increase their income (Bennett et al. 2014). In this situation, fishers perceive a need to take maximum advantage of the limited fishing seasons or good climatic conditions to maximize profits.

This research has demonstrated that risk and uncertainty are important drivers associated with both cooperative and competitive attitudes among fishers and have implications for cross-scale interactions in social-ecological systems. Under these conditions, it is necessary to understand the dynamics within each fishing community and the potential for implementing strategies to build capacity for adaptation processes.

### 5.7.2 *Decompression Illness and Intervention Processes*

Considering issues of occupational safety and security, there is a great need for adaptation and capacity building in the fisheries examined here. It is important to keep in mind that fishing has been identified as an activity with one of the highest probabilities of fatal accidents, after logging (Bureau of Labor Statistics 2016). In fact, by the end of the 1990s, 24 million fatal incidents were reported worldwide in fishing-related activities (OIT 2000). These fatalities are linked to the constant reduction of catches and the uncertainty involved in fisheries, which in turn are associated with the decreasing availability of resources, changing markets, and weak institutions. These scenarios only increase the willingness of fishers to take risky actions (Huchim-Lara et al. 2015).

Among the types of accidents commonly associated with fishing-related activities, decompression sickness has become a major issue (Gold et al. 2000; Dunford et al. 2002). The health problems linked to the rate of decompression sickness vary according to different conditions, practices, and factors of different fishing activities (Huchim-Lara et al. 2015). Nonetheless, little has been done to research or plan interventions to address these issues, especially in the case of commercial fisheries (Huchim-Lara et al. 2015; Chin et al. 2016; Huchim-Lara et al. 2016).

A high proportion of divers fishing in Río Lagartos do not adhere to international diving standards when practicing their job, showing a tendency to dive deeper and spend longer periods underwater. However, the high acceptance among divers of the modifications to their compressors to reduce CO in the air in our study shows a shift in attitudes in response to the necessity to improve occupational health conditions and reduce associated health risks. In that case, trust building between researchers and involved fishers was a critical prerequisite to cooperation and the intervention itself (Cinner et al. 2011). In this case, as stated by Guttman (1996) and Basurto et al. (2013), the size of the group was an important condition that facilitated the interaction and cooperative process among researchers and fishers.

### 5.7.3 *Adaptive Capacity and Steps Toward Interactive Governance*

The exposure of people involved in small-scale fisheries to stressors and uncertainty is an unavoidable fact. Under these conditions, it is necessary to widen the scope of governance and policy interventions. Public policy should promote management schemes that contribute to reducing uncertainty, building capacity, and facilitating cooperative arrangements among community members, scientists, and public institutions.

To build capacity and improve fisheries governance, it is necessary to explore structural changes in the institutions in charge of public policies affecting fisheries. However, these changes are usually difficult, costly, and sometimes unfeasible. However, as Eakin and Lemos (2006) state, to achieve that change, it is necessary to create "enabling environments" as a first step to facilitating strategic decisions regarding capacity building in fishing communities. In that regard, this task could be easier in localities where a sense of community already exists, since different stakeholders who feel bound to their community and to each other can help foster an enabling environment for change. Therefore, it is necessary to understand how these stakeholders respond to different conditions, as well as what factors can promote cooperative arrangements among them (Fabricius et al. 2007; Fulton et al. 2011).

Fisheries systems are complex, incorporating different components from preharvest to postharvest subsystems, each of which has its own dynamic system that involves multiple interactions at different scales. This complexity demands the consideration of multiple layers when attempting to design and implement adequate policies to suit all the subsystems (Jentoft et al. 1998; Basurto et al. 2013; Chuenpagdee and Jentoft 2015). These layers can include implicit uncertainty in different components of the activity such as markets, resource abundance, environmental conditions, and other factors. The involvement of multiple users, multiple gears, and multiple species and the existence of multiple landing sites – like in the case of small-scale fisheries – increase the challenges for fisheries governance (Elías et al. 2011).

Interactive governance accounts for the dynamics, complexity, and interactions from both the system-to-be-governed and the governing-system (Fig. 5.7). There are an ample number of factors that influence the way small-scale fishers operate and respond to incentives or threats (Badjeck et al. 2011). Under these conditions, policymakers need to be adaptive and innovative in finding approaches that enable the agency of fishers. These innovations need to be informed by knowledge about how related systems work and what kind of governance tools can best work in different contexts while at the same time acknowledging the inherent risk and uncertainty in the activity. Additionally, policymakers should seek to understand factors such as (a) the dynamics of the systems-to-be-governed at different levels (i.e., preharvest, harvest, and postharvest), (b) what "mobilizes" the system (drivers, constraints, context), and (c) what instruments are required to move toward good governance (e.g., setting common goals, cooperative processes, adaptive capacity) (Fig. 5.7).

In order to improve, accelerate, and better decisions for effective fisheries governance, it is important that policies articulate the common interests of the users involved in order to promote cooperation. These processes would ideally involve robust, reliable, respectful, and transparent interactions. Decision-making settings must also minimize asymmetries among actors (Kooiman et al. 2005; Janseen and

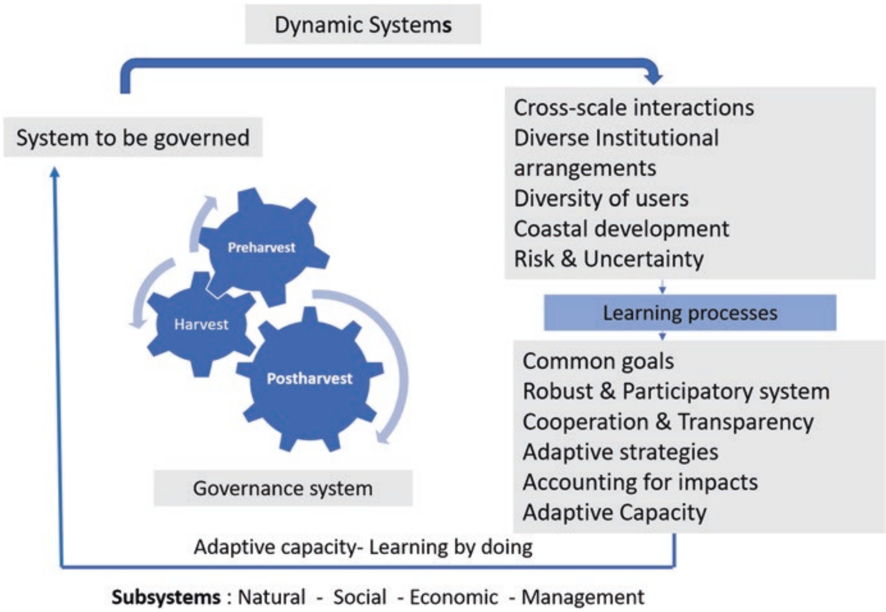



**Fig. 5.7** Small-scale fisheries system governance and adaptive capacity (Diagram built by the authors)

Ostrom 2006; Jentoft and Chuenpagdee 2015). Within this perspective, cooperation between those who are governed and governors is recognized to play an important role in the development of adaptive strategies.

**Acknowledgments** We thank community members from Dzilam de Bravo and Río Lagartos, Yucatán, Mexico. Data provided by the fishing cooperative's logbooks were very useful. Financial support was obtained from CINVESTAV and the University of California, Los Angeles (UCLA) for the case studies. Huchim-Lara O. and Guevara C. were supported by a fellowship from CONACYT for their PhD and master's programs, respectively; part of their dissertation research is integrated in this chapter. Miguel A. Cabrera and Alicia Saldaña helped in sand database management.

## References

Amarsinghe O, Bavinck M (2011) Building resilience: fishing cooperatives in Southern Sri Lanka. In: Jentoft S, Eide A (eds) Poverty mosaics: realities and prospects in small-scale fisheries. Springer, Dordrecht, pp 383–406

Badjeck MC, Katikiro RE, Flitner M, Diop N, Schwerdtner M (2011) Envisioning 2050: climate change, aquaculture and fisheries in West Africa (Workshop report No: 2011-09: Dakar, Senegal 14–16 April 2010). WorldFish/ZMT, Penang/Bremen

Basurto X, Gelcich S, Ostrom E (2013) The social–ecological system framework as a knowledge classificatory system for benthic small-scale fisheries. Glob Environ Chang 23:1366–1380

Bennett NJ, Dearden P, Murray G, Kadfak A (2014) The capacity to adapt?: communities in a changing climate, environment, and economy on the northern Andaman coast of Thailand. Ecol Soc 19(2):5

Bennett NJ, Govanb H, Satterfield T (2015) Ocean grabbing. Mar Policy 57:61–68

Blondin D, Dumas M, Breton Y (1981) Milieu et procèss de travail dans la pêche côotière Yucatèque. In: Breton Y, Labrecque MF (eds) L'agriculture, la pêche et l'artisanat au Yucatan: prolétarisation de la paysannerie maya au Mexique. Les Presses de l' Universite Laval, Québec, pp 152–229

Bodin Ö, Crona BI (2009) The role of social networks in natural resource governance: What relational patterns make a difference. Glob Environ Chang 19(3):366–374

Bodin Ö, Norberg J (2005) Information network topologies for enhanced local adaptive management. Environ Manag 35:175–193

Bureau of Labor Statistics (2016) National census of fatal occupation injuries in 2015 (preliminary results). https://www.bls.gov/news.release/pdf/cfoi.pdf. Accessed 30 June 2016

Centers for Disease Control and Prevention (CDCP) (2010) Commercial fishing deaths – United States, 2000–2009. Morb Mortal Wkly Rep 59(27):842–845

Chin W, Huchim-Lara O, Salas S (2016) Decreasing carbon monoxide in the diving air of artisanal fishermen in the Yucatán Peninsula by separation of engine exhaust from compressor intake. Undersea Hyperb Med Soc, Inc 43(4):410–426

Chuenpagdee R, Jentoft S (2015) Exploring challenges in small-scale fisheries governance. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries. Springer, Dordrecht, pp 3–16

Cinner JE, McClanahan TR, Daw TM, Maina J, Stead SM, Wamukota K, Brown K, Bodin Ö (2011) Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries. Glob Environ Chang 22:12–20

Cochrane K, De Young C, Soto D, Bahri T (2009) Climate change implications for fisheries and aquaculture (FAO fisheries and aquaculture technical paper, 530, 212). FAO, Rome

Diario official de la Federación (DOF) (2012) Carta nacional pesquera. http://www.inapesca.gob.mx/portal/documentos/publicaciones/carta-nacional-pesquera/Carta-Nacional-Pesquera-2012.pdf. Accessed 20 June 2016

Dunford RG, Mejia EB, Salbador GW, Gerth WA, Hampson NB (2002) Diving methods and decompression sickness incidence of Miskito Indian underwater harvesters. Undersea Hyperb Med 29(2):74–85

Eakin H, Lemos MC (2006) Adaptation and the state: Latin America and the challenge of capacity-building under globalization. Glob Environ Chang 16(1):7–18

Elías I, Carozza C, Di Giácomo EE, Isla MS, Orenzans, J.M. (Lobo), Parma AM, Pereiro RC (2011) Coastal fisheries of Argentina. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and Aquaculture Technical Paper 544. FAO, Rome, pp 13–48

Fabricius C, Folke C, Cundill G, Schultz L (2007) Powerless spectators, coping actors, and adaptive co-managers: A synthesis of the role of communities in ecosystem management. Ecol Soc 12(1):29. http://www.ecologyandsociety.org/vol12/iss1/art29/

Fulton EA, Smith ADM, Smith DC, van Putten IE (2011) Human behaviour: The key source of uncertainty in fisheries management. Fish Fish 12:2–17

Gatewood J (1984) Cooperation, competition, and synergy: Information-sharing groups among Southeast Alaskan salmon seiners. J Am Ethnoll Soc 11(2):350–370

Gold D, Aiyarak S, Wongcharoenyong S, Geater A, Juengprasert W, Gerth WA (2000) The indigenous fisherman divers of Thailand: diving practices. Int J Occup Saf Ergon 6(1):89–112

Guttman JM (1996) Rational actors, tit for tat, and the evolution of cooperation. J Ecol Behav Organ 29:27–56

Huang Y, Vuong PT (2016) Fisheries cooperation and management mechanisms in the South China Sea: context, limitations, and prospects for the future. Chin J Comparative Law 4(1):128–148

Huchim-Lara O, Salas S, Chin W, Montero J, Fraga J (2015) Diving behavior and fishing performance: the case of lobster artisanal fishermen of the Yucatán coast, Mexico. Undersea Hyperb Med J 42(4):285–296

Huchim-Lara O, Salas S, Fraga J, Méndez-Domínguez N, Chin W (2016) Fishermen's perception and attitudes toward risk diving and management issues in small-scale fisheries. Am J Human Ecol 5(1):1–10

IMSS (Instituto Mexicano del Seguro Social) (2013) Documento interno. IMSS, Yucatán

INEGI (2010) Instituto Nacional de Estadística y Geografía. http://www.censo2010.org.mx/. Accessed 03 Nov 2014.

IPCC (Intergovernmental Panel on Climate Change) (2014) Climate change 2014–impacts, adaptation and vulnerability: regional aspects. Cambridge University Press, Cambridge

Janseen MA, Ostrom E (2006) Governing social ecological systems. Handb Comput Econ 2:1465–1509

Jentoft S, Chuenpagdee R (2015) Assessing governability of small-scale fisheries. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries: global reflections, MARE Publications Series 13. Springer, Dordrecht, pp 17–39

Jentoft S, McCay J, Wilson DC (1998) Social theory and fisheries co-management. Mar Policy 22(4–5):423–436

Johnson JE, Welch DJ (2009) Marine fisheries management in a changing climate: A review of vulnerability and future options. Rev Fish Sci 18(1):106–124

Kooiman J, Bavinck M, Jentoft S, Pullin R (2005) Fish for life: interactive governance for fisheries. Amsterdam University Press, Amsterdam

Leibbrandt A, Gneezy U, List JA (2013) Rise and fall of competitiveness in individualistic and collectivistic societies. Proc Natl Acad Sci 110(23):9305–9308

Manuel-Navarrete D, Pelling M, Redclift M (2011) Critical adaptation to hurricanes in the Mexican Caribbean: development visions, governance structures, and coping strategies. Glob Environ Chang 21(1):249–258

OIT (Organización Internacional del Trabajo) (2000) Nota sobre las labores: reunión tripartita sobre la seguridad y la salud en las industrias pesqueras. Programa de Actividades Sectoriales. TMFI/1999/12. Ginebra, Suiza, 13–17 December 1999

Ovando D, Deacon RT, Lester SE, Costello C, Van Leuvan T, Mcllwain K, Strauss CK, Arbuckle M, Fujita R, Gelcich S, Uchida H (2013) Conservation incentives and collective choices in cooperative fisheries. Mar Policy 37:132–140

Pedroza C, Salas S (2011) Responses of the fishing sector to transitional constraints: From reactive to proactive change, Yucatán fisheries in Mexico. Mar Policy 35(1):39–49

Pielke R, Landea C (1998) Normalized hurricane damages in the United States: 1925-95. Am Meteorol Soc 13:621–631

Rutan LM (1998) Closing the commons: cooperation for gain or restrain. Hum Ecol 26(1):43–66

Salas S, Gaertner D (2004) The behavioural dynamics of fishers: management implications. Fish Fish 5:153–167

Salas S, Bjørkan M, Bobadilla F, Cabrera MA (2011) Addressing vulnerability: coping strategies of fishing communities in Yucatán, Mexico. In: Jentoft S, Eide A (eds) Poverty mosaics: realities and prospects in small-scale fisheries. Springer, Dordrecht, pp 195–220

Salas S, Fraga J, Euan J, Chuenpagdee R (2015) Common ground, uncommon vision: a study of cooperation between two small-scale fishing communities in Mexico. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries: global reflections, MARE Publications Series 13. Springer, Dordrecht, pp 477–493

Seijo JC, Salas S (2014) The role of capacity building for improving governance of fisheries and conservation of marine ecosystems. In: Garcia SM, Rice J, Charles A (eds) Governance of marine fisheries and biodiversity conservation interaction and co-evolution. West Sussex, Wiley Blackwell

Seijo JC, Defeo O, Salas S (1998) Fisheries bioeconomics: theory, modelling and management, FAO Fisheries Technical Paper No. 368. FAO, Rome

Westin AA, Asvall J, Idrovo G, Denoble P, Brubakk AO (2005) Diving behaviour and decompression sickness among Galapagos underwater harvesters. Undersea Hyperb Med 32(3):175–184

**Silvia Salas** is a professor at the Marine Resources Department at Cinvestav, Unidad Merida, Mexico. Her background is in marine science (Cinvestav, MSc) and resource management and environmental studies (University of British Columbia, Canada, PhD). She has competence in fisheries bio-economics and management, fleet dynamics and fishing strategies, vulnerability, and risk perception with an emphasis on small-scale fisheries. She has participated as a consultant in several FAO workshops and has collaborated as a member of the advisory committee of the WECAF Region (FAO). Currently she is the representative of Latin America in the IIFET Board Committee and represents Mexico in NAAFE Board Committee. She collaborates in the TBTI partnership.

**Oswaldo Huchim-Lara** is a postdoctoral researcher at the *Universidad Marista de Mérida*. He obtained his MD at the Yucatán Autonomous University, followed by a MSc in human ecology and a PhD in marine sciences at the Cinvestav, Unidad Mérida. During his postgraduate education, he focused on epidemiology, risk factors, and diving behavior of small-scale fishers, working with a multidisciplinary team. He has undertaken residencies at the UCLA Fielding School of Public Health and Gonda Center for Hyperbaric Medicine with a Fogarty Scholarship, and he has collaborated as a consultant with FAO. His current research focuses on the risk perception and long-term sequelae of diving in small-scale fishers and has published several papers in that field.

**Citlalli Guevara-Cruz** is a lecturer at the *Centro de Estudios Tecnológicos del Mar* #17, Progreso, Yucatán, Mexico. Her background is in marine biology, including a bachelor's degree from the *Instituto Tecnológico de Bahía de Banderas*, Nayarit, and a master's degree from Cinvestav, Unidad Mérida. She has experience working on artisanal fisheries with an emphasis on shark fisheries from the Pacific coast of Mexico and on cooperative processes among artisanal fishers, including the development of research in Yucatán on this field. She had worked as a consultant and lecturer in local universities.

**Walter Chin** BSN, Walter Chin, BSN is the Clinic nursing director of the Radiation Oncology Department at the University of California (UCLA), he has led several studies related to diving and hyperbaric medicine. He has over 10 years of hands-on experience managing critically ill patients and overseeing the hyperbaric program at UCLA. Recently, he led a nationwide survey to determine the availability of hyperbaric programs capable of treating hyperbaric emergencies in the USA. He has worked in Mexico for several years with local researchers and fishers to implement community-based interventions that would help reduce dive-related injuries and deaths among small-scale fishers. Walter has published several papers in this field and researches several issues associated with decompression illness, including the development of a model to deal with such cases.

# Chapter 6
# Drivers of Adaptive Capacity to Climate Change in Coastal Fishing Communities of Tabasco, Mexico

**Octavio Tolentino-Arévalo, Marianna Markantoni, Alejandro Espinoza-Tenorio, and Maria Azahara Mesa-Jurado**

**Abstract** Global climate change will become an additional source of stress on coastal fishing communities. Therefore, adaptation to climate change is becoming a key feature for the development of sustainable livelihoods in these socioecological systems and has become a priority for governments. Analysing and highlighting the factors that influence the adaptive capacity of communities in these contexts have become an urgent matter for governments to overcome foreseeable threats. In this study, a qualitative bottom-up approach was used to explore the conditions affecting the drivers of adaptive capacity of three small-scale artisanal fishing communities dealing with the oil industry and threatened by climate change in Tabasco, Mexico. Information about the adaptive capacity of these communities was obtained through semi-structured interviews and was analysed using a set of proxy indicators: (1) flexibility and diversity, (2) capacity to organize, (3) learning and knowledge, and (4) access to assets. The analysis confirmed that adaptive capacity is highly context-specific but also revealed that multiple ways of adaptation are conditioned by historical social agreements and geographic location, as well as defined by adverse conditions that force individuals to diversify their income sources. Our findings emphasize the need to analyse adaptive capacity on a local scale to better inform policymakers and improve adaptation policies' design. Reducing the negative impacts of climate change in fishing communities in Tabasco is possible, but social, economic, and cultural changes must first occur on different levels ranging from the government to the communities themselves.

**Keywords** Climate change · Adaptive capacity · Small-scale fisheries

O. Tolentino-Arévalo · M. Markantoni
Scotland's Rural College, Edinburgh, Scotland

A. Espinoza-Tenorio (✉) · M. A. Mesa-Jurado
El Colegio de la Frontera Sur, Villahermosa, Tabasco, Mexico
e-mail: aespinoza@ecosur.mx



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_6

## 6.1 Introduction

Coastal fishing communities are considered socioecological systems that depend on small-scale fisheries as a source of food and income (Defeo et al. 2013). These fisheries have shown a noticeable decline over the last several decades due to anthropogenic disturbances such as overfishing, habitat degradation, invasive species introduction, and pollution (McClanahan et al. 2013). Moreover, anthropogenic climate change and other disturbances are expected to impose additional challenges to fisheries because it may cause changes in ocean temperature, ocean circulation and chemistry, nutrient cycling, and the frequency and intensity of extreme climatic events (Brander 2010; Johnson and Welch 2010).

Climate change impacts both directly and indirectly on human health, wellbeing, and the economies of communities in multiple ways (Sumaila et al. 2011). Human health can be affected by extreme climatic events in the form of deaths and accidents. Economic impacts include changes to income-generating activities and the damage or destruction of productive and non-productive material assets and infrastructure (Badjeck et al. 2010). Climate change effects are spatially and socially differentiated (Adger 2003). For instance, coastal communities located in low-elevation areas and highly dependent on specific local marine resources, as well as the poorest sectors of society, are likely to be more affected than others (Faustino and Sales 2009). Most coastal fishing communities are included in at least one of these groups and are also subject to high climatic variability and extreme meteorological events, making them particularly vulnerable to climate change (Bunce et al. 2010; Defeo et al. 2013).

Given all the impacts that affect coastal fishing communities, adaptation to climate change has become a major concern (Niang et al. 2014). Although communities have an inherent adaptive capacity that is the result of their historic interaction with the coastal ecosystems they inhabit, climate patterns are changing rapidly, and communities' adaptive capacity might not to be sufficient to develop adaptation strategies that allow them to deal with these challenges (Blythe et al. 2014). Thus, enhancing adaptive capacity to climate change is fundamental for the maintenance of sustainable livelihoods in these communities (Uy et al. 2011; Cinner et al. 2012; Bennett et al. 2014).

Although a significant number of studies have investigated the adaptive capacity to climate change (see next section for an explanation of the 'adaptive capacity' concept) (Cinner et al. 2012, 2013; Mamauag et al. 2013), most of them have examined it at the national scale. Studies implemented at the local scale have focused mainly on agriculture-based communities (Blythe et al. 2014; Islam et al. 2014). This represents a current gap in the literature on adaptive capacity to climate change. The present study addresses such a gap by exploring the adaptive capacity to climate change in fisheries-based communities at the local level. It seeks to answer the question: *What is the social adaptive capacity to climate change in the coastal fishermen communities in the state of Tabasco, Mexico?*

Tabasco is a first-level administrative territorial entity of Mexico, and it is situated in a low-elevation area with a high flood risk due to a combination of biophysical conditions and anthropogenic activities. Tabasco has historically suffered from flooding, and, according to local forecasts (SERNAPAM 2011), it will be particularly vulnerable to increasing extreme climatic events, including sea level rise. Therefore, Tabasco is a relevant case for exploring the adaptive actions that fishing communities in the area can undertake to cope with climatic events and understand how these similarities and differences could help enhancing adaptive capacity in the region.

## 6.2 Adaptive Capacity

The concept of adaptive capacity was developed to analyse the adaptability of nations, communities, and individuals to external perturbations affecting them (Maldonado and Moreno-Sánchez 2014). Several definitions of adaptive capacity can be found in the literature (McClanahan et al. 2013; Moreno-Sánchez and Maldonado 2013; Adelekan and Fregene 2015; Blythe et al. 2014; Dutra et al. 2015), but adaptations can generally be considered as changes in the community (or persons) to better cope with challenging exposures and risky situations (Smit and Wandel 2006). Therefore, adaptation refers to the actions that are implemented in a community, even in the absence of external changes (Gallopín 2006). In the context of climate change, the Intergovernmental Panel on Climate Change (IPCC) defines adaptation as the process of adjustment to actual or expected climate change and its effects, and, in human systems, adaptation seeks to reduce or avoid harm or could also be an incentive to exploit advantageous opportunities (Niang et al. 2014).

### *6.2.1 Drivers of Adaptive Capacity*

The nature of adaptive capacity is context-specific in terms of place and culture and is reflective of the resources and processes of a given region (Smit and Wandel 2006). However, there are common drivers or determinants of adaptive capacity. These drivers include access to natural, physical, financial, human, and social capitals; institutions and governance; knowledge and capacity to learn; and occupational multiplicity and mobility (Gupta et al. 2010; Cinner et al. 2012; Shaffril et al. 2013; Adelekan and Fregene 2015; Bennett et al. 2014). Most of these drivers are interrelated (Dutra et al. 2015); for example, access to natural and financial capitals is related to occupational multiplicity and mobility.

Human and social capitals represent important drivers of adaptive capacity. Social capital is a complex concept that was not designed for the purpose of analysing adaptive capacity, but it is directly related to it (Adger 2003). At its core, it involves relations of trust, reciprocity, and exchange, the evolution of common rules, the role of networks, and the resultant willingness and ability of groups to act collectively (Bennett et al. 2014). Institutions play a facilitating role by enabling and encouraging society to develop governance forms that help it to cope with external changes. Organizations should also allow society to learn from new insights and provide flexibility in the process of making rules to better manage expected and unexpected situations (Gupta et al. 2010). Knowledge and capacity to learn are also important because they determine the types of responses that a community can have. Also, current reactions to changes are the result of a history of adapting to external stimuli (Dutra et al. 2015).

Adaptive capacity can be analysed on the individual, household, community, regional, or national scales (Shaffril et al. 2013). The relevance of the drivers varies depending on the scale of analysis. For example, social capital is more important on the community level, while political systems are more important on the national level. Temporal scale is also important, some authors use adaptive capacity to refer to long-term adjustments, and terms such as "coping ability" or "coping range" are used for short-term responses, which refer to the amount of change a system can deal with. In this terminology, extreme changes or perturbations usually exceed the coping range (Smit and Wandel 2006). A system's coping range and its adaptive capacity are dynamic and change in response to the previously mentioned drivers.

## 6.3 Tabasco Coast: Between Oil, Fisheries, and Climate Change

The state of Tabasco is located on the southern part of the Gulf of Mexico (see Fig. 6.1), with core human activities of oil extraction and fisheries. Oil extraction represents the biggest contribution to the state's gross domestic product (GDP); however, the relation between the oil and the fisheries industries has been permanently conflictive. The greatest source of conflict between both industries came in 2001 when the federal government implemented security measures in the coastal platform (Campeche Bank) which included the establishment of an exclusion zone where marine transit was forbidden (Bozada-Robles 2006). These regulations reduced the available fishing areas, generating fishermen's protests against this regulation, and led to the establishment of governmental programmes oriented at creating alternative income sources for the fishermen (Pérez-Sánchez and Muir 2003; Arias-Rodríguez and Ireta-Guzmán 2009).

### *6.3.1 Fishing Localities*

Small-scale artisanal fisheries represent a primary source of food and income for Mexican coastal communities (Salas et al. 2007). The fisheries administration is led by the secretary in charge of implementing production-related policies (Secretary of

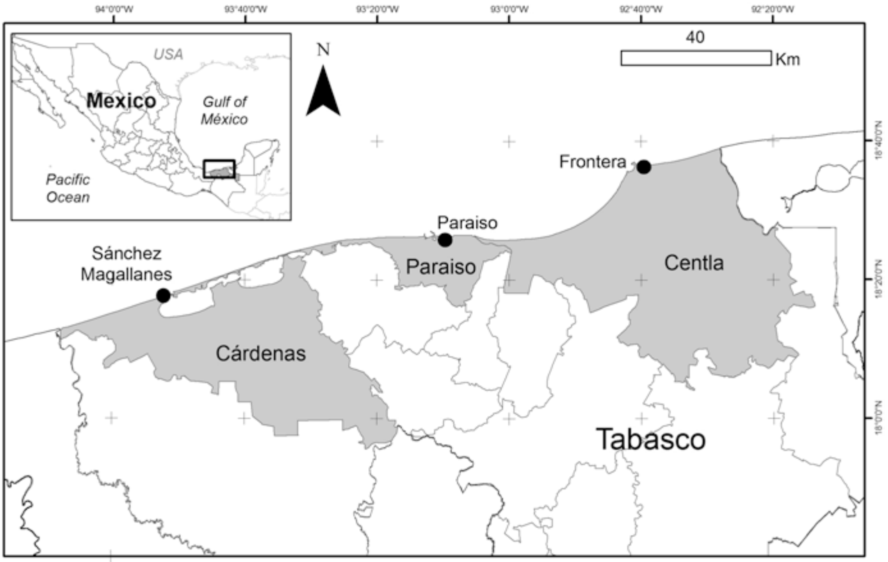



**Fig. 6.1** Coastal municipalities in Tabasco, Mexico, and its three main fishing localities

**Table 6.1** Socioeconomic indicators of coastal Municipalities in Tabasco, Mexico by municipality

| Municipality | Cárdenas | Paraiso | Centla |
|---|---|---|---|
| Population (inhabitants) | 248,481 | 86,620 | 102,110 |
| Access to elementary school (inhabitants) | 89,971 (36%)[a] | 29,007 (33%)[a] | 35,098 (34%)[a] |
| Access to health services (inhabitants) | 174,139 (70%)[a] | 64,428 (74%)[a] | 72,292 (71%)[a] |
| Local domestic product (US dollars/5 years) | 665,044 | 6,807,683 | 14,252 |
| Public investment in social development (US dollars/year) | 50,029 | 17,537 | 23,988 |
| Fishing and aquaculture organizations | 290 | 169 | 654 |

Source: Instituto Nacional de Estadística, Geografía e Informática (2010)
[a]Refers to the percentage of the total population of the municipality

Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA)), and it is based on permit grants to groups or individuals authorized by the National Commission of Aquaculture and Fishing (CONAPESCA, by its Spanish acronym).

The most important marine fishing communities in Tabasco, including Sanchez Magallanes, Paraiso, and Frontera (Fig. 6.1), are homogenous in terms of education and health access; however, there are noticeable differences in the economic productivity and public investments undertaken in each community (Table 6.1). Only Paraiso, which has 1113 inhabitants, promotes touristic activities in the area, but most of its inhabitants have fluctuating populations (tourist and oil workers). Oil platforms and the main port of *Petroleos Mexicanos* (PEMEX) are near the community. This region connects with the Mecoacan Lagoon, which sustains shrimp and oyster farming (Pérez-Sánchez et al. 2002).

Frontera, a primarily urban small town located on the delta formed by the Usumacinta and Grijalva rivers, which are two of the biggest rivers in Mexico, has the biggest port in Tabasco. Fishing cooperatives located in the river have historically provided an important source of food to Centla, one of the poorest municipalities in Tabasco.

Sánchez Magallanes, with 6913 inhabitants, connects with the Carmen-Pajonal-Machona system, the biggest coastal lagoon in Tabasco, where the oyster fishery and aquaculture represent the most important sources of income. Cardenas is one of the municipalities with the most agriculture and livestock in Tabasco. Both Frontera and Sanchez Magallanes are located in two of the state's most vulnerable zones to sea level rise and storms (Núñez et al. n.d.).

## 6.4 Methodology

The case study was developed using a bottom-up qualitative approach. This approach seeks to study phenomena in their natural settings and interpret them from people's perspectives (Denzin and Lincoln 2005). Therefore, we were able to identify what the actors involved in the fishing activity consider relevant to the problem at hand and why. For this purpose, two types of interviews were designed: one for fishermen and one for permit holders and presidents of fishing cooperatives. Both interviews were intended to be complementary and obtain as much information as possible for the indicators proposed by Bennett et al. (2014), which are described in Table 6.2. Respondents were selected using the snowball sampling technique which is useful when first approaching communities (Cataldo et al. 2011). An academic expert who is also a native of the region who continues to live and work there validated the questionnaires in terms of wording, order, and duration so that people understood the questions the way they were intended. The questionnaires were then tested through pilot interviews to make final adjustments so that they could obtain the most information possible.

A total of 19 semi-structured interviews were conducted with key experienced fishermen (3 for each community), permit holders (2 in Frontera, 3 in Paraiso, and 2 in Sanchez Magallanes), and presidents of fishing cooperatives (2 in Frontera and 1 in Sanchez Magallanes) between May and June 2015. All interviews took place at landing sites or in fishers' homes. To provide additional information, four informal conversations were conducted: one with a government agent, two with the fishing office chiefs in Paraiso and Sanchez Magallanes, and one with a fisherman from Sanchez Magallanes who worked in Frontera. Both scientific literature and government databases were used to complement qualitative information.

All interviews were recorded with the interviewees' consent, and the information was later categorized into the different indicators proposed (Table 6.2). Transcripts were not generated due to time constraints, but the full interviews were listened to repeatedly in order to obtain relevant information and categorize it into each indica-

**Table 6.2** List of proxy indicators of adaptive capacity used for the analysis

| Categories | Indicators | Definition |
|---|---|---|
| Flexibility and diversity | 1. Occupational multiplicity and income diversity | Number of different occupations and sources of income |
| | 2. Occupational mobility | Capacity to change occupations |
| | 3. Dependence on fisheries | Degree to which the community depends on the fisheries to support its livelihood |
| Capacity to organize | 1. Social capital and networks | Existence of social networks and organizations and collective action |
| | 2. Governance and social norms | Formal and informal arrangements that regulate the fishing activity |
| | 3. Institutions | Presence of different types of institutions |
| Learning and knowledge | 1. Resource monitoring | Perception and/or evaluation of changes in natural resources over time |
| | 2. Knowledge of climate change | Knowledge of climate change and how it might affect the community |
| | 3. Change anticipation and response | Capacity to identify future changes in time to respond accordingly |
| | 4. Recognition of causality and human agency | Identification of the causes of phenomena and the role human society plays on them |
| Access to assets | 1. Material assets | Productive material assets for fishing including infrastructure |
| | 2. Financial status | Relative income level in relation with the community |
| | 3. Institutional support | Institutional actions that help the community response to different situations |
| | 4. Equity and rights | Equitable distribution of benefits from the fishing activity |

Adapted from Bennett et al. (2014)

tor. Such information (including quotes) was organized using a table where each interviewee represented a row and each indicator represented a column.

Information provided through the interviews was 'labelled' under each of the indicators. The information was then aggregated so that it was possible to provide a general status for each indicator, after which the results obtained were compared to previous studies for discussion. The discussion also included interviewees' quotes, which provided valuable insights on the status of the indicator. A traffic light (red, yellow, or green) was used to represent the capacity of each community to deal with climate change.

## 6.5 Results

This section presents the information provided by the interviewees as well as some of the information obtained through the informal conversations. Table 6.3 summarizes the results obtained in each of the communities.

**Table 6.3** Level of adaptive capacity of three fishing communities in Tabasco, Mexico, according to proxy indicators

| Categories | Indicators | F | P | SM |
|---|---|---|---|---|
| Flexibility and diversity | 1. Occupational multiplicity and income diversity | L | L | H |
| | 2. Occupational mobility | L | H | M |
| | 3. Dependence on fisheries | H | L | L |
| Capacity to organise | 1. Social capital and networks | M | M | M |
| | 2. Governance and social norms | L | L | L |
| | 3. Institutions | M | M | M |
| Learning and knowledge | 1. Resource monitoring | M | M | M |
| | 2. Knowledge of climate change | L | L | M |
| | 3. Change anticipation and response | H | H | H |
| | 4. Recognition of causality and human agency | H | H | M |
| Access to assets | 1. Material assets | L | L | L |
| | 2. Financial status | M | L | L |
| | 3. Institutional support | M | M | M |
| | 4. Equity and rights | L | L | L |

Proposed by Bennett et al. (2014)
*F* Frontera, *P* Paraiso, *SM* Sánchez Magallanes, *L/M/H* low/medium/high

## 6.5.1 Flexibility and Diversity

### 6.5.1.1 Occupational Multiplicity and Income Diversity

Occupational multiplicity and income diversity were very contrasting in fishermen from Sanchez Magallanes with respect to Frontera and Paraiso where both are very limited. All of the permit holders and presidents of cooperatives in Sanchez Magallanes had a second source of income (such as agriculture, government jobs, or a music band); one fisherman even reported owning a gasoline business. On the other hand, in Frontera only one of the cooperative presidents worked in agriculture, with the fishing activity as his main source of income. Similar findings were observed in Paraiso, where only one permit holder held agricultural land as another source of income besides fishing.

#### 6.5.1.2 Occupational Mobility

Sanchez Magallanes exhibits high occupational mobility, with fishermen typically working in other sectors during the tropical storm season, when fishing activity is very limited or even non-existent due to dangerous weather conditions. These jobs include oyster harvesting in the nearby lagoon, construction and maintenance work, and driving public transport vehicles. Fishermen in Paraiso also find other jobs during this season, such as river fisheries, agriculture, livestock, or construction and maintenance.

In contrast, occupational mobility in Frontera is practically non-existent. Sometimes fishermen turn to river fisheries during the season, but the most common survival strategy is asking the permit holders or cooperatives for loans. During this time, fishermen usually provide maintenance for boats and fishing gear, but this activity is not paid and thus does not generate any income for them.

#### 6.5.1.3 Dependence on Fisheries

The fishing activity represents the primary occupation for all respondents, who unanimously stated that it was also their primary source of income. This fact may seem to suggest that there is high dependence on fisheries in the three communities; however, differences between them were found, and the reasons for it are discussed in the next section. While they are dependent on fisheries, the communities are not dependent on a specific species, with several species being targeted using different fishing gear.

### *6.5.2 Capacity to Organize*

#### 6.5.2.1 Social Capital and Networks

Social capital and networks were reflected in two main situations: first, during the fishing activity and, second, during extreme climatic events. The fishing activity reflects the presence of social capital and networks since no problems were reported to exist between different fishing groups or within them. However, when extreme climatic events occur, network responses are based on government support. In Frontera, one cooperative president identified the presence of government support in the form of food for people. In Paraiso, one permit holder and two fishermen identified government support consisting of food, shelter, and construction material to rebuild their houses after the tropical storm, such as hurricanes. In Sanchez Magallanes, only one permit holder and one fisherman did not identify any kind of government support. The type of support mentioned included food, help from the army to relocate people to safer communities before the event, and money to rebuild after the event.

#### 6.5.2.2 Governance and Social Norms

In terms of social norms, the main restriction identified was a no-fishing season for sharks and rays, which are defined by CONAPESCA. However, the shift from an open access fisheries regime to a regulated one via fishing permits has not helped to curb fisheries decline due mainly to the lack of enforcement.

A potential source of lack of trust arises from a common practice employed by the fishermen. Before landing, harvesters put some fish aside before reporting the total catch to the permit holder or cooperative. This can happen for two reasons: (1) the fish are used as a source of food for the fishermen and their families, or (2) it can be sold directly to get more income. Even though this is a common practice in all communities, it was only acknowledged in Sanchez Magallanes, where two permit holders identified it as a problem.

In terms of governance of the fisheries, a 'tragedy of the commons' problem seems to be present, at least in Sanchez Magallanes. In that community, a fisherman explained how collective action to reduce fishing efforts seems impossible:

> *[…]* we all know that we are overfishing but no one will stop fishing because you know that if you don't fish, another fisherman will come and will take your share *[…]*

#### 6.5.2.3 Institutions

The main institutions involved in the fishing activity are CONAPESCA, the Navy, permit holder unions, fishing cooperatives, and federations of cooperatives. CONAPESCA defines the official regulatory system and collects information associated with the fishing activity. This government institution has several offices in Mexico, usually at the municipality level, where they record the total catch of permit holders and fishing cooperatives under their jurisdiction. The fishing offices also provide a permit required to sell the product. The Navy and the Ministry of Communication and Transport regulate access to the navigation of fishing vessels, requiring mandatory registration of vessels and fishing permits in order to operate.

The permit holder unions and cooperative federations integrate different groups of fishers and permit holder and define internal regulations, while the cooperative presidents generally serve as a link with the government.

### *6.5.3 Learning and Knowledge*

#### 6.5.3.1 Resource Monitoring

In each of the three communities, it was evident that fishermen have a clear idea of catch trends in the fisheries they depend on and engage in monitoring these resources in an informal manner. Interviewees expressed a noticeable decline in the catch of primary commercial species (e.g. gafftopsail catfish, red snapper, crevalle jack) over the last 10 years. Additionally, most fishermen identified not only a decline in the fisheries but also a shift in some fish populations. Respondents explained that the most common shift has been that fishing is now mostly done offshore, given that fish tend to move away from the oil platforms and intensively fished zones, both of which are located near the shore. Interviewees also identified that the size of individuals belonging to most species, such as snapper, has decreased considerably. As a result of these changes, fishermen must travel farther each time to be able to catch enough fish to at least cover gasoline expenses.

Fisheries declines, and the responses to these changes have not been the same in all communities. In Sánchez Magallanes, fishing has been so poor in recent times that many fishermen are making fishing trips to Frontera, which seems to be the least affected region. Fishers typically travel there by boat and reach an agreement with the local cooperative or permit holder to camp near their landing sites. These arrangements usually happen in exchange for a payment to the permit holder or the cooperative for each kilogramme of product harvested.

#### 6.5.3.2 Knowledge of Climate Change

In Frontera and Paraiso, the respondents have no knowledge about climate change. However, respondents identified changes in the water temperature and/or the tropical storm season patterns even if they did not relate such events with the concept of climate change. Contrasting results were found in Sanchez Magallanes, where all respondents demonstrated considerable knowledge of climate change and identified changes in rain patterns, polar ice melting, and sea level rise, thus recognizing global concerns related to the issue. In addition, local stakeholders identified water temperature increases related to climate change that can cause fish populations to change their distributions.

#### 6.5.3.3 Change Anticipation and Response

There was not any mention of an established strategy for adaptation when cyclones or hurricanes arrive; community members typically rely on external state support after these events. In this regard, a great dependency on the government was identified, with most respondents mentioning government intervention and support as very important for their capacity to respond to cyclones or hurricanes. For example, respondents in Sanchez Magallanes mentioned that when a cyclone or hurricane is approaching, the government evacuates people of the community and takes them to a nearby community with higher elevation to ensure their safety.

Strategic responses to the potential effect of extreme climatic events and tropical storms are similar across the communities. Responses are currently occurring in two main places: at landing sites, on the part of fishermen group, and at the houses of fishermen on the part of their families. At the landing sites, fishermen take the boats to land and secure them, an activity that is done collaboratively between all the fishermen in the group. At their houses, fishermen usually tie and secure the roofs of their houses, which are mainly built of a metal sheet and can get blown away by the wind. This activity is done by each family, and neighbours usually do not help each other.

#### 6.5.3.4 Recognition of Causality and Human Agency

Fisheries declines and fish population distribution shifts were attributed to two main causes by the interviewees: oil platforms and overfishing. When the changes were attributed to the oil platforms, two ways of potential impacts on the fish populations were mentioned: (1) the noise and introduction of infrastructure during the exploration, construction, and operation phases of the oil platforms and (2) pollution generated from the operation phase. Fisheries decline is associated with both of these processes, while distribution shifts were associated with the first one. Overfishing was explained to occur in three different ways: (1) fishing too many individuals, (2) catching individuals out of the fishing season, and (3) catching juvenile individuals.

### *6.5.4 Access to Assets*

#### 6.5.4.1 Material Assets

Material assets identified by the respondents include boats, small ships, fishing nets, and freezing chambers. However, most fishermen usually do not own any of these assets; only one fisherman that was interviewed owned a boat. All material assets are owned by the permit holders and presidents of fishing cooperatives in the three communities. Government support for acquiring productive assets is provided by subsidy because of bylaws that target permit holders or presidents of cooperatives.

Extreme climatic events affect material assets. Fishermen indicated that they have lost fishing equipment and infrastructure due to extreme climatic events in the past. Although questions regarding the acquisition of insurance were not included in the interview questions, three permit holders (one from each community) stated that it was not practical or profitable for them to get their assets insured.

#### 6.5.4.2 Financial Status

Permit holders have a strong financial status relative to that of fishermen and generally have become a source of credit for fishermen, especially in Frontera. The loans that permit holders provide are interest-free, and they know that it is likely that most of it will not be paid back to them, but their financial status allows them to provide such support. Most fishermen who are able to improve their financial status significantly become permit holders at some point, which was the case for some of the interviewees.

#### 6.5.4.3 Institutional Support

The existing support from the government for the fishing activity only reaches the permit holder or the president of the cooperative, and the fishermen do not perceive any benefits from it. Two main forms of support were identified: (1) the subsidy for gasoline provided in compensation for the oil platforms introduction and (2) a financing scheme for acquiring new equipment in which the government covers 50–70% of the cost. The gasoline subsidy seems to be helping only the permit holders and presidents of cooperatives, due to the fact that the fishermen still have to pay them for the gasoline at the same price as if the subsidy did not exist. A recently identified problem with this subsidy is that it is provided based on the number of vessels that are registered, but the government has discovered that many permit holders or cooperatives have a certain number of registered vessels that are not in use in order to receive a larger subsidy. The financing scheme provides a reasonable opportunity for permit holders and presidents of cooperatives to acquire new fishing equipment without incurring in debt that might compromise their financial status. The impacts of this scheme are discussed in the next section.

#### 6.5.4.4 Equity and Rights

In fisheries, the distribution of benefits from the activity is part of a variable sharing system. In this system, the share from each fishing trip is divided between the permit holders, cooperatives, and fishermen. However, these sharing systems are different in each community. In Frontera, the revenues of the trip are divided in two parts: one part goes to the owner of the vessels (permit holder or cooperative) and the other goes to the fishermen. The operation costs typically include gasoline, food, bait, and ice, depending on the type of vessel. The part corresponding to the fishermen is then divided into equal parts between the crew, which usually includes three fishermen. Each fisherman then decides if they will pay back any debts incurred from loans provided by the permit holder or cooperative.

In Paraiso, trip revenues less operation costs are discounted and divided as follows: 30% goes to the permit holder or cooperative, and 70% goes to the fishermen. From the fishermen's share, 15% goes to the vessel's captain, and 55% is divided into equal parts among the rest of the crew. In Sanchez Magallanes, the share is as follows: 40% or 50% (depending on the type of vessel and catch amount) goes to the permit holder or cooperative, and the rest goes to the fishermen. The fishermen's shares are divided into equal parts, and the vessel's captain is paid one or two Mexican pesos (around 0.07–0.14 US dollars) for each kilogramme in addition to his corresponding share.

## 6.6 Discussion

### 6.6.1 Flexibility and Diversity

Adaptive capacity is enhanced by higher levels of occupational pluralism and income diversity. In this formulation, the differences between Sánchez Magallanes and Frontera and Paraiso can be attributed to the decline of fisheries in recent decades in Sánchez Magallanes (Bozada-Robles 2006). The interviewees stated that this decline has resulted in low profitability of the fishing activity and a reduction in the total number of fishing trips undertaken, consequently reducing the number of fishermen who remain employed. This reduction of income could have forced individuals to diversify their income sources to maintain their livelihood. However, this has not been the case of fishermen in Frontera, who do not require to engage in different occupations during no-fishing seasons due to the loan system that operates in this area. While in Paraiso some interviewees had alternative occupation, they do not seem to be in the extreme conditions of fisheries decline as those reported in Sánchez Magallanes.

Occupational mobility is important for community members, since fishing is not viable throughout the whole year due to the tropical storm season. Thus, the higher the occupational mobility, the more adaptive capacity is enhanced. The main difference between Sanchez Magallanes and Paraiso is the relative importance of alternative jobs within the local economy: in Sanchez Magallanes the oyster fishery is the most important activity, while in Paraiso both alternative activities and farming jobs have similar economic importance.

It is interesting how fishermen in Frontera allocate their time during the off season to provide maintenance for boats and fishing equipment owned by permit holders and cooperatives, a service for which they are not paid. Perhaps they do so in order to maintain good relationships with the permit holders or cooperative presidents so that they will be able to continue receiving loans, which they depend on especially during the off season. Further research should explore the reasons why fishermen decide to continue depending on permit holders and cooperative presidents during the off season instead of using their working hours on other paid activity that would help them endure seasonal unemployment.

The income dependence of fishers on fishing varies among communities. For instance, in Sanchez Magallanes and Paraiso, where occupational pluralism, income diversity, and occupational mobility are high, income dependence on fishing is likely to be lower. However, Frontera exhibits a high dependence on fisheries, given the fact that the main survival strategy during the tropical storm season of permit holders, cooperatives, and fishermen alike depends on fisheries. Permit holders and presidents of cooperatives depend mostly on their savings and fishermen on loans. In both cases, income for sustainable livelihoods of the actors comes from fisheries throughout the whole year. In terms of flexibility and diversity (as shown in Table 6.3), Sánchez Magallanes has the greatest adaptive capacity, while Frontera has the lowest. However, it is worth noting that diversification in targeted species and fishing gear seems to be more a reaction response to the decline of specific target species than a strategy to prevent fisheries decline.

### 6.6.2 Capacity to Organize

Social capital and networks play an important role in enhancing social capacity, but they are not easy to build (Adger 2003). Cooperation changed between groups depending on the context. In the case of fishing activities, cooperation is usually present, as a fisherman in Frontera described:

> […] *when you find a very big fish bank you call other fishermen and form a circle around the bank to capture them together* […]

This statement shows that people tend to work together to improve catches. The opposite sometimes occurs when in the face of extreme climatic events. The most common answer of respondents is well represented by the statement of a fisherman from Frontera:

> […] *each one is on their own. Maybe you help a neighbour to secure his house's roof if he is away but if he is home then it's his problem and each one deals with his own roof […] yes, if there is a serious situation like a flooding we help each other but only if it is serious* […]

This mentality is important because sometimes crises can help in the creation of networks. This type of situation was documented by Uy et al. (2011) in the Philippines, where the lack of government support forced communities to develop and strengthen social networks. The reasons why people seem to be selective when helping each other during extreme climatic events (which are very common in the region) were not explored during the interviews but are worth investigating.

Regarding governance and social norms, the decline of fisheries has not been stopped regardless of the regulation regime in place. Lack of monitoring and enforcement is particularly important. In this sense, the informal conversation with the Sanchez Magallanes fishers camping at Frontera revealed that even though it is mandatory by law to record fishing landings in the office corresponding to the community where harvesters live, this does not always occur, and it is common for fishermen to register their catches in the Frontera fishing office.

Reliability of catch data reported by the fishermen is confirmed by a permit holder who considered this situation as inevitable:

> […] *of course you know that fishermen don't report the whole catch to you but that losses are already considered in the calculations* […]

This situation might be creating a vicious circle that undermines social capital, where permit holders and cooperatives pay less to the fishermen because they know they are not reporting the total catch and the fishermen choose not to report the total catch to compensate for the low payments.

Regarding social networks, the loan system in Frontera could be helping to build trust among community members, but it can also undermine social capital when fishermen leave the community or start working for another permit holder or cooperative without paying their debts. Improving fisheries governance is a key step for enhancing adaptive capacity to climate change (Badjeck et al. 2010; Brander 2010; Sumaila et al. 2011; Shelton 2014).

The shared goal of permit holders and cooperative federations is to negotiate with the government. However, they should develop more inclusive processes that allow fishermen to participate in all relevant perspectives of the fishing activity. Inclusive stakeholder engagement in decision-making processes has been identified as relevant for enhancing adaptive capacity (Adelekan and Fregene 2015).

### *6.6.3 Learning and Knowledge*

Based on the information provided by the respondents, the three communities are constantly monitoring fisheries trends, even if in an informal manner. Given the trips that Sánchez Magallanes fishermen have to make to Frontera, it seems to be the most affected community by changes in fisheries, while Frontera is the least. However, it is possible that the actual effects in Paraiso are not that different, but they are perceived to be higher because of their proximity to the oil platforms. Increased operation costs due to shifts in fish stock distributions is one of the expected economic impacts from climate change (Sumaila et al. 2011). In this sense, the adaptation actions developed by fishermen are reactive and were not part of a planned strategy. However, it could prove worthy in the context of climate change because these fishermen will already be familiar with adapting to these shifts.

While climate and weather play a fundamental role in the communities' lives, there is very poor knowledge of the concept of climate change in Frontera and Paraiso. Some interviewees, particularly permit holders and presidents of cooperatives, claimed to have knowledge of climate change but did not demonstrate it. One permit holder in Frontera answered the following:

*Q: What have you heard* (about climate change)*?*

*A: Well, you tell me first and then I'll tell you* […] *They say that it causes the red tides* […]

In the case of Sánchez Magallanes, it was identified during an interview that a climate change workshop had taken place in the community in 2014. This was most likely the reason why knowledge of climate change was better than in Frontera or Paraiso. Knowledge of climate change plays an important role in the design of adaptation measures in the communities (Bennett et al. 2014). The fact that respondents in Frontera and Paraiso are not familiar with the concept of climate change does not mean that they do not have any knowledge of climate change. Most coastal fishing communities possess extensive traditional knowledge of local climate conditions

(Shaffril et al. 2013). This was the case for respondents who identified changes in tropical storm patterns. Communities could benefit from academic knowledge that could be transmitted through workshops, as in the case of Sanchez Magallanes.

Even when government support plays a fundamental role in communities' responses to extreme climatic events, this support is not always fully accepted for different reasons. These reasons include a strong-minded set of people and a preference for not moving out of their homes, even when asked to evacuate for security reasons. One fisherman in Sánchez Magallanes described this sentiment:

> […] *a long time ago they came to move us out but we wouldn't. We, people, are stubborn and didn't move out* […]

However, more complex social processes also affect these decisions. Another fisherman in Sánchez Magallanes stated that, even if his family moves to the other community, he needs to stay to guard the house and their belongings since it is common for thieves to take advantage of the situation:

> […] *sometimes the army comes and takes people to the higher grounds… but one has to stay because you have your things in your house and there's always someone who takes advantage of the situation and they see a lonely house and rob it* […]

Communities' proactivity for planning for or reacting to extreme climatic events seems to be limited by the continuous support from the government. This finding is in line with the research of Uy et al. (2011), who found that access to government support can affect the proactivity of the communities.

The identification of the causes of phenomena and the role that human society plays on them is heterogeneous. In Sánchez Magallanes, few interviewees mentioned the effects of the oil platforms, while it was the main threat mentioned by respondents in Frontera and Paraiso. This difference could be due to the fact that Frontera and Paraiso are more involved in the platforms-conflict processes, thus creating an official discourse in the community that blames the government and PEMEX for most of their problems. West and Hovelsrud (2010) observed that fishermen in oil extraction areas have been politicized through the adoption of an institutional discourse embedded in the communities' mindsets.

### *6.6.4 Access to Assets*

Material assets represent an important difference between fishermen and permit holders and presidents of cooperatives. This finding is particularly worrisome since many case studies in developing countries (Mamauag et al. 2013; Moreno-Sánchez and Maldonado 2013; Bennett et al. 2014; Blythe et al. 2014; Islam et al. 2014; Morzaria-Luna et al. 2014; Finkbeiner 2015) have identified productive assets ownership as key for enhancing adaptive capacity among small-scale fishermen. However, further research about the insurance of material assets is needed. One of fishermen interviewed mentioned that:

[…] *I have looked into it but there are not many companies who offer the service and the prices are too high. It is not like we lose equipment every year so I prefer paying for it if it happens than paying something each year* […].

It is possible that an increase in the frequency and intensity of extreme climatic events, as expected with climate change, might lead owners of equipment to reconsider their decision regarding insurance. The creation of accessible public or private insurance scheme should be pursued to prevent the economic losses that would be incurred during rebuilding or reacquisition following a natural disaster (Badjeck et al. 2010).

There is a clear difference between being a fisherman and a permit holder or president of cooperative in terms of financial status. This difference is so clear that even fishermen who prefer their harvesting job become permit holders if they can; one permit holder in Paraiso is an example of this situation:

*… I was a fisherman for many years but I started saving money until one day I was able to buy a boat and then I got a fishing permit…*

The capacity of this class to absorb fishermen's debts without compromising their own financial status is exemplified by one permit holder in Frontera who mentioned being owed at least 200,000 Mexican pesos (around 14,200 US dollars) yet remains solvent and still provides loans for his fishermen. He also acknowledged that it was not a purely financial transaction but that community bonding and cooperation came into play:

*… you have to provide for your fishermen when you can…we might have the money but without our fishermen, we are nothing…*

However, it does seem that what determines whether a loan is provided or not is the financial status of the permit holder or cooperative at the moment when fishermen ask for them. Financial status relates to occupational mobility because even if permit holders and presidents of cooperatives do not need to search for alternative sources of income during the tropical storm season, their occupational mobility is likely to be high because of their financial capital. This hypothesis is based in the findings of Islam et al. (2014), who found that lack of access to financial capital limited the diversification of livelihoods in Bangladesh. The testimony of a permit holder in Paraiso also suggests this relationship:

[…] *fishing is no longer profitable* […] *I would like to make better use of my money and invest it in other projects like diversified agriculture* […]

Fishermen's financial status is affected by their lifestyle. It is very common in all three communities for fishermen to use their money to buy alcohol. This situation prevents most fishermen from accumulating financial capital. This problem needs to be tackled from a public health perspective to reduce substance abuse, which is likely to have harmful impacts not only on fishermen's health but also on their financial status.

The fact that the gasoline subsidy only benefits permit holders and presidents of cooperatives not only affects fishermen's financial status but also undermines trust and social harmony because fishermen are aware of the subsidy. Regarding the financing scheme, the strong government dependency in Tabasco has gotten most people used to receiving support without the need to invest. This situation has led to a low acceptability in the communities of this government programme. Dutra et al. (2015) documented how a community in Australia has been using government support for implementing actions that will enhance their adaptive capacity. While a similar strategy seems very unlikely, due to high government dependent tradition from fishermen, the three communities would benefit from adopting such an approach.

Regarding equity and rights, the reason why informal labour relations exist was explained by one permit holder from Paraiso and another from Sanchez Magallanes. They said that contract-based labour relations are not beneficial for either one of the parties. For permit holders, it is too expensive to pay for medical insurance, while fishermen do not like it either because when catches are good, they can earn much more money per day than they would if they had a contract with a fixed salary.

There is a marked difference between fishermen and permit holders and presidents of cooperatives in terms of access to assets, which undermines the adaptive capacity of community members. This happens due to the fact that, although permit holders and presidents of cooperatives might be in better position in this regard, they still depend on fishermen. A more equitable distribution of financial capital could help to improve social relations as well as enhance adaptive capacity.

## 6.7 Final Considerations

Climate change is a critical issue for coastal fishing communities and is expected to have a more pronounced impact on their development in the medium and long term. However, the changes in the abundance and distribution of commercial fishing resources might prove either beneficial or harmful for communities depending on their geographic location and capacity to adapt fast enough to environmental changes. The three fishing communities in Tabasco have different adaptive capacities towards climate change. These results suggest that adaptive capacity is highly context-dependent, as proposed by Adger (2003). This study's findings also suggest that adaptive capacity analysis needs to be performed at a local scale, if the goal is to provide insights to policymaking and decision-making processes that aspire to enhance adaptive capacity to climate change.

Despite the fact that Tabasco has an action programme associated with climate change, there are very few contingency strategies that have developed. These strategies must be as cost-effective as possible since there is high agreement that the benefits of protecting against such events are larger than the costs of inaction (IPCC 2014). In this sense, the study provides relevant insights for policymaking at the local level in each of the three communities. These insights include information about which processes enhance adaptive capacity (e.g. reduction of incomes could have forced individuals to diversify their economic activities) and which ones deteriorate it (e.g. historical social agreements, geographic location), as well as identify which drivers are the strongest and weakest in each community. It draws on other case studies to identify similarities and differences and suggest actions that could help enhancing adaptive capacity in these communities. One action that could help improve governance is the creation of a forum where all fishing cooperatives and permit holders can interact and reach agreements about common challenges. One example of this kind of forum being created in a developing country can be found in Brazil, as described in Kalikoski et al. (2010).

More research need to be done to tackle the problems identified in this study. Firstly, due to time availability, the study could not explore the gender relations in the communities, leaving the role of women in the households and the community unexplored. Secondly, the government's perspective was barely explored due to time availability but would be fundamental for gaining a broader, more complete understanding of the processes that influence the adaptive capacity of the community members and the communities as a whole. Thirdly, the study could be made more robust by adding more indicators and selecting a bigger sample.

Future conditions for coastal communities do not look hopeful. In addition to the uncertainty that climate change represents, the government plans for growth of the oil industry seem ineluctable. Reducing the negative impacts of climate change in fishing communities in Tabasco is possible, but social, economic, and cultural changes need to occur at different levels, ranging from the government to the communities themselves.

## References

Adelekan I, Fregene T (2015) Vulnerability of artisanal fishing communities to flood risks in coastal southwest Nigeria. Clim Dev 7(4):1–17

Adger N (2003) Social capital, collective action, and adaptation to climate change. Econ Geogr 79(4):387–404

Arias-Rodríguez JM, Ireta-Guzmán H (2009) *Pesca y petroleo en el Golfo de México* (Electronic Book). Vol 1. Rostros y Voces A.C., XminusY, Villahermosa

Badjeck MC, Allison EH, Halls AS, Dulvy NK (2010) Impacts of climate variability and change on fishery-based livelihoods. Mar Policy 34(3):375–383

Bennett NJ, Dearden P, Murray G, Kadfak A (2014) The capacity to adapt?: communities in a changing climate, environment, and economy on the northern Andaman coast of Thailand. Ecol Soc 19(2):5

Blythe JL, Murray G, Flaherty M (2014) Strengthening threatened communities through adaptation: insights from coastal Mozambique. Ecol Soc 19(2):6

Bozada-Robles LM (2006) Las pesquerías de la zona costera de Tabasco: Una actividad amenazada (Report). Universidad Veracruzana Intercultural. Sede SelvasUniversidad Istmo-americana, A.C

Brander K (2010) Impacts of climate change on fisheries. J Mar Syst 79(3–4):389–402

Bunce M, Brown K, Rosendo S (2010) Policy misfits, climate change and cross-scale vulnerability in coastal Africa: how development projects undermine resilience. Environ Sci Pol 13(6):485–497

Cataldo F, Kielmann K, Seeley J (2011) Introduction to qualitative research methodology. misc, Department for International Development

Cinner JE, McClanahan TR, Graham NAJ, Daw TM, Maina J, Stead SM, Wamukota K, Brown K, Bodin Ö (2012) Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries. Glob Environ Chang 22(1):12–20

Cinner JE, Huchery C, Darling ES, Humphries AT, Graham NAJ, Hicks CC, Marshall N, McClanahan TR (2013) Evaluating social and ecological vulnerability of coral reef fisheries to climate change. PLoS One 8(9):e74321

Defeo O, Castrejón M, Ortega L, Kuhn AM, Gutiérrez NL, Castilla JC (2013) Impacts of climate variability on Latin American small-scale fisheries. Ecol Soc 18(4):30

Denzin NK, Lincoln YS (2005) The SAGE handbook of qualitative research. Writing, vol 3. Sage Publications, Thousand Oaks

Dutra LXC, Bustamante RH, Sporne I, van Putten I, Dichmont CM, Ligtermoet E, Sheaves M, Deng RA (2015) Organizational drivers that strengthen adaptive capacity in the coastal zone of Australia. Ocean Coast Manag 109:64–76

Faustino R, Sales M (2009) Vulnerability and adaptation of coastal communities to climate variability and sea-level rise: Their implications for integrated coastal management in Cavite City, Philippines. Ocean Coast Manag 52(7):395–404

Finkbeiner EM (2015) The role of diversification in dynamic small-scale fisheries: Lessons from Baja California Sur, Mexico. Glob Environ Chang 32:139–152

Gallopín GC (2006) Linkages between vulnerability, resilience, and adaptive capacity. Glob Environ Chang 16(3):293–303

Gupta J, Termeer C, Klostermann J, Meijerink S, van den Brink M, Jong P, Nooteboom S, Bergsma E (2010) The Adaptive Capacity Wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Environ Sci Pol 13(6):459–471

IPCC (Intergovernmental Panel on Climate Change) (2014) Climate change 2014 synthesis report summary chapter for policymakers. Intergovernmental Panel on Climate Change, Geneva

Islam MM, Sallu S, Hubacek K, Paavola J (2014) Vulnerability of fishery-based livelihoods to the impacts of climate variability and change: Insights from coastal Bangladesh. Reg Environ Chang 14(1):281–294

Johnson JE, Welch DJ (2010) Marine fisheries management in a changing climate: A review of vulnerability and future options. Rev Fish Sci 18(1):106–124

Kalikoski DC, Quevedo Neto P, Almudi T (2010) Building adaptive capacity to climate variability: the case of artisanal fisheries in the estuary of the Patos Lagoon, Brazil. Mar Policy 34(4):742–751

Maldonado J, Moreno-Sánchez R (2014) Estimating the adaptive capacity of local communities at marine protected areas in Latin-America: A practical approach. Ecol Soc 19(1):16

Mamauag SS, Aliño PM, Martinez RJS, Muallil RN, Doctor MVA, Dizon EC, Geronimo RC, Panga FM (2013) A framework for vulnerability assessment of coastal fisheries ecosystems to climate change-Tool for understanding resilience of fisheries (VA-TURF). Fish Res 147:381–393

McClanahan T, Allison EH, Cinner JE (2013) Managing fisheries for human and food security. Fish Fish 16:78–103

Moreno-Sánchez RDP, Maldonado JH (2013) Adaptive capacity of fishing communities at marine protected areas: a case study from the colombian pacific. Ambio 42(8):985–996

Morzaria-Luna HN, Turk-Boyer P, Moreno-Baez M (2014) Social indicators of vulnerability for fishing communities in the Northern Gulf of California, Mexico: Implications for climate change. Mar Policy 45:182–193

Niang I, Ruppel OC, Abdrabo MA, Essel A, Lennard C, Padgham J, Urquhart P (2014) Climate change 2014: impacts, adaptation and vulnerability. In: Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR (eds) Part B: regional aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, pp 1199–1265

Núñez J, Ramos-Reyes R, Barba-Macías E, Espinoza-Tenorio A, Gama-Campillo L (n.d.) Índice de vulnerabilidad costera (IVC) del litoral tabasqueño. Investig Geogr 91:70–85

Pérez-Sánchez E, Muir JF (2003) Fishermen perception on resources management and aquaculture development in the Mecoacan estuary, Tabasco, Mexico. Ocean Coast Manag 46(6–7):681–700
Pérez-Sánchez E, Muir JF, Ross L (2002) Coastal aquaculture and sustainable livelihoods in Mecoacán, Tabasco, México. Universidad y Ciencia 18(35):42–52
Salas S, Chuenpagdee R, Seijo JC, Charles A (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fish Res 87(1):5–16
SERNAPAM (2011) *Programa de acción ante el cambio climático del Estado de Tabasco 2011* (Primera.). Gobierno del Estado de Tabasco, SEMARNAT-INE, UJAT, ECOSUR, COLEF, Villahermosa
Shaffril HAM, Samah BA, D'Silva JL, Yassin SM (2013) The process of social adaptation towards climate change among Malaysian fishermen. Int J Clim Change Strateg Manag 5(1):38–53
Shelton C (2014) Climate change adaption in fisheries and aquaculture – compilation of initial examples (unpublished), FAO Fisheries and Aquaculture Circular, Vol 1088. FAO, Rome
Smit B, Wandel J (2006) Adaptation, adaptive capacity and vulnerability. Glob Environ Chang 16(3):282–292. JOUR
Sumaila UR, Cheung WWL, Lam VWY, Pauly D, Herrick S (2011) Climate change impacts on the biophysics and economics of world fisheries. Nat Clim Chang 1(9):449–456
Uy N, Takeuchi Y, Shaw R (2011) Local adaptation for livelihood resilience in Albay, Philippines. Environ Hazards 10(2):139–153
West JJ, Hovelsrud GK (2010) Cross-scale adaptation challenges in the coastal fisheries: Findings from Lebesby, Northern Norway. Arctic 63(3):338–354

**Octavio Tolentino-Arévalo** obtained his MSc in Ecological Economics with the "Best Overall Contribution to the Programme" prize at the University of Edinburgh in 2015. His experience with environmental science and ecological economics includes payment for ecosystem services assessment, ecosystem services valuation, marine systems and policy, adaptive capacity to climate change, and natural protected areas management. His work and research interests include ecological economics, monetary and nonmonetary valuation of ecosystem services, behavioural economics, cognitive and social psychology, socio-ecosystem governance, marine systems management, and fisheries management. In January 2016, he joined the National Commission of Natural Protected Areas, where he works as an environmental economics advisor in the Department of International Cooperation.

**Marianna Markantoni** is a cultural geographer and rural society researcher at Scotland's Rural College. She has over 10 years of experience analysing the differences between policy vision and experience on the ground in rural communities. She focuses particularly on rural community development policies and strategies, as well as community-led initiatives. As a social geographer, she examines community resilience, empowerment, participatory governance, transitions towards enabling states, and social inequalities. She also studies the role of communities in low carbon transitions, community renewables, energy transitions, sustainable development, and social, environmental, and climate justice. Her current work focuses on local assets, local decisions, and community resilience in rural communities (funded by the Scottish Government RESAS Programme).

**Alejandro Espinoza-Tenorio** obtained his PhD in 2011 at the University of Bremen, Germany. His experience in territorial ordinance, community aquaculture, and environmental indicators for fisheries management has led him to develop methodologies for holistic management in coastal areas of Mexico. After a brief postdoctoral fellowship at the *Instituto de Ecología, Pesquerías y Oceanografía del Golfo de* México (EPOMEX) at the Campeche Institute, he joined *El Colegio de la Frontera Sur* (ECOSUR) in 2011 as a researcher. Currently an investigator at the Transdisciplinary Laboratory for Sustainability-ECOSUR, he works to coordinate holistic frameworks for coastal resource management, emphasizing ecosystem-based fisheries management and the use of traditional ecological knowledge in the management of socioecological systems.

**Maria Azahara Mesa-Jurado** is a researcher with over 8 years' experience working in water management and economic valuation of water resources. His research aims to contribute to water management decision-making processes in a context of global change. His personal interests are in enhancing the importance of ecosystem services conservation and including local communities in decision-making processes of natural resources management. He has worked extensively on water-scarce regions such as the Guadalquivir River basin (Southern Spain) and currently on tropical regions such as Southern Mexico. He is a member of the National Researcher System (SNI Candidate Level); CONACYT, México; and the wetland-specialized group, Grijalva-Usumacinta Watershed Council, Tabasco, México (2012-2013).

# Part III
# Monitoring, Management and Conservation

# Chapter 7
# From Fishing Fish to Fishing Data: The Role of Artisanal Fishers in Conservation and Resource Management in Mexico

**Stuart Fulton, Arturo Hernández-Velasco, Alvin Suarez-Castillo, Francisco Fernández-Rivera Melo, Mario Rojo, Andrea Sáenz-Arroyo, Amy Hudson Weaver, Richard Cudney-Bueno, Fiorenza Micheli, and Jorge Torre**

**Abstract** Although, the involvement of artisanal fishing communities in conservation and management is now commonplace, their participation rarely goes beyond providing local and traditional knowledge to visiting scientists and managers. Communities are often excluded from ongoing monitoring, evaluation, and decision-making, even though these measures can have tremendous impacts on their livelihoods. For the past 17 years, we have designed, tested, and implemented a community-based monitoring model in three key marine ecosystems in Mexico: the kelp forests of Pacific Baja California, the rocky reefs of the Gulf of California, and the coral reefs of the Mesoamerican Reef System. This model is intended to engage local fishers in data collection by fulfilling two principal objectives: (1) to achieve science-based conservation and management decisions and (2) to improve livelihoods through access to knowledge and temporary employment. To achieve these

S. Fulton (✉) · A. Hernández-Velasco · A. Suarez-Castillo · F. Fernández-Rivera Melo
M. Rojo · J. Torre
Comunidad y Biodiversidad A.C., Guaymas, Sonora, Mexico
e-mail: sfulton@cobi.org.mx

A. Sáenz-Arroyo
Departamento de Conservación de la Biodiversidad, El Colegio de la Frontera Sur, San Cristóbal de Las Casas, Chiapas, Mexico

A. H. Weaver
Sociedad de Historia Natural Niparajá A.C., La Paz, Baja California Sur, Mexico

R. Cudney-Bueno
The David and Lucile Packard Foundation, Los Altos, CA, USA

F. Micheli
Hopkins Marine Station, Stanford University, Pacific Grove, CA, USA



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_7

goals, over 400 artisanal fishers and community members have participated in a nationwide marine reserve program. Of these, 222 fishers, including 30 women, have been trained to conduct an underwater visual census using SCUBA gear, and, to date, over 12,000 transects have been completed. Independent scientists periodically evaluate the training process and standards, and the data contribute to international monitoring efforts. This successful model is now being adopted by both civil society and government for use in different parts of Mexico and neighbouring countries. Empowering community members to collect scientific data creates responsibility, pride, and a deeper understanding of the ecosystem in which they live and work, providing both social and ecological benefits to the community and marine ecosystem.

**Keywords** Citizen science · Local and Traditional Knowledge (LTK) · Community participation · Small-scale fisheries

## 7.1 Introduction

Given growing concerns about declining environmental conditions in marine habitats in the face of climate change, the impacts of increasing fishing pressure on commercial stocks, and the impacts on the livelihoods of artisanal fishers operating in the coastal waters of developing countries, measures are being undertaken by researchers, governments, and civil society to involve fishers in improving fisheries and coastal zone management. Fishers are often highly aware of subtle changes in the environment in which they operate and thus can provide important information to scientists and managers. Fishers' local and traditional ecological knowledge (LTK) has been recognized as an important resource for marine conservation initiatives worldwide (Schafer and Reis 2008; Butler et al. 2012). For a review of this literature, see Thornton and Maciejewski-Scheer (2012).

Berkes et al. (1995) list five ways in which traditional ecological knowledge (TEK) is relevant to fishers and fishing: (1) TEK is known to offer biological and ecological insights, (2) some TEK systems provide models for sustainable resource management, (3) TEK is relevant for protected areas and conservation education, (4) the use of TEK is often crucial for development planning, and (5) TEK may be used in environmental assessment.

In the vast majority of cases, LTK that is documented by researchers has been orientated towards species-specific studies. Few genuinely collaborative studies, in which fishers have been able to address conservation and management issues, have been documented in the literature (Thornton and Maciejewski-Scheer 2012). Despite this shortcoming, strong arguments can be made that the inclusion of local communities in conservation programs can strengthen conservation projects and create environmental and social benefits (Drew 2005).

Fishers' LTK should not be considered a panacea to the threats that coastal oceans face. However, incorporating LTK into co-management arrangements allows the interchange of knowledge between fishers, scientists, civil society organizations (CSOs), and governmental agencies. There are numerous benefits to the use of LTK. Favourable conditions are created for the advancement of mutually beneficial arrangements; fishers can potentially maintain their stock levels (Roberts et al. 2001; Russ and Alcala 2004; Cudney-Bueno et al. 2009a; White 2009); scientists can use LTK to test hypotheses and generate recommendations (Ballantine 2014); conservationists can maintain biodiversity (Groves et al. 2002); and the government can balance both environmental and social development goals (Thomas et al. 2014).

### *7.1.1 Marine Reserves as Fisheries Management Tools*

Bottom-up resource management, in which communities are directly involved in managing the resources they exploit, has been gaining ground over the past decade, as human-environment interactions have become recognized as a key part of the now popular ecosystem-based management approach (Pikitch et al. 2004). The importance of combining LTK and community-led resource management is increasingly recognized (Thornton and Maciejewski-Scheer 2012), but this integration requires a cautious, participatory, and transparent approach in order to establish successful conservation measures. Worldwide, one of the most popular conservation tools of this kind is the establishment of community marine reserves, particularly in developing countries (Russ and Alcala 2003).

Marine reserves are not the only conservation solution, and other strategies must be employed in order to achieve widespread benefits, including direct benefits to fisheries (Hilborn 2016). However, in many cases, marine reserves have provided benefits to both ecosystems (Roberts and Hawkins 2000; Williamson et al. 2004; Aburto-Oropeza et al. 2011) and fisheries (Roberts et al. 2001; Gell and Roberts 2002). Hence, experts have recommended increasing the area that is fully protected from fishing to preserve fish stocks for future generations (Marine Conservation Institute 2013). Similarly, local management action has been highlighted as a key component of future ocean conservation to counter the threat of climate change (Micheli et al. 2012; Kennedy et al. 2013).

While fishers are generally aware of the benefits that marine reserves can provide, they are often reluctant to set aside parts of their fishing grounds for several reasons. These include (1) marine reserve creation that concentrates fishing in a smaller open area (Charles and Wilson 2009); (2) a lack of clear property rights (e.g. fishing concessions) in the water (Costello and Kaffine 2010); (3) a lack of surveillance and enforcement by authorities, resulting in illegal fishing practices (Cudney-Bueno et al. 2009b; Velez et al. 2014); (4) benefits that are often not felt in the short term (Russ and Alcala 2004; Ovando et al. 2016); (5) a lack of adequate compensa-

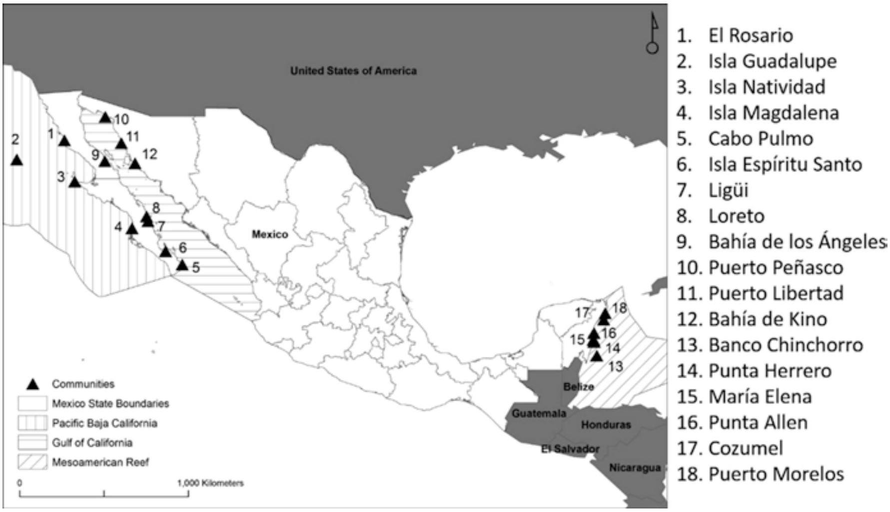



**Fig. 7.1** The three marine priority ecoregions and 18 communities in Mexico where fishers have participated in collaborative research to implement fishery management tools

tion (Ovando et al. 2016); and (6) a lack of leadership to guide the community through changes (Cudney-Bueno et al. 2009b).

This chapter describes the key features of a model that demonstrates how the involvement of small-scale fishers in community-inclusive processes to establish marine reserves[1] leads to successful outcomes in marine conservation and fisheries management. The model is a successful program that has been implemented in three marine priority areas of Mexico. It shows how to overcome or reduce the aforementioned issues (Fig. 7.1). Through collaborative research, this model involves fishers in science-based decision-making processes. Its implementation has resulted in the training of 222 fishers in underwater visual census techniques. Data have been generated to further our understanding of Mexico's marine ecosystems and provide evidence to support new conservation and fisheries management tools for over 620,000 hectares of coastal ocean.

### 7.1.2 *Citizen Science*

Conservation and research organizations around the world are incorporating an increasing amount of non-expert, trained observers – sometimes called 'citizen scientists' or 'volunteers' – to support a variety of biological and environmental

[1] In this chapter, 'marine reserve' refers to an area completely closed to extractive activity, also commonly referred to as a no-take zone.

monitoring needs. Participants in citizen science initiatives receive project-specific training and engage in scientific research. Citizen science has its roots in the early days of the conservation movement. The National Audubon Society's Christmas Bird Count began in 1900 as an alternative to the traditional Christmas shoot, a program that continues to this day, with tens of thousands of observers counting over 63 million birds in North America in 2014. Data collected have contributed to over 350 scientific publications (Silvertown 2009). Other common uses for citizen science include mapping invasive species, restoration, monitoring climate change and species distribution changes, and biological monitoring (Thornton and Maciejeski-Sheer 2012).

In the marine realm, the boom in recreational SCUBA diving towards the end of the twentieth century allowed organizations such as REEF (founded 1990) and Reef Check (founded 1996) to achieve worldwide popularity in volunteer-led underwater visual census monitoring. These organizations have particularly focused on heavily fished and indicator species in their citizen monitoring programs. In these programs, volunteer divers undertake training courses in simple but robust methodologies before collecting data to contribute to marine science initiatives. Subsequently, more complex methodologies were developed to allow volunteers with a background in marine science or sufficient training and experience in the field to collect more detailed data. Examples of these methodologies include the Atlantic Gulf Rapid Reef Assessment (AGRRA), Mesoamerican Barrier Reef Synoptic Monitoring Program, and the Global Coral Reef Monitoring Network.

Since these programs began, the use of volunteers to collect scientific data in the coastal zone has become commonplace in many countries, including Australia (Hassell et al. 2013), Belize (Mumby et al. 1995), Fiji (Leopold et al. 2009), Indonesia (Harding et al. 2000), New Zealand (Fletcher and Shortis 2001), the Philippines (Beger 2002), Tanzania (Darwall and Dulvy 1996), the USA (Schmitt and Sullivan 1996; Pattengill-Semmens and Semmens 2003; Shuman et al. 2011), and the Wider Caribbean Region (Ward-Paige et al. 2010). In the developed world, participants in marine citizen science programs generally participate as a hobby, focusing on areas of high-perceived value such as coral reefs and popular SCUBA dive sites. In developing countries, it is more common for the resource users themselves to participate, as the project objectives are more local in focus and aligned for the benefit of the community.

The advantages of involving volunteers in data collection are clear. Using volunteers to collect part, or all, of the scientific data required for monitoring reduces costs, allows long-term regular monitoring rather than one-off investigations, and raises awareness amongst marine resource users. While concerns have been raised over the quality of the data collected by non-professionals, it is generally accepted that a well-trained volunteer conducting an appropriate methodology can collect reliable data (Mumby et al. 1995; Darwall and Dulvy 1996; Harding et al. 2000; Hassell et al. 2013; Fulton et al. 2013; Forrester et al. 2015). In addition, the process can help build trust and facilitate the involvement of resource users in conservation practices.

## 7.2 Implementing a Community-Based Monitoring Model

### *7.2.1 Involving Mexican Fishers in Data Collection*

The management of Latin American small-scale fisheries is notoriously complex (Salas et al. 2007). Fisheries are often multi-specific, poorly regulated, labour-intensive, and data-poor. Mexican small-scale fisheries are no different, with 102,807 registered boats (CONAPESCA 2009) supporting at least 308,421 fishers, based on an average of 3 fishers per boat (Moreno-Baéz et al. 2012). The sector fishes along the length of Mexico's extensive 9330 km coastline, which is the 13th longest in the world.

*Comunidad y Biodiversidad* (COBI), a Mexico marine conservation CSO, was founded in 1999 with a mission to develop effective participatory approaches for fisheries management and marine biodiversity conservation (Espinosa-Romero et al. 2014). The organization's multidisciplinary team operates along four national strategies: (1) capacity building to strengthen skills of local leaders and fishing organizations for achieving sustainable fisheries, (2) implementation of international standards for sustainable fishing, (3) implementation of marine reserves for fishery and ecosystem recovery, and (4) collective action for the development of formal institutional arrangements to promote sustainable fishing. This chapter discusses Mexican fishers' involvement in a national marine reserve program which implicitly incorporates the four strategies supported by COBI. This section discusses the participatory process implemented in the program, the products generated, and the implications of the program.

Fishers from 18 communities around Mexico took part in the program (Fig. 7.1). These fishers target a mix of small-scale fisheries including both high value (lobster, abalone) and low value (mixed finfish) species. Fishers operate from small fibreglass or wooden boats (7–9 m in length), but fishing gear is varied, including lobster pots, hook and line, SCUBA, hookah, and free diving. Relatively few fishers regularly use nets. In Pacific Baja California and the Mesoamerican Reef, concessions are common for some high-valued benthic species such as lobster and abalone. These are only allocated to cooperatives, and exclusive access to the resource is granted through a fishing permit. Fishing permits to common access areas, for finfish and other species, are assigned to cooperatives and individual fishers alike.

Fully protected marine reserves (or no-take zones) have been established in many developing countries with the aim of maintaining or promoting marine biodiversity and protecting heavily fished stocks. In Mexico, three management tools are available to completely protect areas from fishing: voluntary community reserves[2],

[2] Voluntary community reserves are areas set aside by fishers for the recuperation of target species based on traditional knowledge and fishery interests.

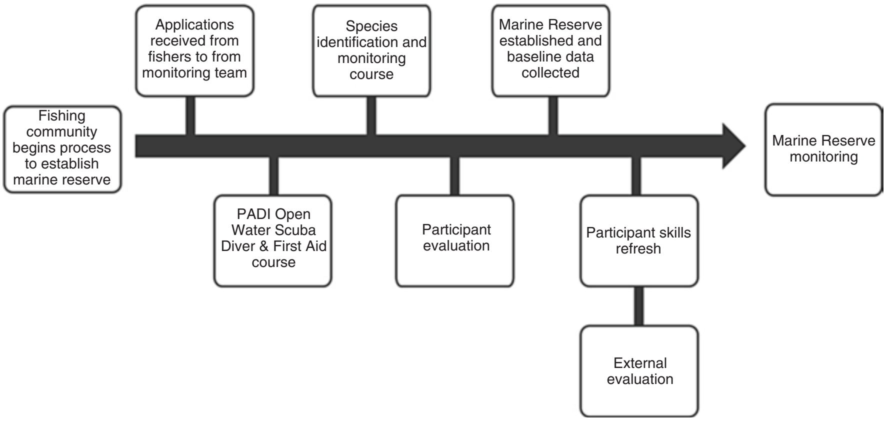



**Fig. 7.2** Process to establish a community-led marine monitoring team

core zones of federal protected areas[3], and fish refuges[4]. During the process of marine reserve creation (Fig. 7.2), which was monitored by the fishers in the case study, introductory workshops were held in each community in which stakeholders discussed the biological and fisheries benefits (and risks) of setting aside areas for marine reserves. As the process advanced, fishers were invited to apply for the opportunity to participate in the biological monitoring team, a community group supported by biologists that evaluates the effectiveness of the sites closed to fishing. The selection criteria for fishers were based on their status and standing in the fishing organization and/or community (reputation for following social and legal norms, relationships with other fishers) as well as other factors such as physical condition (based on internationally recognized SCUBA diving medical standards) and literacy.

The fishers were trained in a variety of monitoring techniques, including underwater visual census with SCUBA, surface snorkel surveys, installation and use of oceanographic equipment, and the identification and capture of invasive species. During data collection, fishers were offered a stipend to compensate for the forgone fishing days. This was estimated by taking the mean of the difference between a good and bad day's fishing. In cases where socioeconomic data for the fishery exist, this can be calculated precisely. If no such data exist, estimates were made within the monitoring team and a suitable level for the stipend was agreed upon.

[3] Core zones of federal protected areas defined by the General Law of Ecology and Environmental Protection (LGEEPA in Spanish) are areas where the principal objective is long-term ecosystem preservation.

[4] Fish refuges (or *refugios pesqueros* in Spanish), a term used by the General Law of Sustainable Fishing and Aquaculture (LGPAS in Spanish), are no-fishing areas established in federal waters that preserve and contribute to the development of fishing resources, with a particular focus on reproduction, recruitment, and growth. They can be either temporary, permanent, species specific, or completely closed.

During the program, 222 fishers were trained to conduct underwater visual censuses in the kelp forests of the Baja California Peninsula, the rocky reefs of the Gulf of California, and the coral reefs of the Mesoamerican Reef System. While each environment requires specific protocols, fishers followed a standardized training program to ensure accuracy, precision, and confidence in the data generated. Fishers received an internationally recognized SCUBA certification from the Professional Association of Diving Instructors (PADI) and first aid training before undertaking an intensive course in species identification and underwater visual census techniques. Methodologies were selected that are both internationally recognized and locally appropriate (based on habitat type) in order to contribute to other regional datasets. In Baja California, the Reef Check methodology (Freiwald et al. 2013) was used; in the Gulf of California, an adapted version of the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) protocol (PISCO 2016); and in the Mesoamerican Reef, an adapted version of the Atlantic Gulf Rapid Reef Assessment (Lang et al. 2010).

The training courses were divided into three parts: (1) classroom theory sessions, (2) in-water species identification, and (3) monitoring practice. Theory sessions provided participants with in-depth information about ecosystem-based monitoring, marine reserves, and an overview of the importance of monitoring. Focus was subsequently turned to the specific fish and invertebrate species common in the area, as well as detailed information about the types of benthic cover and other information relevant to the local marine reserves. Common names for species can vary greatly from one community to the next. Although common names were often used initially, fishers were strongly encouraged to use scientific names as soon as possible to reduce errors in data collection and facilitate collaboration with scientists and fishers from other areas. In-water species identification began when fishers demonstrated mastery of the theory. In dive groups with low fisher to trainer ratios (ideally 1:1), fishers learned to identify fishes and their estimate sizes correctly. Size estimation, which is key for biomass calculations, was evaluated using a line of plastic fish for each of which the observer estimates the size to the nearest centimetre from a distance of 2–3 m. After each practice session, trainers reviewed and gave feedback on the fishers' performances during the dive.

Monitoring protocol training included land-based practice in which transect dimensions and speed were demonstrated, while the fishers familiarized themselves with the monitoring equipment (fibreglass tape measures, underwater tables with waterproof paper, quadrants, PVC measuring poles). This was followed by in-water practice in which fishers laid practice transects accompanied by the trainer and demonstrated safe diving practices. Training was complete when the trainer was confident that each fisher was able to collect accurate data for each species group (fish, invertebrates, and benthic cover). Fishers were provided with waterproof species ID guides to assist with the learning process, and many began to use the guides outside of survey periods to identify catches and species seen during their fishing trips. In many cases, the competitive nature of fishers provided unexpected benefits. The daily challenge between participants ranged from 'who caught the most today?' to 'who knows the scientific name of her/his catch?'

When monitoring teams were established to collect data in newly established marine reserves, baseline data had to be collected before the reserve was formally closed to fishing. Subsequent surveys were completed at suitable intervals to detect ecological changes. Intervals vary on a case-by-case basis depending on the objectives and target species of the reserve. The monitoring program must be adapted to reflect the recovery rate of the target species (Abesamis et al. 2014). Before each subsequent survey, fishers underwent a 2-day refresher course and evaluation to ensure that their proficiency had not dropped. Periodically, visiting scientists were consulted to provide an objective external assessment of fishers' activities. The scientists evaluated the fishers on their ability to correctly apply the methodology and correctly identify and estimate the size of marine organisms. Recommendations were also provided by the scientists on how to improve the training process and diver performance during surveys.

Fishers' participation in citizen science during the program was not restricted to transect SCUBA surveys in community marine reserves. Fishers along the Mexican portion of the Mesoamerican Reef have also conducted surveys and control measures for the invasive lionfish (*Pterois volitans*) population, monitored megafauna (shark, ray, and turtle), and identified fish spawning aggregation sites for key commercial species such as groupers (Serranidae) and snappers (Lutjanidae). The contribution of fishers' LTK to the search for fish spawning aggregations has been extensively documented (Hamilton et al. 2011; Heyman 2011). However, in the Sian Ka'an Biosphere Reserve, the fishers successfully petitioned the government to create a fish refuge on a Nassau grouper (*Epinephelus striatus*) spawning site (Secretaria de Gobernación 2013), the first visually verified fish spawning aggregation site to be closed to fishing in the Mexican Caribbean. Fishers continue to survey the site during spawning season.

In the Pacific island community of Isla Natividad, two marine reserves were established in 2006 to protect dwindling abalone stocks from over-exploitation. Approximately 8% (200 hectares) of the cooperative's fishing ground was included in the marine reserves, with fishers selecting the sites based on past productivity and the estimated opportunity cost of the lost fishing grounds. In 2009, fishers observed an unusually high mortality of benthic invertebrates, mostly likely caused by a hypoxic event linked to changes in the California current (Micheli et al. 2012). In collaboration with the fishing cooperative, scientists used oceanographic instruments to monitor both hypoxic events and temperature fluctuations. This biological and oceanographic monitoring program, established in 2006, continues to give a unique perspective of the impact of changes in large-scale ocean processes on local marine biodiversity. While abalone density inside the reserves declined during the hypoxic events, declines were greater outside the reserves. Additionally, the larger size and higher density of abalone inside the reserves led to increased post-mortality recruitment, not only inside the reserves but also in adjacent areas (Micheli et al. 2012).

### 7.2.2 Outputs and Products of Collaborative Research

Fishers who took part in the community-led monitoring programs described herein are active participants in the evaluation of their resources and help to generate information that can be used in science-based decision-making for local- and regional-level management. To date, community partners have contributed to over 60 projects including undergraduate and Masters' theses, PhD dissertations, book chapters, conference proceedings, and articles focusing on biogeography, biodiversity, bioeconomics, and fisheries. Table 7.1 summarizes the products of the collaborative research program, and some of the most important contributions to both the scientific literature and fisheries management are discussed below.

The success of any conservation or fisheries management tool depends heavily on community acceptance, implying that active stakeholder participation is key to ensuring local buy-in to the project (Espinosa-Romero et al. 2014; Ruiz-Frau et al. 2015). In this case, the marine reserves were designed with data collected by the fishers themselves. Each reserve has specific objectives, primarily fishery recuperation or ecosystem protection. Examples of reserves with the goal of fishery recuperation are those of the blue (*Haliotis fulgens*) and yellow (*H. corrugata*) abalone fishery of Isla Natividad and the lobster (*Panulirus argus*) and grouper (*Epinephelus striatus*) fisheries of Quintana Roo (Secretaria de Gobernación 2013). Reserves created to protect and restore ecosystems include the core zone of the Isla San Pedro Mártir Biosphere Reserve (Secretaria de Gobernación 2002) and the coral reefs of María Elena, Sian Ka'an Biosphere Reserve (Secretaria de Gobernación 2012).

All area-based management tools (core zones of federal protected areas, fish refuges, and community reserves) allow both principal objectives to be reached and can be effective tools to mitigate the negative effects of climate change on marine ecosystems and livelihoods in coastal communities (Micheli et al. 2012).

Information generated by fishers has been used to create recommendations for the management of the pen shell (*Atrina tuberculosa*; temporary closures, marine reserves; Moreno et al. 2005) and swimming crab (*Callinectes* spp.; marine reserves, fishery effort monitoring, fishing gear improvements; Torre et al. 2004) fisheries of Bahia de Kino, Sonora (Cisneros-Mata et al. 2011a, b), and the development of a management plan for aquarium fish fisheries (Secretaría de Medio Ambiente y Recursos Naturales 2012). The data collected and management tools put in place have also allowed fishers to gain access to permits through the use of the data to calculate quotas. These fisheries include the clam (*Megapitaria squalida*, *M. aurantiaca*) fishery in Puerto Libertad and the aquarium fish and invertebrate fishery in Ligüi, Baja California Sur. Range extensions for species have been detected in these cases. In the Gulf of California, four species of the genus *Scarus* (Gonzalez-Cuellar et al. 2013) and Limbaugh's damselfish (*Chromis limbaughi*), a highly sought-after fish in the aquarium trade (Martínez-Torres et al. 2014), were detected. In Baja California, as water temperatures rise with climate change, tropical species have also been detected (Hernández-Velasco et al. 2016). Additional reports have included invasive species (*Sargassum filicinum*) by Riosmena et al. (2012) and

**Table 7.1** Products generated through collaborative research

| Product | Relevance/focus | References |
|---|---|---|
| Journal articles, book chapters, and proceedings | Benefits of marine reserves | Micheli et al. (2012), Rossetto et al. (2013), Munguia-Vega et al. (2015a), Rossetto et al. (2015), and Villaseñor-Derbez et al. (2015) |
| | Community participation in marine conservation | Fulton et al. (2013, 2014) and Heyman et al. (2014) |
| | Ecosystem services | Suarez-Castillo et al. (2014) |
| | Species range extensions | Gonzalez-Cuellar et al. (2013), Martínez-Torres et al. (2014), Fernández-Rivera Melo et al. (2015b), and Hernández-Velasco et al. (2016) |
| | Interdisciplinary research | Munguía-Vega et al. (2015b) |
| | Species distribution | Riosmena-Rodríguez et al. (2012) and Fernández-Rivera Melo et al. (2015a) |
| | Fisheries management, economics, and sustainability | Reyes-Bonilla et al. (2009), Moreno-Baez et al. (2012), Micheli et al. (2014), and Germain et al. (2015) |
| | Genetics and connectivity | Greenley et al. (2012) and Munguía-Vega et al. (2014) |
| Theses | Critical habitats | Moreno-Dávila (2013) and Suárez-Castillo (2014) |
| | Population dynamics | Rossetto (2012) |
| | Fishery impacts | Hernandez-Velasco (2010) |
| | Species distribution | Gonzalez-Cuellar (2012) and Precoma de la Mora (2015) |
| | Optimization of monitoring protocols | Fernández-Rivera Melo (2015) |
| | Co-management and marine reserves | Revollo-Fernández (2012) and Germain (2014) |
| Communication articles | Community participation and co-management | Fernández-Rivera Melo et al. (2013, 2014), Hernández-Velasco et al. (2015), and Fernández-Rivera Melo et al. (2015c) |
| | Women in citizen science | Hernandez-Velasco & Vazquez-Vera (2013) |
| Technical reports | Coral reef health | Healthy Reefs Initiative (2012) and Kramer et al. (2015) |
| | Stock assessments and fishery information | Torre et al. (2004), Moreno et al. (2005), and Cisneros-Mata et al. (2011a, b) |
| | Threatened species | Mercier et al. (2013) |
| | Ecosystem services | Lucas et al. (2012) |
| | Ecosystem modelling | Ainsworth et al. (2011) |
| | Seafood eco-certification | Marine Stewardship Council (2012) and Monterey Bay Aquarium Sea Food Watch (2014) |
| Management plans | Ornamental fish management plan | Secretaria de Medio Ambiente y Recursos Naturales (2012) |
| Biological monitoring protocols | | Fernández-Rivera Melo et al. (2012) |
| Protected area creation | Marine protected areas | Secretaria de Gobernación (2002) |
| | No-take zones | Secretaria de Gobernación (2012) |
| | | Secretaria de Gobernación (2013) |

albinism in brown sea cucumber (*Isostichopus fuscus*) by Fernández-Rivera Melo et al. (2015a). These official reports have been the result of having more trained eyes in the water than was previously possible, which has allowed for more effective, data-driven decisions to be made on species management and capture.

### *7.2.3 Gender Equality in Conservation*

The stereotypical fishing camp brings to mind a group of weathered men working their nets, traps, and lines, with little interest in resource conservation. Mexico, which currently ranks 71st out of 187 countries on the United Nations Development Program Gender Inequality Index (UNDP-HDR 2015), has, like most countries, a largely male-dominated fishery. The fishing cooperative, *Mujeres del Golfo*, is a leading example for other female fishers and women in coastal communities along the Baja California Peninsula. The cooperative, dedicated to catching and commercializing ornamental fish for the aquarium trade, was founded and is currently run by women from the community of Ligüi, Baja California Sur. In 2007, after a member of the cooperative took part in a species identification and monitoring workshop with male fishers, a group of her colleagues quickly followed, and the cooperative began monitoring their own resources to ensure sustainable catches. This project inspired other women, now totalling 30 from 6 communities in Baja California, to request and take part in SCUBA diving training and monitoring courses.

In Isla Natividad, Baja California Sur, 14 women have collaborated in research projects that take place on the island with a variety of different organizations. The women currently organize their own research trips, conduct underwater visual censuses, enter the data into databases, and send it directly to both national and international researchers. The advantages of working with women's groups such as those mentioned here are numerous. From a purely logistical point of view, the women are available to take part in research projects year-round, unaffected by the state of the fishery which, during peak times, can affect male fishers' willingness to participate. However, the social benefits are much greater in the long-term. Gender barriers are being broken down in what are traditionally some of the more conservative communities in the country.

### *7.2.4 Measuring Confidence in the Data*

During the training process and before each monitoring session, fishers passed through a series of evaluations to ensure the accuracy and precision of the data collected. Species identification was tested using a combination of slideshow exams and in-water 1:1 dives with a trainer. Size estimation accuracy was evaluated by having fishers visually estimate the size of objects underwater.

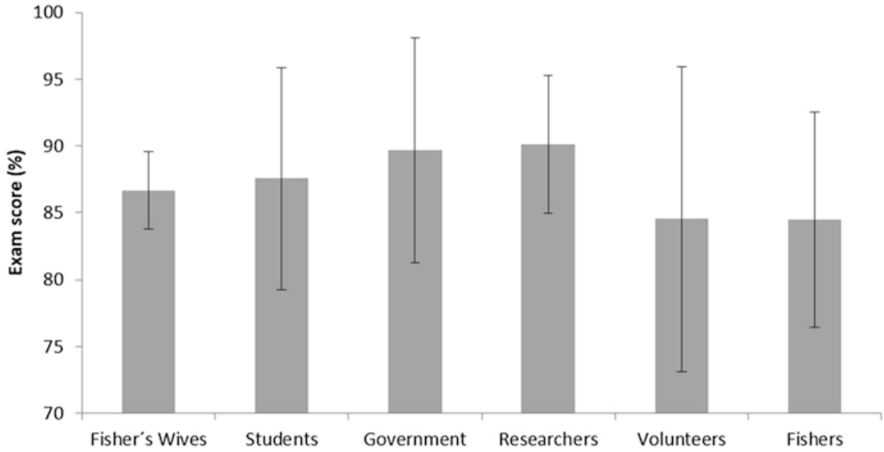



**Fig. 7.3** Classroom species ID exam scores (%) for participants of different backgrounds with standard deviation

Classroom exam scores for fishers were compared with other participants who have also taken the monitoring course, including volunteers, students, fishers' wives, researchers, and members of government agencies (Fig. 7.3). To detect possible differences between the scores, one-way analysis of variance (ANOVA, $\alpha = 0.05$; Zar 2010) was conducted. Taking into account the two principles for parametric analysis (normality and homoscedasticity), corresponding a priori tests were carried out, Bartlett's Chi-Square (Zar 2010). The analysis did not show significant differences between the participants ($F_{(5,90)} = 1.107$, $p = 0.362$).

In-water species identifications skills were evaluated by comparing data collected by trainers with those of the fishers taken on the same transect line. Coral and benthic data were evaluated by both divers, who registered data along a leaded rope that remained stationary on the seafloor (unlike a fibreglass tape which may sway with the surge), and allowed the same point to be registered by both divers. Fish data were collected by the trainer simultaneously, who swam above the fisher during the transect. The measure of similarity in the results was calculated using the Bray-Curtis measure (Smith 2002):

$$BC_{ij} = \frac{\sum\left[p_{ik} - p_{jk}\right]}{\sum\left[p_{ik} + p_{jk}\right]}$$

**Equation 7.6.1** Calculation of the Bray-Curtis measure.

where $p_{ik}$ and $p_{jk}$ represent the proportions of individuals in census $i$ and $j$, respectively, which belong to species $k$. The index ranges from 0, where there are no species in common, to 1.0, where the distribution of species is identical. The data,

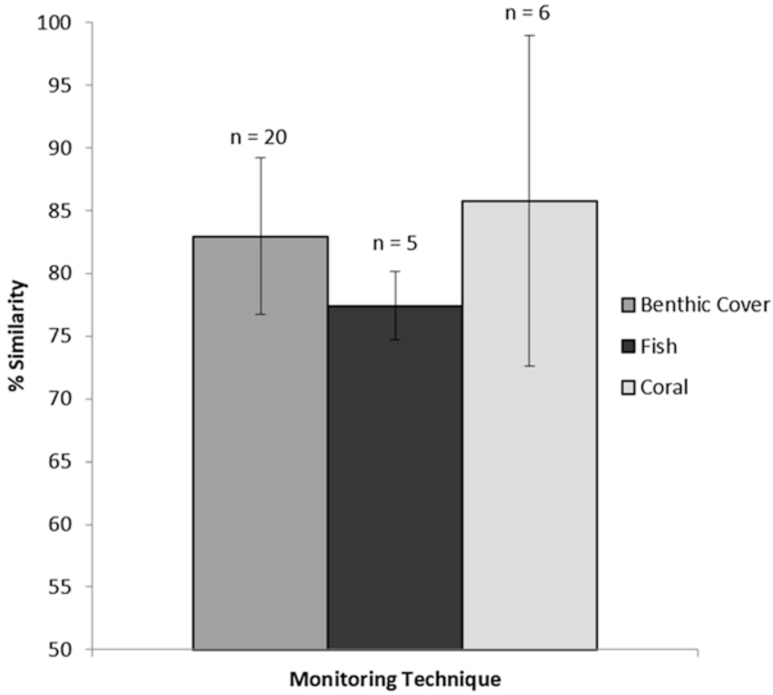



**Fig. 7.4** Bray-Curtis similarity measure for species identification between fishers and trainer during in-water tests

expressed as a similarity percentage (Fig. 7.4), suggest that fishers can successfully identify coral and benthic cover accurately (85.7% and 82.9% similar to the instructor, respectively).

Fish identification accuracy was slightly lower (77.4% similar), although more variation is expected due to the differing viewpoints of the two observers on the simultaneous transect. All three techniques compare favourably to other studies on volunteer divers using similar methodologies. Mumby et al. (1995) found that volunteer divers in Belize could correctly identify coral 52–70% of the time and benthic cover 70–90% of the time. Similarly, Harding et al. (2000) found volunteer diver fish data to be 75.3% similar to that of instructors after 1 week's training, rising to 78.5% after 4 weeks.

Preliminary analysis of the fish data reported in this study suggests that the error incurred is a result of underrepresentation of smaller fishes, such as those of the family Labridae. Analyses of this type provide trainers with the necessary information to focus further training and improve performance.

Considering that fishers target many of these species on a daily basis, it comes as no surprise that identification of commercial species is highly accurate. During training, attention was focused more on non-commercial species, including those of

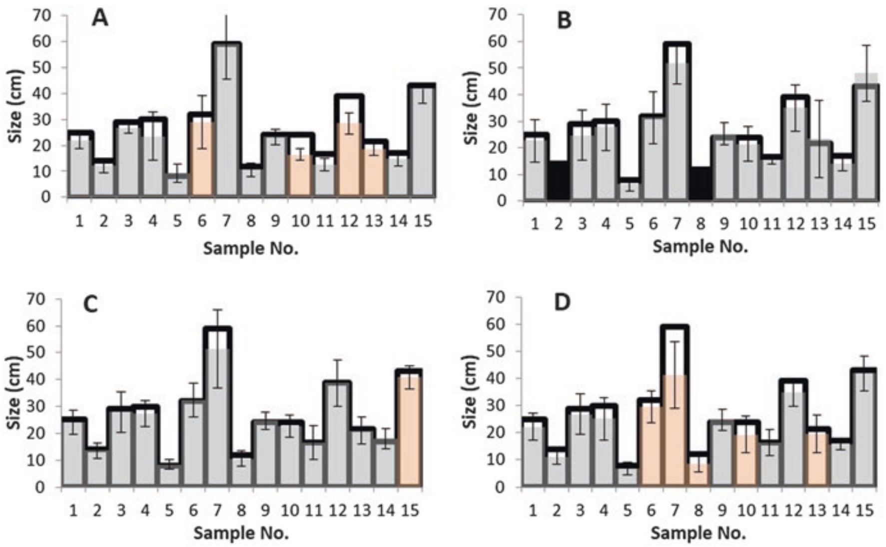



**Fig. 7.5** Results of underwater size estimation exercises using plastic fish. Thick black line represents the true size of each plastic fish (n = 15), and the coloured shading represents the averaged estimates of each group (**a**, **b**, **c**, **d**) with standard deviation. Grey shading represents estimations within the correct size category, red shading represents an underestimated size, and a black column represents no data. (**a**) Fishers from the Cozumel Fishing Cooperative, Maria Elena, Sian Ka'an, March 2015, n = 6; (**b**) fishers from Banco Chinchorro, June 2013, n = 3; (**c**) students on a university training course, July 2014, n = 14; and (**d**) volunteer divers (principally biologists) taking part in AGRRA workshop, April 2013, n = 7

high importance to ecosystem health that fishers may have previously ignored. It has been noted that, particularly for cryptic commercial species (organisms that are not easily visible) such as octopus, lobster, and some shellfish, fishers are considerably more reliable than biologists in registering the species present. For example, during abalone censuses in Isla Natividad, abalone fishers found abalone much more quickly than researchers, and similar results have been seen with lobster in the Mesoamerican Reef. In general, we saw that fishers have a heightened awareness for their target species, which can prove beneficial during surveys.

Size estimation accuracy, which is critical for biomass calculation, is also consistent amongst fishers and volunteer observers. The size of the plastic fish was estimated underwater by each observer as mentioned above. Postdive, the plastic fish were measured, and sizes were compared to the observers' estimates. Group average size estimations by fishers (Fig. 7.5, A and B) and volunteer divers taking part in reef monitoring training workshops (C and D) were registered. Non-fisher groups consisted principally of biology students or biologists working in CSOs. The results showed that fishers can estimate size underwater as effectively as volunteer divers, even when the majority of the volunteer divers are biologists. We can also see that, amongst all observers, underestimation is more common than overestimation with individual data, again calling for personalized training to be undertaken to improve estimation accuracy for those individuals that need it.

## 7.3 Discussion and Conclusion

It is important to highlight that, while the fishers engaged in this program are participants in a citizen science program, the program differs somewhat from the conventional sense: with the establishment of marine reserves, the fishers are investing in their future. This is unlike the Audubon Society's Bird Surveys or REEF, where data are collected by volunteers in their free time and used by the host organization to monitor general population health and large-scale changes in species distribution. In the case studies discussed in this chapter, the fishers collect the data at a very local level, and, while scientists provide technical support and make management suggestions, the fishers are the ones who decide whether to implement them based on the data collected. The fishers also keep the data for their own use.

Successful implementation of the recommendations is often due to increased trust in the data and concerns over the long-term sustainability for their fisheries. Unfortunately, it is common for scientists to visit communities and collect data without providing feedback to the community, causing fishers to fear that these data will be used against them in top-down management measures, such as the closure of fishing grounds, rather than for their benefit and in a clear, transparent process in which they have a voice. The result is that they can be less likely to participate or share important information that could be mutually beneficial for both fishers and scientists alike.

In the case of marine reserves where members of affected communities collect the data themselves, there can be no quibble amongst fishers regarding their reliability. Additionally, data generated in the marine reserves has been seen to provoke one of two reactions: (1) if no recovery of marine biodiversity is seen, fishers feel the need to redouble their conservation efforts, given that they have a vested personal interest in the area and are responsible for the data collected; and (2) if improvements in the marine biodiversity are seen, great pride is felt within the community without the suspicion that the data are not representative or trustworthy. To date, we have not seen a negative reaction to the reserves that have shown slow or little recovery. The adaptive management options available also help to curtail this possibility. The most commonly used framework for these marine reserves is the voluntary community scheme or the 'fish refuge' scheme governed by Mexican Fisheries Law. Both frameworks allow reserves to be moved or modified, if necessary.

The importance of data collected by non-professionals is well documented, and, despite some criticism, the majority of studies comparing the validity of data collected by volunteers and experts using suitable methodologies have been favourable (Schmitt and Sullivan 1996; Hassell et al. 2013). Fewer studies have evaluated the ability of small-scale fishers from developing countries to collect accurate data, although Beger (2002) and Uychiaoco et al. (2005) found more variation in data collected by the fishers than what was collected by trainers. However, in the second study, training time was limited due to financial restrictions and the capacity of the monitoring team.

In the case of this program, fishers are financially compensated with a small stipend for the time they commit to the monitoring program, thus avoiding conflicts between taking part in the monitoring program and supporting their families. In this study, we observed that fishers can conduct visual censuses and estimate sizes with the same accuracy as trained volunteer divers, as reported by Mumby et al. (1995) and Harding et al. (2000). Similarly, test results suggest that fishers can identify species as successfully as groups with stronger formal educational backgrounds, although, as expected, professional researchers did score considerably higher. The range of evaluations conducted with the fishers in this study are necessary to ensure the validity of the data collected, and confidence in the resulting data is not only high amongst fishers but also government agencies and visiting scientists. The importance of a suitable methodology cannot be overemphasized.

Most of our community partners have completed only basic education, and while literacy is a requirement for joining the monitoring team, individual literacy abilities can vary. The methodology, data sheets, and databases should take this into account to ensure that minimal errors occur during data collection and entry into the databases. Frequent follow-up with the community is also important. Data analysis is performed off-site by CSO staff or researchers, and, as such, data must be given back to the fishers as soon as possible.

This chapter demonstrates how the involvement of small-scale fishers in the implementation of conservation measures in three ecoregions of Mexico – kelp forests, coral reefs, and rocky reefs – has been achieved through a participatory process. The model used in this chapter has been adopted for use by organizations in other areas, both in Mexico and neighbouring countries. These findings suggest that it is a very effective community empowerment tool, given that involving community members in the scientific process creates responsibility, pride, and a deeper understanding of the ecosystem in which they live and work. In this way, the empowerment of fishers allows them to make more effective, participatory management decisions for their fisheries to ensure the long-term success of fisheries and fishers' livelihoods.

The program shows the importance of participative processes, including training, follow-up, and returning data back to those involved in monitoring. Work needs to be done to ensure the long-term sustainability, expansion, and replication of such programs for the benefit of resource conservation, the sustainability of fisheries, and the viability of fishing communities.

**Acknowledgements** First and foremost, we would like to thank all the fishers who made this work possible. Without the proactive, positive thinking of the fishers throughout Mexico who participated, who foresaw the need to create marine reserves in and around their fishing grounds, we would never have had the opportunity to put into practice a marine monitoring model on this scale. We thank The David and Lucile Packard Foundation, Marisla Foundation, Sandler Supporting Family Foundation, the Oak Foundation, The Summit Foundation, and the Walton Foundation; without their support this work would not have been possible. We also thank the Alianza World Wildlife Fund-*Fundación Carlos Slim*, *Fondo Mexicano para la Conservación de la Naturaleza*, and The Nature Conservancy. Finally, over the years we have had logistical, financial, and strategic support from the *Comisión Nacional de Áreas Naturales Protegidas* (CONANP), *Comisión Nacional de Acuacultura y Pesca* (CONAPESCA), and *Instituto Nacional de Pesca* (INAPESCA).

## References

Abesamis RA, Green AL, Russ GR, Jadloc CRL (2014) The intrinsic vulnerability to fishing of coral reef fishes and their differential recovery in fishery closures. Rev Fish Biol Fish 24(4):1033–1063

Aburto-Oropeza O, Erisman B, Galland GR, Mascareñas-Osorio I, Sala E, Ezcura E (2011) Large recovery of fish biomass in a no-take marine reserve. PLoS One 6(8):e23601. https://doi.org/10.1371/journal.pone.0023601

Ainsworth CH, Kaplan IC, Levin PS, Cudney-Bueno R, Fulton EA, Mangel M, Turk-Boyer M, Torre-Cosio J, Pares-Sierra A, Morzaria-Luna H (2011) Atlantis model development for the Northern Gulf of California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-110

Ballantine B (2014) Fifty years on: lessons from marine reserves in New Zealand and principles for a worldwide network. Biol Conserv 176:297–307

Beger M (2002) Fish and benthic monitoring at Danjugan Island Marine Reserve and Sanctuaries, Negros Occidental, Philippines: training local fisherfolk to monitor their reefs using SCUBA. Rufford Small Grants Foundation, London

Berkes F, Folke C, Gadgil M (1995) Traditional ecological knowledge, biodiversity, resilience and sustainability. In: Perrings CA (ed) Biodiversity conservation. Kluwer Academic Publishers, Dordrecht, pp 281–299

Butler JRA, Tawake A, Skewes T, McGrath V (2012) Integrating traditional ecological knowledge and fisheries management in the Torres Strait, Australia: the catalytic role of turtles and dugong as cultural keystone species. Ecol Soc 17(4):34. https://doi.org/10.5751/ES-05165-170,434

Charles A, Wilson L (2009) Human dimensions of marine protected areas. ICES J Mar Sci: J Conseil 66(1):6–15

Cisneros-Mata MA, Ulloa R, Laurencez-Reyes V, Rojo M, Meza A, Torre J, Andrews K (2011a) Evaluación de un banco de callo de hacha liso (Atrina oldroydii) en Bahía de Kino, Sonora en marzo de 2011 (Technical Report). Instituto Nacional de Pesca, Guaymas

Cisneros-Mata MA, Ulloa R, Laurencez-Reyes V, Rojo M, Meza A, Torre J, Andrews K (2011b) Evaluación de un banco de callo de árbol en El Desemboque, Sonora en marzo/abril de 2011 (Technical Report). Instituto Nacional de Pesca, Guaymas

Comisión Nacional de Pesca y Acuacultura (2009) Anuario estadístico de pesca y acuacultura. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, Mazatlán

Costello C, Kaffine DT (2010) Marine protected areas in spatial property-rights fisheries. Aust J Agric Resour Econ 54(3):321–341

Cudney-Bueno R, Lavín MF, Marinone SG, Raimondi PT, Shaw WW (2009a) Rapid effects of marine reserves via larval dispersal. PLoS One 4(1):e4140. https://doi.org/10.1371/journal.pone.0004140

Cudney-Bueno R, Bourillón L, Sáenz-Arroyo A, Torre-Cosío J, Turk-Boyer P, Shaw WW (2009b) Governance and effects of marine reserves in the Gulf of California, Mexico. Ocean Coast Manag 52(3):207–218

Darwall WR, Dulvy NK (1996) An evaluation of the suitability of non-specialist volunteer researchers for coral reef fish surveys. Mafia Island, Tanzania—a case study. Biol Conserv 78(3):223–231

Drew J (2005) Use of traditional ecological knowledge in marine conservation. Conserv Biol 19:1286–1293

Espinosa-Romero MJ, Rodríguez LF, Weaver AH, Villanueva-Aznar C, Torre J (2014) The changing role of NGOs in Mexican small-scale fisheries: from environmental conservation to multi-scale governance. Mar Policy 50:290–299

Fernández-Rivera Melo FJ (2015) Análisis de los métodos de monitoreo empleados para evaluar el estado de las áreas naturales protegidas marinas en el Golfo de California. Master's thesis, Universidad Autónoma de Baja California Sur, Mexico

Fernández-Rivera Melo FJ, Hernández-Velasco A, Luna M, Lejbowicz A, Sáenz-Arroyo A (2012) Protocolo de Monitoreo para reservas marinas del Golfo de California (Programa Península de Baja California). Comunidad y Biodiversidad A.C., La Paz BCS

Fernández-Rivera Melo FJ, Reyes-Bonilla H, Sánchez-Alcántara I (2013) Un ejemplo de co-manejo pesquero en el Golfo de California: Caso de estudio cooperativa pesquera 'Mujeres del Golfo'. El Sudcaliforniano, p 6

Fernández-Rivera Melo FJ, Suarez-Castillo A, Hernández-Velasco A, Fulton S, Cuevas-Zimbron E, Torre-Cosio J (2014) Ciencia ciudadana: ¿Qué es?, ¿Cómo participan las comunidades? El Sudcaliforniano, p 11

Fernández-Rivera Melo FJ, Reyes-Bonilla H, Cantú A, Urías J (2015a) First record of albinism in the brown sea cucumber *Isostichopus fuscus* in the Gulf of California, Mexico. Mar Biodivers Rec 8:14. https://doi.org/10.1017/S1755267214001353

Fernández-Rivera Melo FJ, Reyes-Bonilla H, Campos-Dávila L, Balart EF (2015b) Range extension of *Lutjanus inermis* (Peters, 1896) (Perciformes: Lutjanidae) to the central region of the Gulf of California, Mexico. J Appl Ichthyol 31(3):541–543

Fernández-Rivera Melo FJ, Hernández-Velasco A, Suarez-Castillo A, Rojo M, Weaver AH, Walther-Mendoza M, Padilla R (2015c) Monitoreo submarino comunitario en el Golfo de California: un ejemplo de como las comunidades costeras participan en el manejo y conservación de sus recursos naturales. El Sudcaliforniano, p 3

Fletcher D, Shortis M (2001) A comparison of the precision and accuracy of estimates of reef-fish lengths determined visually by divers with estimates produced by a stereo-video system. Fish Sci 99(1):63–71

Forrester G, Baily P, Conetta D, Forrester L, Kintzing E, Jarecki L (2015) Comparing monitoring data collected by volunteers and professionals shows that citizen scientists can detect long-term change on coral reefs. J Nat Conserv 24:1–9

Freiwald J, Wisniewski C, Wehrenberg M, Shuman CS, Dawson C (2013) Reef check California instruction manual: a guide to rocky reef monitoring, 7th edn. Reef Check Foundation, Pacific Palisades

Fulton S, Caamal J, Ribot C, Lucas B, Garcia C, Bourillon L, Flores E (2013) Coral reef monitoring with fishers' participation in Quintana Roo, Mexico: building social capital to preserve marine ecosystems. In: Proceedings of the Gulf and Caribbean Fisheries Institute 2013, Corpus Christi, Texas, USA, November 4–8, 2013, pp 353–359

Fulton S, Bourillón L, Ribot C, Caamal J, García C, Flores E, Heyman W, Olivares M (2014) Fishermen investing in a network of fish refuges (no-take zones) in Quintana Roo, Mexico. In: McConney P, Medeiros RP, Pena M (eds) Enhancing stewardship in small-scale fisheries: practices and perspectives. Centre for Resource Management and Environmental Studies & Too Big to Ignore, Barbados, pp 138–144

Gell FR, Roberts CM (2002) The fishery effects of marine reserves and fishery closures. WWF-US, Washington

Germain N (2014) Factibilidad de la pesquería de ornato y co-manejo sostenible en áreas costeras e insulares. Doctoral thesis, Universidad Autónoma de Baja California Sur, Mexico

Germain N, Hartmann HJ, Fernández-Rivera Melo FJ, Reyes-Bonilla H (2015) Ornamental reef fish fisheries: new indicators of sustainability and human development at a coastal community level. Ocean Coast Manag 104:136–149

Gonzalez-Cuellar OT (2012) Estructura comunitaria y zonación geográfica de peces en arrecifes rocosos del norte del Golfo de California. Bachelors' thesis, Universidad Autónoma de baja California Sur, Mexico

Gonzalez-Cuellar OT, Reyes-Bonilla H, Fourriere M, Rojo M, Hernandez-Velasco A, Sanchez-Alcántara I, Pfister T (2013) Range extensions of four species of parrotfishes (Scaridae) in the northern Gulf of California, Mexico. Cybium 37:223–226

Greenley AP, Muguia-Vega A, Saenz-Arroyo A, Micheli F (2012) New tetranucleotide microsatellite loci in pink abalone (*Haliotis corrugata*) isolated via 454 pyrosequencing. Conserv Genet Resour 4(2):265–268

Groves CR, Jensen DB, Valutis LL, Redford KH, Shaffer ML, Scott JM, Baumgartner JV, Higgins JV, Beck MW, Anderson MG (2002) Planning for biodiversity conservation: putting conservation science into practice. Bioscience 52(6):499–512

Hamilton RJ, Potuku T, Montambault JR (2011) Community-based conservation results in the recovery of reef fish spawning aggregations in the Coral Triangle. Biol Conserv 144(6):1850–1858

Harding S, Lowery C, Oakley S (2000) Comparison between complex and simple reef survey techniques using volunteers: is the effort justified? In: Proceedings of the 9th international coral reef symposium. International Coral Reef Society, Bali, October 23–27, 2000, pp 883–889

Hassell NS, Williamson DH, Evans RD, Russ GR (2013) Reliability of non-expert observer estimates of the magnitude of marine reserve effects. Coast Manag 41:361–380

Healthy Reefs Initiative (2012) Report card for the Mesoamerican Reef. Healthy Reefs Initiative, Belize City

Hernández-Velasco JA (2010) Efecto de la pesca artesanal en la estructura comunitaria de peces de arrecife rocoso del noreste del Golfo de California, México. Bachelors' thesis, Universidad Autónoma de Baja California Sur, Mexico

Hernández-Velasco A, Vásquez-Vera L (2013) Pioneras del buceo comunitario en la Península de Baja California. Espacio Profundo Digit 123:33–39

Hernández-Velasco A, Villaseñor JC, Torre J, Suarez-Castillo A, Espinoza A (2015) Un bosque bajo el agua Isla Natividad. Espacio Profundo Digit 136:28–33

Hernández-Velasco A, Fernández-Rivera-Melo FJ, Melo-Merino SM, Villaseñor-Derbez JC (2016) Occurrence of *Holacanthus clarionensis* (Pomacanthidae), *Stegastes leucorus*, and *Stegastes acapulcoensis* (Pomacentridae) at Magdalena Bay, BCS, Mexico. Mar Biodivers Rec 9(1):49. https://doi.org/10.1186/s41200-016-0062-1

Heyman WD (2011) Elements for building a participatory, ecosystem-based marine reserve network. Prof Geogr 63(4):475–488

Heyman WD, Olivares M, Fulton S, Bourillón L, Caamal J, Ribot C, Kobara S (2014) Prediction and verification of reef fish spawning aggregation sites in Quintana Roo, Mexico. In: McConney P, Medeiros RP, Pena M (eds) Enhancing stewardship in small--scale fisheries: practices and perspectives. Centre for Resource Management and Environmental Studies & Too Big to Ignore, Barbados, pp 73–81

Hilborn R (2016) Policy: marine biodiversity needs more than protection. Nature 535(7611): 224–226

Kennedy EV, Perry CT, Halloran PR, Iglesias-Prieto R, Schönberg CH, Wisshak M, Form AU, Carricart-Ganivet JP, Fine M, Eakin CM, Mumby PJ (2013) Avoiding coral reef functional collapse requires local and global action. Curr Biol 23(10):912–918

Kramer P, McField M, Álvarez-Filip L, Drysdale I, Rueda-Flores M, Giro A, Pott R (2015) 2015 Report card for the Mesoamerican Reef. Healthy Reefs Initiative, Miami

Lang J, Marks KW, Kramer PA, Kramer R, Ginsburg RN (2010) Atlantic Gulf rapid reef assessment protocol version 5.4. http://www.agrra.org/. Accessed 19 Aug 2016

Leopold M, Cakacaka A, Meo S, Sikolia J, Lecchini D (2009) Evaluation of the effectiveness of three underwater reef fish monitoring methods in Fiji. Biodivers Conserv 18(13):3367–3382

Lucas B, Lau W, Rolón E (2012) Feasibility study for a marine payment for ecosystem services in the Mesoamerican Reef of Mexico (Final Report). Comunidad y Biodiversidad. A.C., Puerto Morelos

Marine Conservation Institute (2013) Global ocean refuge system. https://globaloceanrefuge.org. Accessed 19 Aug 2016

Marine Stewardship Council (2012) MSC Public Certification Report for Sian Ka'an and Banco Chinchorro Biosphere Reserves Spiny Lobster fishery. MRAG Americas Inc., St. Petersburg

Martínez-Torres M, Reyes-Bonilla H, Fernández-Rivera Melo FJ, Sánchez-Alcántara I, González-Cuellar OT, Morales-Portillo CD (2014) Range extension of the blue and yellow damselfish *Chromis limbaughi* (Pomacentridae) to the northern Gulf of California, Mexico. Mar Biodivers Rec 7. https://doi.org/10.1017/S1755267214000281

Mercier A, Hamel J-F, Toral-Granda T-G, Alvarado JJ, Paola Ortiz E, Benavides M (2013) *Isostichopus fuscus*. The IUCN red list of threatened species 2013. https://doi.org/10.2305/IUCN.UK.2013-1.RLTS.T180373A1621878.en

Micheli F, Sáenz-Arroyo A, Greenley A, Vazquez L, Espinoza Montes JA, Rossetto M, De Leo GA (2012) Evidence that marine reserves enhance resilience to climatic impacts. PLoS One 7(7):e40832. https://doi.org/10.1371/journal.pone.0040832

Micheli F, Butner C, De Leo G, Martone RG, Shester G (2014) A risk-based framework for assessing the cumulative impact of multiple fisheries. Biol Conserv 176:224–235

Monterey Bay Aquarium Sea Food Watch (2014) California Yellowtail. http://www.seafoodwatch.org/-/m/sfw/pdf/reports/mba_seafoodwatch_mexicocayellowtailreport.pdf. Accessed 14 May 2015

Moreno C, Torre J, Bourillón L, Durazo M, Weaver AH, Barraza R, Castro R (2005) Estudio y evaluación de la pesquería de callo de hacha (Atrina tuberculosa) en la Región de Bahía de Kino, Sonora y recomendaciones para su manejo (Internal Report). Comunidad y Biodiversidad, A.C., Guaymas

Moreno-Báez M, Cudney-Bueno R, Orr BJ, Shaw WW, Pfister T, Torre-Cosio T, Loaiza R, Rojo M (2012) Integrating the spatial and temporal dimension of fishing activities for management in the Northern Gulf of California, Mexico. Ocean Coast Manag 55:111–127

Moreno-Davila BB (2013) Taxonomía y biogeografía de ascidias (Tunicata: Ascidiacea) asociados a mantos de rodolitos y bosques de sargazo en el noroeste del Pacífico Mexicano. Master's thesis, Universidad Autónoma de Baja California Sur, Mexico

Mumby PJ, Harborne AR, Raines PS, Ridley JM (1995) A critical assessment of data derived from Coral Cay conservation volunteers. Bull Mar Sci 56(3):737–751

Munguia-Vega A, Jackson A, Marinone SG, Erisman B, Moreno-Baez M, Girón-Nava A, Pfister T, Aburto-Oropeza O, Torre J (2014) Asymmetric connectivity of spawning aggregations of a commercially important marine fish using a multi-disciplinary approach. PeerJ 2:e511. https://doi.org/10.7717/peerj.511

Munguía-Vega A, Sáenz-Arroyo A, Greenley AP, Espinoza-Montes JA, Palumbi SR, Rossetto M, Micheli F (2015a) Marine reserves help preserve genetic diversity after impacts derived from climate variability: lessons from the pink abalone in Baja California. Glob Ecol Conserv 4:264–276

Munguía-Vega A, Torre J, Turk-Boyer P, Marinone SG, Lavín MF, Pfister T, Shaw W, Danemann G, Raimondi P, Castillo-Lopez A, Cinti A, Duberstein JN, Moreno-Báez M, Rojo M, Soria G, Sánchez-Velasco L, Morzaria-Luna HM, Bourillón L, Rowell K, Cudney-Bueno R (2015b) PANGAS: an interdisciplinary ecosystem-based research framework for small-scale fisheries in the Northern Gulf of California. J Southwest 57:337–390

Ovando D, Dougherty D, Wilson JR (2016) Market and design solutions to the short-term economic impacts of marine reserves. Fish Fish 17:939–954

Pattengill-Semmens CV, Semmens BX (2003) Conservation and management applications of the Reef Volunteer Fish Monitoring Program. Environ Monit Assess 81(1–3):43–50

Pikitch EK, Santora EA, Babcock A, Bakun A, Bonfil R, Conover DO, Dayton P, Doukakis P, Fluharty D, Heheman B, Houde ED, Link J, Livingston PA, Mangel M, McAllister MK, Pope J, Sainsbury K (2004) Ecosystem-based fishery management. Science 305:346–347

PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) (2016) Partnership for interdisciplinary studies of coastal oceans. http://www.piscoweb.org. Accessed 20 Feb 2016

Precoma de la Mora M (2015) Distribución potencial de peces de importancia comercial en el norte del Golfo de California, México: influencia del cambio climático sobre las principales áreas de pesca de la zona. Master's thesis, Centro de Investigación Científica y de Educación Superior de Ensenada. Ensenada, Baja California, Mexico.

Revollo-Fernández DA (2012) Eficiencia técnica, social y económica de la pesquería de abulón bajo un esquema de gestión por medio de reservas marinas: el caso de Isla Natividad, Baja California, México. Doctoral thesis, Universidad Nacional Autónoma de México, México, D.F

Reyes-Bonilla H, Herrero-Perezrul MD, Fernández-Rivera Melo FJ (2009) Aspectos económicos de los recursos pesqueros no tradicionales residentes en zonas arrecifales del Golfo de California. In: Urciaga-Garcia J, Beltrán-Morales LF, Lluch-Belda D (eds) Recursos marinos y servicios ambientales en el desarrollo regional. Instituto Politécnico Nacional. Centro Interdisciplinario de Ciencias Marinas, La Paz, pp 245–264

Riosmena-Rodríguez R, Boo GH, López-Vivas JM, Hernández-Velasco A, Sáenz-Arroyo A, Boo SM (2012) The invasive seaweed *Sargassum filicinum* (Fucales, Phaeophyceae) is on the move along the Mexican Pacific coastline. Bot Mar 55(5):547–551

Roberts CM, Hawkins JP (2000) Fully-protected marine reserves: a guide. WWF Endangered Seas Campaign and University of York, Washington, DC & York, UK

Roberts CM, Bohnsack JA, Gell F, Hawkins JP, Goodridge R (2001) Effects of marine reserves on adjacent fisheries. Science 294(5548):1920–1923

Rossetto M (2012) Population dynamics and resilience of green abalone *Haliotis fulgens* in Isla Natividad. Doctoral thesis, UniversitàdegliStudi di Parma. Dipartimento di Scienze Ambientali, Italy

Rossetto M, Leo GAD, Greenley A, Vazquez L, Saenz-Arroyo A, Montes JAE, Micheli F (2013) Reproductive potential can predict recruitment rates in abalone. J Shellfish Res 32(1):161–169

Rossetto M, Micheli F, Saenz-Arroyo A, Montes JAE, De Leo GA (2015) No-take marine reserves can enhance population persistence and support the fishery of abalone. Can J Fish Aquat Sci 72(10):1503–1517

Ruiz-Frau A, Possingham HP, Edward-Jones G, Klein CJ, Segan D, Kaiser MJ (2015) A multidisciplinary approach in the design of marine protected areas: integration of science and stakeholder based methods. Ocean Coast Manag 103:86–93

Russ GR, Alcala AC (2003) Marine reserves: rates and patterns of recovery and decline of predatory fish, 1983–2000. Ecol Appl 13(6):1553–1565

Russ GR, Alcala AC (2004) Marine reserves: long-term protection is required for full recovery of predatory fish populations. Oecologia 138(4):622–627

Salas S, Chuenpagdee R, Seijo JC, Charles A (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fish Res 87(1):5–16

Schafer AG, Reis EG (2008) Artisanal fishing areas and traditional ecological knowledge: the case study of the artisanal fisheries of the Patos Lagoon estuary (Brazil). Mar Policy 32(3):283–292

Schmitt EF, Sullivan KM (1996) Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. Bull Mar Sci 59(2):404–416

Secretaria de Gobernación (2002) Decreto por el que se declara área natural protegida con la categoría de reserva de la biosfera, la región denominada Isla San Pedro Mártir, ubicada en el Golfo de California, frente a las costas del Municipio de Hermosillo, Estado de Sonora, con una superficie total de 30,165-23-76.165 hectáreas. Gobierno de Mexico, Mexico, D.F

Secretaria de Gobernación (2012) Acuerdo por el que se establece una red de zonas de refugio pesquero en aguas marinas de jurisdicción federal en el área de Sian Ka'an, dentro de la Bahía Espíritu Santo en el estado de Quintana Roo. Diario Oficial de la Federación. México. Gobierno de Mexico, Mexico, D.F

Secretaria de Gobernación (2013) Acuerdo por el que se establece una red de zonas de refugio pesquero en aguas marinas de jurisdicción federal en las áreas de Banco Chichorro y Punta Herrero en el estado de Quintana Roo. Diario Oficial de la Federación. México. Gobierno de Mexico, Mexico, D.F

Secretaria de Medio Ambiente y Recursos Naturales (2012) Plan de manejo tipo para peces marinos de ornato. Gobierno de Mexico, México, D.F. http://www.semarnat.gob.mx/archivosanteriores/temas/gestionambiental/vidasilvestre/Documents/Planes%20de%20Manejo/PM%20Peces%20Ornato%2031%20octubre%202012.pdf. Accessed 19 Aug 2016

Shuman CS, Dawson C, Wisniewski C, Wehrenberg M, Freiwald J (2011) Reef check California instruction manual: a guide to rocky reef monitoring, 6th edn. Reef Check Foundation, Pacific Palisades

Silvertown J (2009) A new dawn for citizen science. Trends Ecol Evol 24(9):467–471

Smith EP (2002) Ecological statistics. In: El-Shaarawi AH, Piegorsch WW (eds) Encyclopedia of environmetrics. John Wiley and Sons, Ltd., Chichester, pp 589–602

Suárez-Castillo A (2014) Bosques de Sargassum en el Golfo de California: estrategias para su conservación y manejo. Doctoral thesis, Universidad Autónoma de Baja California Sur, Mexico

Suarez-Castillo AN, Torre-Cosío J, Rojo-Amaya M, Fernández-Rivera Melo FJ, Talamantes C, Figueroa-Carranza AL, Mariano-Meléndez E, Urciaga-García J, Cabrera A, Sáenz-Arroyo A, Aburto-Oropeza O, Riosmena-Rodríguez R (2014) Valoración económica de los servicios ecosistémicos de los bosques de sargassum en el Golfo de California, Mexico. En: Urciaga J (ed) Desarrollo regional en Baja California Sur: una perspectiva de los servicios ecosistémicos, Universidad Autónoma de Baja California Sur, La Paz, pp 79–111

Thomas HL, Macsharry B, Morgan L, Kingston N, Moffitt R, Stanwell-Smith D, Wood L (2014) Evaluating official marine protected area coverage for Aichi Target 11: appraising the data and methods that define our progress. Aquat Conserv Mar Freshwat Ecosyst 24(S2):8–23

Thornton TF, Maciejeski-Sheer A (2012) Collaborative engagement of local and traditional knowledge and science in marine environments: a review. Ecol Soc 17(3):8. https://doi.org/10.5751/ES-04714-170,308

Torre J, Bourillón L, Weaver AH (2004) La pesquería de la jaiba verde (*Callinectes bellicosus*) en la región de Bahía de Kino y Canal de Infiernillo entre 1998 y 2002 (Informe Interno) Comunidad y Biodiversidad, A.C, Guaymas

UNDP-HDR (2015) Gender inequality index. http://hdr.undp.org/en/composite/GII. Accessed 19 Aug 2016

Uychiaoco AJ, Arceo HO, Green SJ, Margarita T, Gaite PA, Aliño PM (2005) Monitoring and evaluation of reef protected areas by local fishers in the Philippines: tightening the adaptive management cycle. Biodivers Conserv 14(11):2775–2794

Velez M, Adlerstein S, Wondolleck J (2014) Fishers' perceptions, facilitating factors and challenges of community-based no-take zones in the Sian Ka'an Biosphere Reserve, Quintana Roo, Mexico. Mar Policy 45:171–181

Villaseñor-Derbez JC, Hernández-Velasco A, Erauskin M, Fulton S, Cota-Nieto JJ, Torre-Cosio J, Herzka-Llona S, Aburto-Oropeza O (2015) Effects of short-term marine reserves on grouper and bass populations. DataMares. Interactive Resource. https://doi.org/10.13022/M33K52

Ward-Paige CA, Mora C, Lotze HK, Pattengill-Semmens C, McClenachan L, Arias-Castro E, Myers RA (2010) Large-scale absence of sharks on reefs in the Greater-Caribbean: a footprint of human pressures. PLoS One 5(8):e11968. https://doi.org/10.1371/journal.pone.0011968

White C (2009) Density dependence and the economic efficacy of marine reserves. Theor Ecol 2(3):127–138

Williamson DH, Russ GR, Ayling AM (2004) No-take marine reserves increase abundance and biomass of reef fish on inshore fringing reefs of the Great Barrier Reef. Environ Conserv 31(2):149–159

Zar JH (2010) Biostatistical analysis. Pearson Education. Inc., Englewood Cliffs

**Stuart Fulton** coordinates the national marine reserves program at *Comunidad y Biodiversidad A.C.* (COBI). Stuart has a Master's degree in Oceanography from the National Oceanography Centre at the University of Southampton in the UK. He is currently responsible for collaborative marine reserve projects in three priority marine ecosystems: the Mesoamerican Reef, Baja California's giant kelp forest, and the Gulf of California's rocky reef. Stuart works closely with coastal communities to establish, implement, and monitor the community marine reserves.

**Arturo Hernández-Velasco** is project manager for the marine reserves in the Baja California Peninsula at *Comunidad y Biodiversidad A.C.* (COBI). Arturo is a marine biologist with a Master's in Climate Change and Sustainable Development from the Barcelona National Ecology Institute (INIECO). He has worked for 10 years developing and implementing community-based marine reserves in Mexico. Arturo has trained more than 100 fishers in SCUBA diving and safety and monitoring techniques.

**Alvin Suarez-Castillo** a marine biologist with a PhD in Marine and Coastal Sciences from the Autonomous University of Baja California Sur (UABCS). Until July 2017 he was the project manager for the marine reserves in the Gulf of California at Comunidad y Biodiversidad A.C. (COBI). His research has focused on the study of marine ecosystems formed by marine plants in the Gulf of California, mainly by the rockweed Sargassum. Currently he is developing the biophysical marine reserves principles for three ecosystems in Mexico (kelp forest, rocky, and coral reefs) in collaboration with a team of fishers, NGOs, researchers, and governmental agencies.

**Francisco Fernández-Rivera Melo** coordinates the national sustainable fisheries program in *Comunidad y Biodiversidad, A.C.* (COBI). Francisco is a marine biologist with a master's degree in Marine and Coastal Science from Baja California Sur Autonomous University (UABCS). Francisco has worked for 12 years developing and implementing sustainable fisheries management projects working hand in hand with rural coastal communities.

**Mario Rojo** is a fisheries engineer with over a decade of community-based marine conservation projects in Mexico. Until August 2016, he was the national coordinator of the capacity building program for leaders and fishing organizations at *Comunidad y Biodiversidad, A.C.* (COBI). Mario is currently is a consultant for fishing cooperatives.

**Andrea Sáenz-Arroyo** is a professor and researcher at ECOSUR, a research centre aiming to promote sustainable development in Mesoamerica and the Caribbean. She is a marine biologist with a PhD in Environmental Economics from the University of York. Her main research interest is the identification of the conditions that help users of public goods cooperate towards the common good and the use of local ecological knowledge to better understand what we receive for 'free' from nature. She is a Pew Fellow in Marine Conservation.

**Amy Hudson Weaver** specializes in marine fisheries management and public participation. She currently works as the Fisheries Program Coordinator at *Sociedad de Historia Natural Niparajá*. Some of her projects are focused on the management of the marine park of Espiritu Santo and fisheries management in the San Cosme-Punta Mechudo Corridor. Other projects she coordinates include *Pescador a Pescador*, Pride of Fishing, and Fisheries Fellows in the Southern Gulf of California. She holds a master's degree in Marine Affairs from the University of Washington and a Bachelor's degree from Prescott College.

**Richard Cudney-Bueno** is a program officer at the David and Lucile Packard Foundation, where he leads strategies for ocean conservation and fisheries management in Latin America. He holds a master's degree and a PhD from the School of Natural Resources and the Environment at the University of Arizona, as well as a minor in Cultural Anthropology. In 2005, he co-founded the PANGAS Project, an interdisciplinary, binational initiative for ecosystem-based research and management of coastal fisheries based at the University of Arizona. Richard is a senior fellow with the Environmental Leadership Program and serves in several conservation advisory boards in the USA and Mexico.

**Fiorenza Micheli** is a marine ecologist at the Hopkins Marine Station of Stanford University, where she is the David and Lucile Packard Professor of Marine Science and co-director of the Center for Ocean Solutions. Micheli researches the processes shaping marine communities and incorporating this understanding in marine management. She investigates the climatic impacts and resilience of small-scale fisheries of Baja California, Mexico, the impacts of coastal hypoxia and ocean acidification on marine species and communities, and the function of Large Marine Protected Areas. She is a Pew Fellow in Marine Conservation, a fellow of the California Academy of Sciences, and a senior fellow at Stanford's Woods Institute for the Environment.

**Jorge Torre** is the general director of *Comunidad y Biodiversidad, A.C.* (COBI). He has a PhD in Renewable Natural Resources Management from the University of Arizona. His research has focused on the development of applied investigation in marine conservation and fisheries management, including both ecological and social aspects. He is particularly interested in promoting long-term evaluation and monitoring programs that incorporate traditional knowledge and community participation to measure the impact of conservation and human use on biodiversity. In 2012, he received the Conservation Award from the Desert Museum Arizona-Sonora.

# Chapter 8
# Assessing and Managing Small-Scale Fisheries in Belize

**Rod Fujita, Amy Tourgee, Ramon Carcamo, Lawrence Epstein, Todd Gedamke, Gavin McDonald, Jono R. Wilson, and James R. Foley**

**Abstract** Belize is a global leader in marine conservation, widely recognized for innovative and effective ecosystem-based management. The management of small-scale fisheries in Belize is a recent example. Historically, Belize's commercial fisheries had been managed as an open access resource. In recent years, the number of fishermen and fishing pressure has increased, exacerbating the risk of overfishing and overcapitalization and threatening to erode profits, reduce food production, impact livelihoods, and adversely impact ecosystems. Belize is engaged in two initiatives to reduce this risk: (1) the implementation of spatial secure fishing privileges, known as Managed Access in Belize and (2) the development of an adaptive fisheries assessment and management framework. In this chapter, we describe these two initiatives and highlight the factors associated with successful outcomes observed, thus far, including the engagement of fishermen in the design and implementation of Managed Access and the adaptive management framework. We also discuss the importance of joint workplanning and execution and the need for flexibility and adaptation as new information is obtained and as political and other conditions change.

R. Fujita (✉) · A. Tourgee · L. Epstein
Environmental Defense Fund, San Francisco, CA, USA
e-mail: rfujita@edf.org

R. Carcamo
Belize Fisheries Department, Belize City, Belize

T. Gedamke
MER Consultants, Stuart, FL, USA

G. McDonald
Marine Science Institute and Bren School of Environmental Science & Management, University of California, Santa Barbara, CA, USA

J. R. Wilson
The Nature Conservancy, Bren Hall, University of California at Santa Barbara, Santa Barbara, CA, USA

J. R. Foley
Toledo Institute for Development and Environment, Punta Gorda, Toledo District, Belize



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_8

**Keywords** Belize · Ecosystem management · Secure fishing rights · Adaptive management

## 8.1 Introduction

Belize is a relatively small country with extensive and diverse marine resources within its jurisdiction, including about one third of the Mesoamerican reef, one of the largest barrier reefs in the world. The waters of Belize include an extensive and productive shelf, with a nearshore ecological mosaic of mangrove forests, seagrass meadows, patch reefs, and islands. These habitats support commercial and subsistence fisheries exploited by small-scale fishermen, who mostly use skiffs and sailing vessels. These fisheries make important contributions to food security, the economy, and Belizean culture.

Belize has a long tradition of implementing management measures in response to scientific evidence of threats to marine biodiversity and other ecosystem goods and services. This practice started with the establishment of the nation's first nature reserve, Half Moon Caye National Monument, in 1928 (Young and Horwich 2007). Marine Protected Areas (MPAs) encompass approximately 12% of Belize's waters (within 12 nautical miles from shore), including zones where fishing and other extractive activities are prohibited (Belize Fisheries Department 2016a; Belize Info Center 2016).[1]

In line with this tradition, Belize has responded to scientific evidence suggesting that Belizean fisheries may be overcapitalized; i.e., more capital and other resources are being expended to achieve optimal profit levels. Catch monitoring programs revealed a steady and rapid increase in fishing effort during the late 1990s: for example, the number of conch and lobster fishing licenses increased by 88% between 1997 and 2011 (Gongora 2010[2]; Foley 2012). However, landings started to plateau after 2004, while fishing effort was steadily increasing.

Because Belize's fishery management goals include ensuring that catch does not exceed sustainable levels and the provision of sustainable livelihoods, these trends prompted the Belize Fisheries Department to investigate new ways to manage fishing effort, including the creation of secure fishing privileges attached to specific fishing grounds (Territorial Use Rights for Fisheries or TURFs, called Managed Access in Belize) and adaptive fisheries management (Government of Belize 2009).

In this chapter, we describe how these two initiatives were designed and implemented in Belize and discuss the lessons that were learned in the process. We focus on the importance of participatory processes. A detailed description of how Managed

[1] Calculated from a Belize Fisheries Department estimate of total MPA area of 2929 $km^2$ and the estimated area of 23,660 $km^2$ of lagoons and coastal waters within 12 nm of shore

[2] Unpublished data

Access was scaled to the national level from two pilot sites is available elsewhere (Fujita et al. 2017), as are the details of the adaptive management framework that was developed in Belize (Fujita et al. 2013; McDonald et al. 2014).

## 8.2 Managed Access

In response to increasing fishing pressure and decreasing catch per unit effort (CPUE), which was thought to be degrading fishing livelihoods in Belize, the Belize Fisheries Department (BFD) began investigating management approaches that could align fishing effort with stock productivity to ensure sustainable fishery yields and profits. These investigations led to a decision in 2012 to establish two pilot sites to test the efficacy of establishing secure fishing privileges within designated fishing territories, i.e., Managed Access Areas (see Fig. 8.1). Glover's Reef Marine Reserve[3] was selected as one of the pilot sites; it is an offshore coral atoll with reef-associated finfish, lobster, and conch fisheries. The other pilot site was established at the Port Honduras Marine Reserve, encompassing an estuary fringed with mangrove forests and including patch reefs and seagrass meadows. Reef fish, lobster, and conch are also harvested at this site.

The exclusive rights to fish within the Managed Access pilot sites were assigned based on a combination of historical use of fishing areas and a vetting process that ensured that fishermen met the criteria for licenses set out by the Managed Access Committees, which are comprised of fishermen elected by their peers. Conditions were imposed on fishing rights, including a requirement that the rights holder must follow fishing regulations that include seasonal closures, size limits, no-take zones (known as Replenishment Zones in Belize), prohibited species, and some gear restrictions. Fishermen are also required to record and submit their catch and effort data. Enforcement is overseen by BFD and local NGOs which are authorized as co-managers; in addition, under the Managed Access system, there is increasing participation from fishermen in reporting violations.

Many concerns with Managed Access were expressed at the outset of these pilots. These included the concern that fishermen would not report the catch data required for scientific management and that enforcement would be inadequate (Foley 2012). However, 80% of participating fishermen are currently reporting catch data, which have proven to be reliable enough to support data-limited stock assessments (Babcock et al. 2014). Higher catches have been reported by over 70% of participating fishermen, relative to catches prior to the establishment of Managed Access (Belize Fisheries Department, unpublished data). Violations of fishing regulations have decreased by 60% according to patrol data, including less poaching in no-take areas and less fishing for lobster and conch during the closed seasons (Belize Fisheries Department, unpublished data).

[3] In Belize, the term "marine reserve" refers to multiple-use Marine Protected Areas.

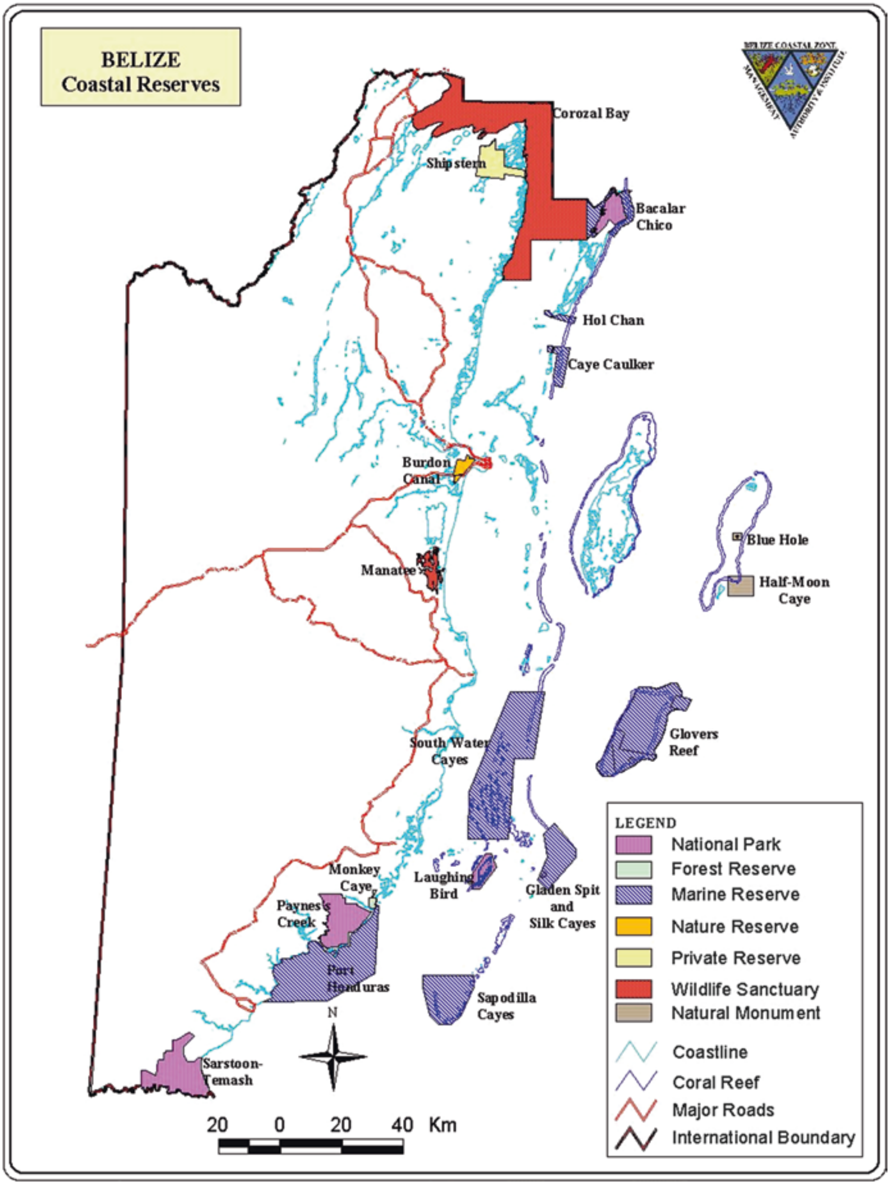



**Fig. 8.1** Belize's marine reserves, showing the two pilot Managed Access sites at Glover's Reef and Port Honduras. (Belize Fisheries Department 2014)

The success of the two pilot sites led to the approval by the government of Belize of a plan in 2015 to implement Managed Access throughout Belizean territorial waters. A Managed Access Working Group comprised of BFD staff, NGO representatives, and fishermen was formed to design the new Managed Access Areas. The work-

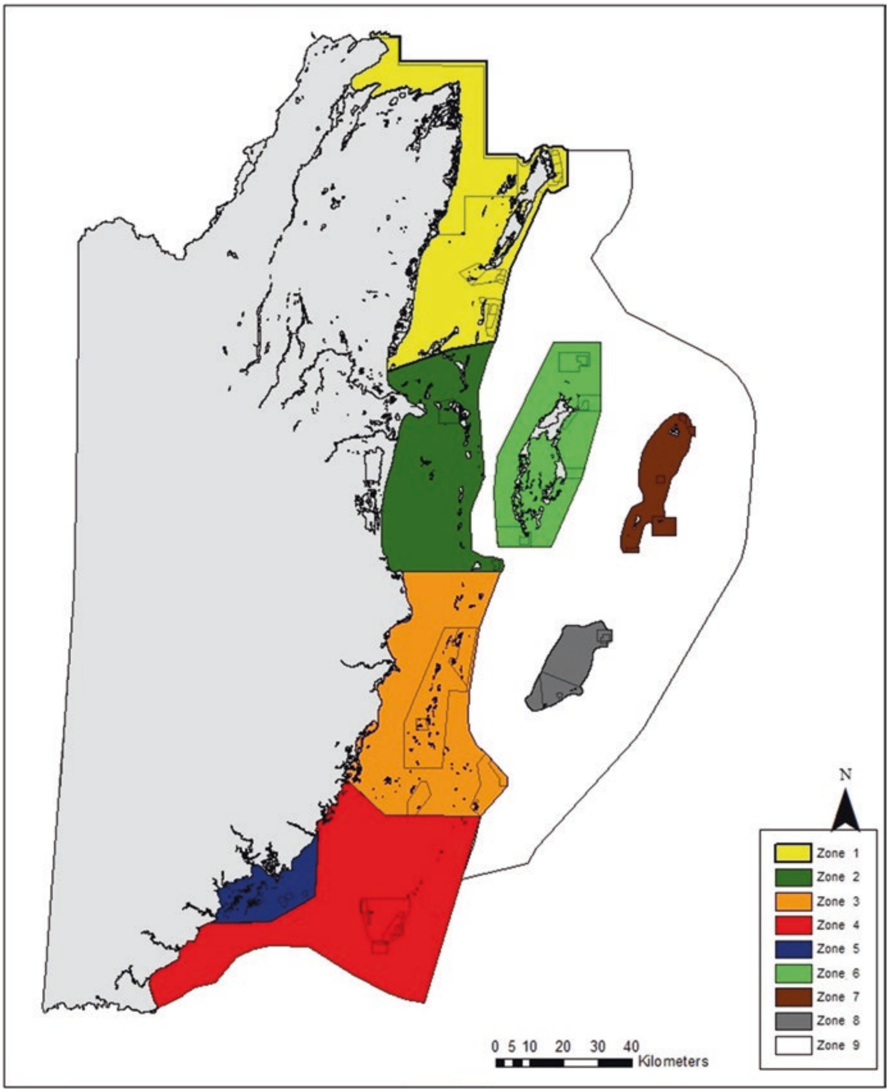



**Fig. 8.2** Belize's national system of Managed Access Areas. (Belize Fisheries Department 2014)

ing group created a joint workplan (Managed Access Working Group 2014), to which they held themselves accountable, generating designs for nine Managed Access Areas that encompass about 60% of Belize's fishing grounds (Fig. 8.2). A robust outreach effort was conducted by Belize Fisheries Department staff trained by Rare, an NGO with expertise in social marketing of conservation and management initiatives. The outreach effort was aimed at communicating the results of the Managed Access pilots and generating support for the national Managed Access plan. These efforts engaged approximately 2000 of Belize's 2600 fishermen.[4] Elections were held to select members of the Managed Access Committees, who were charged with vetting the eligibility of fishermen applying for Managed Access permits. The elections were carefully monitored by the Managed Access Working Group, the representatives from BFD, the Belize Federation of Fishers, and the Belize Fishermen Cooperatives Association. Committee members are currently being trained by BFD and several NGOs working in fisheries management and other aspects of governance. The responsibilities of these committee members are expected to grow as they complete their training.

For any initiative to scale up successfully, policies must either facilitate the scaling or not interfere with it, and any barriers to implementation must be removed (Fujita et al. 2017). While Managed Access is legal under existing Belizean law, a recent update to the nation's overarching fisheries legislation is expected to include specific authorization to establish Managed Access Areas. Efforts are also underway to remove several important barriers to Managed Access. These include piloting vessel monitoring systems to improve boundary enforcement and safety at sea and increasing the efficiency of the licensing system, including new processes for validating the allocation of licenses in the Managed Access Areas. It will also be important to increase fishery value in order to improve fishing livelihoods. To achieve this goal, a traceability system is being developed so that seafood from well-managed areas can be tracked through the supply chain and marketed as such with the hope of attracting premium prices. Several studies have been conducted to identify key investments and new markets necessary to increase fishery value. A more detailed description of the strategy employed to scale Managed Access in Belize is provided by Fujita et al. (2017).

The transition from an open access system to Managed Access is a learning process for all stakeholders. Fishermen must become familiar with new rules and the Managed Access Area boundaries. The concept of co-management, though very popular with fishermen and managers in Belize, requires a dedicated effort to understand and carry out new roles and responsibilities, and therefore a lengthy adjustment process can be expected. Some Managed Access Areas (which overlap with multiple use Marine Protected Areas) have a history of participatory management. But for several Managed Access Areas without this history, there will be a more gradual transition to co-management, which will require extensive training and capacity building.

The challenge of adequate enforcement, which is common to many small-scale fisheries, is also a pressing issue in Belize. Even as compliance with regulations increases and fishermen take on a larger role in stewardship, traditional enforcement still plays a critical role. The credibility of the Managed Access program could be vulnerable if repeated infractions occur, which would undermine the gains afforded to individuals who comply with regulations. New technology and training for enforcement rangers is helping to strengthen enforcement, and the increasing involvement of the Coast Guard is also helpful. This effort will be especially important to combat illegal fishing from nearby countries, which threatens to erode the potential benefits of the Managed Access program.

---

[4] Based on meeting sign in sheets and unpublished data provided by Belize Fisheries Department

## 8.3 Adaptive Fisheries Assessment and Management

Implementing fisheries management regimes such as Managed Access that improve governance is a necessary condition for the success of fishery management, but it is not sufficient; fishing mortality must also be controlled. In this section, we describe how the elements of a new framework for controlling fishing mortality using data-limited fishery assessment and management methods were developed and implemented in Belize for key species of interest including lobster and conch.[5]

A participatory approach that engaged NGOs, BFD, and fishermen was employed to develop the adaptive management framework and generate local ownership of the outcomes and management implications. The approach was coordinated by a science team with members from BFD, the University of Belize, the University of California at Santa Barbara, and an array of NGOs. This team convened a series of workshops in Belize with fishermen and other stakeholders to develop the adaptive management framework. In the workshops, the fundamentals of adaptive management were introduced, and the participants then articulated consensus objectives, fishery performance indicators with metrics, and harvest control rules. Using these components, the science team then worked closely with the BFD's Capture Fisheries Unit to develop fishery management plans (FMPs) for conch and lobster. These workshops were followed by the dissemination of the FMPs by BFD and training on this process to local fishery managers and the fishermen cooperatives.

The first step of the adaptive management framework consisted of characterizing the ecological context in which these fisheries operate, including an evaluation of ecosystem status and risks to valued aspects of the ecosystem. This step was important for understanding the risks posed by fishing and other human activities to the supporting ecosystem.

Next, fishery indicators were chosen based on fishery objectives and available data through a collaborative process conducted during a series of workshops and informal meetings. The science team performed basic analyses of the data in order to evaluate the indicators, including length-based approaches to stock assessment such as estimating fishing mortality rates from length frequency distributions of the catch (Sparre and Venema 1998), as well as depletion analyses using CPUE data (Babcock et al. 2014). Outputs of the assessments were compared to target and limit reference points, which were chosen during the participatory process outlined above, in order to understand the status of the fisheries examined relative to these targets and limits.

[5] The general framework and supporting materials are available online at www.fishe.edf.org and in Fujita et al. (2013).

### 8.3.1 Ecosystem Context, Status, and Management Goals

Because Belize's natural resource management goals include both marine ecosystem conservation and sustainable fisheries, an analysis of the relationship between fishing pressure and coral reef status was undertaken. The data collected over 20 years from 25 countries throughout the Caribbean were used to describe the relationship between a variety of coral reef metrics – including macroalgal cover, coral cover, and fish diversity. These data were also used to describe fish biomass levels and the ratio of fish biomass on the fishing grounds to fish biomass within no-take reserves (Karr et al. 2015), which was used as a proxy for fishing pressure (Babcock et al. 2010; McGilliard et al. 2010).

The results indicate that coral reefs with fish biomass ratios (fished/unfished biomass) greater than 0.5 (i.e., presumably lower fishing pressure) are associated with higher fish diversity, higher levels of coral cover, and lower levels of macroalgal cover than reefs with lower fish biomass ratios and presumably higher fishing pressure (Karr et al. 2015). Moreover, fish biomass ratios of less than 0.3, which suggest even higher fishing pressures, are associated with macroalgal dominance and the degradation of ecological process and functions that are critical for the maintenance of healthy coral reefs (Karr et al. 2015). The country of Belize has a relatively high level of maximum estimated unfished biomass (1109 kg/ha), based on data from 1997 to 2011 (Karr et al. 2015).

Because each area of Belize is different, it is important to use fine-scale data for computing biomass ratios to inform management at individual reefs. Our analysis of data collected at Glover's Reef Atoll Managed Access Area suggests that finfish and other species appear to be relatively abundant, with relatively high coral cover and low macroalgal cover (based on unpublished data). The same analysis of data collected at Port Honduras Managed Access Area resulted in a lower fish biomass ratio, suggesting that several important attributes, such as the abundance of grazers and fish species richness of the coral reefs, may be in decline, with the caveats that sample sizes are lower than at Glover's Atoll (unpublished data), and that coral habitats and ecological context are quite different between the two sites.

This characterization of ecosystem status is intended as general guidance for ecosystem-based fisheries management. It provides a general sense of the capacity of the ecosystem to support goods and services, including fisheries (Fujita et al. 2012), that can be used to supplement stock-specific assessments and the setting of management measures in fisheries that seek to protect ecosystem structure and function in addition to generating sustainable yields. As more data become available at specific sites, fish biomass ratios may be useful for setting biomass targets to allow multispecies fisheries to produce good yields while maintaining ecosystem structure and function (McClanahan et al. 2011; Karr et al. 2015).

### *8.3.2 Fisheries Characterization*

To provide context for stock-specific analysis and target-setting, we also characterized Belize's fisheries. This context is important for interpreting data streams and informing adaptive management.

The main fishery targets in Belize can be characterized as conch, lobster, snapper/grouper complex, cross-shelf migrators (e.g., snook and croakers), and migratory fish (e.g., jacks, tunas, and sharks) (FAO 2005). The initial focus of BFD has been on lobster and conch due to the broadly recognized high social and economic importance of these two species. Recognizing the important roles that finfish play in maintaining ecosystem integrity and supporting subsistence fishing, livelihoods, and fishing culture, efforts are underway to improve the understanding of finfish habitat types and stock status.

Official statistics suggest that fisheries in Belize produce about 1141 mt of seafood from capture fisheries and aquaculture for internal consumption and export annually, with an estimated gross value of over US$30 million in 2013 (Villanueva 2013), constituting a significant portion (2%) of gross domestic product (World Bank 2016). However, Zeller et al. (2011) concluded that total catch could reach 6000 mt per year if estimates of traditionally under-reported catches, such as those for subsistence or the tourism sector, are included.

The fisheries sector supports 2594 licensed fishermen and their immediate families, totaling about 15,000 Belizeans altogether (Belize Fisheries Department 2015). Many coastal communities are highly dependent on fishing. Thus, fisheries are important for Belize's food security, economy, and cultural identity. While these numbers alone are significant, they underestimate the true value of fisheries, which also make critical contributions to Belize's important tourism industry (Cooper et al. 2008).

Most of the economic value from commercial capture fisheries results from the export of lobster and conch, since finfish are mostly consumed locally, except for a small-scale export fishery to other Caribbean countries. The fishing sector is comprised primarily of artisanal fishermen who sell their catch. The fleet consists of over 500 boats, including open boats, sailing sloops, and canoes. Conch and lobsters are taken by free divers using 8–12 m wooden sailing sloops or 6–8.5 m fiberglass skiffs with outboard motors (25–60 hp). Lobster traps are also used. The conch open season extends from October 1 until June 30, or until the quota is reached, whichever occurs first. The lobster season extends from June 15 through February 14. From October to June 15, when both the conch and lobster seasons are open, these fishermen target both species. Nearshore finfish are harvested using a variety of gears, including handlines, spear guns, and traps.

### 8.3.3 Queen Conch

Queen conch (*Lobatus gigas*) is a large gastropod mollusk that achieves full size at about 3–5 years of age, growing to a maximum of about 12 inches (30.4 cm) long and weighing about 5 pounds (2.3 kg) total weight. Queen conch has separate sexes and reproduces through internal fertilization. After mating, females lay long egg masses that contain hundreds of thousands of eggs, which hatch after about 5 days. Larvae then spend about 18–40 days floating and feeding on plankton before settling to the bottom and metamorphosing into their adult form. Once in their benthic, adult form, they graze on algae and detritus. The queen conch is a long-lived species, generally reaching 20–30 years old; however, the lifespan has been estimated to be as long as 40 years (McCarthy 2007; NOAA 2015).

Adults and juvenile conch are found in seagrass meadows and coral reefs, suggesting perhaps that these habitats provide protection from predation during post-larval metamorphosis and rearing, as well as feeding grounds for juveniles and adults and spawning grounds. Certain important aspects of conch life history and ecology are poorly documented, creating challenges for interpreting survey and catch data. For example, some conch stocks may include a deep-water population that is relatively protected from fishing, perhaps resulting in high spawning potential even when the fishable portion of the population is subjected to high fishing pressure (Fanning et al. 2011). On the other hand, declines in conch stocks in response to high fishing pressure have been documented (Bell et al. 2005; Stoner et al. 2011, 2012). Because queen conchs are grazers in seagrass/coral reef ecosystems, they likely contribute to the maintenance of coral-dominated coral reefs and healthy seagrass meadows.

Queen conch is a critical fishery resource in Belize, supporting livelihoods, promoting food security, and contributing significantly to Belize's economy. This fishery is the second most important fishery in Belize, generating US$4.09 million in 2011 (Belize Fisheries Department 2015).

Fishing effort for queen conch has been increasing over time (Foley 2012). Catch has also been increasing since 2008, but fortunately abundance may have also been increasing in recent years, leading to a general increase in CPUE. Early season CPUE (Fig. 8.3) appears to rebound after each season, suggesting that stocks replenish through growth, recruitment, or migration. However, recent analyses suggest that fishing pressure has reduced the density of conch significantly (Belize Fisheries Department, unpublished data). If abundance decreases, either due to changes in environmental factors such as ocean productivity or increased fishing mortality, profits and revenues could be adversely affected if effort and catch are not limited. These analyses also suggest that reducing harvest levels in the short term could result in larger overall yields, which prompted an early closure of the conch season in 2015.

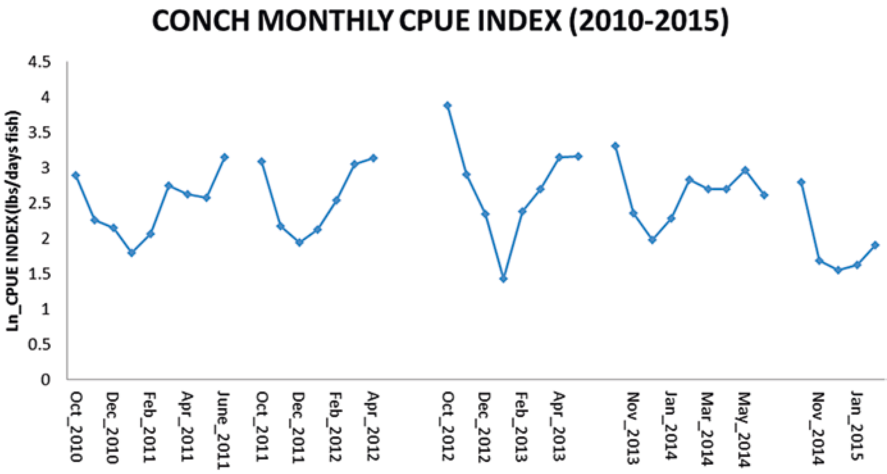



**Fig. 8.3** Conch catch per unit effort (CPUE) trends. Note depletion and recovery pattern (high CPUE early in the season in October, followed by decline then recovery). (Belize Fisheries Department 2016b)

### *8.3.4 Spiny Lobster*

Spiny lobsters (*Panulirus argus)* are large marine crustaceans that reach maturity at about 78 mm carapace length, or in 3–4 years, and achieve full size (45 cm, 4.5 kg) at about 20 years of age. Lobsters generally reach legal size (carapace length of 3 inches or tail weight greater than 4 oz. between 20 and 40 months (Gongora 2010)). They are usually found in shallow waters up to depths of 90 m. Juveniles normally reside in vegetated habitats, later moving to rock and reef habitat as adults. Adequate cover and shelter can be a limiting factor for lobster populations. The nearshore rearing areas can be damaged by coastal activities that have negative impacts on vegetated habitats such as seagrass meadows, which are sensitive to increased sediment input and turbidity (Orth et al. 2006).

Spawning occurs during late spring into summer. The fecundity of females increases with size and large females can carry over 1 million eggs. The females retain the eggs for up to 4 weeks before they are released. Larvae are planktonic for 6–12 months, and in the northern part of the species' range from North Carolina (USA) to southern Brazil, larvae are found mainly from June to December (Gongora 2010). In autumn, mass migrations occur as the lobster travels to deeper water. The reason for this migration is still unknown, though it seems to be triggered by the first autumnal storm.

Lobsters feed primarily on a variety of gastropods, bivalves, and detritus. They also sometimes eat sea urchins, worms, other kinds of crustaceans, and some types of marine algae. Lobsters are preyed upon by many species including nurse sharks, triggerfish, and moray eels.

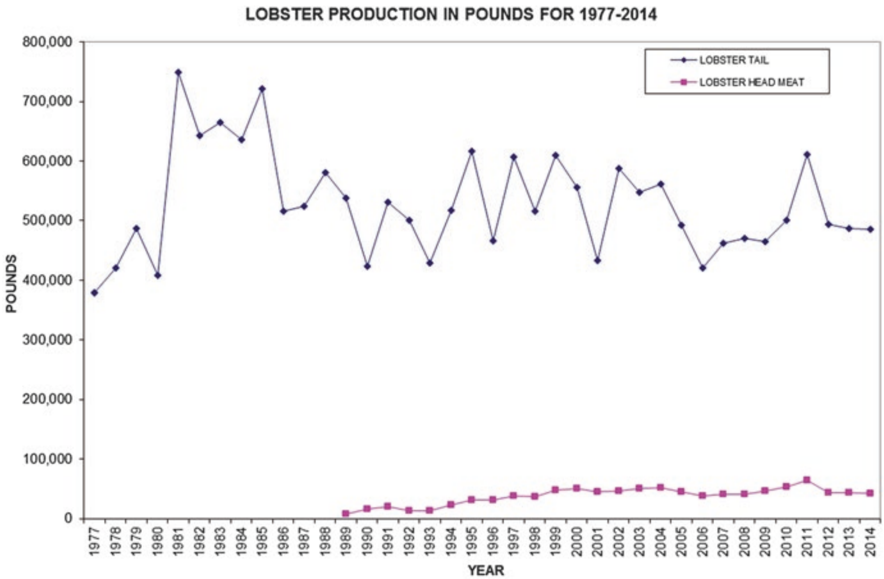



**Fig. 8.4** Lobster production (catch in pounds), 1977–2014. (Belize Fisheries Department 2015)

Lobsters appear to be generally quite resilient to fishing pressure, and local populations often build to high densities (with improved size and age structure) within no-take reserves (Lipcius et al. 1997; Bertelsen and Cox 2001; Bertelsen et al. 2004; Cox and Hunt 2005; Dahlgren 2014).

The spiny lobster fisheryis the most important small-scale fishery in Belize, accounting for 67% of capture fishery export earnings and contributing over $10 million to the national economy annually (Belize Fisheries Department 2015). It is currently an open access fishery, except for Managed Access pilot programs at Glover's Reef and Port Honduras Marine Reserves, in which access is limited. Harvest is controlled with a season which opens on June 15 and closes on February 14 each year. Other regulations include size restrictions, gear prohibitions, and no-take areas. Free diving using hook-sticks and wooden traps is the most common means of harvesting lobster, accounting for >90% of extraction. Other gear used includes "shades" (artificial shelters that attract lobster), drums, and tires. Undersized lobsters are landed at some markets, but lobsters aged 2–3 years accounted for 98% of the annual catches in 2009 (Gongora 2010). The Belize Fisheries Department has intensified enforcement efforts aimed at minimizing mortality of undersized lobsters.

Lobster tail and head meat (historical annual production shown in Fig. 8.4) produced by fishers are sold to two main fishing cooperatives: Northern Fishermen Cooperative Soc. Ltd. and the National Fishermen Producers Cooperative Soc. Ltd., both of which are based in Belize City. These cooperatives mainly process and export lobster products, but some lobster is sold locally. Other fishing cooperatives (Placencia and Rio Grande fishermen's cooperatives) sell fisheries products locally and also export through either of the aforementioned cooperatives.

As of 2010, there were 2200 Belizean fishermen recorded as having caught lobster, and the number of licensed fishermen has continued to rise over the last few years. Landings appear to be stabilizing over time, suggesting that the fishery is mature, resulting in reduced CPUE. These trends indicate a need for limiting access to lobster fishing and controlling harvest levels in order to maintain lobster populations that can produce high sustained yields and allow fishermen to catch them more profitably.

### *8.3.5 Goals, Indicators, and Reference Points for Management*

Fisheries management goals were articulated through a participatory process which applied an ecosystem-based framework (see above for descriptions of the process and framework). Models that quantified services provided by corals, mangroves, and seagrasses were available to illustrate synergies or trade-offs among multiple objectives. These models were also used to generate maps of the impacts of human activities on ecosystem services, which allowed stakeholders to characterize zones of human use (Arkema et al. 2015). In a series of workshops, fishermen, officials from BFD, international NGOs, and MPA co-managers used these and other sources of information to discuss different kinds of potential goals and converged on several which varied by fishery and scale. For example, goals for national level fisheries such as lobster and conch contrasted with those of local level fisheries within the two pilot Managed Access Areas at Glover's Reef and Port Honduras Marine Reserves.

The harvest management goal for lobster in Belize is to ensure that catch does not exceed sustainable levels. Indicators related to this goal were developed in a series of workshops, described above, which were designed to elicit a variety of perspectives and included representatives from the BFD and NGOs. These indicators include early and late season CPUE, total annual catch (from the previous season), and preseason mean tail weight. The targets for these indicators are averages over the last 10 years for CPUE and a running average over the last 10 years for previous season's catch.

Two main data streams have been identified to inform the three indicators at the national scale: national co-op purchase receipt data (to inform total catch from previous season and early season CPUE) and national fishery independent lobster surveys (to inform mean length). According to the Belize Fisheries Department (2015), the harvest management objectives for conch in Belize are to:

1. Achieve sustainable yields consistent with stable or increasing profit
2. Achieve sustainable yields consistent with stable or increasing export revenue
3. Maintain conch populations at densities capable of generating these yields on an ongoing basis
4. Maintain conch populations at densities sufficient for the fullfilment of their most important ecological roles

Accordingly, relevant indicators include preseason adult and subadult patch density, previous season total catch, preseason mean shell length, and early- and late-season CPUE. Reference values consist of average levels of these indicators over time (targets), plus a limit of 88 individuals/ha for patch density (based on Stoner and Ray-Culp 2000; SEDAR 2007).

While these are the main data streams for assessing fishery status and calculating indicators, other data streams should also be considered when interpreting trends and considering management actions. These could include export data, logbooks, local and expert knowledge, and other independent fishery surveys such as those conducted at the local scale or for scientific purposes. New data streams, such as boat intercept surveys, could be used to add spatial resolution to the understanding of the fishery and could be used to complement and cross-check national data streams such as co-op data.

### *8.3.6 Data Management System*

To make it possible to easily use data to evaluate the chosen fishery indicators, it was necessary to ensure that the necessary data streams were collated, quality controlled, and available in electronic format for analysis. Following the establishment of Managed Access Areas, initial efforts to create a data management system and analyze available data were undertaken by the Belize Science Team (described above). These efforts were focused on the large amount of information from the cooperatives, which is believed to represent approximately 90% of national landings (FAO 2005). Quality control codes were written in the software program *R* (R Development Core Team 2012), and all existing data were quality controlled, formatted, and evaluated for inclusion in a comprehensive database. A national relational Microsoft Access database was developed to streamline the data processing (e.g., data entry and quality control) and allows for rapid in-season evaluations of the fishery-dependent cooperative data. User-friendly data entry forms with built-in quality control rules (e.g., dates in appropriate formats) were also developed.

### *8.3.7 Data Analysis*

Once the database was established, codes were written in *R* to access the raw data directly from the database and provide quality control plots to verify any new data added to the database. Filtering routines which allow for subsetting the master dataset (e.g., by species, season, or month) were also developed to allow flexibility in data analysis. Codes were written to automatically calculate current landings, current CPUE values, and the recent averages which are summarized as needed so that indicator values can be easily compared to reference values (targets and limits) in order to facilitate management decisionmaking. Initial CPUE and early season changes in CPUE can be generated as soon as data are entered from the cooperatives, allowing for close to real-time in-season monitoring of indicators derived from the cooperative data sets.

### *8.3.8 Harvest Control Rules*

The final step in the adaptive management framework is to use the evaluations of fishery indicators relative to reference points in the formulation of appropriate management measures. While it may be intuitive and somewhat obvious to determine that landings or effort should be reduced (or increased) when all indicators suggest that the fishery is performing poorly (or very well), the question of "how much" to adjust catch or effort is much more complicated, especially when multiple indicators are in conflict with one another. BFD is currently in the process of finalizing harvest control rules based on indicators and reference values for the national lobster and conch fisheries. A management strategy evaluation was recently developed to investigate the effects of different harvest control rules on stock biomass levels, the probability of stock collapse, and the yield to help guide this effort (McDonald et al. 2014; Harford et al. 2016).

## 8.4 Conclusions

Belize has long been a leader in marine conservation, having established nine large multi-use MPAs (called Marine Reserves in Belize) along with several other important marine conservation measures. In keeping with this national policy priority, BFD embarked on an initiative to institute science-based fisheries management embedded within an improved fishery governance system. Belize recognizes the importance of limiting the unsustainable growth in the number of fishermen and of providing secure harvest privileges to counteract incentives to maximize catch. In Belize, these secure harvest privileges take the form of permits to harvest in the Managed Access Areas. The Managed Access permits are granted by BFD after vetting by a Managed Access Committee made up of experienced fishermen elected by their peers and after careful consideration of eligibility requirements. Several responsibilities are attached to these permits, including an agreement to comply with regulations and report data.

While an assessment of the long-term biological performance of these Managed Access Areas is not possible at this time, early indications are promising. Compliance with regulations has increased within the two pilot sites and preliminary assessments of lobster population status suggest that, while fishing pressure is high, local populations within both sites appear to rebound after the season closes, although there are some signs that fishing pressure on lobster is too high, such as reduced average size (Babcock et al. 2014; Foley et al. 2015; Harford et al. 2015).

Belize has designed a national system of Managed Access Areas which it is now in the process of implementing. This system is to be accompanied by science-based adaptive management. This combination of improved fishery governance and a better scientific basis for management should improve fishery management performance with respect to social, economic, and conservation goals.

## References

Arkema KK, Verutes GM, Wood SA, Clarke-Samuels C, Rosado S, Canto M, Rosenthal A, Ruckelshaus M, Guannel G, Toft J, Faries J, Silver JM, Griffin R, Guerry AD (2015) Embedding ecosystem services in coastal planning leads to better outcomes for people and nature. Proc Natl Acad Sci 112(24):7390–7395

Babcock RC, Shears NT, Alcala AC, Barrett, Edgar GJ, Lafferty KD, McClanahan TR, Russ GR (2010) Decadal trends in marine reserves reveal differential rates of change in direct and indirect effects. Proc Natl Acad Sci 107(43):18256–18261

Babcock EA, Harford WJ, Coleman R, Gibson, Maaz J, Foley JR, Gongora M (2014) Bayesian depletion model estimates of spiny lobster abundance at two marine protected areas in Belize with or without in-season recruitment. ICES J Mar Sci 72:i232–i243

Belize Fisheries Department (2014) Belize fisheries department, managed access working group, roll-out workplan. Government of Belize, Belmopan

Belize Fisheries Department (2015) Annual statistical report, 2015. Government of Belize, Belmopan

Belize Fisheries Department (2016a) Marine reserves. http://www.protectedareas.gov.bz/marine-reserves/. Accessed 15 June 2016

Belize Fisheries Department (2016b) Belize queen conch (Strombus gigas) fishery management plan. Government of Belize, Belmopan

Belize Info Center (2016) The fishing and aquaculture industry. http://belizeinfocenter.org/. Accessed 15 June 2016

Bell JD, Rothisberg PC, Munro JL, Loneragan NR, Nash WJ, Ward RD, Andrew NL (2005) Restocking and stock enhancement of marine invertebrate fisheries. Elsevier Academic Press, San Diego

Bertelsen RD, Cox C (2001) Sanctuary roles in population and reproductive dynamics of Caribbean spiny lobster. Spatial processes and management of marine populations. Publication number AK-SG-01-02. Alaska Sea Grant Publications, pp 591–605

Bertelsen RD, Cox C, Beaver R, Hunt JH (2004) A reexamination of monitoring projects of southern Florida adult spiny lobster *Panulirus argus*, 1973–2002: the response of local spiny lobster populations, in size structure, abundance, and fecundity, to different sized sanctuaries. Am Fish Soc Symp 42:195–210

Cooper E, Burke L, Bood N (2008) Coastal capital: economic contribution of coral reefs and mangroves to Belize. World Resources Institute, Washington, DC

Cox C, Hunt JH (2005) Change in size and abundance of Caribbean spiny lobsters *Panulirus argus* in a marine reserve in the Florida Keys National Marine Sanctuary, USA. Mar Ecol Prog Ser 294:227–239

Dahlgren C (2014) Review of the benefits of no-take zone: a report to the Wildlife Conservation Society. http://www.wcs.org/saving-wild-places/~/media/Files/pdfs/Review%20of%20the%20Benefits%20of%20No%20Take%20Zones_Final.pdf. Accessed 15 June 2016

Fanning L, Mahon R, McConney P (2011) Towards marine ecosystem-based management in the wider Caribbean. Amsterdam University Press/Centre for Maritime Research, Amsterdam

FAO (Food and Agricultural Organization of the United Nations) (2005) Fishery country profile: Belize. FAO, Rome

Foley JR (2012) Managed access: moving towards collaborative fisheries sustainability in Belize. In: Proceedings of the 12th international coral reef symposium

Foley JR, Barona T, Irvine T (2015) Port Honduras Marine Reserve commercial benthic species update: 2009-2014. Conch, lobster and sea cucumber. Toledo Institute for Development and Environment, Research and Monitoring Department, Punta Gorda

Fujita R, Moxley JH, Debey H, Van Leuvan T, Leumer A, Honey K, Aguilera S, Foley M (2012) Managing for a resilient ocean. Mar Policy 38:538–544

Fujita R, Karr K, Battista W, Rader D (2013) A framework for developing scientific management guidance for data-limited fisheries. In: Proceedings of the 66th Gulf and Caribbean Fisheries Institute. Gulf and Caribbean Fisheries Institute, Corpus Christi, Texas, USA, pp 83–90

Fujita R, Epstein L, Battista W, Karr K, Higgins K, Landman J, Carcamo R (2017) Scaling territorial use rights in fisheries (TURFs) in Belize. Bull Mar Sci 93(1):137–153

Gongora M (2010) Assessment of spiny lobster (*Panulirus argus*) of Belize based on fishery dependent data. United Nations University Fisheries Training Programme, Iceland [final project]. http://www.unuftp.is/static/fellows/document/mauro09prf.pd. Accessed 15 June 2016

Government of Belize (2009) Statutory instrument No. 49 of 2009. Fisheries (Nassau grouper 722 and species protection) regulations. Government of Belize, Belmopan

Harford WJ, Ton C, Babcock EA (2015) Simulated mark-recovery for spatial assessment of a spiny lobster (*Panulirus argus*) fishery. Fish Res 165:42–53

Harford WK, Gedamke T, Babcock EA, Carcamo R, McDonald G, Wilson JR (2016) Management strategy evaluation of a multi-indicator adaptive framework for data-poor fisheries management. Bull Mar Sci 92(4):423–445

Karr KA, Fujita R, Halpern BS, Kappel CV, Crowder L, Selkoe KA, Alcolado PM, Rader D (2015) Thresholds in Caribbean coral reefs: implications for ecosystem-based fishery management. J Appl Ecol 52(2):402–412

Lipcius R, Stockhausen W, Eggleston D, Marshall L Jr, Hickey B (1997) Hydrodynamic decoupling of recruitment, habitat quality and adult abundance in the Caribbean spiny lobster: source–sink dynamics? Mar Freshw Res 48:807–816

McCarthy K (2007) A review of queen conch (*Strombus gigas*) life-history. SEDAR 14-DW-4. National Marine Fishery Service, Southeast Fisheries Science Center, Sustainable Fisheries Division, Contribution SFD-2007-008

McClanahan TR, Graham NAJ, MacNeil MA, Muthiga NA, Cinner JE, Bruggemann JH, Wilson SK (2011) Critical thresholds and tangible targets for ecosystem-based management of coral reef fisheries. Proc Natl Acad Sci 108:17230–17233

McDonald G, Carcamo R, Fujita R, Gedamke T, Karr K, Wilson J (2014) A multi-indicator framework for adaptive management of data-limited nearshore fisheries. In: Proceedings of the Gulf and Caribbean Fisheries Institute, Vol 67, Gulf and Caribbean Fisheries Institute

McGilliard CR, Hilborn R, MacCall A, Punt AE, Field JC (2010) Can information from marine protected areas be used to inform control-rule-based management of small-scale, data-poor stocks? ICES J Mar Sci: J Conseil 68:201–211

NOAA (2015) Queen conch (*Strombus gigas*). http://www.fisheries.noaa.gov/pr/species/invertebrates/queen-conch.html. Accessed 28 Aug 2016

Orth RJ, Carruthers TJ, Dennison WC, Duarte CM, Fourqurean JW, Heck KL Jr, Hughes AR, Kendrick KA, Kenworthy WJ, Olyarnik S, Short FT, Waycott FW, Williams SL (2006) A global crisis for seagrass ecosystems. Bioscience 56(12):987–996

R Core Team (2012) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. ISBN 3-900051-07-0. http://www.R-project.org/. Accessed 15 June 2016

SEDAR (Southeast Data, Assessment, and Review) (2007) Caribbean queen conch. SEDAR 14, Stock assessment report 3. SEDAR, San Juan

Sparre P, Venema SC (1998) Introduction to tropical fish stock assessment (FAO fisheries technical paper 306/1 Rev. 2). FAO, Rome

Stoner AW, Ray-Culp M (2000) Evidence for Allee effects in an over-harvested marine gastropod: density-dependent mating and egg production. Mar Ecol Prog Ser 202:297–302

Stoner A, Davis M, Booker C (2011) State of knowledge of conch resources in the Bahamas and management considerations (Community Conch Technical Brief)

Stoner AW, Davis MH, Booker CJ (2012) Negative consequences of Allee effect are compounded by fishing pressure: comparison of queen conch reproduction in fishing grounds and a marine protected area. Bull Mar Sci 88(1):89–104

Villanueva J (2013) Fisheries statistical report. Belize Fisheries Department, Ministry of Agriculture & Fisheries, Belmopan

World Bank (2016) Belize country data. http://data.worldbank.org/country/belize. Accessed 16 May 2017

Young C, Horwich RH (2007) History of protected area designation, co-management and community participation in Belize. In: Balboni BS, Palacio JO, Awe JJ (eds) Taking stock: Belize at 25 years of independence, vol 1. Cubola Productions, Belize City, pp 123–145

Zeller D, Graham R, Harper S (2011) Reconstruction of total marine fisheries catches for Belize, 1950–2008. In: Palomares MLD, Pauly D (eds) Too precious to drill: the marine biodiversity of Belize. University of British Columbia, Fisheries Centre Research Reports, Vancouver, pp 142–151

**Rod Fujita** received his PhD from the Boston University Marine Program at the Marine Biological Laboratory in Woods Hole, Massachusetts, and served as a researcher at the Woods Hole Oceanographic Institution, Oregon State University's Hatfield Marine Laboratory, and the Harbor Branch Oceanographic Institution before joining the staff of the Environmental Defense Fund in 1988. He co-founded EDF's Oceans Program and has worked for over 30 years to improve fisheries management so that fisheries can produce more food, better jobs, and more wealth while resulting in better ocean conservation.

**Amy Tourgee** is a former member of the Oceans Program at Environmental Defense Fund (EDF). There, she focused on managing data-limited fisheries in Latin America, conducted research on the most effective management systems for multispecies fisheries, and contributed to the development of a toolkit to help communities set realistic goals for their fisheries. Amy received her bachelor's degree in Ecology and Evolutionary Biology from Princeton University.

**Ramon Carcamo** is the fisheries analyst of the Capture Fisheries Unit of the Belize Fisheries Department. He oversees the monitoring and assessment of the traditional commercial fisheries of Belize. Ramon has a BSc in Biology from the University of Belize and an MBA in Sustainable Development from Galen University. He has previously worked at the Land Department and the Geology Department for the Government of Belize. He has worked at the Belize Fisheries Department for over 16 years. Ramon has represented the Belize Fisheries Department in an array of local, regional, and international forums.

**Lawrence Epstein** is a regional director with the Environmental Defense Fund's Oceans Program. He manages fisheries sustainability initiatives in Myanmar and in Belize. Larry manages partnerships that cut across governmental, industry, and NGO sectors and integrates science, fisheries governance, finance, and social marketing. He has a master's degree in Public Policy for Resource Management and Economics from Syracuse University.

**Todd Gedamke** obtained his PhD from the Virginia Institute of Marine Science in 2006 and began working as a stock assessment scientist at National Marine Fisheries Service (NMFS) at the Southeast Fisheries Science Center in Miami, FL. In 2010, Dr. Gedamke was promoted to branch chief of Gulf and Caribbean Fisheries and oversaw stock assessments for both regions. His primary focus is on data-limited fisheries in the US Caribbean and in the development of data-poor methodologies. Dr. Gedamke founded MER Consultants in 2012, which has focused efforts on improving data collection, analyses, and providing advice to researchers and managers in data-limited fisheries around the world.

**Gavin McDonald** is a project researcher with the Sustainable Fisheries Group (SFG) at the University of California, Santa Barbara (UCSB). He holds a Master of Science in Mechanical Engineering from Georgia Tech, and a Master of Environmental Science and Management from the Bren School of Environmental Science & Management at UCSB. His interests lie in using science to improve fisheries management for the benefit of both conservation and fisher livelihoods. His work includes bio-economic forecasting modeling, developing tools for data-limited assessment and management, and designing data collection systems. His applied projects are in Belize, Brazil, Indonesia, Mozambique, and the Philippines.

**Jono R. Wilson** is the codirector of FishPath, a global fisheries management and training program at The Nature Conservancy aimed at improving outcomes for nature and people in fishing dependent countries. Dr. Wilson also leads the Fisheries Science Program for The Nature Conservancy in California and is an adjunct professor at The Bren School of Environmental Science and Management at the University of California at Santa Barbara (UCSB). He received a MSc in Biology from California Poly State University and a doctorate from UCSB in 2011.

**James R. Foley** has been the science director at the Toledo Institute for Development and Environment (TIDE) in southern Belize since 2011. He holds a master's degree in Tropical Coastal Management from Newcastle University, UK. Before joining TIDE, he worked in marine conservation with Global Vision International in Mexico, and Roatan Marine Park in Honduras. He directs research to inform management of Port Honduras Marine Reserve and engages directly with the fishing community to build consensus on fisheries management issues. James is a member of the National Coral Reef Monitoring Network and the Belize Fisheries Science Group, and serves as scientific advisor to the Trinational Alliance for the Gulf of Honduras.

# Chapter 9
# Exclusive Fishing Zone for Small-Scale Fisheries in Northern Chocó, Colombia: Pre- and Post-implementation

**Viviana Ramírez-Luna and Ratana Chuenpagdee**

**Abstract** Exclusive fishing zones (EFZs) are a type of place-based management tool designed primarily to mitigate conflicts between fishing sectors by granting exclusive rights to one sector to fish the resources that occur in a specific area. As with other tools, several factors can determine effectiveness of EFZs, and knowing what these factors are could lead to improving how the tool is performed. The effectiveness of EFZs depends first and foremost on the way in which they are considered, how they are introduced, and by whom. Such an understanding is especially pertinent when EFZs involve small-scale fisheries in order to avoid violation of rights or the displacement of livelihoods. Learning about the effects of EFZs on small-scale fisheries provides useful insights for the implementation of the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (SSF Guidelines), which were developed to protect the rights of small-scale fishers and fish workers around the world. Under this premise, this chapter presents a case study of an EFZ established in Chocó, Colombia, in 2008. Specifically, it examines the pre- and post-implementation processes of the Chocó-EFZ, asking questions about what triggered its establishment, who was involved in the process, who was excluded, and what challenges it faced in the implementation. Finally, insights from the case study are drawn, along with a discussion of the implications for the implementation of the SSF Guidelines in Colombia.

**Keywords** Small-scale fisheries · Fishing conflicts · Exclusive fishing zones · Pre- and post-implementation processes · SSF Guidelines

V. Ramírez-Luna (✉)
Fundación Colombiana para la Investigación y Conservación de Tiburones y Rayas SQUALUS, Cali, Colombia
e-mail: vramirez@squalus.org

R. Chuenpagdee
Department of Geography, Memorial University of Newfoundland, St. John's, NL, Canada



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_9

## 9.1 Introduction

Place-based management, with either temporary or permanent restriction of uses in certain areas, is a common practice that can be implemented through different frameworks, including customary sea tenure (Johannes 1981), co-management (Jentoft et al. 1998), community-based management (Davis et al. 2006), government-based management regimes (Murawski et al. 2000), and voluntary agreements (Hart 1998). Marine protected areas (MPAs) are one of the best known place-based management tools, which have the primary goals of protecting biodiversity and ecosystem integrity, as well as supplemental goals of developing opportunities for education, research, and tourism. Research on MPAs has looked at how they are established and the role they play in conservation and fisheries management, as well as their impact on fishing communities (Cadiou et al. 2009; Mascia et al. 2010; Agardy et al. 2011; Chuenpagdee et al. 2013). Studies also show that some MPAs help to achieve balance between resource uses and conservation (Boudouresque et al. 2005), while others create conflicts between stakeholders and lead to the displacement of fishing livelihoods (Jentoft et al. 2012). This is typically the case when MPAs result in the total exclusion of certain groups of stakeholders, particularly small-scale fisheries actors who are often marginalized geographically, socially, economically, and politically and are thus likely to be negatively affected by such arrangements. Addressing the marginalization of small-scale fisheries and reducing their vulnerability to different types of change, including governance, are the main reasons for the development of the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (SSF Guidelines). The SSF Guidelines are particularly concerned with how spatially based tools could restrict small-scale fishers and their families from accessing the resources and fishing places upon which they depend, thus impeding their livelihoods and way of life (FAO 2015).

Another common place-based management tool is exclusive fishing zones (EFZs), which can be either permanent or temporary. EFZs are designed primarily to mitigate conflicts between fishing sectors by granting exclusive rights to one sector to fish the resources that occur in a specific area (LeDrew 1988; Castilla and Fernández 1998; Davis et al. 2006; Gelcich et al. 2010; Orensanz and Seijo 2013). Like MPAs, EFZs can also be implemented under informal or formal mechanisms and can be instituted separately or in combination with other governance arrangements, including customary sea tenure (Ruddle et al. 1992), co-management (Nielsen et al. 2004), community-based management regimes (Davis et al. 2006), centralized management systems (Murawski et al. 2000), and voluntary agreements (Hart 1998). MPAs and EFZs sometimes coexist, as when a specific group of fishers is allowed to use low-impact fishing gear like hooks and lines to fish areas within MPAs (Chuenpagdee et al. 2013).

Research on EFZs has been mostly focused on the legal frameworks through which EFZs are implemented, and on the outcomes of these tools (Castilla and Fernández 1998; Hart 1998; Kaiser et al. 2000; Gelcich et al. 2010). Some attention has been paid to the processes through which EFZs are developed, the conditions that trigger such initiatives, and to the factors that shape their design and lead to their implementation, including the historical interactions between sectors (LeDrew 1988; Bourillón-Moreno 2002; Davis et al. 2006). Additional questions could be asked about these EFZs such as how they were considered and introduced in the first place and by whom. Learning about the "pre-implementation" stage (the "step zero") is as important as the implementation itself (Chuenpagdee and Jentoft 2007; Pomeroy and Douvere 2008). Whether these place-based schemes are successful or not depends on several factors, including what happens prior to their implementation and under what conditions they are implemented (Chuenpagdee et al. 2013).

Using a case study of an EFZ in Chocó Province on the Colombian Pacific coast (referred to as Chocó-EFZ hereafter), which was officially established in 2008, this chapter explores the "step zero" process and discusses outcomes and challenges after the implementation of the EFZ. Following Chuenpagdee and Jentoft (2007), key questions of the case study include: What factors triggered the process and shaped its development? Who initiated the discussion? Who was involved and in what capacity? How did interactions among stakeholders shape the conditions under which the Chocó-EFZ was designed and established? What challenges do the Chocó-EFZ face today? Additionally, informed by literature on "legal pluralism" (Bavinck 2005), this chapter also examines how small- and large-scale fishing sectors may differ in their association with the term "exclusive zone" and discusses how such a fundamental difference may contribute to shaping the Chocó-EFZ process. The legal pluralism framework highlights the fact that stakeholders represent different normative orders and "may disagree about basics, such as what belongs to whom, and why, and who decides" (Bavinck 2005, p. 817).

The following section provides an overview of the history of both small-scale fisheries (also referred to as local fisheries) and large-scale tuna and shrimp fisheries in the study area (also referred to as tuna and shrimp fisheries). Next, an overview of the Chocó-EFZ and a general characterization of local fisheries are provided. The methods section includes a review of secondary sources and empirical data collected through interviews with key informants from different sectors, including small-scale fisheries, shrimp and tuna fisheries, and government. The chapter then illustrates the complexity of the decision-making process before and after the implementation of the Chocó-EFZ and highlights lessons learned from this case study, especially in the context of the SSF Guidelines.

## 9.2 Small- and Large-Scale Fisheries in Northern Chocó: Past and Present

Communities in Northern Chocó were primarily agricultural, but commercial small-scale fisheries started to develop since the 1960s. Handline is the traditional fishing gear. Beach seines, gill nets, and longlines were introduced and subsequently modified to increase efficiency. Boats with larger storage capacity and less costly engines and equipped with fish-finding gears were also introduced. These changes led local fishers to use deeper, more distant, and larger fishing grounds; to take longer trips and to expand fishing seasons; and to initially target new resources and eventually target the same resources but in smaller sizes. Consequently, local fisheries experienced some of the symptoms of the fishing-up sequence (Neis and Kean 2003): shifts across species, peaks, and valleys, overall decline in fish landings, and conflicts between handliners and gill-netters within communities (Ramírez-Luna 2013).

Shrimp and tuna fisheries have occurred in Northern Chocó waters since the 1950s. From that time until the 2000s, interactions between local and large-scale fishers were mostly positive (e.g., exchange of goods). Over time, shrimp and tuna fisheries expanded and intensified in Chocó waters. These processes in the shrimp fishery were in part driven by the introduction of the deepwater shrimp fishery and the degradation of shrimp grounds elsewhere, leading to more intensive fishing in northern waters. The tuna fishery, on the other hand, started fishing in inshore grounds again when the use of "fish aggregating devices" (FADs) to fish skipjack increased. The expansion and intensification of both the small- and large-scale fisheries sparked conflicts between these two sectors in Chocó in the late 1990s (see Table 9.1). Specifically, shrimpers damage local longlines and generate bycatch of key fish species that long-liners target. Resource competition also exists between tuna vessels and local handliners, who both target the same tuna resources (Ramírez-Luna 2013).

### *9.2.1 The Chocó-EFZ*

The Chocó-EFZ was established temporarily in 2008 by the Colombian government (*Instituto Colombiano Agropecuario* [ICA] 2008). Initially, it covered an area of about 800 km$^2$ and later was extended seaward to about 2.5 NM from the coastline. It included 22 villages and two major urban centers, Juradó and Bahía Solano (referred to as Bahía hereafter) (ICA 2008; Ramírez-Luna et al. 2008). Bahía is the largest community in Northern Chocó, with 8785 inhabitants in 2005 (Federación Colombiana de Municipios n.d.) (Fig. 9.1). The closure became permanent in 2013, with a northward extension to Panama's border and southward to the Utría National Park. A "Special Zone for the Management of Fishing Resources" (referred to as Special Zone hereafter) to enhance the protection to 12 NM was also added (*Autoridad Nacional de Acuicultura y Pesca* [AUNAP] 2013) (Fig. 9.1). See Table 9.1 for more details. Gill nets and beach seines used by small-scale fishers, all large-scale fisheries, and commercial exploratory fisheries were banned inside the Chocó-EFZ. On the other hand, longlines and handlines that are used by small-scale fishers, subsistence, and sport fisheries were allowed both inside and outside the Chocó-EFZ (ICA 2008; *Instituto Colombiano de Desarrollo Rural* [INCODER] 2009; INCODER 2010; AUNAP 2012; AUNAP 2013). Tuna seiners (<108 net register tonnage (NRT)) and tuna longline vessels (< 24 m long) are allowed to fish inside the Special Zone (AUNAP 2013).

**Table 9.1** Timeline of events related to the pre- and post-implementation processes of the Chocó-EFZ

| | |
|---|---|
| Late 1990s | Conflicts between shrimpers and local long-liners began. Shrimpers damaged longlines and by-caught key fish species harvested by long-liners |
| | Fish trader complained before port authorities about these conflicts (Path 1) |
| | The *Grupo Interinstitucional y Comunitario de Pesca Artesanal de la costa norte chocoana* (GIC-PA, a multi-stakeholder organization) was created. They negotiated with the shrimp organization and drafted EFZs to mitigate conflicts between these sectors, but those zones were never implemented (Path 2) |
| Early 2000s | Conflicts between tuna seiners and local handliners began. Both sectors competed for tuna |
| | No actions were taken to mitigate these conflicts |
| 2000–2007 | Conflicts continued |
| 2007 | A tuna vessel was reported to be encroaching local fishing grounds and was detained but released within a few hours. Local people perceived this decision as an act of corruption in the government |
| | *This situation triggered the Chocó-EFZ process* |
| 2008 | Fish trader (now the representative of small-scale fishers), representatives of the tuna and shrimp fishery sectors, and fisheries authorities met to negotiate. During the last meeting, the government made the decision to temporarily designate the Chocó-EFZ for 1 year initially. A study on local fisheries inside and outside the closure was conducted (Ramírez-Luna et al. 2008) |
| 2009–2013 | The Chocó-EFZ was extended three times (2009–2010, 2010–2012, 2012–2013) for further assessment of fisheries |
| | Several studies were conducted on local fisheries (Navia et al. 2010; MarViva 2012, cited by AUNAP 2012) and on the shrimp fishery (Rueda et al. 2010; INVEMAR 2012). Studies looked at fisheries inside and outside the EFZ |
| | There were no studies on the tuna fisheries |
| 2013 | The Chocó-EFZ was established as a permanent measure and extended northward and southward. A "Special Zone for the Management of Fishing Resources" was also added to enhance the protection to 12 NM. For the tuna fishery, certain tonnage and size vessels were allowed in this zone, but it was not defined whether the shrimp fishery is banned or allowed |
| | Both the fish trader and a GIC-PA member participated as representatives of the small-scale fishing sector in the annual meeting (the two paths intersected) |
| 2014 | The design of the management plan of the EFZ (first 2.5 NM) was initiated, involving the small-scale fishing sector and regional, national, and international governmental and nongovernmental organizations |

At least 700 people (fishers and their families) depend directly on the small-scale fisheries carried out inside the Chocó-EFZ and in surrounding waters. Additional activities that fishers engage in are agriculture, cattle farming, tourism, and "miscellaneous" (construction, commerce, sport fisheries, mechanics, etc.) (Navia et al. 2010). Fishers use boats that range between 3 m (wooden boats) and 13 m (fiberglass) long. Most fiberglass boats are powered by outboard motors (9–75 horse power), and some have diesel engines. Wooden boats are powered mostly by outboard motors (9–15 horse power) and a few by paddles. Fish landings include at

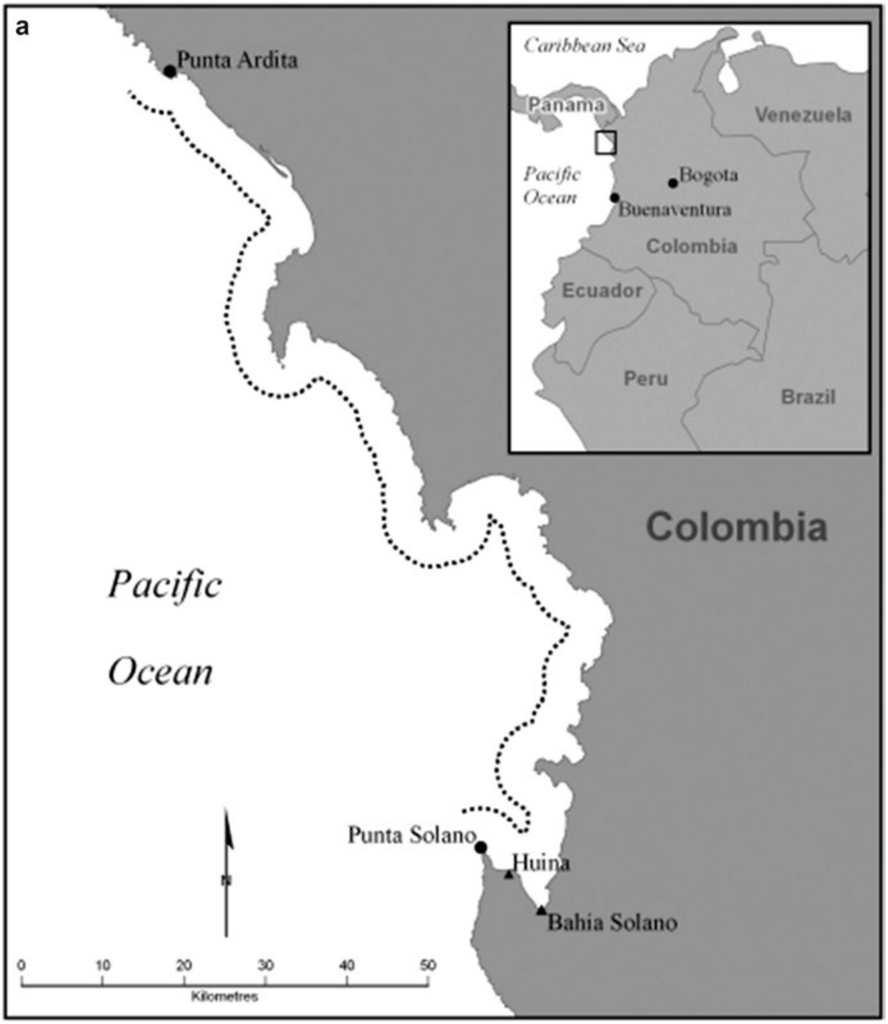



**Fig. 9.1** Study area. *Left, top corner* (Fig. 9.1a): Bogotá (tuna fishery and government headquarters, some small-scale fisheries stakeholders) and Buenaventura (shrimp fishery headquarters). *Left, larger map*: Bahía Solano (local government headquarters, some small-scale fisheries stakeholders) and original boundaries of the Chocó-EFZ (2008–2013) – first 2.5 NM from shoreline (dotted line), Punta Ardita (north) and Punta Solano (south). Source: Viviana Ramírez-Luna. *Right* (Fig. 9.1b): Chocó-EFZ (first 2.5 NM), the Special Zone added in 2013 (ZEMP in Spanish, between 2.5 and 12 NM), and current northern and southern boundaries – Panamanian border and Utría National Park, respectively. (Source: *Autoridad Nacional de Acuicultura y Pesca* (AUNAP))

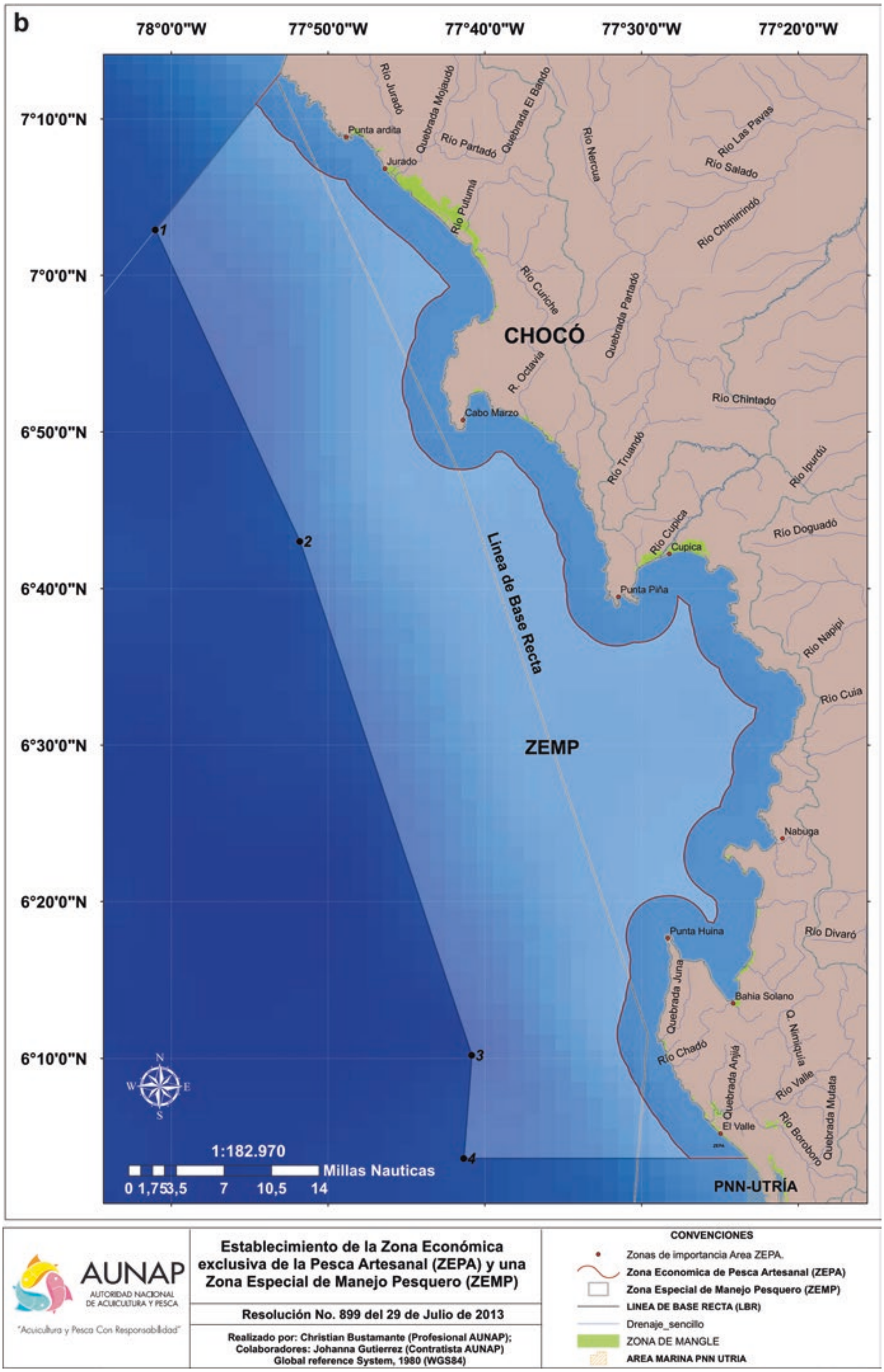



**Fig. 9.1** (continued)

least 68 species. The most frequent species are yellowfin tuna (*Thunnus albacares*), bluestriped chub (*Sectator ocyurus*), longfin yellowtail (*Seriola rivoliana*), spottail grunt (*Haemulon maculicauda*), Pacific bearded brotula (*Brotula clarkae*), and different species of jacks (*Caranx* spp.), snappers (*Lutjanus* spp.), and roosters (*Epinephelus* sp.). Local fishers do not target shrimp species. During the study, a total catch of 23,767 kg was recorded, of which approximately 75% was captured using hooks (handlines and longlines) and 25% using nets (gill nets and beach seines) (Navia et al. 2010). All the fish is sold to fish plants in Bahía and then sold locally or to inland cities. There are less than ten fish plants in Bahía, and some of the largest ones generate four jobs on average (Navia et al. 2008).

The large-scale fisheries excluded from the Chocó-EFZ (first 2.5 NM) were the deepwater shrimp trawl fishery (8–90 NRT) and the tuna purse seine fishery (12–650 NRT). The shrimp fishery targeted yellow leg shrimp (*Penaeus californiensis*), pink shrimp (*P. brevirostris)*, and kolibri shrimp (*Solenocera agassizii)* (Barreto et al. 2001). The tuna purse seining targeted yellowfin tuna (*T. albacares*), skipjack tuna (*Katsuwonus pelamis*), and bigeye tuna (*T. obesus*) (Wielgus et al. 2010; Ramírez-Luna 2013). The shrimp fishery is carried out by a domestic fleet of trawlers, and it is headquartered in Buenaventura (the main port on the Colombian Pacific coast). The tuna purse seining fishery is carried out by both domestic and foreign vessels (mostly foreign), and it is headquartered in Bogotá (Fig. 9.1) (Ramírez-Luna 2013).

Besides mitigating conflicts between sectors, the Chocó-EFZ also aimed at encouraging the participation of local fishers in co-management and promoting food security (ICA 2008). Some key elements in the Chocó-EFZ included (a) an adoption of the precautionary principle and the recognition of small-scale fisheries as sources of employment, income, and food security; (b) the involvement of other stakeholders in the process, such as the local municipal authorities, fisher organizations, and local "community council," an ethnic authority for black communities created by constitutional reform in 1991; (c) the participation of local fishers in the fishing monitoring program; and (d) a verification committee, composed of representatives of the national government and small- and large-scale fishing sectors to oversee the post-implementation process (ICA 2008). While established before the adoption of the SSF Guidelines, the principles and approaches stated in the Chocó-EFZ align well with those stipulated in this recently endorsed international instrument.

The Chocó-EFZ had a 1-year initial time frame (2008–2009) and was temporarily extended three times before it became a permanent closure in 2013. Temporary extensions happened because the studies conducted after implementation were considered insufficient to modify the closure, and therefore more research was required. Ramírez-Luna et al. (2008), Navia et al. (2010), and MarViva (2012, cited by AUNAP 2012) examined local fishing grounds inside and outside the closure, as well as documented catch composition, fishing gears, and socioeconomic factors. These studies recommended the extension of the Chocó-EFZ further seaward. Rueda et al. (2010) looked at the deepwater shrimp fishery along the Pacific coast, including the Chocó-EFZ, and found that the Chocó-EFZ might be protecting nursery grounds for shrimp. The tuna fishery was never studied, despite the resource competition issues.

## 9.3 Methods

Two data sources were used in this study, including literature review (secondary data) and face-to-face, semi-structured interviews (primary data). Literature review complemented the interviews and aided in tracking events related to the Chocó-EFZ after the fieldwork conducted in 2010 and 2011. The literature review included technical reports, meeting minutes, government resolutions, letters, scientific research, newspapers, magazines, and personal communications. Face-to-face, semi-structured interviews were conducted with 11 key informants, between July 2010 and February 2011, in Bogotá, Buenaventura, and Bahía (see Fig. 9.1). Informants were knowledgeable about the Chocó-EFZ process and belonged to different sectors: small-scale fishing sector (six informants), government (three), shrimp organization (one), and tuna organization (one). They were chosen based on the list of organizations and names mentioned either in the resolution that established the Chocó-EFZ (ICA 2008) or in meeting minutes related to the Chocó-EFZ. Follow-up interviews were conducted between 2014 and 2016 via e-mail and video calls with the informant from the shrimp sector, two of the six informants from the small-scale fishing sector, and one from the three informants from government. These follow-up questions asked interviewees what elements led the government to implement the Chocó-EFZ permanently and to extend the boundaries, whether the government set up agreements with the tuna and shrimp sectors, and what were the new challenges and expectations of the Chocó-EFZ.

All interviewees were asked about their background and involvement with the Chocó-EFZ process. Subsequently, following the step zero framework (Chuenpagdee and Jentoft 2007), questions were asked related to what triggered the pre-implementation process of the Chocó-EFZ; who was involved in introducing, initiating, communicating, and participating the negotiations that led to its implementation; and how negotiations influenced the present form of the Chocó-EFZ. Further, key informants were asked whether the Chocó-EFZ was contributing to mitigating conflicts between sectors and what their perceptions were about the future of the Chocó-EFZ. As the study progressed, disagreement on the basics of the EFZ emerged, such as what belongs to whom and why and who decides (Bavinck 2005), as well as a debate which became central in interviews about the term "exclusive zone" and its influence in the decision-making process. Consequently, interviews incorporated questions about what interviewees thought about the term "exclusive zone."

Using NVivo 9 software, interviews were transcribed, and information was coded into multiple nodes and then regrouped based on the following categories: origin of the Chocó-EFZ, closure design (geographical configuration, time frame), stakeholders' role, implications of the term "exclusive zone," achievement of goals, and future of the Chocó-EFZ. Names and gender of interviewees are omitted as per privacy and confidentiality commitments stated throughout the Ethics Application approved by the Interdisciplinary Committee on Ethics in Human Research of Memorial University of Newfoundland, Canada.

## 9.4 Results

### *9.4.1 Many Incidents Triggered the Long Process to the Establishment of the Chocó-EFZ*

Table 9.1 shows a series of events that led to the establishment of the Chocó-EFZ. Some interviewees affiliated with small-scale fisheries stated that the process was triggered in the late 1990s by conflicts between local bottom long-liners and bottom trawl shrimpers. However, this situation did not lead to the negotiation of the Chocó-EFZ. It was a tuna purse seiner reported to be encroaching small-scale fishing grounds in 2007 that led to the EFZ negotiations. The encroachment per se did not trigger the process, but its release a few hours after being detained did because the decision was perceived as an evidence of corruption in the government and a result of its favoritism of the tuna sector. In 2010, during a public meeting, the Port Authority listed some of the violations that the tuna vessel committed which caused its detention, including not possessing a vessel monitoring system (VMS), failing to meet the minimum percentage of Colombians in the crew required by law (all crew members were foreigners), and lacking a *zarpe* (clearance papers required to leave the port). The Port Authority did not mention encroachment and mentioned that the vessel installed the VMS and completed the *zarpe* and that the crew could not be changed for security reasons and for the lack of qualified personnel in Bahía. Then, the vessel was released (Meeting minutes, Bahía Solano, March 25, 2010).

The spokesperson of the seiners' association who was interviewed never mentioned this incident but stated that the Chocó-EFZ process started because of the small-scale fishing sector's complaint to the Ministry of Agriculture about fishing conflicts in general, not only with seiners. The shrimpers' organization representative did not know what triggered the Chocó-EFZ and only found out about the closure when the organization was invited to the third meeting. At that point, the closure was already being discussed, and the shrimpers' input did not alter the course of the implementation process.

### *9.4.2 Multi-stakeholders' Involvement in the Chocó-EFZ Process and the Influence of Their Interactions*

According to the interview responses, there were two separate but interrelated paths that led to the establishment of the Chocó-EFZ (see Table 9.1). One process was started by a fish trader in the early 2000s. Noting gear conflicts between the deep-water shrimpers and local long-liners working for him, he reported the damages caused by shrimpers to the port authorities and asked for compensation. His attempts failed and conflicts continued. During this time, the fish trader's role was invisible to most people since he communicated only with people in his network, including fishers working for him, friends who were public employees, and a few people interested in the process.

Between 2006 and 2008, the same trader attended several public meetings related to marine fisheries outside of Bahía. The defining moment for the EFZ came during three meetings in 2008. The first was a public meeting held in Buenaventura and chaired by the Vice Minister of Agriculture. During this meeting, the fish trader complained about the conflicts in Chocó between sectors, to which all the small-scale fishers reacted and said that these conflicts were also occurring around the central Pacific coast. This collective reaction caught the attention of the authorities and set the stage for future stakeholders' consultative meetings and negotiations about conflicts in Northern Chocó. The second was a private meeting attended by the fish trader, the tuna seiners, and the fisheries authorities. The shrimpers' spokesperson joined the third private meeting. At this point, the discussion focused on the spatial coverage of the EFZ. Under pressure and lacking consensus and technical or legal support, the government made the decision in 2008 to temporarily designate an area of 2.5 NM from shore for exclusive access to local fishers.

Due to his participation in multiple meetings, the fish trader became recognized as a person who was knowledgeable about fishing conflicts and who had the skills needed to negotiate with the "powerful" large-scale fishing sector. After the meeting in Buenaventura, he was elected by local fishers as their representative for the Chocó-EFZ negotiations. The tuna and shrimp stakeholders questioned his involvement and argued that he was not representing the community but rather defending his own interests as a trader. Some interviewees affiliated with the small-scale sector expressed similar sentiment but added that the actions of the fish trader were positive for them.

The other path started in 1998 with the creation of the Inter-Institutional and Community Committee of the Small-Scale Fishery of the Northern Chocó Coast (GIC-PA, Spanish acronym). The GIC-PA brought together fishers, processors, ice-makers, NGOs (with multidisciplinary teams), government, and academia. They developed a fisheries management plan that addressed diverse topics from conflicts with shrimpers to food security (GIC-PA 2001). In the 1990s, the GIC-PA drafted potential EFZs based on fishers' knowledge to mitigate conflicts with shrimpers, which had partial overlap with the Chocó-EFZ. However, the government did not ratify these proposed zones. Neither those charts nor discussions were considered for the negotiation of the boundaries of the Chocó-EFZ. The GIC-PA became inactive in 2004 due to lack of funding but was reactivated in 2008 when the Chocó-EFZ was implemented. The organization had such a positive impact on the community while it was active that individual fishers and researchers continued to act as members of GIC-PA in the discussions about the EFZ even while the organization was dormant. Consequently, most of the small-scale fisheries stakeholders referred to the GIC-PA as the champion of the Chocó-EFZ.

In 2013, the two paths "officially" intersected when both the fish trader and a GIC-PA member participated as representatives of the small-scale fishing sector in the annual meeting of the Chocó-EFZ. During this meeting, the closure was expanded and implemented permanently. The tuna seiners and shrimpers were invited to this meeting but did not attend arguing safety reasons. The follow-up interviews indicate that the decision regarding the permanent closure was supported by the key studies conducted by MarViva (2012, cited by AUNAP 2012) and INVEMAR (2012). MarViva (2012) built on previous studies (Ramírez-Luna et al. 2008; Navia et al. 2010) and helped expand existing knowledge about local fisheries inside and outside the 2.5 NM boundary. INVEMAR (2012) looked at catch and bycatch in the deepwater shrimp fishery and found that key species for small-scale fisheries were part of the bycatch. Additionally, a meeting between the government and the tuna sector revealed that the expansion of the Chocó-EFZ to 12 NM would not have any impact on tuna fishing grounds.

Although the Chocó-EFZ studies were conducted under cooperation agreements with the government, none of them were considered sufficient for deciding the future of the zone, and the research was perceived to be biased. This lack of consensus and trust caused the sectors to demand more research to make a final decision regarding the time frame and configuration of the Chocó-EFZ. INVEMAR (2012) was the exception because it was conducted onboard a commercial shrimp vessel and had the participation of fishers from Bahía and the fishing trips were carried out as if it were a commercial operation. The results left little room for arguments or perception of bias toward the small-scale fishing sector.

After the implementation of the Chocó-EFZ as a permanent measure, efforts have focused on the design of the fisheries management plan for the EFZ (within the first 2.5 NM), through a participatory process involving multiple stakeholders associated with the small-scale fishing sector (GIC-PA and multiple national and international governmental agencies and NGOs). Follow-up interviews did not gather any data related to the management plan of the Special Zone (between 2.5 and 12 NM) which would involve the tuna and shrimp sector.

#### 9.4.2.1 The Role of the Chocó-EFZ in Mitigating Fisheries Conflicts

Small-scale fisheries stakeholders indicated that the shrimp fleets were not sighted as frequently in the area after the implementation of the Chocó-EFZ as they had been prior to its establishment. Some of them suggested that shrimpers might have been fishing in areas away from Bahía where there was no surveillance, or in southern areas outside the EFZ. However, the shrimpers' representative said that their vessels were anchored in Buenaventura's port because it was not profitable to go fishing elsewhere. He claimed that the Chocó-EFZ led to unemployment among workers in the shrimp fishery and that the resource and the economic benefits of the shrimp fishery were being wasted because local fishers did not have the gear to catch shrimp. The local fishers' spokesperson, on the other hand, noted that although there was no local shrimp fishery, the resource was an important prey item for the Pacific bearded brotula, the key species for local long-liners.

Regarding resource competition between tuna vessels and local handliners, key informants from Bahía indicated that the Chocó-EFZ needed to be up to 12 NM to eliminate these conflicts. Seiners had always fished in the first five or six NM and would come near the 2.5 NM boundary using small speed boats to herd tuna toward the vessel. The extension of the Chocó-EFZ to 12 NM would address the conflict, although surveillance would be needed to prevent encroachment.

### *9.4.3 Support for and Constraints to the Chocó-EFZ*

It was always the expectation of the small-scale fishing sector that the closure would become permanent and that it would expand beyond the original boundaries. To achieve this goal, they considered it important to have all local fishers involved, as well as organizations from other coastal provinces and local and national government departments. Research was also considered important, especially to assess the effectiveness of the Chocó-EFZ and to improve management. The small-scale fishing sector also argued that the adjacent marine waters and the resources in it belong to the local communities and should not be damaged or taken away by the large-scale fisheries. Through the GIC-PA, they worked together with organizations specialized in legal matters to use community rights as an argument to support the permanent implementation of the Chocó-EFZ. Forum minutes and legal documents reflect the demand of the small-scale fishing sector that the government must recognize the ancestral use by black communities of the marine environment and the link between local fisheries and fishers' rights to a healthy environment, food security, and the preservation of national cultural heritage (*Tierra Digna*, *Acción Popular*, *January* 2012; Ministry of Agriculture and Ministry of Internal Affairs 2013). While none of the resolutions mentions ancestry, traditional territories, or rights of black communities, one of the newsletters issued by AUNAP states that, through an exclusive zone, the State is protecting the marine area adjacent to the territories of small-scale fishing communities "assuring a preferential access to coastal resources, traditionally used by them" (AUNAP 2014, p. 2).

Opinions of the tuna and shrimp sectors were mixed. Although during the first years of the process the tuna spokesperson considered the expansion of the Chocó-EFZ beyond 2.5 NM "absurd," in 2013, they did not have major issues with the expansion to 12 NM. However, they were never willing to allow any monitoring to occur onboard tuna fishing vessels other than that carried out by scientific observers from the Inter-American Tropical Tuna Commission (IATTC). Furthermore, the resolution that implemented and expanded the Chocó-EFZ (AUNAP 2013) modified an older resolution that fully excluded the tuna fishery from the first 30 NM (INCODER 2004). Consequently, AUNAP (2013) has allowed tuna seiners (<108 net register tonnage (NRT)) and tuna longline vessels (< 24 m long) to fish closer to shore. An interviewee from the small-scale fisheries said that "that's a separate battle" when referring to this situation.

The shrimp sector, on the other hand, was against the Chocó-EFZ from the beginning to the end. The representative claimed that the shrimp sector had not been considered in the early discussion about the zone boundary. Additionally, he insisted that no sector should be allocated privileges that harm other sectors. In a letter to AUNAP (May 2013), the sector requested that they be allowed to fish inside the 2.5 NM from August to November when shrimp is large enough for harvesting. They also disagreed with the expansion of the zone beyond the original boundaries. Consistent with their arguments since the beginning of the negotiations, the shrimpers reemphasized that shrimp resources were being wasted because they were not being caught and that the Chocó-EFZ was causing unemployment and negatively impacting the economy. They closed the letter by stating that they were aware of the need for sustainable fishing; therefore the zone should be called “MANAGEMENT ZONE” (original capitalization) rather than “exclusive zone,” so all sectors would benefit while protecting the resources. Through a follow-up interview in 2014, the representative stressed his opposition to the granting of exclusive fishing rights to the small-scale fishing sector (calling it “privatization”) and expected to be allowed to fish inside the 2.5 NM from August to November.

The term “exclusive zone” generated debate among government and representatives of the fishing sectors. It was suggested, for instance, that the designation of the Chocó-EFZ should not imply exclusive access for local fishers but access to tuna and shrimp fisheries under certain conditions. The result is the adoption of an area that combines the allocation of exclusive access to local fishers, but with restriction of gill nets and beach seines, and a Special Zone that allows tuna fishery of certain tonnage and size. The resolution does not state, however, whether the shrimp fishery is banned or allowed in the Special Zone.

## 9.5 Discussion and Conclusion

The study of the step zero of the Chocó-EFZ allowed the examination of what preceded its implementation as well as the events that took place afterward. During the pre-implementation process, stakeholders identified the problem and attempted to fix it in different ways. However, the consolidation of the Chocó-EFZ as we know it today took years to mature. Key elements related to the pre-implementation process included the long history of conflicts between sectors and the local community’s perception of corruption in the government, which was perceived to favor the tuna sector. The permanent and extended Chocó-EFZ represents a success for the small-scale fishing sector over the “powerful tuna sector.” All relevant stakeholders participated in the discussion, but they joined at different points in time, had diverse perceptions of the conflicts, and had various levels of knowledge and understanding of the issues and the process.

Key stakeholders from the small-scale sector involved in the pre-implementation stage included the fish trader (as an individual) and the GIC-PA (a multi-stakeholder organization). Years before the idea of an exclusive zone took form, and following separate paths, both the fish trader and the GIC-PA were aware of the concerns raised by local fishers about gear conflicts with the shrimp fishery and the associated potential risks to their livelihoods. The fish trader and the GIC-PA were interested in resolving the problem, which was within their capacity to address, and addressed it by finding the required support from other individuals and organizations and looking for solutions to solve the problem. These aspects are among the conditions needed to start such an initiative, as also recognized in other cases (Chuenpagdee and Jentoft 2007). However, the way to communicate their ideas and to get the community involved took a different path. The GIC-PA was more effective at communicating with the community than the fish trader, which is a key factor in developing initiatives since it gets people to identify the existence of a problem and gives them an opportunity to provide input into solutions. The GIC-PA, as a multi-stakeholder organization, brought together fishers, processors, ice-makers, NGOs, government, and academic agencies related to the fisheries in Northern Chocó. The GIC-PA held numerous meetings and workshops to develop a fisheries management plan that addressed not only the damage caused by shrimpers to longlines but also the harm to fish populations and food security. Discussions led to the drafting of EFZs for local fishers (Matallana 2000; GIC-PA 2001), but these were never implemented or were even familiar to stakeholders involved in later negotiations. Such engagement and participation from fishers and other key stakeholders have been recognized in other processes as critical to the successful implementation of co-management and MPAs (McCay 2002; Chuenpagdee and Jentoft 2007; Chuenpagdee et al. 2013).

In contrast, the fish trader initially limited his actions to advocating on behalf of the group of long-liners working for him, focusing on a specific problem (the damage of longlines), and looking for help only from the port authorities. Years later, his network expanded to a few local fishers and public employees who provided funding for him to go to meetings. He was invisible at this early stage but gained recognition years later through his participation in the negotiations of the Chocó-EFZ in 2008. As with the development of some co-management initiatives (Chuenpagdee and Jentoft 2007), the Chocó-EFZ discussions had an informal beginning with confined communication that developed into more formal proceedings and settings, with the trader playing a leadership role. Confining communication to a small circle, however, raised suspicions among other stakeholders that there may be hidden agendas, especially that the fish trader was protecting his own interests rather than those of the community. Although the fish trader initiated the negotiations that led to the implementation of the Chocó-EFZ in 2008, and the GIC-PA was dormant when the zone was implemented, most key informants and fishers emphasized the GIC-PA's role in its establishment, lauding their involvement as transparent and legitimate. Transparency and legitimacy are key qualities that generate trust and could help move the discussion about place-based management systems forward (Pinkerton and John 2008; Gutiérrez et al. 2011).

Participation, knowledge, and perception of the Chocó-EFZ process differed significantly between sectors and within the large-scale fishing sector. On one hand, the tuna sector had a vague idea of what triggered the process, participated in all the meetings, and did not seem affected by the closure. On the other hand, the shrimp sector did not know what the trigger was and claimed that they had been excluded from early discussions and that EFZ had a very negative impact for them. Consequently, the shrimp sector strongly opposed the closure. Early involvement of the shrimp sector would have shaped the pre-implementation process differently. Considering that shrimp fishers agreed that there is a need for sustainable fishing and a need to prevent the negative socioeconomic impact on their sector caused by total exclusion, their representative would have brought to the table other management tools to mitigate conflicts with local fishers while allowing shrimpers to access the resources. The dynamics during the post-implementation process have not changed, as they have not been invited to participate in the design of the management plan for the Special Zone. This situation would deepen their opposition to the closure and further undermine their trust of the government. Research has shown that large-scale shrimp fishers are also aware of problems in the fishery and that, by valuing their attitudes and incorporating their knowledge, it is possible to bring out new perspectives that might increase the likelihood of success of new management plans (Foster and Vincent 2010).

The construction of the management plan for the Chocó-EFZ, including the Special Zone, could be an opportunity for a "legitimacy-building process" (Pinkerton and John 2008, p. 689). This process involves four interacting and mutually reinforcing components: regulatory, scientific, political, and moral legitimacy. Stakeholders will only perceive the resulting regulations as fair, democratic, transparent, inclusive, and positive if science is discussed, shared, and communicated effectively (Pinkerton and John 2008). As these authors conclude, building legitimacy is a complex and multifaceted process, especially within a context such as the Chocó-EFZ that involves diverse fish resources and stakeholders with different concerns and perceptions about the process and sea tenure.

The establishment of EFZs might mitigate conflicts, but there is no guarantee that the excluded sector will give up fishing in EFZs. The likelihood of encroachment and thus the need to develop control and surveillance strategies are key elements of EFZ effectiveness (LeDrew 1988; Hart 1998; Bourillón-Moreno 2002; Davis et al. 2006). Ongoing encroachment in areas without surveillance was a concern among local fishers. Another challenge that the Chocó-EFZ faces is the scale at which conflicts occur. For instance, conflicts between long-liners and shrimpers originating in gear conflicts and bycatch impact occur at a local geographical scale. Both fisheries target low-mobility species, and conflicts between them occur in coastal, well-defined areas that are protected by the first 2.5 NM of the EFZ. At this scale, the Chocó-EFZ is effective (at least in theory) in excluding the shrimp vessels, preventing gear conflicts, and protecting low-mobility species. On the other hand, conflicts with seiners occur at a larger geographical scale involving competition for tuna (highly migratory species), which moves from offshore (tuna fishing grounds) to coastal waters (local fishing grounds). Although the extension of the Chocó-EFZ to 12 NM is celebrated by the small-scale fishing sector, it did not completely exclude the tuna fishery, which will increase monitoring and enforcement challenges. Olsen et al. (2011), in the comparison of three spatial scales related to management (local, regional, and large scale), revealed that ecological, governance, and management complexity increased with increasing geographic scale when implementing place-based management tools.

Disagreements between the small-scale and large-scale fishing sector went beyond economic interests to involve dimensions such as fishing rights and exclusive access, reflecting different normative orders that stakeholders represent. The legal pluralism perspective highlights the fact that the conflicting parties "may disagree about basics, such as what belongs to whom, and why, and who decides" (Bavinck 2005, p. 817). Through this lens, reaching agreements about the rules of the game becomes more problematic. One important element is the definition of sea tenure and how several tenants impose claims on similar sea territories (Bavinck 2005). The small-scale fishing sector claims adjacent fishing grounds and resources as theirs because, as black communities, they have inhabited and used the territory for centuries and currently they feel their livelihoods are threatened by the large-scale fishing sector. The State has recognized the right of black communities to exercise stewardship over their territories and has constructed a legal framework to entitle communities to control these territories (*Ley 70*, 1993, and subsequent decrees); however, the sea was not included in the definition of territory. This debate, with its very different points of departure, shaped negotiations about what the zone should be called, such as "exclusive zone" (as the small-scale fishing sector always demanded and supported by one of the public officers), "multiple-use area under fishery management" (suggested by another public officer), or "Special Zone for the Management of Fishing Resources" as suggested by the tuna sector representative. The result was the adoption of an area that combines the allocation of exclusive access to local communities and a Special Zone that allows the tuna fishery to harvest a certain tonnage and size, although it does not state whether the shrimp fishery is allowed.

Exploring the step zero of the Chocó-EFZ also showed that the establishment of the Chocó-EFZ aligns well with three key recommendations made by the SSF Guidelines as part of "Responsible Governance of Tenure" (FAO 2015, Part 2, Section 5a), which states that (1) preferential access to fishery resources by local fishing communities including ethnic minorities should be recognized; (2) creation and enforcement of exclusive zones for small-scale fisheries should be considered as a means to provide preferential access; and (3) granting preferential access should be undertaken with legislation. The Chocó-EFZ has granted preferential rights to black communities and has legal support that not only allows for its creation and enforcement but has also committed the government to designing and implementing a management plan through a participatory process. Materializing this plan is one of the challenges of the Chocó-EFZ post-implementation process. The possibility of "walking the talk" (Jentoft 2014) in the implementation of the SSF Guidelines may be high for Colombia considering the context of the Chocó-EFZ. In a larger scale, however, Saavedra-Díaz and Jentoft (2017) argue that a reform of the Colombian governance system would be needed for a successful implementation of the SSF Guidelines. On the other hand, the SSF Guidelines also recognize that "small-scale fishing communities also commonly suffer from unequal power relations" (Preface, p. x). This makes the implementation of the SSF Guidelines not only technical but also political, since it will inevitably interfere with power relationships (Jentoft 2014). As revealed in the step zero analysis, power struggles between the small- and large-scale fishing sectors were constant during the pre- and post-implementation processes of the Chocó-EFZ.

This case study has shown that place-based management tools such as EFZs can be a powerful mechanism for the protection of the rights of small-scale fisheries and fish workers around the world. However, it demands a transparent, fair, democratic, and inclusive process that must tackle power imbalances and unintended consequences while generating trust among stakeholders. Further, such mechanisms must aim to create the right conditions required to design and implement a management plan that would support the social and ecological sustainability of EFZs and the well-being of stakeholders in the long term.

**Acknowledgment** This chapter is part of V. Ramírez-Luna's master thesis (2013); she wishes to thank the support of their Thesis Committee members B. Neis, D. Schneider, and R. Chuenpagdee, as well as the support of SQUALUS Foundation, GIS specialists A. Torres and D. Mercer, local research assistants A. Zita and T. Villalba, and key informants who shared their time, insights, and knowledge. V. Ramírez-Luna also thanks AUNAP for authorizing the use of the Chocó-EFZ/Special Zone map. Production of the thesis benefitted from financial support from B. Neis' Pierre Elliott Trudeau Foundation Fellow funds and D. Schneider's Natural Sciences and Engineering Research Council of Canada (NSERC) funds and from fellowship support from the School of Graduate Studies of Memorial University of Newfoundland. V. Ramírez-Luna and R. Chuenpagdee wish to thank the reviewers for their constructive feedback.

## References

Agardy T, di Sciara GN, Christie P (2011) Mind the gap: addressing the shortcomings of marine protected areas through large scale marine spatial planning. Mar Policy 35(2):226–232

AUNAP (2013) Resolución 899. Por la cual se establecen una Zona Exclusiva de Pesca Artesanal—ZEPA, una Zona Especial de Manejo Pesquero (ZEMP) en el Departamento del Chocó y se adoptan otras medidas". República de Colombia. http://legal.legis.com.co/document?obra=legcol&document=legcol_e3064d405f2e0042e0430a0101510042. Accessed 30 Mar 2016

AUNAP (2014) La ZEPA como instrumento para una pesca responsable. NotyAUNAP, Bogotá, D.C

AUNAP (Autoridad Nacional de Acuicultura y Pesca) (2012) Resolución 545. Por la cual se amplía la duración del área exclusiva destinada para la pesca artesanal en el Departamento del Chocó, denominada 'ZONA EXCLUSIVA DE PESCA ARTESANAL – ZEPA' comprendida entre las localidades de Punta Solano hasta Punta Ardita (zona norte del Chocó) República de Colombia. http://www.avancejuridico.com/actualidad/documentosoficiales/2012/48516/r_aunap_0545_2012.html. Accessed 30 Mar 2016

Barreto C, Polo G, Mancilla B (2001) Análisis biológico pesquero y económico de la fauna acompañante en la pesquería de arrastre industrial colombiana. Contribución biológica y económica para la investigación y el desarrollo en recursos pesqueros colombianos y estimación del impacto de la fauna incidental en la pesca de arrastre del camarón. In: Tropical shrimp fisheries and their impact on living resources. Shrimp fisheries in Asia: Bangladesh, Indonesia and the Philippines; in the Near East: Bahrain and Iran; in Africa: Cameroon, Nigeria and the United Republic of Tanzania; in Latin America: Colombia, Costa Rica, Cuba, Trinidad and Tobago, and Venezuela. (pp. 234–270). Fisheries Circular. No. 974. FAO, Rome. ftp://ftp.fao.org/docrep/fao/007/y2859e/y2859e00.pdf. Accessed 20 Aug 2016

Bavinck M (2005) Understanding fisheries conflicts in the south – a legal pluralist perspective. Soc Nat Resour 18(9):805–820

Boudouresque CF, Cadiou G, Le Diréach L (2005) Marine protected areas: a tool for coastal areas management. In: Levner E, Linkov I, Proth JM (eds) Strategic management of marine ecosystems. Springer, Dordrecht, pp 29–52

Bourillón-Moreno L (2002) Exclusive fishing zone as a strategy for managing fishery resources by the Seri Indians, Gulf of California, Mexico. Doctoral thesis, University of Arizona. http://cobi.org.mx/wp-content/uploads/2012/08/2002-c-cie_tesis_doctl_lbourillon.pdf. Accessed 30 Mar 2016

Cadiou G, Boudouresque C, Bonhomme P, Le Diréach L (2009) The management of artisanal fishing within the marine protected area of the Port-Cros National Park (northwest Mediterranean Sea): a success story? *J Mar Sci* 66:41–49

Castilla JC, Fernández M (1998) Small-scale benthic fisheries in Chile: on co-management and sustainable use of benthic invertebrates. Ecol Appl. http://www.esajournals.org/doi/pdf/10.1890/1051-0761%281998%298%5BS124:SBFICO%5D2.0.CO%3B2

Chuenpagdee R, Jentoft S (2007) Step zero for fisheries co-management: what precedes implementation. Mar Policy 31(6):657–668

Chuenpagdee R, Pascual-Fernandez JJ, Szeliánszky E, Alegret JL, Fraga J, Jentoft S (2013) Marine protected areas: re-thinking their inception. Mar Policy 39:234–240

Davis R, Whalen J, Neis B (2006) From orders to borders: toward a sustainable co-managed lobster fishery in Bonavista Bay, Newfoundland. Hum Ecol 34:851–867

FAO (Food and Agricultural Organization of the United Nations) (2015) Small-scale fisheries – web Site. International guidelines on Securing Sustainable Small-Scale Fisheries [SSF guidelines]. http://www.fao.org/fishery/ssf/guidelines/en. Accessed 21 Aug 2016

Federación Colombiana de Municipios (n.d.) Bahía Solano. Descifra las cifras de tu municipio. http://www.fcm.org.co/fichamnemotecnica/pdf/choco/bahiasolano.pdf. Accessed 8 Mar 2012

Foster SJ, Vincent ACJ (2010) Tropical shrimp trawl fisheries: fishers' knowledge of and attitudes about a doomed fishery. Mar Policy 34(3):437–446

Gelcich S, Hughes TP, Olsson P, Folke C, Defeo O, Fernandez M, Foale S, Gunderson LH, Rodríguez-Sickert C, Scheffer M, Steneck RS, Castilla JC (2010) Navigating transformations in governance of Chilean marine coastal resources. Proc Natl Acad Sci U S A 107(39):16,794–16,799

GIC-PA (2001) Lineamientos generales para el ordenamiento de la pesca artesanal en la costa norte de Chocó. Technical report

Gutiérrez NL, Hilborn R, Defeo O (2011) Leadership, social capital and incentives promote successful fisheries. Nature 470(7334):386–389

Hart PJB (1998) Enlarging the shadow of the future: avoiding conflict and conserving fish. In: Pitcher TJ, Hart PJB, Pauly D (eds) Reinventing fisheries management. Kluwer Academic Publishers, London, pp 227–238

ICA (Instituto Colombiano Agropecuario) (2008) Resolución 2650. Por la cual se delimita un área exclusiva destinada para la pesca artesanal en el Departamento del Chocó. República de Colombia. http://www.avancejuridico.com/actualidad/documentosoficiales/2008/47068/r_ica_2650_2008.html Accessed 30 Mar 2016

INCODER (2009) Resolución 1051. Por medio de la cual se amplía la duración de la medida en el área exclusiva destinada para la pesca artesanal en el Departamento del Chocó por el término de un (1) año, contado a partir del 31 de julio de 2009 República de Colombia. http://www.avancejuridico.com/actualidad/documentosoficiales/2009/47434/r_incoder_1051_2009.html. Accessed 30 Mar 2016

INCODER (2010) Resolución 2107. Por la cual se amplía la duración de la medida en el área exclusiva destinada para la pesca artesanal en el Departamento del Chocó. República de Colombia

INCODER (Instituto Colombiano de Desarrollo Rural) (2004) Resolución 1856. Por la cual se determinan áreas geográficas en aguas jurisdiccionales del Pacífico colombiano con el fin de ordenar, regular, administrar, controlar y vigilar los recursos pesqueros marinos susceptibles de aprovechamiento, garantizando y asegurando su explotación racional y manejo integral. República de Colombia. http://www.avancejuridico.com/actualidad/documentosoficiales/2004/45749/r_incoder_1856_2004.html. Accessed 30 Mar 2016

INVEMAR (2012) Plan operativo cruceros de prospección pesquera en la ZEPA. Proyecto "Prospección y monitoreo de pesquerías clave en Colombia". Santa Marta

Jentoft S (2014) Walking the talk: Implementing the international voluntary guidelines for securing sustainable small-scale fisheries. Mar Stud 13(1):16

Jentoft S, McCay B, Wilson D (1998) Social theory and fisheries co-management. Mar Policy 22(4–5):423–436

Jentoft S, Pascual-Fernandez JJ, de la Cruz Modino R, Gonzalez-Ramallal M, Chuenpagdee R (2012) What stakeholders think about marine protected areas: case studies from Spain. Hum Ecol 40(2):185–197

Johannes RE (1981) Words of the lagoon. University of California Press, Oakland

Kaiser M, Spence F, Hart P (2000) Fishing-gear restrictions and conservation of benthic habitat complexity. Conserv Biol 14(5):1512–1525

LeDrew B (1988) A study of the conflict between fixed and mobile gear in Western Newfoundland. Department of Fisheries and Oceans, St. John's

Ley 70 (1993). Por la cual se desarrolla el artículo transitorio 55 de la Constitución Política. República de Colombia. http://www.unhcr.org/refworld/pdfid/46d59b7a2.pdf. Accessed 30 Mar 2016

Mascia MB, Claus CA, Naidoo R (2010) Impacts of marine protected areas on fishing communities. Conserv Biol 24(5):1424–1429

Matallana M (2000) Hacia el ordenamiento de la actividad pesquera artesanal en los Golfos de Cupica y Tribugá, Pacífico colombiano. In: Fundación Natura, Proyecto "Comunidades indígenas y negras: desarrollo regional para la conservación de los recursos naturales en el Chocó Biogeográfico – Colombia" [CD], Final report. Bogotá: Fundación Natura

McCay BJ (2002) Emergence of institutions for the commons: contexts, situations and events. In: Dietz T, Dolsak N, Stern PC, Stonich S, Weber EU (eds) *The drama of the commons*. National Academy Press, Washington, DC, pp 361–402

Murawski SA, Brown R, Lai HL, Rago PJ, Hendrickson L (2000) Large-scale closed areas as a fishery-management tool in temperate marine systems: the Georges Bank experience. Bull Mar Sci 66(3):775–798

Navia AF, Mejía-Falla PA, Gómez LS, Payán LF, Ramírez AV, Tobón A (2008) Pesquerías y cadena productiva del recurso tiburón en el Pacífico colombiano: análisis y perspectivas. Fundación SQUALUS Technical report. Fundación SQUALUS, Santiago de Cali

Navia AF, Mejía-Falla PA, López-García J, Muñoz LA, Ramírez-Luna V (2010) Pesquería artesanal de la zona norte del Pacífico colombiano: aportando herramientas para su administración. Fase 2. Fundación SQUALUS Technical report. Fundación SQUALUS, Santiago de Cali

Neis B, Kean R (2003) Why fish stocks collapse: an interdisciplinary approach to understanding the dynamics of 'fishing up'. In: Byron R (ed) Retrenchment and regeneration in rural Newfoundland. University of Toronto Press, Toronto, pp 65–102

Nielsen JR, Degnbol P, Viswanathan KK, Ahmed M, Hara M, Abdullah NMR (2004) Fisheries co-management—an institutional innovation? Lessons from South East Asia and Southern Africa. Mar Policy 28(2):151–160

Olsen E, Kleiven A, Skjoldal H, von Quillfeldt C (2011) Place-based management at different spatial scales. J Coast Conserv 15(2):257–269

Orensanz JM, Seijo JC (2013) Rights-based management in Latin American fisheries. FAO Fisheries and Aquaculture technical paper, no. 582. FAO, Rome. http://www.fao.org/3/a-i3418e.pdf. Accessed 30 Mar 2016

Pinkerton E, John L (2008) Creating local management legitimacy. Mar Policy 32(4):680–691

Pomeroy R, Douvere F (2008) The engagement of stakeholders in the marine spatial planning process. Mar Policy 32(5):816–822

Ramírez-Luna V (2013) The exclusive fishing zone for the artisanal fishery in Chocó Colombia: origins, development, and consequences for artisanal fisheries and food security. Master's thesis, Memorial University of Newfoundland, St. John's

Ramírez-Luna AV, Gómez LS, Tobón A, Mejía-Falla PA, Navia AF (2008) Pesquería artesanal de la zona norte del Pacífico colombiano: aportando herramientas para su co-manejo. Fase 1. Fundación SQUALUS, Colombia Technical Report. Fundación SQUALUS, Santiago de Cali

Ruddle K, Hviding E, Johannes RE (1992) Marine resources management in the context of customary tenure. Mar Resour Econ 7(4):249–273

Rueda M, Rico-Mejía F, Angulo W, Girón A, Rodríguez AL, García LM, Arenas L (2010) Evaluación biológico-pesquera del estado de las poblaciones de camarón de aguas profundas, mediante la aplicación de métodos directos (prospección pesquera) e indirectos (estadísticas de captura y esfuerzo) en el Pacífico colombiano. Informe Final de Proyecto código 031 2007 T6650-909-07. MADR. INVEMAR, Santa Marta, Colombia

Saavedra-Díaz L, Jentoft S (2017) The role of the Small-Scale Fisheries Guidelines in reclaiming human rights for small-scale fishing people in Colombia. In: Jentoft S, Chuenpagdee R, Barragán-Paladines MJ, Franz N (eds) *The small-scale fisheries guidelines. Global implementation*, MARE publication series 14. Springer, Cham, pp 573–596

Wielgus J, Zeller D, Caicedo-Herrera D, Sumaila R (2010) Estimation of fisheries removals and primary economic impact of the small-scale and industrial marine fisheries in Colombia. Mar Policy 34(3):506–513

**Viviana Ramírez-Luna** is a researcher of the SQUALUS Foundation and a TBTI member. She completed a BSc in Biology at the *Universidad del Valle* (Colombia, 2006) and an MSc in Environmental Science at Memorial University of Newfoundland (Canada, 2013). Viviana's research has looked at different dimensions of small-scale fisheries on the Pacific coast of Colombia, including history, biology, socioeconomics, food security, fishing conflicts with large-scale fisheries, and traditional knowledge of both male and female fish harvesters.

**Ratana Chuenpagdee** is a professor at the Department of Geography, Memorial University of Newfoundland, St. John's, Canada. She held the position of Canada Research Chair in Natural Resource Sustainability and Community Development at Memorial University from 2006 to 2016. Her research emphasizes interdisciplinary approaches to coastal, fisheries, and ocean governance, focusing particularly on small-scale fisheries, marine protected areas, community-based management, and food security. She has worked in several countries including Cambodia, Malawi, Mexico, Spain, Thailand, and Canada. Dr. Chuenpagdee is a director of the Too Big To Ignore (TBTI) Global Partnership for Small-Scale Fisheries Research and coedited the book *Interactive Governance for Small-Scale Fisheries: Global Reflections* (2015), with Professor Svein Jentoft.

# Chapter 10
# The Challenge of Managing Amazonian Small-Scale Fisheries in Brazil

**Priscila F. M. Lopes, Gustavo Hallwass, Alpina Begossi, Victória J. Isaac, Morgana Almeida, and Renato A. M. Silvano**

**Abstract** Amazonian fisheries in Brazil contribute to the food security of over 20 million people who are mostly poor. However, multiple examples suggest that freshwater fish stocks may be under the same overfishing threats observed in marine fisheries, in addition to all the risks imposed by infrastructure development projects. While such threats may push some of these vulnerable people to the edge as some fisheries collapse, others will be pushed toward makeshift or elaborated solutions which can help them to maintain or restore local fisheries. In this chapter, we first adopt a theoretical approach to explore the main threats to Amazonian small-scale fisheries and their direct impacts on people's livelihoods. We then move on to an

P. F. M. Lopes (✉)
Fishing ecology, management, and economics group - Departament of Ecology, Federal University of Rio Grande do Norte, Natal, Brazil

FIFO – Fisheries and Food Institute, Santos, SP, Brazil
e-mail: priscila@cb.ufrn.br

G. Hallwass
FIFO – Fisheries and Food Institute, Santos, SP, Brazil

Federal University of Pará, Belém, PA, Brazil

A. Begossi
FIFO – Fisheries and Food Institute, Santos, SP, Brazil

Capesca, Nepa, University of Campinas, Campinas, SP, Brazil

Ecomar, Unisanta, Santos, Brazil

V. J. Isaac · M. Almeida
Laboratório de Biologia Pesqueira e Manejo de Recursos Aquáticos, Ciências Biológicas, Universidade Federal do Pará, Belém, PA, Brazil

R. A. M. Silvano
FIFO – Fisheries and Food Institute, Santos, SP, Brazil

Department of Ecology, Federal University of Rio Grande do Sul, Porto Alegre, Brazil



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_10

empirical solution-based comparison between different types of co-management initiatives, using case studies developed within a protected area framework and community-based arrangements. We expect to show how small-scale fishers themselves can be the best, and sometimes the only, alternative for management. The different kinds of management broaden the application of eventual patterns, discrepancies, limitations, and solutions identified for Amazon to inland fisheries.

**Keywords** Co-management · Hydropower development · Amazonian protected areas · Fishing agreements · Food security

## 10.1 Introduction

Inland fisheries have received considerably less attention in the literature than their marine counterpart (McClanahan et al. 2008; Cinner et al. 2009; Barnes-Mauthe et al. 2013). While there have been multiple warnings and serious concerns about the global state of marine fisheries, with recent figures estimating that most stocks have been already depleted (Costello et al. 2012), the situation for inland stocks is still unclear. Part of this information gap is due to the fact that most inland catches are used for subsistence or sold at local markets (Hallwass et al. 2011), which are often excluded from official estimates. In general, the lack of statistical fisheries data is not an issue that is unique to the Amazon but one that affects the whole country. Brazilian fisheries statistics are usually very susceptible to political and economic turmoil, being the first to be cut in any crisis. In fact, the production of fisheries statistics has been completely absent since 2011 (Felizola Freire et al. 2015).

A variety of fishes, such as some large migratory catfish (e.g., piramutaba, *Brachyplatystoma vaillantii*), Acoupa weakfish (*Cynoscion acoupa*), carnivorous cichlids (e.g., tucunaré, *Cichla* spp.), and frugivorous Characidae fish (e.g., tambaquis – *Colossoma macropomum*), are caught in inland fisheries, but a relatively small number of species receive most of the fishing pressure and are commercialized at national levels (Hallwass and Silvano 2015). Even fewer species are traded internationally, and these are usually ornamental species.

This lack of information has led to two different views about the current status of inland fisheries (Welcomme 2011). The more pessimistic view assumes that stock collapses are imminent or have been happening consistently in different places. This view is based on studies showing local species extinction and overfishing detected at the species and community level (Isaac and Ruffino 1996; Allan et al. 2005). The other view assumes that we do not know enough about the status of fish stocks to predict their decline. According to this view, there are also multiple examples of rising catches (Welcomme 2011), although the reasons explaining such rises are not always suggestive of more sustainable management or ecological conditions.

For example, increased catches can be the result of the replacement of large fish for smaller ones (Welcomme 1999; Welcomme et al. 2010), which are usually lower in value.

The Amazon is an example of a challenging region to manage small-scale fisheries. Although shared by nine countries, 60% of this biome lies within Brazil, where its productive floodplains, rivers, backwaters, and lakes sustain over 20 million people. In fact, the dependence of the Brazilian Amazonian communities on fish is remarkable, with this region having one of the highest per capita fish intakes in the world, varying from 369 to 805 g per day per capita in some places (Isaac and de Almeida 2011). Therefore, assuring the long-term sustainability of fish resources is essential for maintaining local food security and livelihoods.

Although the region also hosts some industrial fisheries (Bayley 1989), which rely on trawling (Fabré and Barthem 2005), the majority of fisheries exploitation is done by small-scale and subsistence fishers (Hallwass et al. 2013b). Small-scale and subsistence fishers usually rely on the same gears and methods, with differences in their effort and capacity (e.g., boat and net size) and in the portion of their catch that is commercialized. In some areas of the Amazon, the prevailing vessel type is still paddled canoes, while low-power motorized canoes predominate in others. Apart from the major fishing ports, which are in the two largest cities (Belém and Manaus), the remaining landings are scattered throughout thousands of small villages, where there is no official data collection (Hallwass et al. 2011). Exceptions are some protected areas which fall under some sort of fisheries management, such as Mamirauá and Amanã (Viana et al. 2004; Almeida et al. 2009).

Therefore, what is known about Amazonian fisheries comes mostly from localized studies, which are limited in time and space (MacCord et al. 2007; Silvano et al. 2009). In this context, the challenge of fisheries management seems able to be addressed only through cooperation between government and local communities. The vast scale of the region, with its tropical biodiversity and hundreds of targeted species, associated with the inherent lack of funding, personnel, and infrastructure in Amazonian countries, make usual management measures which are routinely applied to temperate regions unfitting to tropical fisheries in general and the Amazon specifically (Silva 2004).

On the other hand, problems related to management capacity are perhaps of less concern to fisheries than the threats imposed by large-scale development projects and deforestation (Laurance et al. 2001). For example, the region is believed to have an immense potential for the generation of hydroelectricity, which explains the implementation (existent or under construction) of 105 dams, some of which are very large, in addition to the planning of at least 91 others for the near future. Large dams have been shown to cause negative ecological and social consequences in neotropical rivers, such as local displacement, entrapment of migratory fish upstream or downstream the dam, regional extinctions of commercial fish, and decreases in fishermen's income (Pelicice and Agostinho 2008; Hoeinghaus et al. 2009; Hallwass et al. 2013a; Fearnside 2015). Adding to these negative impacts, some areas are also under the stress by uncontrolled population growth, which are affecting rivers and estuaries with their residues (Sá-Oliveira et al. 2016).

This picture of the challenges currently facing the Amazon region brings to the forefront the need to manage, prevent, or at least mitigate the consequences of fish overexploitation, both those linked to the impacts caused by developmental projects and those occurring separately. If left unattended, fishing pressure and other impacts may disrupt local livelihoods with unpredictable social consequences. In this chapter we will review threats and drivers that are both external and internal to fishing, considering the existing human groups and their associated social capital. We also address the potential and limitations of fisheries management initiatives occurring at different levels and scales. We believe that some initiatives have potential to avoid a doomed future for inland fisheries, but the success of these efforts will depend strongly on users' involvement in management.

## 10.2 Background

### *10.2.1 Amazonian People*

The Brazilian Amazon is inhabited predominantly by indigenous peoples and *caboclos*, who are mostly descendants of indigenous groups and Portuguese settlers and sometimes also of African descent. Most of the fisheries studies published to date regard fishing by *caboclos* (Almeida et al. 2009; Castello et al. 2011). *Caboclos* that depend on fisheries live on natural levees by the main river channels or by lakes in the interior of floodplains (McGrath et al. 2007). Even if living in isolated areas, *caboclos* tend to visit or depend to a certain degree on the urban environment, mostly for commerce (Brondizio et al. 1994). Besides fishing, this group also practices small-scale agriculture, with a strong focus on growing cassava (their main staple) and, to a lesser degree, animal husbandry. These economic activities are highly dependent on the water cycle, which is marked by a low and high water season (Begossi 1998). Fisheries conducted by *caboclos* are usually small-scale. A few exceptions exist such as catfishes, which have received a strong and semi-industrial pressure in the main channel of the Amazon River and its estuary (Fabré and Barthem 2005). Overall, fishing is done with multiple gears (handline, harpoons, and castnets), but the most widely used are gillnets (Hallwass and Silvano 2015).

*Caboclos'* local organization varies from village to village and depends on factors such as whether or not a given community is located inside a protected area and the previous or current presence of religious or grassroots groups. In Brazil, there are multiple categories of protected areas, and at least two of these categories – sustainable development and extractive reserves – allow people to live and extract resources within their limits as long as they follow management rules (Lopes et al. 2011). Religious institutions have played an important role in developing social capital and promoting organization in multiple instances. Perhaps one of the most striking roles was the legacy of a branch of the Catholic Church that operated in the area mostly between the 1960s and 1990s (Basic Ecclesial Communities), which had strong roots in liberation theology (Lima 1999). In the 1980s, grassroots movements such as the one promoted by rubber tappers also represented an active engine toward local rights and conservation (Lima 1999). Such levels of organization facilitated the establishment of official fisheries management in some areas (Begossi 2010). This happened either because, in some places, the church had already established some sort of management, such as lake rotation, or the institutions (churches or rubber tappers' movements) had already developed enough social capital to get people involved in activities that could shape their future (Begossi 2010).

### *10.2.2 Anthropogenic Threats to Amazonian Freshwater Fisheries*

Large-scale human impacts are also a driver for declines in fisheries resources in inland waters. Such impacts include drainage and habitat alteration by agriculture; pollution and degradation of water quality due to urban centers, industry, agriculture, and mining; and habitat alterations and artificial regulation of river flows due to hydroelectric construction for energy production (Welcomme et al. 2010). Together, these impacts lead primarily to habitat loss, which has been attributed as the main cause of biodiversity loss (Barletta et al. 2010, 2016).

Another major driver is the fact that the Amazon forest has historically suffered from bureaucratic land grabbing (known as "*grilagens*"), which has been perpetrated by local, state, and federal authorities that base their success and development on slave work and the murder of indigenous and environmental leaders who are considered to be opponents of "progress" (Torres 2005). In addition, the increase in illegal deforestation in the Amazon benefits the agribusiness industry by facilitating new livestock and soybean production (Nepstad et al. 2002; Torres 2005; Fearnside 2006). Unfortunately, recent projects under analysis by the Federal Congress aim to allow changes in already instituted protected areas and indigenous lands to facilitate the construction of hydroelectric projects and concessions for mining exploitation (Bernard et al. 2014; Ferreira et al. 2014).

Large river dams built to produce energy are one of the main human impacts affecting freshwater fisheries (Ponton and Vauchel 1998). Several hydroelectric projects that are either proposed or under construction have simply ignored technical advice, following political interests in order to ensure private profits to large companies (Fearnside 2014, 2015). Dams alter the physicochemical structure of aquatic environments, changing the composition and trophic structure of fish communities and reducing the abundance and size of fishes (Ponton and Vauchel 1998; Fearnside 1999). They can also interrupt the reproductive migration routes of some species, such as large Amazonian catfishes *Brachyplatystoma rousseauxii* and *B. filamentosum* (Pimelodidae) (Barthem et al. 1991; Petrere-Jr et al. 2004). Moreover, dams have been blamed for causing the local extinction of commercial fish (Hallwass et al. 2013a). The artificial regulation of the river flow and its pulse inundation affects the survival of juvenile fishes in floodplain areas that act as nursery grounds

(Ponton and Vauchel 1998; Agostinho et al. 2005). As it is, dams tend to cause environmental, social, and economic impacts to fishing communities and populations living close or downstream from the impoundment.

In this context of large-scale environmental change, semi-industrial fishing is only one of the threats to Amazonian fisheries. However, overfishing is an important pressure, as fisheries can synergistically interact with and amplify the negative consequences of these other environmental impacts (Allan et al. 2005).

## 10.3 Exploitation Trends of Freshwater Fisheries in the Amazon

Freshwater fisheries in South America, including those in the Amazon, are considered moderately exploited compared to inland fisheries from other parts of the world such as Africa and Asia (Welcomme et al. 2010). However, the Brazilian Amazon offers fishing resources that have attracted the greed of people since early on. Pirarucu (*Arapaima gigas*), for example, which is arguably the largest freshwater scaled fish, has been intensively exploited since colonial times (Veríssimo 1895). The demand for pirarucu meat, which is sought after partly due to the ease of finding this giant obligate air breathing species, led to its collapse in most of the Amazonian territory before the 1980s (Veríssimo 1895; Goulding 1980). Although remarkable for being one of the first Amazonian fish species to show signs of overfishing, pirarucu is by no means the only one (Isaac and Ruffino 1996; Queiroz and Sardinha 1999).

In marine fisheries, the preference for large-bodied species often results in the overfishing of top predators, which leads to consequences that go down the trophic chain (Baum and Worm 2009). The Amazon, on the other hand, provides not only high market value large predatory fish, such as migratory catfishes, but also a handful of large-bodied frugivorous species, which are important for the maintenance of the forest through seed dispersal (Anderson et al. 2009). Their size and delicate taste also make frugivorous species a preferred target. This has resulted in the local overfishing of predators and frugivorous species alike, such as *Brachyplatystoma filamentosum* (piraíba) and *B. rousseauxii* (dourada) and *Colossoma macropomum* (tambaqui), respectively (Isaac and Ruffino 1996; Petrere-Jr et al. 2004; Garcia et al. 2008). Large fish species with slow life cycles have been replaced by smaller ones and faster growing ones (Garcia et al. 2008), suggesting the local occurrence of the fishing down process (Welcomme 1999).

Nevertheless, the variety of human cultures in the Amazon, which possess different levels of organization and management and make differing impacts on habitat quality and diversity, so far has reduced negative impacts on certain fish species. In some instances, some sort of outside initiative needs to take place in order to trigger better local management, as has occurred with some protected areas established in the region (Queiroz 2011). In other cases, conflicts over resource access are the ignition to start a management process, which usually takes the form of a fishing agreement (Castro and McGrath 2003). In the next section, we will first review these two types of initiatives, protected areas and fishing agreements, and will then focus on specific case studies, although we by no means intend to cover all of the management diversity in the Amazon. In the case studies, we will highlight the initiatives, outcomes, and solutions found to deal with fishing and management issues.

## 10.4 Options for Freshwater Small-Scale Fisheries Management in the Amazon

### *10.4.1 Extractive and Sustainable Development Reserves*

Over the first decades of resource management (from the 1930s to 1980s), Brazil adopted the exclusivist North American system of conservation, where people are not allowed to live in protected areas (Silva 2004). Given the amount of inaccessible land, poor governance, and a high population in the Amazon region, with over 15 million people, 69% of whom live in rural areas and depend on natural resources for their livelihoods (IBGE 2016), such protected areas were not an appropriate alternative in the Brazilian Amazon. In fact, in some instances, the simple proposition of one such protected area could give rise to uproars (Queiroz 2005). A new model for protected areas needed to be sought.

Such a model came from two different fronts. The first was a social front, as an outcome of the struggles of the rubber tappers to remain in their land (Goeschl and Igliori 2006). The needs of this movement became highly visible after the murder of the rubber tapper and activist Chico Mendes, who was perhaps the most famous Brazilian environmentalist. The rubber tappers' movement led to the establishment of extractive reserves (ER), where people are allowed (but not required) to live in protected areas as long as there is a management plan in place and inhabitants follow it (Lopes et al. 2011). The second model came from a scientific demand, where researchers themselves realized, after excruciating conflicts with local communities, that excluding people from their land was a recipe for failure (Queiroz 2005). This initiative created another category: sustainable development reserves (SDR), in which users have to live within the limits of the protected area and also must follow a management plan. Apart from the requirement for users to live inside the protected area, there are very few differences between ER and SDR. The main difference historically has been with regard to the origin of the demand, on the one hand coming from local people (ER), and scientists on the other (SDR) (Lopes et al. 2011). However, today there are examples of SDR that are being demanded by local people as well, and the differences between the two categories have been reduced. It is probably a matter of time until both categories are unified.

In the Brazilian Amazon, in 2015, there were 21 SDR and 72 ER, totaling almost 29 million ha (ISA 2015). Even though some of these protected areas were created specifically to manage terrestrial resources, most of them inevitably manage aquatic resources as well, including fishing, especially given the importance of fish consumption in Amazonian culture (Isaac and de Almeida 2011).

### *10.4.2 Fishing Agreements: A Tool for Establishing Fishing Rights for Amazonian Small-Scale Fisheries*

Since the early 1990s, a form of fisheries management has become commonplace in Amazonian lakes: the so-called fisheries agreements (McGrath et al. 1993, 2015). The increase in large-scale commercial fisheries in some rivers and lakes triggered conflicts and consequent responses by small-scale fishers, who tried to exclude outsiders from harvesting and assert control over their fishing grounds (McGrath et al. 1993). Some communities succeeded in closing these areas to outsiders, usually in large lakes, by restricting the fishing gear allowed and establishing quotas or closed periods (McGrath et al. 1993; Castro and McGrath 2003). The Brazilian government has recognized, through federal decrees, the right of some communities to manage their lake fisheries, especially by the autonomous setting of catch or effort limits. The rules and demands are negotiated individually between the government and the communities on a case-by-case basis. Once an agreement is officially recognized, disobeying management rules could potentially result in punishments defined by a court of law. The formalization, aside from establishing a formal system of punishment, gives the community the right to enforce their rules, with recourse to the police and/or environmental agency if necessary.

However, other communities also manage their lakes informally and without governmental recognition through community-based or informal fishing agreements (McGrath et al. 2007). These types of agreement have to rely exclusively on internal enforcement. Ostracism and expulsion from a community have been observed in the Brazilian Amazon after a particular community member's repeated disrespect of these informal community rules (Lopes et al. 2011).

## 10.5 Case Studies

Here we present three case studies, the first one examining two originally top-down SDR (Mamirauá and Amanã) in Central Amazon, the second one analyzing a bottom-up ER (Ipaú-Anilzinho) in Eastern Amazon, and the last one discussing three different systems of bottom-up fishing agreements in the Lower Amazon River (Fig. 10.1). The first two case studies are a review of published work, whereas the third one is based on an unpublished data collection. The detailed methodology for each case study is presented in Appendix 10.1.

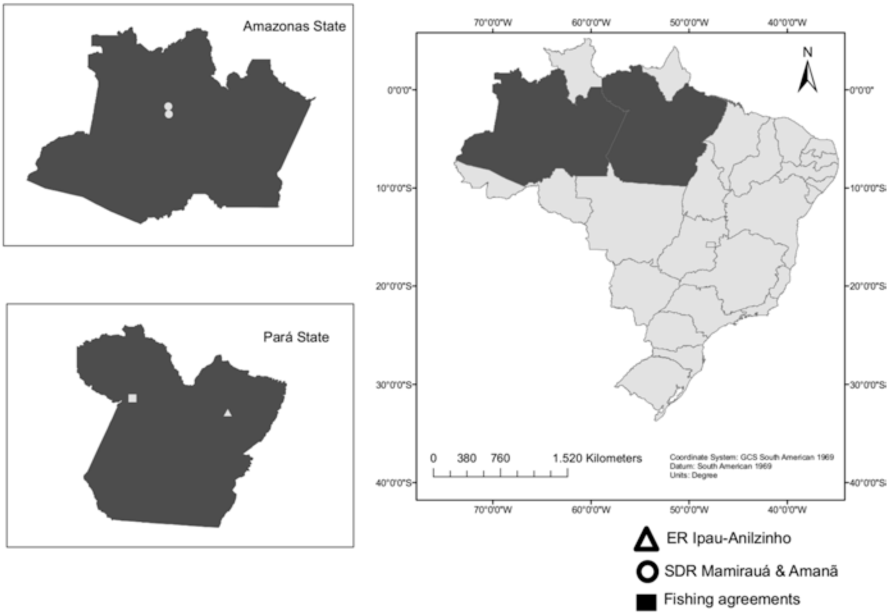



**Fig. 10.1** Map of the study areas. The larger map depicts the two Brazilian Amazonian states considered in the present study, Amazonas and Pará, whereas the zoomed in area points out where each case study was placed. SDR refers to the Sustainable Development Reserves of Mamirauá and Amanã; ER refers to the Extractive Reserve of Ipaú-Anilzinho; and fishing agreements refer to the four case studies with (il)legal and (un)enforced status

### *10.5.1 Top-Down Reserves: Sustainable Development Reserves of Mamirauá and Amanã*

The Mamirauá reserve was the first SDR created in Brazil, established in 1996. Mamirauá was initially proposed as a typical closed protected area in 1986, where human inhabitants would be forced to leave, in order to protect an endemic primate species (*Cacajao calvus calvus*). Given the uses of natural resources that took place in the area and the density of people inhabiting it, closing the protected area to people was unfeasible and, even if possible, would have compromised compliance with regulations (e.g., resource extraction would not be allowed) (Begossi 2002; Queiroz 2005).

Since its establishment, Mamirauá has been the exemplary model of co-management in Brazil (Viana et al. 2004; Castello et al. 2009). Despite its huge area of over 1 million ha, the multiple co-management initiatives underway in the reserve have yielded fruitful results, the most famous of which being pirarucu (*A. gigas*) fishing (Castello et al. 2009). The engagement of users of pirarucu went far beyond discussing regulations and involving local residents with enforcement. Local people actively helped develop a technique that allows a quicker and cheaper way to assess pirarucu stocks (Castello 2004), as well as participated in defining fishing quotas (Castello et al. 2009). The system is not fail proof, but it has mechanisms to deal with free riders (Andrade et al. 2011).

After the success of this initiative, many other areas decided to follow the same path. This was the case for Amanã, another SDR that was established on the boundary of the Mamirauá reserve (MacCord et al. 2007). Amanã is managed by the same institution (Mamirauá Institute) but is subject to somewhat distinct management rules. This is partly because, despite its proximity, Amanã has different environmental features. For example, Amanã does not have nearly as many oxbow lakes as Mamirauá. This has implications in the fishing resources that are caught and the most appropriate management practices (MacCord et al. 2007).

We have observed differences in fishing dynamics between two fishing communities, one in each of these two reserves. In Amanã, fishers used gillnets and longlines to catch catfish in the river, while in Mamirauá fishers often used hook and line or mixed gear to catch large and more valuable lake fishes, such as pirarucu (*A. gigas*) and tambaqui (*C. macropomum*) (MacCord et al. 2007), with significantly different yields between reserves (Fig. 10.2). These differences could be related to both environmental factors, such as a larger floodplain system in Mamirauá, and different management features, such as the fact that fishers from Amanã joined the co-management system more recently (MacCord et al. 2007). However, even considering these differences, the average capture per unit effort or CPUE (kg of fish/fisher) did not differ between these two communities in these reserves (Fig. 10.2, $t = -1.5$; $df = 486$; $p = 0.126$). This lack of difference in CPUE indicates that, even if they do not differ in their amount of fish caught, these two reserves show differences in the quality (or average size) of fish harvested, as larger fish can be more easily found in Mamirauá (MacCord et al. 2007). The improved quality and size of fishing resources in Mamirauá may be at least partially related to the co-management system, as fishers there established no-take protected lakes that have higher abundances of the commercial fish tambaqui (Silvano et al. 2009).

### *10.5.2 Bottom-Up Reserve: Extractive Reserve of Ipaú-Anilzinho*

Ipaú-Anilzinho is located downstream of a large hydroelectric reservoir (Tucuruí) in a clear water river (Tocantins), where productivity is naturally lower than white water rivers (Fittkau et al. 1975). This reserve is a hybrid top-down and bottom-up initiative, depending on the community involved. It encompasses five communities, but only the largest one (Joana Peres) fought for and actively sought the creation of an ER (Lopes et al. 2011). The trigger for Joana Peres was their own perception that their fish was not enough to feed themselves anymore, let alone make a living. At that point, the fishery had already fallen into a repetitive cycle of resource depletion

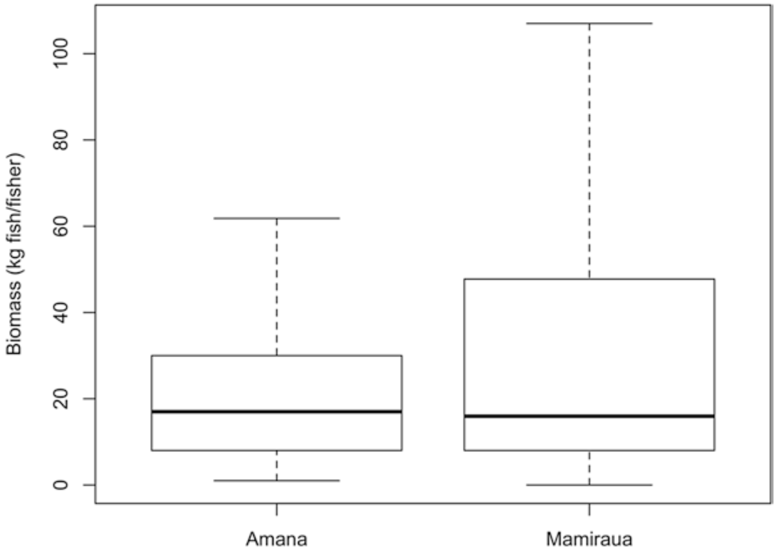



**Fig. 10.2** Comparison of CPUE (kg fish/fisher) of sampled fishing landings between fishing communities located in Amanã (Ebenezer, n = 218) and in Mamirauá (Jarauá, n = 270) SDR, respectively

and recovery, and community members decided that they needed to have an official management system with rigorous rules to avoid future collapses. The rules that they adopted for management completely exclude outsiders from participating in the fishery, due to the use of strict untransferable small quotas and the prohibition of selling fish caught in their protected lake outside their own communities (Lopes et al. 2011).

In 2007 and 2008, we followed the fisheries of Joana Peres, together with the other four communities (Açaizal, Calados, Umarizal, and Ituquara) located outside the protected area, along a full hydrological cycle. Açaizal was engaged in incipient community-based management at the time of the study, but the others had none. We interviewed fishermen, sampled their landings along two consecutive days in a month per season, and sampled their lakes to compare fish abundance, biomass, and diversity (Silvano et al. 2014).

We found that the community of Joana Peres showed higher fishing yields ($H = 15.53$; $p = 0.00004$), besides higher fish abundance (in biomass, $H = 14.23$; $p = 0.0008$; number of individuals was not statistically distinct), than communities outside of the protected area (Fig. 10.3). We also showed that the protected lake of this community had larger and more reproductive fish compared to other communities not involved in co-management (Silvano et al. 2014).

These findings indicate the promising trend that fishers from Joana Peres are enjoying successful ecological and socioeconomic outcomes as a result of their co-management system. This result is especially noteworthy considering the scarcity of

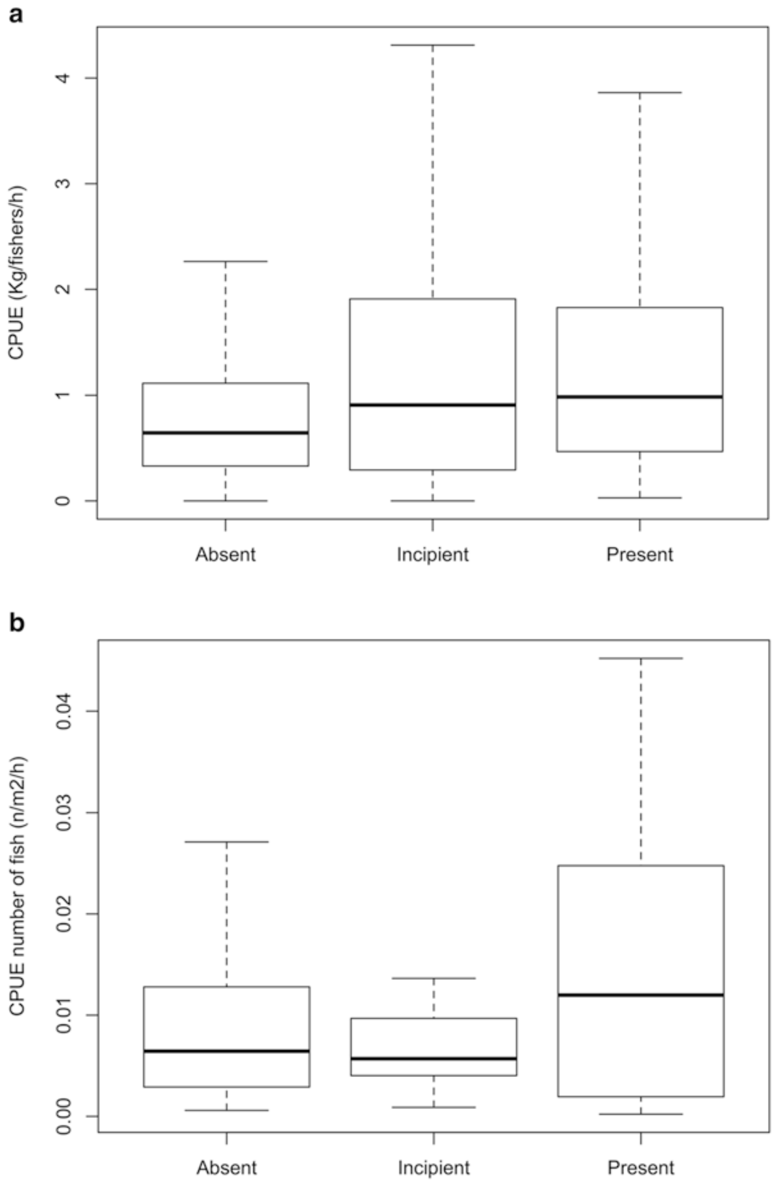



**Fig. 10.3** Comparison of the performance of an ER (Ipaú-Anilzinho, management present) in relation to areas with incipient management (lax community-based system; community: Açaizal) or with no management (communities: Calados, Umarizal, and Ituquara). (**a**) CPUE of fishing landings. (**b**) Number of fish in lakes. (**c**) Biomass of fish in lakes. The Student-Newman-Keuls test showed that areas with incipient management are significantly different than the others regarding fisheries CPUE and fish biomass in lakes ($p < 0.0001$)

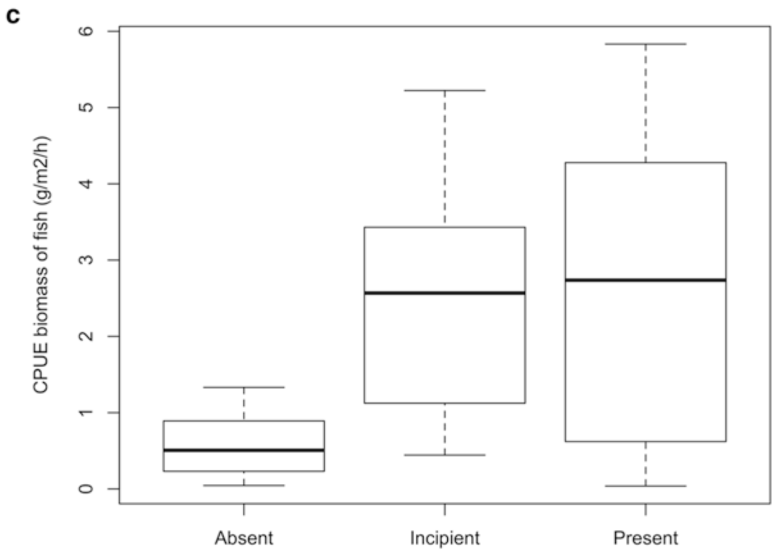



**Fig. 10.3** (continued)

financial resources available to the community, the unfavorable environment of less productive clear waters, and the effects of a large dam upstream (Hallwass et al. 2013a). These findings indicate that co-management may be feasible in other parts of the Amazon, not necessarily only in nutrient-rich rivers such as the Lower Amazon River (Almeida et al. 2009), or to relative pristine environments such as Mamirauá (Castello et al. 2009).

### *10.5.3 Grassroots Initiatives Outside Reserves: Fishing Agreements in the Lower Amazon*

Next, we take a closer look at four case studies from Pará State, where formal and informal agreements with different levels of enforcement of protected lakes have been in place since 2004. The case studies include (1) Água Preta (formal and enforced agreement), (2) Costa do Aritapera (formal, but not enforced), (3) Mamauru (informal and enforced), and Ilha Grande (a private lake used as a control). All the managed lakes are within the same region (Lower Amazon River) and subjected to the same environmental conditions. The three fishing agreement cases have been in place since 2004. We could not confirm if the control area has been managed as a private property for longer than that, but it was certainly privately owned since 2004. This period anticipates the establishment of a wider state fishery policy that mimicked the first centralized fishing agreement policies of the 1990s, during which these fisheries were under the responsibility of the Brazilian Environmental Agency (IBAMA) (McGrath et al. 2015). Contrary to the experience in other Brazilian Amazon states (e.g., Amazonas), this policy has had little influence on local grassroots movements (McGrath et al. 2015), although individual initiatives to establish agreements may still originate from such movements. We examined whether actual enforcement influences fishers' perceptions about improvements in their fisheries, their awareness about fisheries-related problems, and whether such enforcement leads to higher productivity (measured by CPUE). We also examined if CPUE was affected by the water level, gear, habitat, and individual community, which was our proxy for the different types of agreements in use. In order to test these relationships, we used a generalized linear mixed statistical model that used "fishers" as a random factor to account for pseudo-replication, given that the same fishers registered their landings multiple times over consecutive days. We ran different combinations of models and chose the best one based on the Akaike information criterion (AIC). More details on the methods are available as in the Appendices.

According to our findings, fishers believed that the abundance of fish increased in their region after the onset of local management, specifying which species have showed the most marked increase (see Table 10.1). Most fishers also reported that they have participated in the fishing agreement or in the management decision-making process. The fishers are generally satisfied with the agreements because, according to them, agreements provide them with hope for a better future and increased productivity. Such results can drive fishers to "conserve" the fishery and could work as stimulus for fishers' participation and involvement. This perhaps explains why Amazonian fishers seem more eager to participate in conservation than other traditional Brazilian fishers (Begossi 2014). Participation seems to be slightly higher in the communities that have formal management (Table 10.1), probably because the process of formalizing a local agreement requires fishers' participation in the discussion and adoption of the new rules.

Fishers see room for improvement in the agreements, especially through increases in monitoring, governmental support (financial assistance and enforcement), community and individual participation, and specific fishing measures and especially with regard to the potential for greater internal collaboration by the fishers themselves. Internal collaboration implies higher compliance with the established rules on the part of fishers, which is not always easy to achieve. Compliance with management rules can be affected by many factors, such as economic incentives not to comply (e.g., a low probability of detecting cheaters), moral obligations, different levels of community pressure to abide by the law (King and Sutinen 2010), trust, and legitimacy (deVos and vanTatenhove 2011).

Fisheries productivity (CPUE) was affected by the community itself and by its interaction with the season (see Table 10.2, Fig. 10.4a). Among the variables considered (villages, period, gear, and habitat), only village and its interaction with period affected CPUE, while the gear effect was null when period was included.

**Table 10.1** Summary of the four case studies and fishers' perception regarding increased abundance of fish, main species that showed increased abundance, and level of participation in the community decision-making

| Case study | AP (n = 30) | CA (n = 36) | MM (n = 15) | IG (n = 29) |
|---|---|---|---|---|
| Enforced | Yes | No | Yes | Control |
| Formal | Yes | Yes | No | Control |
| Fish increase (%) | 80 | 73 | 100 | 100 |
| Main species | *Pterygoplichthys pardalis* | *Arapaima gigas* | *Prochilodus nigricans* | *Prochilodus nigricans* |
| | | | *Colossoma macropomum* | *Colossoma macropomum* |
| Participation (%) | 95.8 | 90.9 | 82.1 | 60.9 |

*AP* Água Preta, *CA* Costa do Aritapera, *MM* Mamauru, and *IG* Ilha Grande, which is a control case study, as it refers to an area with a private lake where access is restricted. The period evaluated for fishers' perception was between 2004 (onset of management for AP, CA, and MM) and 2010 (time of the study)

**Table 10.2** General linear model (GLM) considering the total fish catch per trip (ln kg fish) (n = 514 fishing trips) in the Lower Amazon River, Brazilian Amazon, based on written reports provided by fishers. Only fish landings with complete information were considered

| Variables | Factor | Degrees of freedom | Sum of squares | Average sum of squares | % of the variation explained | F-value | P |
|---|---|---|---|---|---|---|---|
| Number of fishers | Continuous | 1 | 1.14 | 1.44 | 3.44 | 3.89 | 0.049 |
| Period[a] | Categorical | 2 | 2.95 | 2.954 | 8.89 | 10.04 | 0.002 |
| Habitat[b] | Categorical | 6 | 1.30 | 0.260 | 3.92 | 0.88 | 0.492 |
| Gear[c] | Categorical | 3 | 4.07 | 2.036 | 12.27 | 6.92 | 0.001 |
| Community[d] | Categorical | 4 | 23.70 | 7.901 | 71.47 | 26.87 | 0.000 |
| Residues | | 501 | 147.35 | 0.294 | | | |

[a]Factors: high water season, low water season
[b]Factors: two distinct habitats, flooded forest, tributaries, lake, main river channel, others
[c]Factors: hook and line, gill net, others
[d]Factors: Água Preta, Costa do Aritapera, Ilha Grande, Mamauru

The best model, chosen by the lowest AIC and reinforced by the AIC weight ($w_i$), was the one that included only the significant variables "village" and its interaction with "period." The amount of fish caught was more strongly affected by the community where the fishing took place than by environmental variables, individual fishers, or gear. In fact, fishing at Costa do Aritapera (which is characterized by formal and non-enforced management) or at Ilha Grande (control) was likely to decrease the $_{\log}$CPUE by −0.36 and −0.29 ($p < 0.05$). CPUE was higher where there was enforcement, regardless of the formal status of the agreement (Fig. 10.3b).

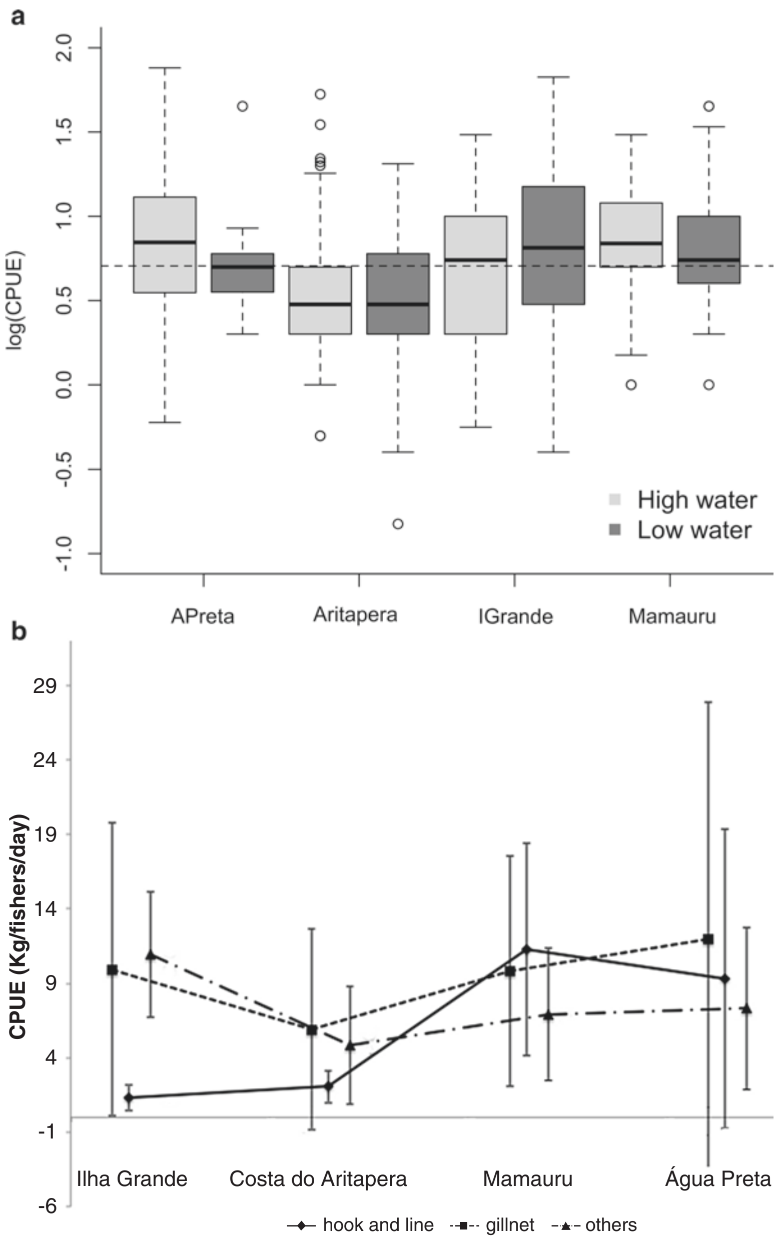



**Fig. 10.4** (**a**) Box plot of the $_{log}$CPUE (kg fish × number of fishers$^{-1}$ × day$-^{1}$) in areas with (Costa do Aritapera, Mamauru, and Água Preta) or without fishing agreements (Ilha Grande) in the Lower Amazon River (Brazil). Results for each village are shown for the two main climate seasons (high and low water). (**b**) Averages and standard deviation of the CPUE by village and gear resulted from data sampled by the fishers themselves (n = 800)

Even though a higher CPUE does not necessarily imply greater sustainability of the fishery (Castello et al. 2011), here we assume that, where management is enforced, fishers have been catching more fish, or catching fish with less effort, which means that fishers may have lower fishing costs or more extra time (Almeida et al. 2009).

We believe that any community management system, whether formal or not, enforced or not, would contribute to a more positive perception of fishers toward management. Despite being a preliminary approach, we suggest that the differences observed in fisheries productivity (CPUE) should be at least partially due to enforcement. No rich environment can provide endless resources by itself if institutions are not strong enough to determine what, where, how, and when resource exploitation should occur (Basurto and Coleman 2010; Gutiérrez et al. 2011).

## 10.6 Conclusions

The productive fishing grounds of the Amazon have fed people for thousands of years and have led to strongly fish dependent livelihoods in the region today. Such livelihoods are now threatened by overfishing and external pressures such as deforestation and hydroelectric dams. While conservation is seen by many as the one and only solution, resource users are the ones who must deal with the delayed payoffs and upfront costs of conservation. Nonetheless, multiple initiatives based on local self-organization and community-based cooperation have overcome noncooperative behavior and avoided fish stock collapses, showing some promising outcomes in the form of protected areas and fishing agreements. However, these agreements are not perfect, with some of these initiatives existing only on paper due to the lack of proper enforcement. Assuming similar biological conditions, the enforcement of management regulations, whether formal or informal, seems to increase fishing yields, an observation that this study has validated empirically. Therefore, assuring functional protected areas and fishing agreements should be a priority in Amazonian fisheries management. What the Amazon region needs even more than statistics is high-quality local management initiatives. While these initiatives tend to be more successful when aimed at addressing specific fisheries problems, some of them (e.g., protected areas) can also act to a certain degree as deterrents of developmental and mining projects. This is not to say that Amazonian fisheries located in protected areas are completely immune from these impacts, since internal problems and defiance to rules are commonplace, and some lawmakers are constantly trying to decrease the degree of protection of these areas. Those threats are, however, just one more reason to highlight the potential and strengths of Amazonian participatory fisheries management, given that it may be the most feasible solution for fisheries sustainability in an otherwise forgotten region.

# Appendix 10.1

## *Methods: Case Study of Sustainable Development Reserves (Amazonas State) and Extractive Reserve of Ipaú-Anilzinho (Pará State)*

For SDR, details of fish and fish landing samplings are described elsewhere (MacCord et al. 2007; Silvano et al. 2009). Here, the average capture per unit effort (CPUE) was compared between reserves through a t-test. For the ER, please refer to Hallwass et al. (2013b), Lopes et al. (2011), and Silvano et al. (2014). For this reserve, we compared the median results of CPUE, the number of fish in lakes, and the abundance of fish in lakes using a Kruskal-Wallis test, with the Student-Newman-Keuls a posteriori.

## *Methods: Case Study of Fishing Agreements in the Lower Amazon (Pará State)*

We interviewed 97 fishers on basic socioeconomic information (age, residence time, main economic activity) and on their primary fishing spots, fishes caught, times of the year when the fish are more abundant, fishing technology used to catch the cited fish species, and to whom the fishers sell their catch. We also asked about which fish species had become more or less abundant in the region after the fishing agreement was implemented (formal or informal), the reasons for those changes in fish abundance, the primary fishing problems in the region, and what could be changed to improve the fisheries and the current agreement. During 14 days in the low water season and 14 days in the high water season, 15 families (initially) in each of the four communities completed a daily form describing their fishing activities (the number of fish caught per species per day and the crew size) on a voluntary basis.

To relate $_{\log}$CPUE to variations between periods of the year (low or high water), management regime (represented by the community), gear (gill net, hook and line, and others), and habitat (lake, river, flooded forest, stream, mixed habitats, and others), we ran a complete model with (mixed model) and without a random intercept ("fishers"). The latter performed better ($L$ = 159.93; df = 24; $p$ < 0.0001). As the proportion of gear used varied among communities, we also included an interaction term (community x gear) in the model. Likewise, we added a community x period interaction. For this analysis, we used the *R* package nlme, which is based on a Gaussian distribution. The full initial model was

$$C_v = (\beta_0 + F) + \beta_1 V + \beta_2 P + \beta_3 G + \beta_4 H + \beta_5 (V.G) + \beta_6 (V.P)\varepsilon$$

where $C_v$ is the inferred CPUE of a given fish landing, V for community, P for period, G for gear used, H for habitat, and F for the random effect of the *i*th fisher, the prime symbol "." indicates interaction terms, βs are the model estimated explanatory coefficients for each fixed effect, and ε is the residual error. We excluded eight landings that resulted in no fish, as this allowed for the residual error to have a mean of zero and to be normally distributed. Fishing events with no return were rare in all communities (IG = 0.87%; CA = 1.16%; MM = 2.54; AP = 0%), but these may be underestimated, as fishers may not have annotated unsuccessful landings. We evaluated the strength and uncertainty of models using Akaike information criterion (AIC), through comparisons between models using ΔAIC (difference between AICs; the best model has ΔAIC of zero). Akaike weights (*w*) were calculated to represent the relative likelihood of each model.

## References

Agostinho AA, Gomes LC, Veríssimo S, Okada EK (2005) Flood regime, dam regulation and fish in the Upper Paraná River: effects on assemblage attributes, reproduction and recruitment. Rev Fish Biol Fish 14(1):11–19

Allan JD, Abell R, Hogan Z, Revenga C, Taylor BW, Welcomme RL, Winemiller K (2005) Overfishing of inland waters. Bioscience 55(12):1041–1051

Almeida OT, Lorenzen K, McGrath D (2009) Fishing agreements in the lower Amazon: for gain and restraint. Fish Manag Ecol 16:61–67

Anderson JT, Rojas JS, Flecker AS (2009) High-quality seed dispersal by fruit-eating fishes in Amazonian floodplain habitats. Oecologia 161(2):279–290

Andrade LCA, Amaral ESR, Silva NB, Queiroz HL (2011) Recount pirarucu: a method for evaluating the quality of the pirarucu counts. Uakari 7(1):29–40

Barletta M, Jaureguizar AJ, Baigun C, Fontoura NF, Agostinho AA, Almeida-Val VMF, Val AL, Torres RA, Jimenes-Segura LF, Giarrizzo T, Fabré NN, Batista VS, Lasso C, Taphorn DC, Costa MF, Chaves PT, Vieira JP, Corrêa MF (2010) Fish and aquatic habitat conservation in South America: a continental overview with emphasis on neotropical systems. J Fish Biol 76(9):2118–2176

Barletta M, Blaber SJM, Craig JF (2016) Fish and aquatic habitat conservation in South America. J Fish Biol 89(1):1–3

Barnes-Mauthe M, Oleson KLL, Zafindrasilivonona B (2013) The total economic value of small-scale fisheries with a characterization of post-landing trends: an application in Madagascar with global relevance. Fish Res 147:175–185

Barthem RB, de Brito Ribeiro MCL, Petrere M Jr (1991) Life strategies of some long-distance migratory catfish in relation to hydroelectric dams in the Amazon Basin. Biol Conserv 55(3):339–345

Basurto X, Coleman E (2010) Institutional and ecological interplay for successful self-governance of community-based fisheries. Ecol Econ 69:1094–1103

Baum JK, Worm B (2009) Cascading top-down effects of changing oceanic predator abundances. J Anim Ecol 78(4):699–714

Bayley P (1989) Amazon fisheries: assessment methods, current status and management options. In: Dodge D (ed) Canadian special publication of fisheries and aquatic sciences, pp 385–398

Begossi A (1998) Resilience and neo-traditional populations: the caiçaras (Atlantic Forest) and caboclos (Amazon, Brazil). In: Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge University Press, Cambridge, pp 129–157

Begossi A (2002) The sustainable development reserve of Mamirauá, Amazonas State, Brazil. Hirtshals, Denmark

Begossi A (2010) Small-scale fisheries in Latin America: management models and challenges. MAST 9:5–12

Begossi A (2014) Ecological, cultural, and economic approaches to managing artisanal fisheries. Environ Dev Sustain 16:5–34

Bernard E, Penna LAO, Araújo E (2014) Downgrading, downsizing, degazettement, and reclassification of protected areas in Brazil. Conserv Biol 28(4):939–950

Brondizio ES, Moran EF, Mausel P, Wu Y (1994) Land use change in the Amazon estuary: patterns of caboclo settlement and landscape management. Hum Ecol 22(3):249–278

Castello L (2004) A method to count Pirarucu Arapaima gigas: fishers, assessment, and management. N Am J Fish Manag 24(2):379–389

Castello L, Viana JP, Watkins G, Pinedo-Vasquez M, Luzadis VA (2009) Lessons from integrating fishers of arapaima in small-scale fisheries management at the Mamirauá Reserve, Amazon. Environ Manag 43:197–209

Castello L, McGrath DG, Beck PSA (2011) Resource sustainability in small-scale fisheries in the Lower Amazon floodplains. Fish Res 110(2):356–364

Castro F, McGrath D (2003) Moving toward sustainability in the local management of floodplain lake fisheries in the Brazilian Amazon. Hum Organ 62:123–133

Cinner J, Fuentes MPB, Randriamahazo H (2009) Exploring social resilience in Madagascar's marine protected areas. Ecol Soc 14(1):41

Costello C, Ovando D, Hilborn R, Gaines SD, Deschenes O, Lester SE (2012) Status and solutions for the world's unassessed fisheries. Science 338(6106):517–520

de Vos BI, van Tatenhove JPM (2011) Trust relationships between fishers and government: new challenges for the co-management arrangements in the Dutch flatfish industry. Mar Policy 35(2):218–225

Fabré NN, Barthem RB (2005) O manejo da pesca dos grandes bagres migradores: Piramutaba e dourada no eixo Solimões-Amazonas. Ibama, Pró Várzea, Manaus

Fearnside PM (1999) Social impacts of Brazil's Tucurui Dam. Environ Manag 24:483–495

Fearnside PM (2006) Deforestation in Amazonia: dynamics, impacts and control. Acta Amazon 36(3):395–400

Fearnside PM (2014) Impacts of Brazil's Madeira River Dams: unlearned lessons for hydroelectric development in Amazonia. Environ Sci Pol 38:164–172

Fearnside PM (2015) Amazon dams and waterways: Brazil's Tapajós Basin plans. Ambio 44(5):426–439

Felizola Freire KM, Negreiros Aragão JA, da Rocha Araújo AR, Ávila da Silva AO, dos Santos Bispo MC, Velasco G, Carneiro MH, Silva Gonçalves FD, Annes Keunecke K, Tomasino Mendonça J, Moro PS, Motta FS, Olavo G, Ricardo Pezzuto P, Filho Santana R, Aguiar dos Santos R, Trindade-Santos, Airton Vasconcelos J, Vianna M, Divovich E (2015) Reconstruction of catch statistics for Brazilian marine waters (1950–2010). In: Freire KMF, Pauly D (eds) Fisheries catch reconstructions for Brazil's mainland and oceanic islands, pp 3–30

Ferreira J, Aragão LEOC, Barlow J, Barreto P, Berenguer E, Bustamante M, Gardner TA, Lees AC, Lima A, Louzada J, Parry L, Peres CA, Pardini R, Pompeu Ps, Tabarelli M, Zuanon J (2014) Brazil's environmental leadership at risk. Science 346(6210):706–707

Fittkau EJ, Irmler U, Junk WJ, Reiss F, Schmidt GW (1975) Productivity, biomass, and population dynamics in Amazonian water bodies. In: Golley FB, Medina E (eds) Tropical ecological systems. Springer, Berlin Heidelberg, pp 289–311

Garcia A, Tello S, Vargas G, Duponchelle F (2008) Patterns of commercial fish landings in the Loreto region (Peruvian Amazon) between 1984 and 2006. Fish Physiol Biochem 35(1):53–67

Goeschl T, Igliori DC (2006) Property rights for biodiversity conservation and development: extractive reserves in the Brazilian Amazon. Dev Chang 37:427–451

Goulding M (1980) Fishes and the forest. University of California Press, Los Angeles

Gutiérrez NL, Hilborn R, Defeo O (2011) Leadership, social capital and incentives promote successful fisheries. Nature 2:5–8

Hallwass G, Silvano RAM (2015) Patterns of selectiveness in the Amazonian freshwater fisheries: implications for management. J Environ Plan Manag 59(9):1537–1559
Hallwass G, Lopes PFM, Juras AA, Silvano RAM (2011) Fishing effort and catch composition of urban market and rural villages in Brazilian Amazon. Environ Manag 47:188–200
Hallwass G, Lopes PF, Juras AA, Silvano RAM (2013a) Fishers' knowledge identifies environmental changes and fish abundance trends in impounded tropical rivers. Ecol Appl 23(2):392–407
Hallwass G, Lopes PFM, Juras AA, Silvano RAM (2013b) Behavioral and environmental influences on fishing rewards and the outcomes of alternative management scenarios for large tropical rivers. J Environ Manag 128:274–282
Hoeinghaus DJ, Agostinho AA, Gomes LC, Pelicice FM, Okada EK, Latini JD, Kashiwaqui EAL, Winemiller KO (2009) Effects of river impoundment on ecosystem services of large tropical rivers: embodied energy and market value of artisanal fisheries. Conserv Biol 23(5):1222–1231
IBGE (2016) Ferramenta Cidades. www.cidades.ibge.gov.br. Accessed 9 Sept 2016
ISA (2015) Instituto Socioambiental. www.socioambiental.org. Accessed 20 Sept 2015
Isaac VJ, de Almeida MC (2011) El Consumo de pescado en la amazonía brasileña. FAO, Rome
Isaac VJ, Ruffino ML (1996) Population dynamics of tambaqui, *Colossoma macropomum* Cuvier, in the Lower Amazon, Brazil. Fish Manag Ecol 3(4):315–333
King DM, Sutinen JG (2010) Rational noncompliance and the liquidation of Northeast groundfish resources. Mar Policy 34(1):7–21
Laurance WF, Cochrane MA, Bergen S, Fearnside PM, Delamônica P, Barber C, D'Angelo S, Fernandes T (2001) The future of the Brazilian Amazon. Science 291(5503):438–439
Lima DM (1999) Equity, sustainable development, and biodiversity preservation: some questions about ecological partnerships in the Brazilian Amazon. In: Padoch C, Ayres JM, Pinedo-Vasquez M, Henderson A (eds) Várzea – diversity, development and conservation of Amazonia's white-water floodplains. New York Botanical Garden, New York, pp 247–263
Lopes PFM, Silvano RAM, Begossi A (2011) Extractive and sustainable development reserves in Brazil: resilient alternatives to fisheries? J Environ Plan Manag 54(4):421–443
MacCord PFL, Silvano RAM, Ramires M, Clauzet M, Begossi A (2007) Dynamics of artisanal fisheries in two Brazilian Amazonian reserves: implications to co-management. Hydrobiologia 583(1):365–376
McClanahan TR, Castilla JC, White AT, Defeo O (2008) Healing small-scale fisheries by facilitating complex socio-ecological systems. Rev Fish Biol Fish 19:33–47
McGrath D, Castro F, Futemma AC, Amaral BD, Calabria J (1993) Fisheries and the evolution of resource management on the lower Amazon floodplain. Hum Ecol 21(2):167–195
McGrath D, Almeida OT, Merry FD (2007) The influence of community management agreements on household economic strategies: cattle grazing and fishing agreements on the lower Amazon floodplain. Int J Commons 1(1):67–87
McGrath DG, Castello L, Almeida OT, Estupiñán GMB (2015) Market formalization, governance, and the integration of community fisheries in the Brazilian Amazon. Soc Nat Resour 28(5):513–529
Nepstad D, McGrath D, Alencar A, Barros AC, Carvalho G, Santilli M, Diaz V, M. del C. (2002) Frontier governance in Amazonia. Science 295(5555):629–631
Pelicice FM, Agostinho AA (2008) Fish-passage facilities as ecological traps in large neotropical rivers. Conserv Biol 22(1):180–188
Petrere-Jr M, Borgues BR, Agudelo CE, Corrales GB (2004) Review of the large catfish fisheries in the upper Amazon and the stock depletion of piraíba (Brachyplatystoma filamentosumLichtenstein). Rev Fish Biol Fish 14(4):403–414
Ponton D, Vauchel P (1998) Immediate downstream effects of the Petit-Saut dam on young neotropical fish in a large tributary of the Sinnamary River (French Guiana, South America). Regul Rivers: Res Manage 14(3):227–243
Queiroz HL (2005) A reserva de desenvolvimento sustentável Mamirauá. Estudos Avançados 19(54):183–203

Queiroz HL (2011) Protected areas of sustainable use, involvement of social actors, and biodiversity conservation in the Várzea: the case of the Mamirauá Reserve—sharing conservation benefits in Central Amazonia, Brazil. In: Pinedo-Vasquez M, Ruffino ML, Padoch C, Brondizio ES (eds) The Amazon Varzea: the decade past and the decade ahead, vol 4. Springer, Dordrecht

Queiroz HL, Sardinha AD (1999) A preservação e o uso sustentado dos pirarucus (Arapaima gigas, Osteoglossidae) em Mamirauá. In: Queiroz HL, Crampton WGR (eds) Estratégias para manejo dos recursos pesqueiros em Mamirauá. SCM, CNPq/MCT, Brasilia, pp 108–141

Sá-Oliveira JC, Ferrari SF, Vasconcelos HCG, Mendes-Junior RNG, Araújo AS, Costa-Campos CE, Nascimento WS, Isaacs VJ (2016) Restoration effects of the riparian forest on the intertidal fish fauna in an urban area of the Amazon River. Sci World J 2016:1–9

Silva PP (2004) From common property to co-management: lessons from Brazil's first maritime extractive reserve. Mar Policy 28:419–428

Silvano RAM, Ramires M, Zuanon J (2009) Effects of fisheries management on fish communities in the floodplain lakes of a Brazilian Amazonian Reserve. Ecol Freshw Fish 18:156–166

Silvano RAM, Hallwass G, Lopes PF, Ribeiro AR, Lima RP, Hasenack H, Juras AA, Begossi A (2014) Co-management and spatial features contribute to secure fish abundance and fishing yields in tropical Floodplain Lakes. Ecosystems 17(2):271–285

Torres M (ed) (2005) Amazônia revelada: Os descaminhos ao longo da BR-163. Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brasília

Veríssimo J (1895) A pesca na Amazônia. Livraria Clássica Alves & Companhia, Rio de Janeiro

Viana JP, Damasceno JMB, Castello L (2004) Desarrollo del manejo pesquero comunitario en la Reserva de Mamiraua. In: Campos-Rozo C, Ulloa A (eds) Fauna socializada en America Latina. Fundacao Natura, MacArthur Foundation, Instituto Colombiano de Antropologia e Historia, Bogota, pp 335–251

Welcomme RL (1999) A review of a model for qualitative evaluation of exploitation levels in multi-species fisheries. Fish Manag Ecol 6(1):1–19

Welcomme RL (2011) Review of the state of the world fishery resources: inland fisheries. FAO Fish Aquac Circ 942(2):1–97

Welcomme RL, Cowx IG, Coates D, Béné C, Funge-Smith S, Halls A, Lorenzen K (2010) Inland capture fisheries. Philos Trans R Soc London B: Biol Sci 365(1554):2881–2896

**Priscila F. M. Lopes** is an ecologist working on interdisciplinary approaches to small-scale fisheries. Her work has focused on understanding fishers' behavior and their socio-ecological resilience to changes and socioeconomic incentives to fisheries and compliance and providing solutions to co-management using local ecological knowledge and ecosystem service approach. Her work relies on existent fishing databases and on direct contact with fishers from small villages in different environments (oceanic, coastal, semiarid, and Amazonian). She is currently the chair of the Department of Ecology at the Federal University of Rio Grande do Norte, where she also coleads the fisheries management, ecology, and economics group.

**Gustavo Hallwass** was formerly a postdoctoral researcher at the Aquatic Ecology and Fisheries Department at the Federal University of Pará and is now a professor at the Federal University of Oeste do Pará. His research interests include fisheries dynamics and management, conservation of natural resources, and human ecology.

**Alpina Begossi** holds a PhD in Ecology (UC Davis, USA, 1989). Alpina has conducted research on the human ecology of small-scale fishers on the Atlantic Forest coast and in the Amazon basin in Brazil for more than 25 years. She studies ecological models (e.g., optimal foraging theory), ethnobiology, reef fisheries, food choices (including food taboos), and food security. She was the president of the Society of Human Ecology in 2006–2007 and executive director of the Fisheries and Food Institute from 2006 to 2014. Alpina is a researcher at Capesca/Nepa/Unicamp (Campinas, SP, Brazil), the research director of Fisheries and Food Institute (FIFO), and a professor at Ecomar/Unisanta (Santos, SP, Braz il).

**Victória J. Isaac** graduated in Biological Sciences from the University of the Republic (1977) in Montevideo, Uruguay, and holds a master's degree of Oceanography (Biological Oceanography) from the University of São Paulo (1981) and a PhD in Marine Sciences from the Institut Fuer Meereskunde (1989) in Kiel, Germany. She is currently a postdoctoral researcher at the University of Florida, Gainesville, USA (2017). She has experience in fisheries resource ecology and management of inland and marine waters, with an emphasis on reproduction, growth, trophic ecology, stock assessment, management of artisanal fisheries, and conservation of the fish fauna in the Amazon region.

**Morgana Almeida** graduated in Biological Sciences from the Federal University of Pará (2006) in Pará, Brasil, where she earned a master's degree of Aquatic Ecology and Fisheries. She is currently a PhD candidate at the Federal University of Pará. She has experience in freshwater, marine, and estuarine fisheries, with an emphasis on the economics and management of Amazonian aquatic resources.

**Renato A. M. Silvano** is an associate professor at the Department of Ecology at the Federal University of Rio Grande do Sul (UFRGS), Brazil. He was head of the Department of Ecology of UFRGS from 2008 to 2010. He has also been a member of the nongovernmental organization Fisheries and Food Institute (FIFO) (Brazil) since 2005, where he now holds the position of research director. He has been doing research on applied ecology, fisheries management and ecology, fish ecology, human ecology, and ethnobiology. He got his PhD in Ecology in 2001 at the University of Campinas, Brazil, and concluded a postdoctoral fellowship at the University of Queensland, Brisbane, Australia, in 2008.

# Chapter 11
# Moving from Stock Assessment to Fisheries Management in Mexico: The Finfish Fisheries from the Southern Gulf of Mexico and Caribbean Sea

**Gabriela Galindo-Cortes, Lourdes Jiménez-Badillo, and César Meiners**

**Abstract** As a signatory of important international fisheries agreements, Mexico should develop and implement proper fisheries management structures to maintain or restore populations in order to maintain sustainable fisheries within its exclusive economic zone. To do so, proper stock assessments of fishery resources based on scientific evidence are required. While this step is not as a legally binding obligation, it is important for understanding the status of fisheries stocks and how Mexican law and regulatory measures should go about accomplishing national and international goals effectively. In this context, small-scale finfish fisheries (SSFF) play a significant role in the Mexican coastal regions in the southern Gulf of Mexico and Caribbean Sea (GMCS). Nonetheless, SSFF have received limited attention despite their contribution in terms of commercial landings, contribution to the diet of coastal communities, and as source of income and employment. In this chapter, we summarize the management and regulatory framework associated with the SSFF in the GMCS. We then evaluate the status of these resources based on catch data of SSFF in the GMCS using two approaches. We developed a typology of these fisheries to define categories and then used a traffic light system to show the status of the resources and management tools used in each case. This chapter also discusses the need for an integral approach to assess and manage this type of fishery and recommends adaptations that are required to improve management strategies for these resources.

**Keywords** Small-scale finfish fisheries · Normative context · Fishery assessment · Precautionary approach · Current status

G. Galindo-Cortes (✉) · L. Jiménez-Badillo · C. Meiners
Instituto de Ciencias Marinas y Pesquerías, Universidad Veracruzana,
Hidalgo 617, Colonia Río Jamapa, Boca del Río 94290, Veracruz, México
e-mail: gagalindo@uv.mx; ljimenez@uv.mx; cmeiners@uv.mx



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_11

## 11.1 Introduction

In Mexico, as in other parts of the world (Béné et al. 2007), small-scale fisheries play a crucial role in overall fisheries, representing approximately 96% of the national fishing fleet and supporting 300,000 people who depend on it (Salas et al. 2007; Fernández et al. 2011). In the Gulf of Mexico and Caribbean Sea (GMCS), fisheries are characterized by small-scale fisheries, comprising an artisanal fleet using non-mechanized fishing gears (e.g., gill nets, small trawls, hand lines, and long lines). The fleet operates within a 234,695 $km^2$ area of marine habitat that is between 0 and 200 m in depth, operating mainly in lagoon-estuarine systems in which a wide variety of species are captured (Quiroga-Brahms et al. 2002; Salas et al. 2007). This reality translates into a marked dependence of coastal communities on small-scale fisheries as a source of employment, income, and food security, especially in highly impoverished and vulnerable communities (Béné 2009). Nonetheless, the assessment and management of these fisheries is usually inadequate or absent, and they continue to fall short of their potential as engines for development and social change (Andrew et al. 2007).

Biogeographic conditions, the climate system, and habitat diversity associated with the GMCS region result in a wide diversity of species, which are captured by several gears and fishing methods in a multi-specific fisheries (Caso et al. 2004; Aldana-Arana et al. 2013). This fishery is distinct from Pacific Mexican fisheries, which are prone to monospecific catches (Jiménez-Badillo 2005). There are an estimated 551 captured species exploited in Mexican fisheries: 287 in the Pacific and 264 in the GMCS (Jiménez-Badillo 2005). Despite these similar figures on both coastlines, the GMCS coastal states together contribute only approximately 13% of Mexican fisheries activity in terms of catch, whereas the Pacific contributes 85% and inland water bodies make up 2% (CONAPESCA 2016).

Although the GMCS artisanal fleet allocates its efforts toward a wide variety of available resources, the most important group in terms of catch volume is represented by a high number of bony fishes, also known as finfish (locally named *escama*). They comprise species found anywhere from coastal resources and lagoon-estuarine environments to marine fish communities, as well as both shallow and deep waters. From the coast to the edge of continental shelf (nearly 200 m depth), the fishing grounds include habitats such as rocky and reef types, as well as soft, sandy, clay-based, and muddy bottom types, including the pelagic coastal and migratory components (Diario Oficial de la Federación 2012). Among all the resource variety captured in the GMCS, finfish represents approximately 40% of the regional catch. In 2014, this figure comprised nearly 78 thousand tons (t), with Veracruz, Campeche, Tabasco, and Yucatán states contributing most of the catch (Fig. 11.1).

The complex oceanographic and bioecological environment prevailing in GMCS create uncertainties regarding resource abundance and availability. This uncertainty poses challenges for stock assessment and fishery management, which are difficult to carry out when information is limited, and limits the accuracy of formal

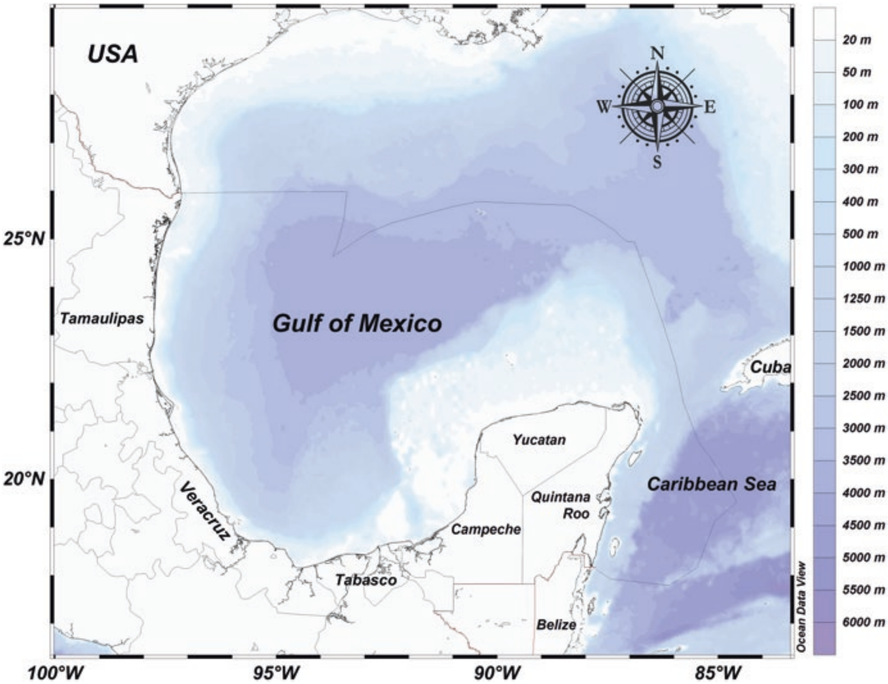



**Fig. 11.1** Map of the southern Gulf of Mexico and the Caribbean Sea, its exclusive economic zone (blue dotted line), and depth profile. It includes the six Mexican coastal states of this area

assessment models that are applied to report the status of the resources to decision-makers. This is a common situation for most finfish resources captured by the artisanal fleet in this region. Among the most important factors that have limited the implementation of an integrated framework to evaluate small-scale fisheries with respect to these resources has been the high diversity of the region's fisheries, as well as the scarce biological information available about these fisheries. These conditions hamper accurate assessment and the establishment of reference points based on abundance levels following the sustainability criterion. However, based on the precautionary approach, the lack of suitable scientific information should not be used as the reason for delaying or not taking actions associated with fisheries under exploitation. Fish species conservation must be carried out with a full consideration of the most reliable scientific data available (FAO 1995). Where data availability problems exist, management must acknowledge data-poor conditions when generating stock assessments.

This chapter addresses issues regarding the assessment and management of GMCS small-scale finfish fisheries (SSFF). The main SSFF issues in GMCS are discussed in terms of their relationship with catch composition, and a typology is introduced that integrates the GMCS fisheries into their respective species categories before the assessment of the status of different species groups. A review on the institutional arrangements and the legal organizational framework under which SSFF develop is presented and discussed to arrive to proposals based on the assessment and the prevailing conditions associated to SSFF in the GMCS.

## 11.2 Main Challenges Faced by GMCS Small-Scale Finfish Fisheries

The problems faced by SSFF in GMCS include the fact that: (i) the assessment and management of highly diverse resources can be complex, especially when they have seasonal and climatic fluctuations; (ii) there is a low level of commercialization; (iii) market demand is biased towards a small number of principal species; (iv) postharvest management of the products is poor, limiting export of the products to international markets; (v) there is a high number of landing areas which limits both product traceability and the assessment of the fishing effort allocation over species; (vi) middlemen can accumulate more marginal profit than fishermen; (vii) these activities make a small contribution to gross domestic product, which restricts its competitive capacity regarding other economic coastal activities (e.g., tourism, urban development, and oil extraction); and (vii) there is limited government investment to contribute to growth and development of fishery sector.

Mexico has signed important international fisheries agreements (FAO 1995, 2015), as well as national initiatives, in which the importance of fisheries activities is stressed for their provision of quality food with high nutritional value at reasonable prices while maintaining biological and economic yield on a sustainable base. However, for the SSFF in GMCS, there is not any resulting change in policy or practice that has helped shift the fishery toward sustainable development.

Knowledge associated with the diverse fisheries resources in the GMCS has concentrated on biological aspects (Mexicano-Cíntora et al. 2007, and references therein; Ibáñez et al. 2012; Pérez-Chacón and Aguilar-Perera 2015), whereas full stock assessment reports are more limited. In addition, existing biological studies have focused to a large extent on the most profitable species such as tuna, sea shrimp, and octopus (Beléndez-Moreno et al. 2014). Socioeconomic aspects have been addressed to a lesser extent (Fraga et al. 2008; Pedroza and Salas 2010). Issues regarding human health and risks to health and food safety, including laws regulating fisheries, are even more limited (Huchim et al. 2015). Overall, information concerning the fishery system (biological resources, fishers, fleet, market, and environment) is incomplete, hindering the ability of decision-makers to implement viable management regulations (Charles 2001; Andrew et al. 2007). Furthermore, the implementation of assessment and management approaches should integrate external and internal domains to examine more efficient and timely management strategies and consequently prioritize financial and human resource sustainability.

Unlike in South American countries, where researchers and managers use several sources of information to assess and manage artisanal fisheries (Elías et al. 2011; Valle et al. 2011), catch statistics in Mexico are rarely separated by fishery type (Fernández et al. 2011). Where available, records are predominantly based on the logbooks of cooperatives or other organizations, resulting in a wide variation in the availability of data by region and fishery. Therefore, fishery statistics must be used cautiously when used in resource assessment (Salas et al. 2007, 2011). Despite this context, and considering the precautionary approach, an assessment of SSFF in GMCS based on the best available information is still valuable and necessary, considering the number of species involved, the conditions associated to each fishery, and the importance of the fishery for communities in the region.

In this chapter, a typology of small-scale finfish fisheries in GMCS is defined in order to characterize the conditions of different resources that support the economy of large coastal populations. Rapid assessment techniques based on statistical information are used to conduct a traffic light system to monitor the conditions of different groups of species that comprise the SSFF in GMCS. The chapter incorporates information on legal issues, illustrating the management system in Mexico, discusses the status of the resources, and recommends required strategies that must be developed in order to maintain sustainable fisheries in the GMCS.

## 11.3 The Fishing Context

Marine and estuarine fisheries of GMCS are comprised of approximately 50 commercially target groups as reported in official catch statistics, which consist of more than 100 species of bony and cartilaginous fish, crustaceans, mollusks, and echinoderms. During 2009–2014, the annual average catch in this area was 165,000 t, representing an approximate value of $192 million US dollars (Fig. 11.2).

Most fishing activity along the GMCS is performed by a large, scattered, and multi-specific artisanal fleet, which is responsible for almost 65% of the total catch in the area that generates an annual value of $117 million US dollars. During the 2009–2014 period, sea and estuarine finfish resources caught by this fleet represented approximately 34% (56,000 t) of the total catch and 23% ($45 million) of the annual catch value in the GMCS (CONAPESCA 2016).

The catch composition of finfish is distributed across 15 families of bony fishes. Half of the finfish catch relies on species of five families, Carangidae (13.8%), Scombridae (13.0%), Serranidae (11.5%), Lutjanidae (11.3%), and Mugilidae (7.9%), as depicted in Fig. 11.3. One of the challenges for assessing and monitoring these fisheries is their high diversity and the complex interactions that take place between different fisheries. Excessive taxonomic clustering of most of the fishing resources within the area makes it difficult to establish a clear and reliable monitoring system. Thus, there can be a frequent delay regarding the detection of changes in the most vulnerable resources. Additionally, the potential impacts of these changes, including changes in the market, are relevant. In addition, a wide variety of common names are used among distant fishing villages to refer to the same species, creating problems for the standardization of catch records in the area.

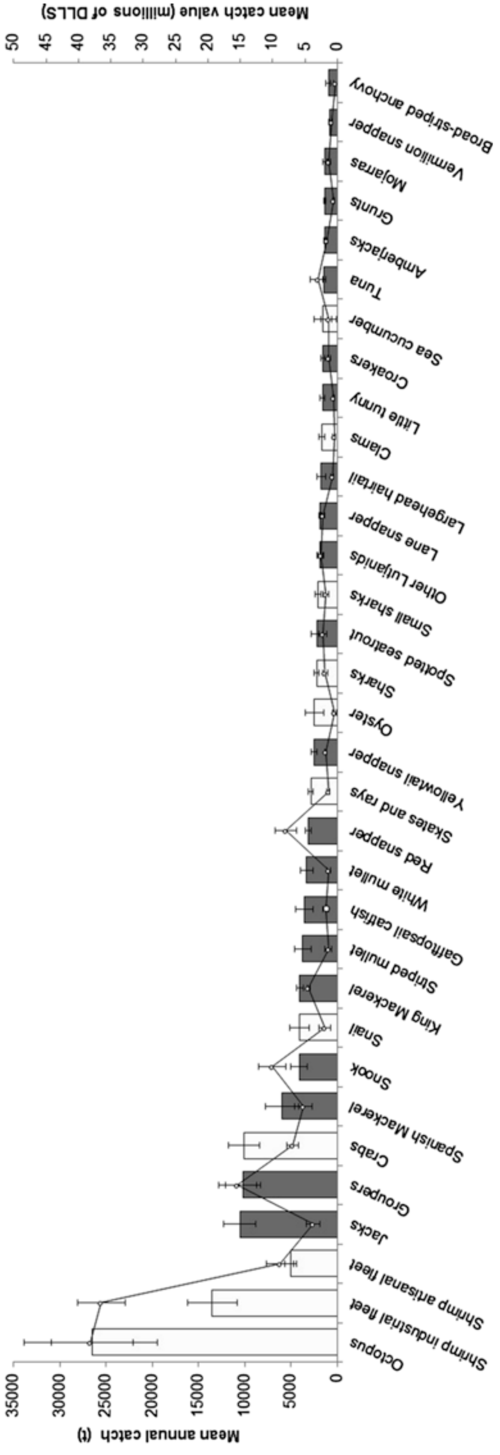



**Fig. 11.2** Mean annual catch (Bars + SD) and mean annual catch value (line + SD) of main estuarine and marine species fished along the Mexican waters of the Gulf of Mexico and Caribbean Sea. The annual mean for the period 2009–2014 comes from official statistics (CONAPESCA 2016). Darker bars correspond to finfish species

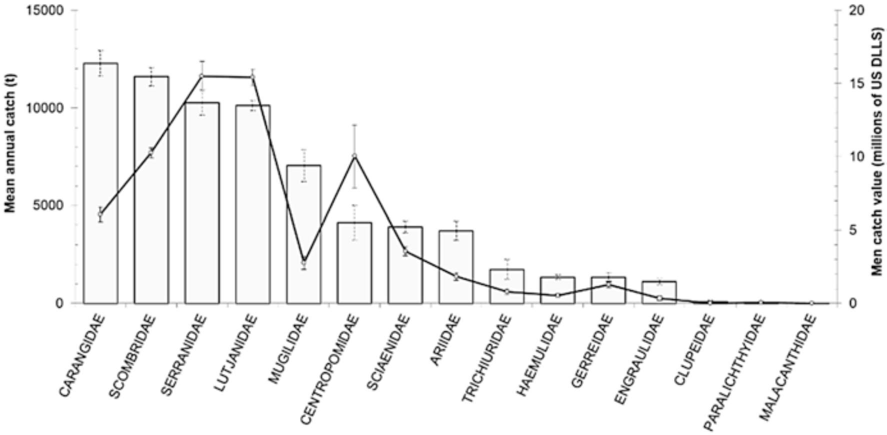



**Fig. 11.3** Annual mean catches (Bars + SD) and annual mean catch value (Line + SD) of finfish by family caught along the Mexican waters of the Gulf of Mexico and Caribbean Sea

## 11.4 Management and Regulatory Framework

Fisheries management requires the understanding of factors associated with the dynamics of resources (including ecological components), as well as dynamics of the fleet and economic, sociocultural, political, and institutional arrangements (Charles 2001; McConney and Salas 2011). In Mexico, while a clear institutional management structure exists, integrated management plans have been built more recently. However, the implementation of such plans remains as a challenge.

The Mexican Constitution establishes that terrestrial and aquatic resources within territorial limits are public property and the state has the right to transfer its usufruct to an individual or group of individuals. The jurisdiction of these responsibility lies with the Ministry for Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA, Spanish acronym). In turn, it relies on two federal institutions (National Commission of Aquaculture and Fisheries (CONAPESCA) and National Fisheries Institute (INAPESCA)) which work in coordination on the management and sustainable use of fishing resources under the General Law for Sustainable Fisheries and Aquaculture (LGPAS). In addition, the Ministry of Environment and Natural Resources (SEMARNAT) oversees the management of protected areas (PA). In areas where fishing activities are in place (such as the Veracruz Coral Reef System National Park), SEMARNAT (more specifically through the CONANP) and CONAPESCA must coordinate actions for regulation (Fig. 11.4).

CONAPESCA oversees the enforcement and surveillance that is supported by INAPESCA, which is responsible for assessing resource conditions to define the appropriated level of exploitation. This assessment is reported in the National Fishing Charter (NFC), which is binding when decisions are made. These institutions coordinate actions for the development and implementation of the fisheries

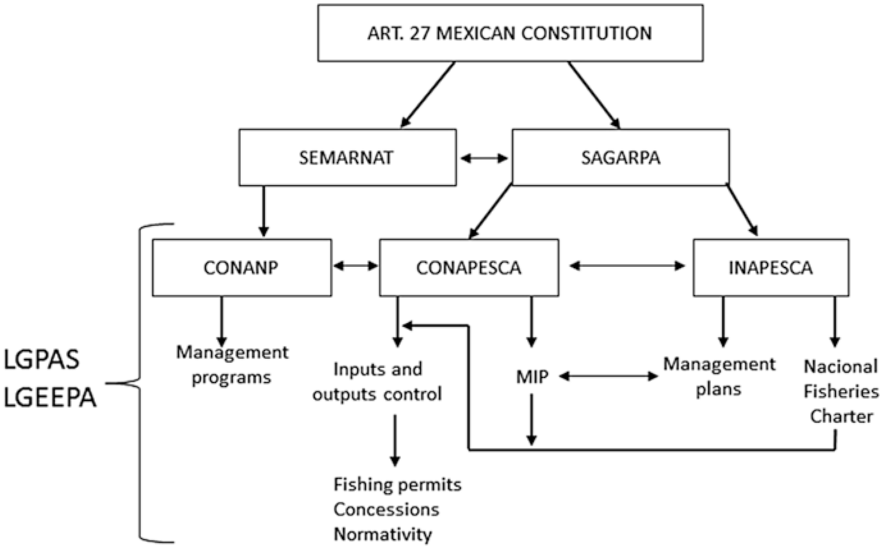



**Fig. 11.4** Federal institutional arrangements in fisheries management in Mexico. Acronyms: Ministry of Environment and Natural Resources (SEMARNAT), Ministry for Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA), General Law for Sustainable Fisheries and Aquaculture (LGPAS), Law of Ecological Equilibrium and Environmental Protection (LGEEPA), National Commission of Natural Protected Areas (CONANP), National Commission of Aquaculture and Fisheries (CONAPESCA), National Fisheries Institute (INAPESCA), management implementation programs (MIPs)

management plans (FMPs) and management implementation programs (MIPs). Between 2012 and 2015, 9 and 12 FMPs for the Pacific Ocean and the GMCS regions have been approved and published, whereas 13 MIPs are in process. Regarding GMCS, two of those plans are associated with SSFF (snook and striped mullet–white mullet), and there is one plan that includes small-scale and middle-scale fleets (groupers and associated species).

Access to fishery resources can be obtained through fishing concessions and fishing permits, which are granted more frequently than concessions. The latter, unlike other fisheries in Mexico, are issued displaying the generic name marine finfish or just finfish, depending on the catch zone. In terms of species, the catch composition is implicitly regulated by fishing gear restrictions and authorized catching zones indicated in the fishing permits as well as other applied management tools, like gear restrictions and closed areas. Formal viable and efficient regulations require sound information and efficient surveillance and compliance systems, which bear implicit and explicit transaction costs (Table 11.1). Several agencies, including the Organization for Economic Cooperation and Development (OECD), acknowledge that the enforcement of regulations within artisanal fisheries and many small-scale fleets is nearly impossible given the current volume of resources and without causing a significant impact on the livelihoods of low-income fishers (2006). Overall, this elevates the challenge for managing such fisheries.

**Table 11.1** Main Fishery Management Tools for Small-Scale Finfish Fisheries in the Coastal Zone of the Gulf of Mexico and Caribbean Sea. The implicit transaction cost associated to implementation of management tools are included

| Management tool | Transaction costs | | | Some attributes |
|---|---|---|---|---|
| | Information | Surveillance | Enforcement | |
| Fishing permits | High | High | High | For individuals or fishing cooperatives |
| | | | | Effective period 2–5 years |
| | | | | Renewable |
| | | | | Transferable on death |
| | | | | Multispecies |
| | | | | Do not require technical and economic studies |
| | | | | New permits have not been issued for most fisheries in recent years |
| Concessions | High | High | Medium | For individuals or organizations |
| | | | | Effective years |
| | | | | Renewable |
| | | | | Single species |
| | | | | Require technical and economic studies |
| Gear selectivity | High | High | High | Based mainly on main target species |
| Gear restrictions | Medium | Medium | Medium | Based mainly on main target species |
| Closed seasons and areas | High | High | High | Based mainly on biological studies, not always updated |
| Minimum size | High | High | High | Based mainly on biological studies, not always updated |
| Protection of gravid females | High | High | High | Based mainly on biological studies, not always updated |
| Catch limit | High | High | High | Population biomass is not assessed routinely, assessments mainly based on catch trends |

## 11.5 Finfish Fisheries Typology and Current Status of Resources

Taking into account the principal finfish fishery resources caught within the GMCS coastal zone, three fishing groups were defined for the development of the typology introduced in this chapter. The criteria for this definition include diversity of target species for a given fishery, clustering level in official catch records, and contribution of target species as incidental in other fisheries.

After these classifications were established, the resource status was defined for each species based on two sources of information: the International Union for the Conservation of Nature (IUCN) Red List and the NFC. Furthermore, NFC reference points (RP) were considered for target species (Diario Oficial de la Federación

2012). Regarding most of the SSFF in the GMCS, the RP includes the catch limit, which can be estimated using the average ratio between the catch within a defined year ($C_y$) and the maximum recorded catch ($C_{max}$) for an approximate 10-year period ($C_y/C_{max}$). NFC refers to this indicator as the catch index or relative catch index (RCI). The RCI may be expressed in terms of catch limit (in tons) by multiplying it by $C_{max}$ (Tables 11.2 and 11.3). Finally, in the next section, we will describe each fishery group.

### 11.5.1 Type 1: Target Species

The first group includes fisheries that have a low diversity of target species (up to 2). Its official catch records are reported separately by species. They are caught using specific fishing gears and have contributions from incidental fishing (Table 11.2). Three fisheries were included within this group, and, of these, mackerels have the highest economic value (Fig. 11.5). These species are internationally managed since they have a wide distribution outside of the Mexican exclusive economic zone and their catching zone encompasses all coastal states of the GMCS. On the other hand, mullets include species of low economic value but are socially relevant as a source

**Table 11.2** Main species comprising the group of target species captured by the small-scale fleet in the GMCS

| Resources | Species | IUCN Red List | Status[b] | Management tools |
|---|---|---|---|---|
| Mullets | *Mugil curema*[a] | LC | Tam and Ver: fully exploited | Commercial fishing permit for finfish |
| | *M. cephalus*[a] | LC | Tam, fully exploited; Ver, deteriorated | Closed fishing seasons |
| | | | | Minimum legal size |
| | | | | There is a FMP and MIP |
| Mackerels | *Scomberomorus maculatus*[a] | LC | Fully exploited | Commercial fishing permit for marine finfish |
| | *S. cavalla*[a] | LC | Fully exploited | International management for ICCAT |
| Catfishes | *Bagre marinus*[a] | LC | Tab and Camp: fully exploited | Commercial fishing permit for finfish |
| | *Ariopsis felis*[a] | LC | Tam and Ver: fully exploited | |

*Tam* Tamaulipas, *Ver* Veracruz, *Tab* Tabasco, *Camp* Campeche, *Yuc* Yucatán, *Q.Roo* Quintana Roo
NE: not evaluated; DD: data deficient; **LC**: least concern; **NT**: near threatened; **VU**: vulnerable; **EN**: endangered; **CR**: critically endangered; MSY: maximum sustainable yield (t), $C_y$ catch data in a given year, $C_{max}$ maximum catch (t)
[a]Target species
[b]According to last updated version of NFC (Diario Oficial de la Federación 2012); FMPs, fisheries management plans; MIPs, management implementation programs; ICCAT, International Commission for the Conservation of Atlantic Tunas

**Table 11.3** Main species comprising the group of target-incidental species captured by the small-scale fleet in the GMCS

| Resources | Species | IUCN Red List | Status[b] | Management tools |
|---|---|---|---|---|
| Snooks | *Centropomus undecimalis*[a] | LC | Fully exploited | Commercial fishing permit for finfish |
| | *C. parallelus*[a] | LC | | Closed fishing seasons for Tamaulipas and Veracruz |
| | *C. poeyi*[a] | DD | | There is a FMP and MIP |
| | *C. pectinatus* | LC | | |
| Weakfish | *Cynoscion arenarius*[a] | LC | Fully exploited | Commercial fishing permit for finfish |
| | *C. nebulosus*[a] | LC | | |
| | *C. nothus*[a] | LC | | |
| Jacks, runners | *Caranx hippos*[a] | LC | Fully exploited | Commercial fishing permit for finfish |
| | *C. crysos*[a] | LC | | |
| | *C. latus*[a] | LC | | |
| | *C. lugubris*[a] | LC | | |
| | *Elagatis bipinnulata* | LC | | |
| Snappers | *Lutjanus campechanus*[a] | VU | Tam, Tab, and Q.Roo: fully exploited | Commercial fishing permit for marine finfish |
| | *L. cyanopterus*[a] | VU | Yuc, Camp, and Ver: deteriorated | |
| | *L. analis*[a] | VU | | |
| | *L. apodus*[a] | NE | | |
| | *L. griseus*[a] | NE | | |
| | *L. jocu*[a] | NE | | |
| | *L. purpureus*[a] | NE | | |
| | *L. synagris*[a] | NE | | |
| | *L. vivanus*[a] | NE | | |
| | *L. buccanella*[a] | NE | | |
| | *Rhomboplites aurorubens*[a] | NE | | |
| | *Ocyurus chrysurus*[a] | NE | | |
| | *Etelis oculatus*[a] | NE | | |

(continued)

**Table 11.3** (continued)

| Resources | Species | IUCN Red List | Status[b] | Management tools |
|---|---|---|---|---|
| Groupers | *Epinephelus morio*[a] | **NT** | Deteriorated | Commercial fishing permit for marine finfish |
| | *E. adscensionis*[a] | **LC** | | Closed fishing seasons for Campeche Bank |
| | *E. drummondhayi*[a] | **CR** | | Minimum length for *E. morio* |
| | *E. guttatus*[a] | **LC** | | There is a FMP and MIP |
| | *E. itajara*[a] | **CR** | | |
| | *E. striatus*[a] | **EN** | | |
| | *Mycteroperca bonaci*[a] | **NT** | | |
| | *M. interstitialis*[a] | **VU** | | |
| | *M. phenax*[a] | **LC** | | |
| | *M. microlepis*[a] | **LC** | | |
| | *M. venenosa*[a] | **NT** | | |
| | *M. tigris*[a] | **LC** | | |
| | *Hyporthodus flavolimbatus*[a] | **VU** | | |
| | *H. nigritus*[a] | **CR** | | |
| | *H. niveatus*[a] | **VU** | | |
| Menhaden, herrings, anchovies, sardines | *Brevoortia gunteri*[a] | **LC** | Fully exploited | Commercial fishing permit for marine finfish |
| | *B. patronus*[a] | **LC** | | |
| | *Harengula clupeola*[a] | **LC** | | |
| | *H. jaguana*[a] | **LC** | | |
| | *Opisthonema oglinum*[a] | NE | | |
| | *Cetengraulis edentulus* | NE | | |
| | *Etrumeus sadina* | NE | | |

*Tam* Tamaulipas, *Ver* Veracruz, *Tab* Tabasco, *Camp* Campeche, *Yuc* Yucatán, *Q.Roo* Quintana Roo. NE: not evaluated; DD: data deficient; **LC**: least concern; **NT**: near threatened; **VU**: vulnerable; **EN**: endangered; **CR**: critically endangered; MSY: maximum sustainable yield (t), $C_y$ catch data in a given year, $C_{max}$ maximum catch (t)

[a]Target species

[b]According to last updated version of NFC (Diario Oficial de la Federación 2012); FMPs, fisheries management plans; MIPs, management implementation programs

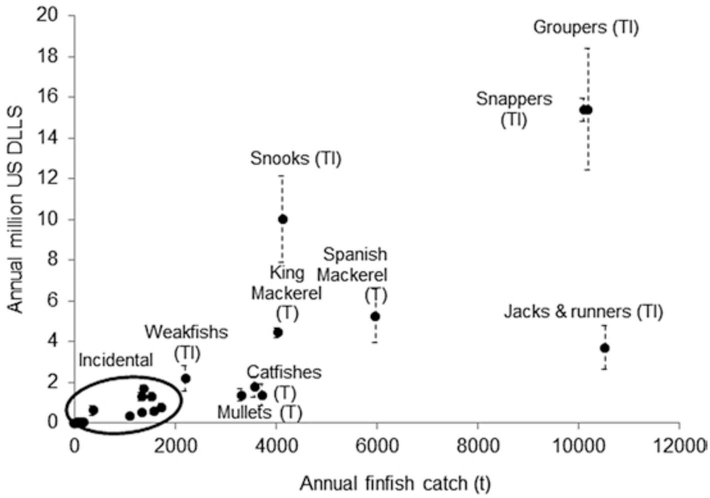



**Fig. 11.5** Mean annual value of catches (+ SD) of estuarine and marine species caught in the Gulf of Mexico and Caribbean Sea by groups: target (T), target-incidental (TI), and incidental. The mean annual values were estimated for the period 2009–2014 from official records (CONAPESCA 2016)

of employment and food security for fishing communities located around the major lagoon systems in Tamaulipas and Veracruz – Laguna Madre, Pueblo Viejo, and Tamiahua (Fig. 11.5). The highest commercial value of these resources is attained during two periods per year during their respective reproductive migration toward the sea (November–December and February–March), because market price for the female gonads can exceed that of meat by two- or threefold (Diario Oficial de la Federación 2014). In this fishing group, mullets rely on FMP and MIP, although they have not been implemented.

### 11.5.2 Type 2: Target-Incidental

The group defined as *target-incidental* (Table 11.3) comprises six fisheries that exhibit a wider diversity of target species. The official catch records for each fishery include several species caught with different fishing gears, with some potentially representing an important contribution as incidental catch in other fisheries (e.g., snappers, groupers, weakfishes), while others constitute a lower proportion in incidental catches (e.g., snooks and sardines). Due to their high economic value, grouper, snapper, and snook fisheries stand out (Fig. 11.5). The grouper fishery is considered as sequential: juveniles and subadults are exploited by the small-scale fleet at the coastal area, whereas adults are targeted by the middle-scale fleet in offshore waters (Seijo 2004; Monroy et al. 2010; Coronado and Salas 2011); these interactions generate sequential externalities among the resource users (Seijo et al.

1998). This fishery has high socioeconomic relevance as source of employment for thousands of workers in the fishing communities of the Yucatan shelf. However, the status of this fishery in its main fishing area has been defined as in deterioration, and several species from this group are included in high-risk categories of IUCN Red List. The latest evaluations for red grouper show a drastic reduction of the population's biomass at the Campeche Bank (Monroy-García et al. 2014). The red grouper and its associated species as well as snooks rely on specific management tools and both FMP and MIP, which have not yet been implemented.

### *11.5.3 Type 3. Incidental*

Finally, the third identified group was named *incidental*, which includes non-targeted resources which are caught incidentally in several targeted fisheries. These species have official catch records derived from several fishing gears. Given that the resources included in this group are not considered formal fisheries, the stock status is unknown, and therefore no reference points or management tools exist for them. They are mostly commercialized locally or consumed in nearby communities for subsistence. This group comprises at least six stocks, including grunts (*Conodon nobilis*, *Haemulon* sp.), hairtail (*Trichiurus lepturus*), pompanos (*Alectis ciliaris*, *Trachinotus* sp.), amberjacks (*Seriola* sp.), graysbys (*Cephalopholis* sp.), and drums and croakers (*Sciaenops* sp., *Menticirrhus* sp.). None of these is included in any high-risk category in the IUCN Red List.

Snappers and groupers, which belong to the *target-incidental* group, are resources classified in the deteriorating category at the regional level as well as in some major fishing zones. Additionally, several of their stocks are included in high-risk categories in the IUCN Red List (Table 11.3). Incidentally, these are the most commercially valuable finfish resources in the GMCS (Fig. 11.5). One concern is that this condition can affect the trading of these resources at national and, especially, international markets. International organizations (e.g., the Convention on International Trade in Endangered Species of Wild Fauna and Flora, World Trade Organization) place an emphasis on developing market mechanisms that allow the tracing of operations and management of these resources; however, there are no mechanisms toward this type of regulations at the national level in Mexico.

In terms of total catch value, the resources included in group type 2 are the most commercially valuable, followed by those of group type 1, and type 3 at the lowest total value (Fig. 11.5). Jack and runner fisheries stand out in this category due to their high catch levels, which give them a large total catch value despite a low market price. However, their meat represents an important source for local consumption in coastal fishing communities spanning from the state of Veracruz to the state of Tabasco.

## 11.6 Regulatory Flaws: How to Make Improvements?

The Code of Conduct for Responsible Fisheries (FAO 1995) and the recent Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (FAO 2015) highlight that, even in cases for which data available are scarce, the assessment of fishing resources should not be delayed. To that end, Froese and Kesner-Reyes (2002) propose a basic approach for assessing resource status based on historical catch statistics that may be applied to the main SSFF in GMCS. The authors suggest that catches between 0.5 and 1.0 $C_{max}$ are indicative of fully exploited stocks. Thus, they implicitly assume that maximum sustainable yield (MSY) would normally be found within this range. This assumption was later confirmed by Srinivasan et al. (2010) and Froese et al. (2012), using data from several stocks from the northeast and northwest of the Atlantic and characterized by formal evaluations. Likewise, Froese and Kesner-Reyes (2002) defined $C_y/C_{max}$ thresholds for overexploited (0.1–0.5) and collapsed (<0.1) fisheries. The basic assumption of this approach is that the trends of target resources in a fishery reflect the resource abundance once it reaches the maximum exploitation levels (Arreguín-Sánchez and Arcos-Huitrón 2011). The approach was used for the assessment of most important resources referred above (types 1 and 2) considering the officially reported catch for 2013 ($C_{2013}$) (CONAPESCA 2015).

In Table 11.4, the status of the 25 main target species regarding $C_{max}$ is depicted using a color-coded rating system to distinguish the different status of the fish stocks. Green represents fully exploited fisheries ($C_{2013}/C_{max} > 0.5$), red represents overexploited fisheries ($0.1 > C_{2013}/C_{max} < 0.5$), and orange represents collapsed fisheries ($C_{2013}/C_{max} < 0.1$). This analysis shows that 11 target fisheries were classified as overexploited in contrast to 5, reported at the NFC in this status (Tables 11.2 and 11.3).

For mullets, catfishes, weakfishes, and snappers, it was found that current exploitation conditions are above their replenishment capacity, implying that these resources need attention for attaining sustainable exploitation rates. In addition, the 14 remaining fisheries are at the MSY (56%). However, it is noteworthy that some fisheries reached values $C_{2013}/C_{max} > 1.0$, indicating that $C_{max}$ was surpassed in 2013 and that these fisheries require attention to follow their trends. Special consideration must be paid to jacks and runners, given their high catch levels and their social relevance as a food source. It should be noted that groupers were excluded from this analysis since official statistics pooled the catch made by small-scale, semi-industrial, and industrial fleets for this group. In this fishery there are about 15 species included (Table 11.3), and the status of the majority of them remains unknown in the GMCS. However, this fishery is labeled as in decline. For this reason, the percentage of overexploited fisheries calculated by this analysis may be underestimated.

Comparatively, the relative catch index (RCI) included in the NFC and the indicator proposed by Froese and Kesner-Reyes (2002) have similarities as assessment tools, both allowing for a rapid appraisal of the status of primary SSFF target groups. However, the RCI has some drawbacks, including the following:

**Table 11.4** Level of exploitation of main finfish fishery resources caught in the Gulf of Mexico and Caribbean Sea, Mexico

| Taxonomic group | Fishery Classification | Resource | Capture zone | $C_{2013}$ | $C_{max}$ | $C_{2013}/C_{max}$ | Status |
|---|---|---|---|---|---|---|---|
| Mugilidae | Target | *M. curema* | Veracruz | 2,321 | 7,220 | 0.32 | |
| Mugilidae | Target | *M. cephalus* | Tamaulipas | 2,961 | 4,168 | 0.71 | |
| Mugilidae | Target | *M. cephalus* | Veracruz | 415 | 2,062 | 0.20 | |
| Mugilidae | Target | *M. curema* | Tamaulipas | 90 | 400 | 0.22 | |
| Scombridae | Target | *S. maculatus* | Gulf of de Mexico | 6,155 | 8,382 | 0.73 | |
| Scombridae | Target | *S. cavalla* | Gulf of de Mexico | 3,976 | 5,780 | 0.69 | |
| Ariidae | Target | *B. marinus* | Campeche | 1,311 | 1,956 | 0.67 | |
| Ariidae | Target | *B. marinus* | Tabasco | 3,516 | 3,811 | 0.92 | |
| Ariidae | Target | *B. marinus* | Veracruz | 284 | 1,036 | 0.27 | |
| Ariidae | Target | *A. felis* | Tamaulipas | 868 | 1,494 | 0.58 | |
| Ariidae | Target | *A. felis* | Veracruz | 227 | 1,662 | 0.14 | |
| Centropomidae | Target-Incidental | *Centropomus* sp. | Tamaulipas | 163 | 149 | 1.09 | |
| Centropomidae | Target-Incidental | *Centropomus* sp. | Yucatan | 165 | 148 | 1.11 | |
| Centropomidae | Target-Incidental | *Centropomus* sp. | Veracruz | 1,577 | 2,088 | 0.76 | |
| Centropomidae | Target-Incidental | *Centropomus* sp. | Tabasco | 1,895 | 3,311 | 0.57 | |
| Centropomidae | Target-Incidental | *Centropomus* sp. | Campeche | 1,994 | 3,860 | 0.52 | |
| Centropomidae | Target-Incidental | *Centropomus* sp. | Quintana Roo | 97 | 212 | 0.46 | |
| Sciaenidae | Target-Incidental | *Cynoscion* sp. | Gulf of de Mexico | 3,044 | 6,925 | 0.44 | |
| Lutjanidae | Target-Incidental | Manly *Lutjanus* sp. | Campeche | 663 | 2,282 | 0.29 | |
| Lutjanidae | Target-Incidental | Manly *Lutjanus* sp. | Quintana Roo | 20 | 109 | 0.18 | |
| Lutjanidae | Target-Incidental | Manly *Lutjanus* sp. | Tabasco | 1,095 | 1,227 | 0.89 | |
| Lutjanidae | Target-Incidental | Manly *Lutjanus* sp. | Tamaulipas | 509 | 889 | 0.57 | |
| Lutjanidae | Target-Incidental | Manly *Lutjanus* sp. | Veracruz | 322 | 1,399 | 0.23 | |
| Lutjanidae | Target-Incidental | Manly *Lutjanus* sp. | Yucatan | 477 | 2,214 | 0.22 | |
| Carangidae | Target-Incidental | *Caranx* sp. | Gulf of Mexico | 9,756 | 8,800 | 1.11 | |

Status of fishery resources was defined according to Froese and Kesner-Reyes (2002): in green, fisheries fully exploited ($C_{2013}/C_{max} > 0.5$); in red, fisheries overexploited ($0.1 > C_{2013}/C_{max} < 0.5$)
Analysis was based on official statistics of 2013 (CONAPESCA 2015). $C_{2013}$, catch data in 2013 (t); $C_{max}$, maximum catch (t)

(i) The indicator generally has a time lag when reported at the NFC. For instance, in its most recent update published in mid-2012 (Diario Oficial de la Federación 2012), the assessment corresponds to information from 2008 and a limited amount of data from 2009.

(ii) The indicator is fixed until the next NFC update.

(iii) The indicator, as a reference point, lacks a decision criterion to provide information on the status of stock in relation to predefined thresholds or limits, which should be avoided to ensure that stock and their exploitation remain within safe biological limits.
(iv) There is no follow-up over time regarding the indicator's trends, which may conceal dangerous conditions for fisheries, such as overexploitation at mid- or long-term or even collapse.

The first two points describe aspects that are linked to intrinsic processes of the NFC official publishing system, whereas the rest of them are intrinsic to the RCI indicator itself. Accordingly, the use of the $C_y/C_{max}$ ratio as fishery indicator possesses thresholds to define the distinct resource exploitation status, and it may be easy to be monitored through time.

## 11.7 Recommendations

To enhance finfish resources management in GMCS, statistical data collection and reporting needs to be improved by providing separated data which shows the contribution of SSFF gears (e.g., hand lines, gill nets, small trawls) that are distinct from that of semi-industrial and industrial fisheries and gears. This information must be available for governments and civil society, including data on illegal, unreported, and unregulated (IUU) fishing. Information on risk, climate change, livelihood vulnerability, and food security also need to be addressed in addition to stock assessment tasks, paying special attention to the conditions of vulnerable and marginal groups which are often heavily reliant on small-scale fisheries (Béné et al. 2007; Pedroza and Salas 2010; FAO 2015). It is important to include non-dependent fishery assessment to ensure accurate abundance' estimates based on available information, which would improve the ability for assessment and prediction models to serve as sound information for fisheries decision-making to define management plans and pertinent strategies.

In this regard, the current regulatory framework expressed in the LGPAS considers the active participation of all stakeholders in alignment with the precautionary principle and highlighting collaborative participation in resource management. This framework is aimed at moving toward greater use of co-management, as opposed to the predominant top-down system which is controlled by the government and its agencies (Ponce-Díaz et al. 2009). Many changes have occurred in the last 5 years, including the interest on the part of the federal government to comply with the SSF guidelines to achieve small-scale fisheries sustainability (FAO 2015).

The transition toward a more participative system requires trust among key stakeholders in the fishery, but it also demands the sharing of reliable information for informed decision-making and to enable implementation. Thus, information recording and reporting systems must be improved, with the participation of academics, harvesters, and government in order to include the minimum essential information to develop common strategies.

Due to the numerous sources of uncertainty in the estimations of abundance of the main SSFF resources, it is important to discourage practices which seek to increase fishers' income based on increased catch level, since this intervention would risk the sustainability of fisheries resources. It is necessary to build capacity through several actions including the development of capacity in fishing cooperatives and other organizations associated with the small-scale fisheries sector at different levels (Eakin and Lemos 2006; Cox and McConney 2011; Seijo and Salas 2014; FAO 2015).

## 11.8 Conclusions

This chapter discusses the general context of SSFF in GMCS, their exploitation levels, and the limitations of the current management instruments with respect to sustaining their viability. In this sense, it must be acknowledged that SSFF management is highly complex, both in Mexico and internationally, because several factors impact its dynamics. Accordingly, it is necessary to generate reliable basic information in order to conduct accurate assessments of the status of the resource, including information on fisheries, which are often lacking in official data such as SSFF. An integrated vision is required which considers the involved groups of species, the potential existing interactions, the fishing gears and methods used, as well as the risks these might represent or the modifications to drive improvements. It is also important to identify factors that could define ecosystem dynamics and fishery system modifications, including biological, economic, social, and management components.

The analysis of the finfish fisheries typology allowed us to address the complexity of these fisheries. It is clear that the resources included in the group target-incidental present one of the major challenges in the assessment and management of these fisheries, due to their high interaction with other finfish fisheries. Thus, we insist that more detailed data collection and reporting procedures are necessary for improved management.

The assessment and management for the SSFF in the GMCS need to be improved based on the best available information. Ideally this information would be based on fishery-independent estimates of fish abundance. Instead, assessing fishery status has been often done based on catch data. In this context, it is necessary to identify reference points, which can provide an important metric to estimate fishery status. With this consideration in mind, the $C_y/C_{max}$ ratio could be used as an exploitation reference point to establish the catch-based status classification for the SSFF.

Even though an official regulatory and management framework exists in Mexico, much effort is still needed to overcome the challenges faced by small-scale fisheries. The first steps have been taken to promote stakeholder involvement in the definition of public policies and in garnering support for management implementation.

Now is the moment to move on from paper to practice through collaborative participation and the taking of responsibility between key stakeholders to strengthen the agencies in charge of fisheries management by providing them with trained staff, financial support to collect reliable and complete information, and the ability to generate well-defined programs to monitor and assess resources in a permanent and accurate manner.

**Acknowledgments** This work was funded by the Mexican Ministry of Public Education (SEP) through project PRODEP (DSA/103.5/15/7127) and by the program Programa del Fortalecimiento de la Calidad en Instituciones Educativas (PROFOCIE) 2014–2015.

## References

Aldana-Arana D, Enríquez-Díaz M, Elías V (2013) Manejo de los recursos pesqueros de la cuenca del Golfo de México y del mar Caribe. Universidad Veracruzana, México

Andrew NL, Béné C, Hall SJ, Allison EH, Heck S, Ratner BD (2007) Diagnosis and management of small-scale fisheries in developing countries. Fish Fish 8:227), 227–227), 240

Arreguín-Sánchez F, Arcos-Huitrón E (2011) La pesca en México: Estado de la explotación y uso de los ecosistemas. Hidrobiológica 21(3):431–462

Beléndez-Moreno LFJ, Espino-Barr E, Galindo-Cortes G, Gaspar-Dillanes T, Huidobro-Campos L, Morales-Bojórquez E (2014) Sustentabilidad y pesca responsable en México evaluación y manejo. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA), México

Béné C (2009) Are fisheries poor or vulnerable? Assessing economic vulnerability in small-scale fishing communities. J Dev Stud 45(6):911–933

Béné C, Macfadyen G, Allison EH (2007) Increasing the contribution of small-scale fisheries to poverty alleviation and security (Fisheries technical paper no. 481). FAO, Rome

Caso M, Pisanty I, Ezcurra E (2004) Diagnóstico ambiental del Golfo de México. Instituto Nacional de Ecología, México

Charles AT (2001) Sustainable fishery systems. Blackwell Science, Oxford

CONAPESCA (2015) Anuario estadístico de acuacultura y pesca 2013. Comisión Nacional de Acuacultura y Pesca Comisión Nacional de Acuacultura y Pesca (CONAPESCA), México

CONAPESCA (2016) Anuario estadístico de acuacultura y pesca 2014. CONAPESCA, México

Coronado E, Salas S (2011) Analysis of operating characteristics of three fleets that affects the red grouper resources and associated species in Yucatan, Mexico: potential effects of externalities. In: Proceedings of the 64th Gulf and Caribbean Fisheries Institute (pp 258–268)

Cox SA, McConney P (2011) Exploring adaptive co-management as a pathway to enhance the governability of sea urchin fisheries in Barbados and Saint Lucia. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries: global reflections. Springer, New York, pp 583–604

Diario Oficial de la Federación (2012 viernes 24 de agosto) Acuerdo por el que se da a conocer la Actualización de la Carta Nacional Pesquera. México D. F.: Gobierno de México

Diario Oficial de la Federación (2014 lunes 31 de marzo.) *Acuerdo por el que se da a conocer el Plan de Manejo Pesquero de Lisa (*Mugil cephalus*) y Lebrancha (*Mugil curema*), en las costas de Tamaulipas y Veracruz*. México D. F.: Gobierno de México

Eakin H, Lemos MC (2006) Adaptation and the state: latin America and the challenge of capacity-building under globalization. Glob Environ Chang 16(1):7–18

Elías I, Carozza C, Di Giácomo EE, Isla MS, Orensanz, J.M. (Lobo), Parma AM, Pereiro RC, Perier MR, Perrotta RG, Ré ME, Ruarte C (2011) Coastal fisheries of Argentina. In: Salas

S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 13–48
FAO (Food and Agricultural Organization of the United Nations) (1995) Code of conduct for responsible fisheries. FAO, Rome
FAO (2015) Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. FAO, Rome
Fernández JI, Álvarez-Torres P, Arreguín-Sánchez F, Lopez-Lemus LG, Ponce G, Díaz da Leon A, Arcos-Huitron E, del Monte-Luna P (2011) Coastal fisheries of México. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 231–284
Fraga J, Villalobos G, Doyon S, García A (2008) Descentralización y manejo ambiental: gobernanza costera en México. Plaza y Valdés, México
Froese R, Kesner-Reyes K (2002) Impact of fishing on the abundance of marine species. ICES document CM 2002/L12: Denmark
Froese R, Zeller D, Kleisner K, Pauly D (2012) What catch data can tell us about the status of global fisheries. Mar Biol 159(6):1283–1292
Huchim-Lara O, Salas S, Chin W, Montero J, Fraga J (2015) Diving behavior and fishing performance: the case of lobster artisanal fishermen of the Yucatan coast, Mexico. Undersea & Hyperbaric Medical Society, Inc 42(4):285–296
Ibáñez AL, Chang CW, Hsu CC, Wang CH, Lizuka Y, Tzeng WN (2012) Diversity of migratory environmental history of the mullets *Mugil cephalus* and *M. curema* in Mexican coastal waters as indicated by otolith Sr:Ca ratios. Cienc Mar 38(1A):73–87
Jiménez-Badillo M (2005) Caracterización de la pesca en la zona costera veracruzana. In: Moreno-Casasola P, Rojas Peresbarbosa E, Bello-Travieso AC (eds) Estrategia para el Manejo costero integral: el enfoque municipal, vol 2. Instituto de Ecología, A.C, México, pp 265–295
McConney P, Salas S (2011) Why incorporate social considerations into marine EBM? In: Fanning L, Mahon R, McConney P (eds) Towards marine ecosystem-based management in the wider Caribbean. Amsterdam University Press, Amsterdam, pp 99–109
Mexicano-Cintora G, Leonce-Valencia CO, Salas S, Vega-Cendejas E (2007) Recursos pesqueros de Yucatán: Fichas técnicas y referencias bibliográficas. CINVESTAV, México
Monroy C, Salas S, Bello-Pineda J (2010) Dynamics of fishing gear and spatial allocation of fishing effort in a multispecies fleet. N Am J Fish Manag 30:1187–1202
Monroy-García C, Galindo-Cortes G, Hernández A (2014) Mero *Epinephelus morio*, en la Península de Yucatán. In: Beléndez-Moreno LFJ, Espino-Barr E, Galindo-Cortes G, Gaspar-Dillanes T, Huidobro-Campos L, Morales-Bojórquez E (eds) Sustentabilidad y pesca responsable en México evaluación y manejo. SAGARPA, Mexico, pp 245–276
Organization for Economic Cooperation & Development (OECD) (2006) Agricultural and fisheries policies in Mexico: recent achievements, continuing the reform agenda. OECD Publishing, Boston
Pedroza C, Salas S (2010) Responses of the fishing sector to transitional constraints: from reactive to proactive change, Yucatan fisheries in Mexico. Mar Policy 35(1):39–49
Pérez-Chacón JE, Aguilar-Perera A (2015) Length–weight and length–length relationships of the Hogfish, *Lachnolaimus maximus*, off the northern coast of the Yucatan Peninsula, Mexico. Gulf Caribb Res 26(1):SC1–SC3
Ponce-Diáz G, Weisman W, McCay B (2009) Co-responsabilidad y participación en el manejo de pesquerías de México: Lecciones de Baja California Sur. Pesca y Conservación 1(1):1–9
Quiroga-Brahms C, Valdez-Guzmán A, Hernández-Tabares I, García GM, Guzmán AP (2002) Peces ribereños. In: Guzmán-Amaya P, Quiroga-Brahms C, Díaz-Luna CD, Fuentes D, Contreras C, Silva LG (eds) La pesca en Veracruz y sus perspectivas de desarrollo, Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. Instituto Nacional de la Pesca, y Universidad Veracruzana, México, pp 155–165
Salas S, Chuenpagdee R, Seijo JC, Charles A (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fish Res 87:5–16

Salas S, Chuenpagdee R, Charles A, Seijo JC (2011) Coastal fisheries of Latin America and the Caribbean region: issues and trends. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO fisheries and aquaculture technical paper. No. 544. FAO, Rome, pp 1–12

Seijo JC (2004) A simple framework for proactive management to mitigate unsustainability in fisheries: estimating risks of exceeding limit reference points of bio-ecologic, economic and social indicators. In: Swan J, Gréboval D (eds) Overcoming factors of unsustainability and overexploitation in fisheries: selected papers on issues and approaches, FAO fisheries report. No. 782. FAO, Rome, pp 235–248

Seijo JC, Salas S (2014) The role of capacity building for improving governance of fisheries and conservation of marine ecosystems. In: Garcia SM, Rice J, Charles A (eds) Governance of marine fisheries and biodiversity conservation: interaction and coevolution. Wiley, Chichester, pp 374–384

Seijo JC, Defeo O, Salas S (1998) Fisheries bioeconomics: Theory, modelling and management, FAO Fisheries Technical Paper No. 368. FAO, Rome

Srinivasan UT, Cheung WWL, Watson R, Sumaila UR (2010) Food security implications of global marine catch losses due to overfishing. J Bioecon 12(3):183–200

Valle SV, Sosa M, Puga R, Font L, Duthit R (2011) Coastal fisheries of Cuba. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) *Coastal fisheries of Latin America and the Caribbean*, FAO fisheries and aquaculture technical paper no. 544. FAO, Rome, pp 155–174

**Gabriela Galindo-Cortes** is a full-time professor at the Institute of Marine Sciences and Fisheries at the University of Veracruz, Mexico. She holds a PhD from Northwestern Center of Biological Research, Baja California Sur, Mexico. Her research interests focus mainly on fisheries biology, assessment, and management. More recently, she has been interested in data-poor stock assessment.

**Lourdes Jiménez-Badillo** is a fisheries scientist with a PhD from the National Autonomous University of Mexico. She is a full-time professor at the Institute of Marine Sciences and Fisheries at the University of Veracruz, Mexico. Her research has focused on assessment and management of small-scale fisheries and marine protected areas. She has coordinated several projects and published several scientific papers, books, and book chapters.

**César Meiners** is a titular professor at the Institute of Marine Sciences and Fisheries at the University of Veracruz, Mexico. He holds a PhD from Polytechnic University of Catalonia, Spain. His research is in marine ecology, fisheries oceanography, population dynamics, oceanography, applied climatology, and deep marine systems. He has done studies in the coastal and sublittoral ecosystems of several oceanic regions (Mexican Pacific and Caribbean, Mediterranean, and African Atlantic).

# Part IV
# Socio-Economic, Markets and Livelihoods

# Chapter 12
# Socioeconomic Monitoring for Sustainable Small-Scale Fisheries: Lessons from Brazil, Jamaica, and St. Vincent and the Grenadines

**Peter Edwards, Maria Pena, Rodrigo Pereira Medeiros, and Patrick McConney**

**Abstract** Obtaining reliable socioeconomic information on small-scale fisheries for use in decision-making at multiple levels of governance remains a challenge for conventional approaches to data gathering, analysis, and interpretation on a global scale. Fisheries information is most often derived from biophysical data rather than human or socioeconomic sources. Even where socioeconomic data are used, the complexity of small-scale fisheries as adaptive social-ecological systems (SES) presents further challenges to aligning information, interventions, and objectives. This chapter presents the Global Socioeconomic Monitoring Initiative for Coastal Management (SocMon) methodology for assessing the social-ecological dynamics of small-scale fisheries. It uses case studies from the Caribbean region, where SocMon has been applied for over 10 years, and from Brazil, which recently implemented the methodology. The cases examine how three features of SocMon—comprehensive socioeconomic data gathering linked to biophysical parameters, participatory methods that include stakeholders in data collecting and management, and integrated information and knowledge mobilization for decision-making—

P. Edwards (✉)
National Oceanic and Atmospheric Administration, Coral Reef Conservation Program, Office for Coastal Management, Silver Spring, MD, USA

The Baldwin Group Inc., Manassas, VA, USA
e-mail: peter.edwards@noaa.gov

M. Pena · P. McConney
Centre for Resource Management and Environmental Studies (CERMES), The University of the West Indies, Barbados, Jamaica
e-mail: maria.pena@cavehill.uwi.edu; patrick.mcconney@cavehill.uwi.edu

R. P. Medeiros
Centro de Estudo do Mar, Universidade Federal do Paraná, Curitiba, Brazil
e-mail: rodrigo.medeiros@ufpr.br



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_12

contribute to better understanding of small-scale fisheries dynamics. The cases outline challenges to implementing SocMon from a fisheries adaptive co-management perspective. The SocMon participatory methodology for monitoring socioeconomic dimensions and dynamics was found suitable for informing adaptive co-management and developing adaptive capacity in small-scale fisheries.

**Keywords** Socioeconomic monitoring · Caribbean · Jamaica · Brazil · Coastal communities · Socio-ecological

## 12.1 Introduction

Fisheries and coastal ecosystem scientists and managers have realized that coastal and marine resources cannot be effectively managed using biophysical scientific monitoring alone. The recent report on the Status and Trends of Caribbean Coral Reefs found that key drivers of coral reef ecosystem change have human root causes including population, tourism development, overfishing, and coastal pollution (Jackson et al. 2014). Systematic monitoring of social science indicators must be done in conjunction with biophysical monitoring. This approach enhances the ability to understand and predict the social-ecological dynamics of coastal systems for improved management.

The significant contribution of small-scale fisheries to the food security and livelihoods of millions of people worldwide is acknowledged, despite basic data being imprecise and often underestimated (Chuenpagdee 2011). As a result, small-scale fisheries are difficult to measure and monitor by conventional means (FAO and WorldFish Center 2008). In comparison to large-scale fisheries, small-scale fisheries are often perceived to be less important from a national economic perspective, although they tend to contribute less to fuel consumption, play a larger role in employment and food security, and are usually more environmentally sustainable than large-scale fisheries. Nonetheless, small-scale fisheries are generally marginalized and ignored in national fisheries policies despite their importance as socioeconomic institutions (Chuenpagdee 2011; Mahon and McConney 2011). In order to better understand how to make fisheries sustainable for the benefit of ecosystems, fisheries resources, and people, as well as advance the process of policy and practice for sustainable livelihoods, socioeconomic information is critical. The following sections examine the application of the Global socioeconomic Monitoring Initiative for Coastal Management (SocMon) methodology in addressing such challenges. Further information is available online at www.socmon.org.

### 12.1.1 Global Socioeconomic Monitoring for Coastal Management

In 1994, the Global Coral Reef Monitoring Network (GCRMN) was established to support a call to action by the International Coral Reef Initiative (ICRI) to increase research and monitoring of coral reefs to inform policy and decision-making. By 2000, GCRMN recognized the need for collecting socioeconomic data on coral reefs and other coastal areas in order to improve the understanding of the social, economic, political, and cultural conditions, contexts, and motivations associated with the use of coral reef ecosystems globally. Subsequently, the GCRMN *socio-economic Manual for Coral Reef Management* (Bunce et al. 2000) and regionally specific guidelines were then developed to inform data collection (Bunce and Pomeroy 2003a, b; Malleret-King et al. 2006; Hoon et al. 2008; Wongbusarakum and Pomeroy 2008). These publications complement the GCRMN biophysical manual to foster integrated coral reef monitoring of both biophysical and human impacts (English et al. 1997).

SocMon aims to advance global and regional understanding of human interactions with and dependence on coastal resources. Its flexible and participatory methodology enables fisheries and coastal managers to identify potential problems and shocks, mitigate negative impacts, and focus management priorities accordingly to achieve management objectives. SocMon is a means of promoting the use of social and economic data in fisheries and coastal management decision-making. It is designed to be combined with many approaches and tools including ecosystem-based management (EBM), ecosystem approach to fisheries (EAF), sustainable livelihoods enhancement and diversification (SLED), integrated coastal zone management (ICZM), and marine spatial planning (MSP).

Implementation occurs through coordinators in the seven SocMon regions—the Caribbean, Central America, Brazil, South Asia, Southeast Asia, Western Indian Ocean, and the Pacific Islands. Regional and local partners provide technical support, conduct trainings, and promote the methodology for community-based monitoring and shared learning. Each region's tailored guidelines for socioeconomic monitoring are used with the GCRMN manual that details field methods and techniques (SocMon n.d.). An addendum addresses ten climate change indicators (Wongbusarakum and Loper 2011). SocMon is adaptable to local conditions, capacity, culture, and research needs. SocMon is applied at the site level, with indicators for measurement prioritized according to (1) the goals and objectives for assessment or monitoring or management questions, (2) their general importance to data collection, and (3) site-specific conditions.

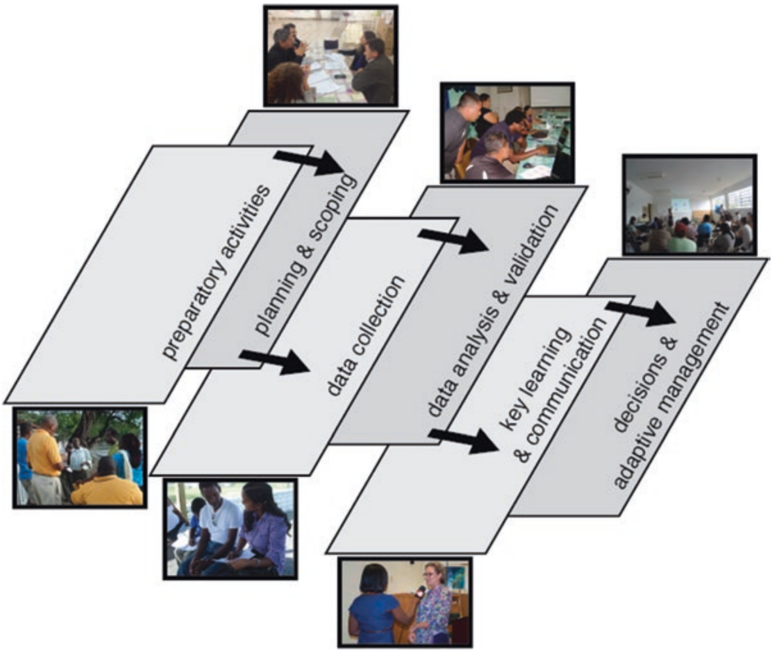



**Fig. 12.1** Typical steps for conducting socioeconomic monitoring

### *12.1.2 SocMon Methodology*

Applying SocMon typically includes six main phases with steps that guide the methodology at study sites. These phases are presented here as a linear process, but often in practice, iterations occur between the steps (Fig. 12.1).

To date, over 70 assessments using SocMon have been completed in more than 35 countries. Half of these assessments have been conducted in coastal communities, such as fishing villages, with a focus on small-scale fisheries. The other half have been conducted in relation to marine protected areas (MPAs),[1] national parks, or other areas with conservation plans (SocMon n.d.).

Goals and objectives for small-scale fisheries-related socioeconomic site monitoring include:

- Baseline data gathering on coastal communities against which to measure changes and trends

[1] Focus on MPAs has been partly due to recent coral reef initiatives such as the Coral Triangle, Micronesia Challenge, and Caribbean Challenge. International funding strategies for socioeconomic monitoring such as the NOAA Coral Reef Conservation Program (CRCP) International Strategy 2010–2015 offer grant funding to support socioeconomic monitoring at MPAs. Since marine livelihoods are linked to MPAs, SocMon assessments have collected valuable socioeconomic data relevant to small-scale fisheries.

- Informing fisheries and MPA management plans of ongoing socioeconomic changes and trends
- Promoting the use of socioeconomic data in fisheries decision-making
- Developing socioeconomic profiles for fisheries and communities
- Determining the adaptive capacity of coastal communities to climate change
- Enhancing the management capacity of stakeholders
- Using socioeconomic data to complement biophysical monitoring

Compiling socioeconomic information relevant to marine livelihoods includes data on demographic trends, occupations, coastal and marine activities, types of resource use, household market orientation (i.e., for subsistence or sale), attitudes and perceptions of resource conditions, and perceived threats to coastal resources. Governance data are also collected during site assessments, including information on awareness of rules and regulations, compliance, enforcement, and participation in decision-making, among others. According to Pena and McConney (2014), socioeconomic assessments relevant to small-scale fisheries indicate trends such as:

- A high level of livelihood dependency on subsistence and small-scale fishing
- Declining resource conditions and reduction in catches at some sites
- Reluctance to change to alternative livelihoods due to a number of factors
- Threats such as restricted access, overfishing, pollution, and sedimentation, among others

All SocMon indicators are applicable to small-scale fisheries, but a core set of indicators can be used specifically to monitor these SES. The effective monitoring of small-scale fisheries on a global scale requires the revision of some SocMon indicators and the development of new ones. Using core indicators in small-scale fisheries monitoring programs or research frameworks ensures regional collection of standardized data. An improved understanding of the socioeconomic contexts of these SES is critically needed to encourage sustainable development, effective management, and governance, especially in developing countries. Yet, there is low evidence of SocMon data use in decision-making. This issue is not unique to social science monitoring, as use of biophysical monitoring information in policy decision-making is also infrequent. In addition, a goal of SocMon partners globally is the increased use of data in management (Edwards 2014).

The SocMon methodology continues to evolve. For example, the SocMon Caribbean node has developed a practical method for integrating SocMon and participatory GIS, which has been coined SocMon Spatial. One of the main aims of SocMon Spatial is to offer an alternative visualization of socioeconomic data that may be more useful for decision-making than traditional GIS products (Wood et al. 2013). Integrating SocMon with other methodologies such as cost-benefit analysis, resource valuation, management effectiveness evaluation, dynamic modeling, and participatory management should result in the increased uptake of SocMon data in management and governance.

## 12.2 Socioeconomic Monitoring Case Studies of Small-Scale Fisheries

In this section, we review the practical application of SocMon to improve small-scale fisheries governance in the Caribbean region and Brazil. We have used case studies that are representative of the global experience across all seven regions, including the two from which the case studies are drawn. The Caribbean case studies consist of one project from Jamaica, undertaken to inform fisheries management planning, and one from the Grenadine Islands, which aimed to develop socioeconomic profiles of fishers. The case studies from Southern Brazil are focused on two MPAs and examine the fishing monitoring system for Santa Catarina state using socioeconomic and fisheries participatory assessments in the Bay of Tijucas, as well as community-based monitoring of SES in MPAs. These MPAs were chosen as pilot sites to implement socioeconomic and fisheries monitoring in Brazilian MPAs under national jurisdiction.

### *12.2.1 Caribbean Case Studies*

National and regional fisheries authorities in the Caribbean Community (CARICOM) region have long articulated the need for more attention to be paid to socioeconomics in data collection, information generation, and decision-making; however, varied to little progress has been made by these authorities toward implementation. The cases studies for the Negril Marine Park, Jamaica, and the Grenadine Islands discussed here demonstrate that this regional need can be adequately fulfilled by sustained socioeconomic monitoring (Table 12.1, Fig. 12.2).

### *12.2.2 Informing Fisheries ManagementPlanning for the Negril Marine Park (NMP), Jamaica*

#### 12.2.2.1 Overview

Negril is a premier mass tourism destination at the western end of Jamaica, home to all-inclusive resorts and other large hotel chains (Otuokon 1997; Thacker and Hanson 2003). Rapid growth in the tourism sector over a 30-year period beginning in the 1960s brought benefits for many local residents but at a considerable cost to others and the environment (Goreau et al. 1995). Small-scale fishing has been a traditional income source for many people in Negril (CFRAMP 2000; NEPA 2015). However, the resources on which fishermen from within and outside Negril depend are negatively affected by, and are at risk from, coastal physical development in the tourism sector, which lacks systems to protect resources (Thacker and Hanson 2003).

**Table 12.1** Caribbean case study summaries

| | Negril Marine Park, Jamaica | The Grenadine Islands |
|---|---|---|
| Goal | To inform fisheries management planning at the Negril Marine Park | To acquire socioeconomic information on fisheries in the Grenadines for future use in fisheries and integrated coastal management decision-making |
| Objectives | Determine the kind of information needed to be generated for the marine park's fisheries management plan (FMP) | Create basic demographic profile of fishers |
| | | Acquire information on fishing practices (temporal and spatial) of Grenadine fishers |
| | Determine how the information for the FMP should be generated | Understand market orientation of fishers, prices received, and patterns by island |
| | Determine the implications of the information for management | Acquire basic information on income, expenditure, and material style of life of the fishers |
| Methods | Secondary data collection and surveys | Secondary data collection and surveys |
| SocMon team | NGO, teachers, and researchers | Researchers |
| Findings | Fishing is mainstay of community livelihoods; high level of dependency on fish for food; drastic decline in fish stocks; alternative livelihood options limited; resource condition perceived to have declined; communities accept co-management but have limited influence on management | Strong historical fishing traditions exist; high dependency on fishing for livelihoods; overexploited demersal fishery; high incidence of disregard for safety equipment; trading vessels play role in sustaining livelihoods; fishers believe government not concerned about fishing industry |
| Partners | Jamaica fisheries division | St. Vincent and the Grenadines and Grenada fisheries divisions |

The Negril Marine Park (NMP) is the marine component of the larger Negril Environmental Protection Area (EPA), which includes five watersheds and a major wetland. Since 2002, the Natural Resources Conservation Authority (NRCA) delegated management of the NMP to the Negril Coral Reef Preservation Society (NCRPS), a nonprofit, nongovernmental, charitable organization with voluntary membership. The NMP encompasses approximately 160 km$^2$, extending about 3 km seaward from the high water mark to the deep water drop-off, with a coastal boundary of approximately 33 km, as shown in Fig. 12.3 (NEPT, NRCA, and NGIALPA 1997). The vision for the NMP is that of sustainable and collaborative management for the conservation of marine and coastal biodiversity, resources, and ecosystems with simultaneous provision of an improved quality of life for all (NEPA 2015). Natural resources within the park include coral reefs, seagrass beds, mangrove communities, and a variety of commercially important fisheries resources such as snapper, grunts, and groupers (Thacker and Hanson 2003). The area has communities that are highly dependent on fishing as a livelihood and are threatened by declining conditions of fish stocks in the area.


**Fig. 12.2** SocMon Caribbean case study locations (Created by Maria Pena)

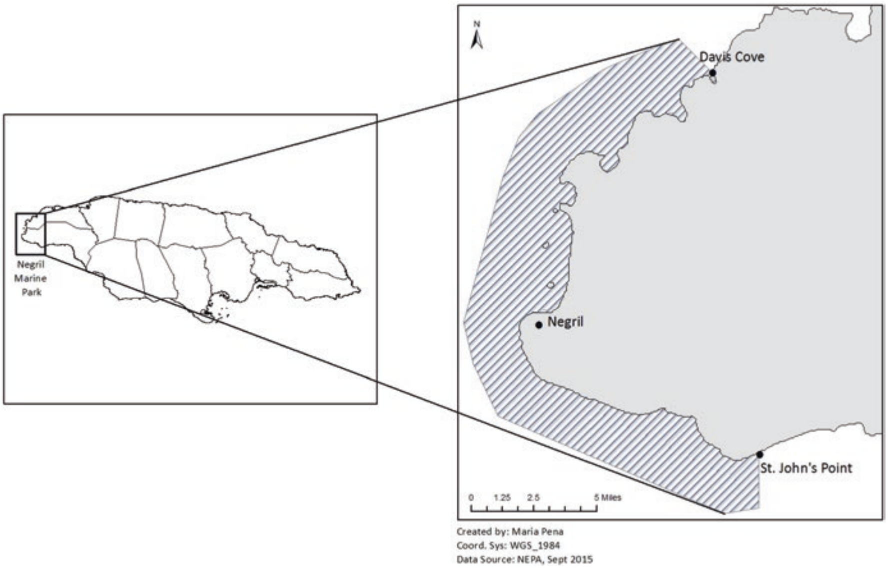



**Fig. 12.3** Negril Marine Park boundaries and extent of SocMon study area

Fishing is second only to tourism as the major marine economic activity in the NMP. Historically, overfishing has impacted the NMP with heavy fishing occurring in inshore areas by people considered to be living in poverty (Geoghegan et al. 2001). To date the problem of overfishing still remains (Waite et al. 2011). Fishery data collected prior to this SocMon study showed deterioration in the condition of all resources that the NMP was attempting to protect (Garaway and Esteban 2002). Detrimental effects have been documented such as dramatic declines in fish stocks since 2000, exemplified by low levels of fish abundance and primarily undersized fish for the commercially targeted species. These effects were noted within and adjacent to the NMP and are attributed to destructive fishing techniques such as seining, spearfishing, and dynamiting, as well as practices such as the use of illegal mesh size in fish traps or pots (Otuokon 1997; Garaway and Esteban 2002; O'Sullivan 2002; NCRPS 2003).

#### 12.2.2.2 Assessment

Developing a fisheries management plan (FMP) for the NMP was the next step toward protecting the fisheries while maintaining livelihood opportunities for people in communities adjacent to the marine park (Blackman 2005). In drafting the first FMP for the NMP, it was essential that social, economic, and governance information on all stakeholders, particularly fishers of the inshore areas of the NMP, were incorporated into planning since these people would potentially be impacted by resulting regulations (Pena et al. 2007). Graduate research was undertaken by the University of the West Indies Centre for Resource Management and Environmental Studies (CERMES) and the SocMon node for the English-speaking Caribbean, in collaboration with the NCRPS, to gather socioeconomic information to inform the draft FMP.

After an extensive secondary data review, a survey was conducted by the NCRPS in 2005 to obtain information to improve management. Seventeen SocMon indicators were measured in the survey (Table 12.1), which was conducted in 10 fisheries-oriented communities within and adjacent to the NMP and gathered data from 88 households. The surveys were administered by female teachers from schools in the ten communities. Survey data were analyzed via Statistical Package for the Social Sciences (SPSS) and Excel to provide descriptive statistics. These results were presented at workshops with the survey personnel and fisheries stakeholders for interpretation and validation of how the information would assist management of the NMP. Socioeconomic data and information for fisheries management were selected for incorporation into the FMP based on ecological, socioeconomic, and governance criteria adopted by Blackman (2005) from examples of local (Dudley et al. 2000), species-specific (Schrading et al. 1998), and national fisheries management plans (Fisheries Division 2004). The FMP also was informed by the 1997 FAO Technical Guidelines for Responsible Fisheries (FAO 1997), as well as general literature on managing small-scale fisheries (Berkes et al. 2001).

#### 12.2.2.3 Key Learning

The SocMon survey data were used primarily to develop socioeconomic profiles of NMP fisheries for informing the FMP. The profiles used data on demographics, perceptions of resource status, management responsibility and participation in management, livelihoods and alternative livelihoods, and interactions between user groups, particularly fisher-tourism and fisher-fisher interactions (Blackman 2005). The assessment confirmed that fishing was the mainstay community livelihood in the NMP, which was identified by more than 75% of respondents as their primary occupation, and these respondents had no secondary source of income. There is also a high level of dependency on fish as food, with over 47% of the seafood consumed in a month caught in the NMP. Families in communities in and around the NMP would be affected by restrictions on fishing in the NMP. Displacement of inshore fishers, who are often the poorest fishers in Negril, due to management regulations would have a significant impact on household income (Blackman 2005; Pena et al. 2007).

Alternative livelihood options in the area are limited and must be related to fishing to be successful. In terms of alternative income generation strategies, 23% of respondents indicated an interest in tourism; however, 39% said they had no other alternative income generation opportunities. The barrier to switching jobs was largely due to financial reasons (60%). Most respondents (88%) were not trained for alternative occupations. Thirty-five percent believed training was not necessary, while 25% indicated that no opportunity existed for them, and 13% noted that age constraints and other commitments prohibited them from participating in job training (Blackman 2005). SocMon findings indicated that livelihood options would have to be economically feasible from the fisher's perspective. Key learning suggested that new strategies would have to be developed for older fishers since they are unwilling or unable to switch from fishing to another profession. Emphasis must be placed on educating all fishers on sustainable fishing practices and introducing complementary livelihoods.

Local knowledge of resource conditions was consistent with scientific evidence of deteriorating coastal and marine resources (Espeut and Grant 1990; Garaway and Esteban 2002; Francis 2002; O'Sullivan 2002). Perceptions of the state of inshore and offshore reefs, mangroves, seagrass beds, and beaches indicated a decline from "very good" in the mid-1990s to "very bad" in 2005 (Blackman 2005). Although communities recognized declines in fishery resources, the amount of fishing within the NMP was said to be "just right," indicating that people believed fishing was not a problem while implying that harvesting within the park was feasible. This optimism could be linked to the high proportion of persons within and adjacent to the park that depend on fishing as their primary and secondary occupations and rely on fish as their main food source (Blackman 2005).

Communities in Negril are accepting of the idea of co-management of the NMP but believe that management should be shared by government and nongovernmental organizations. Furthermore, the communities believed they had limited influence on park management. For successful management, communities must be encouraged to participate in decision-making regarding the park. At the same time, fishers must be made aware that they can play a role in management as partners in the NMP. Communities must have a sense of ownership of park resources in order for fisheries management to be successful. In order to increase the level of stakeholder participation within the NMP, park managers need to find effective methods of informing nearby communities and continually keeping them involved. In order to be effective, approaches to public education have to be carefully designed to cater to both the literate and illiterate members of these communities, especially since the majority of respondents possessed only a primary level of formal education (Pena et al. 2007).

## *12.2.3 Fisheries Profiling in the Grenadine Islands*

### 12.2.3.1 Overview

The Grenadine Islands comprise an archipelago with over 30 islands and cays which lie on the Grenada Bank, an area of approximately 2000 km$^2$, between the small island developing states of St. Vincent and the Grenadines to the north and Grenada in the south (Fig. 12.4). The Grenadines form a complex transboundary marine management environment. The international boundary between Grenada and St. Vincent and the Grenadines runs east to west across the bank between the islands of Petite Martinique and Petit St. Vincent. Fishing, informal trade, tourism, and island social life proceed with little attention to the boundary (Mahon et al. 2004).

People in the Grenadines depend on the marine and coastal environment for food security, sustainable livelihoods, and cultural and social activities. The fisheries sector is one of the main sources of income and livelihoods for most families. This high level of dependency, as well as the severe impacts caused by hurricanes, creates vulnerability within a large proportion of the population. Some fishers cushion against this vulnerability by diversifying their livelihoods through other occupations such as water taxiing, construction, transportation of goods between islands, and small-scale agriculture (Cooke et al. 2007; Gill et al. 2007).

Fisheries resources in the Grenadines consist of shallow-shelf reef fishes and deepwater demersal fishes (snappers and groupers), lobsters, conchs, coastal pelagics, offshore pelagics (short-finned pilot whales in Bequia), and sea turtles (Mahon 1990; Mohammed et al. 2003; Gill et al. 2007; Mohammed and Lindop 2015). Fisheries are small-scale, multi-gear and multi-species, with fishers operating independently without formal organizations (Mohammed et al. 2003; Staskiewicz and Mahon 2007). In the Grenada Grenadines, most catches do not enter the local market systems but instead are traded with the French Overseas Department of Martinique. This traditional market exerts a tremendous influence on catch quantity. Considerable declines in catches from the inshore fishery in the Grenada Grenadines and the offshore fishery in the St. Vincent and the Grenadines indicate overexploitation (Mohammed et al. 2003; Mohammed and Lindop 2015).

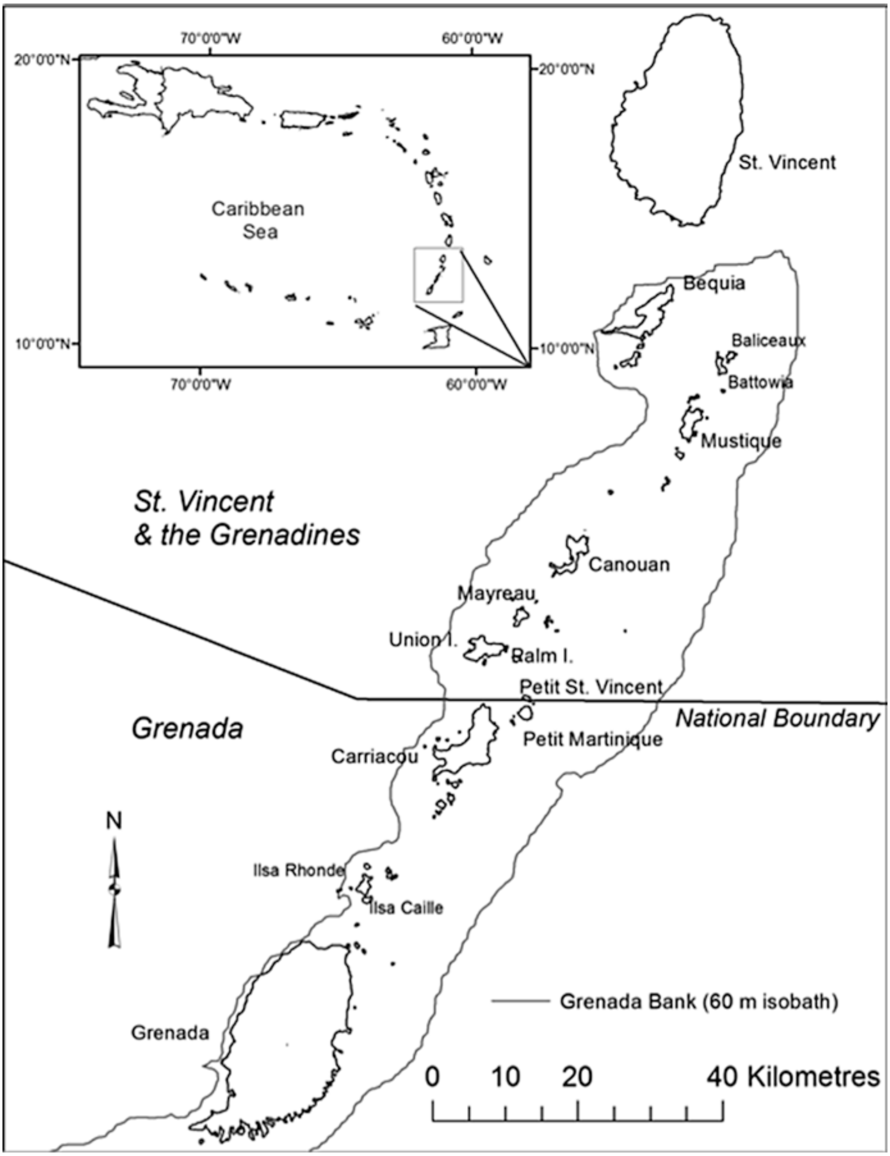



**Fig. 12.4** Grenadine Islands SocMon study area (Source: http://www.grenadinesmarsis.com)

Tourism is important to the economies of the Grenadine Islands but has come at a cost. Coastal ecosystem damage (reef and seagrass) has accompanied tourism development in the area, especially within the Tobago Cays Marine Park (TCMP) in the St. Vincent and the Grenadines. The main fisheries-tourism interaction in the Grenadines is the sale of catches, particularly lobster, to hotels, to restaurants, and directly to tourists. The market for fish is anticipated to increase in the future with increasing tourism arrivals (Gill et al. 2007).

#### 12.2.3.2 Assessment

This study involved a transboundary socioeconomic and livelihood assessment of fisheries in the Grenadines for integrated coastal management decision-making linked to two subregional initiatives—the Sustainable Grenadine Project (SusGren) and the Grenadines Marine Resource and Space-Use Information System (MarSIS).[2]

A series of rapid and in-depth surveys were conducted in Bequia, Mustique, Canouan, Mayreau, Union Island (St. Vincent and the Grenadines), and Petite Martinique and Carriacou (Grenada Grenadines), across 20 fishing villages. The rapid survey produced a basic fishers' demographic profile, including data on gear and resource use patterns. The in-depth survey developed a detailed fisheries socioeconomic profile, including temporal and spatial features of fishing practices, market orientation, revenue, expenditures, and material lifestyle. Eight key informant/secondary source indicators and nine survey indicators were measured (Table 12.1). Two new indicators were designed to assess the environmental impacts of fishing.

In the rapid survey, all persons in major fishing villages and markets were surveyed, which represented a saturated sample. Although not based on a statistically representative sample of all fishers in the Grenadines, results from the 267 fishers identified likely reflect key socioeconomic characteristics of the total population and were estimated to include 10–20% of all fishers. The in-depth survey reinterviewed 25–33% of the rapid survey respondents. New fishers encountered were not rejected. Most of the 64 fishers in the in-depth survey were interviewed during the rapid survey (Gill et al. 2007).

Key informants identified in the MarSIS project by Baldwin et al. (2006), who consisted primarily of fisheries officers, were consulted to validate the data. The data were compiled and analyzed in Microsoft Excel 2003 and Statistical Package for the Social Sciences (SPSS) version 11.7. Following data analysis, community meetings comprising mainly fishers were held in each island to validate key results (Gill et al. 2007).

[2] Formerly an 8-year initiative (2002–2010) of the University of the West Indies, Cave Hill Campus, Barbados, funded by the Lighthouse Foundation, Germany, SusGren was later transitioned into a trans-boundary Grenadine (St. Vincent and the Grenadines and Grenada) nongovernmental organization. The overall goal of SusGren Inc. is to promote the conservation of the coastal and marine environment while promoting and supporting sustainable livelihoods within communities of the Grenadine Islands. MarSIS is a participatory geographic information system (PGIS) created with a range of stakeholders to integrate social, economic, cultural, and biophysical resource information and policy to provide resource managers with an information base for coastal marine planning and management in the Grenadines (http://www.grenadinesmarsis.com/).

#### 12.2.3.3 Key Learning

The key learning provided in this section draws on research conducted by Gill et al. (2007). Strong historical fishing traditions have resulted in a high dependency on fishing in the Grenadines. There is a high dependence among older fishers; 64% of those who participated in the rapid survey and 70% from the in-depth survey were found to be solely dependent on fishing for income. Younger fishers have more diversified sources of income. Therefore, there is considerable vulnerability within Grenadine fisheries, since the average age of fishers is between 43 (rapid survey cohort) and 45 (in-depth cohort). Financial insecurity due to the lack of pension schemes for seniors as well as the lack of alternative options and age limitations further increases fishers' vulnerability. The establishment of pension schemes would protect the livelihoods of older fishers, many of whom fish until their health declines (Gill et al. 2007). The dependence on fishing for livelihoods varies by island. Fishers from islands with higher levels of reliance and fishing traditions are expected to be more heavily impacted by declining fisheries. Part-time fishers supplement their income with a range of secondary occupations including masonry, carpentry construction, agriculture, tourism, the public sector, as well as maritime trade.

Demersal fish are targeted by the majority of fishers, followed by lobsters and offshore pelagics. The two most popular fishing methods used to catch demersal species are handlining and spearfishing, which is done with or without scuba gear. These results confirm reports of overexploitation of demersals in the Grenadines. Fisheries managers, particularly in the Grenada Grenadines, have attempted to determine the suitability of sustainably harvesting less targeted species as well as exposing fishers to other types of fishing (such as longlining) that target under- or less exploited species; however, some fishers believe more effort should be applied to this effort, especially in the St. Vincent and the Grenadines.

Fishers in the Grenadines tend not to use safety equipment at sea. Many harvesters scuba dive without professional training and intentionally go beyond safe dive limits to increase their catch per dive. This practice results in many suffering from dive-related injuries. One fisher estimated that up to 30 fishers per year suffered decompression sickness and had to be airlifted to Barbados for treatment in the decompression chamber—a costly experience. The limited use of safety equipment could partly be due to high equipment costs that significantly reduce accessibility to safety gear for fishers who earn lower incomes. Proper safety training is required to equip fishers to better protect themselves and others.

Many fishers prefer to sell their catch to trading vessels for export because they are reputed to be the leading and most reliable buyers of fish. Therefore, trading vessels play a vital role in sustaining the livelihoods of fishers in the Grenadines. Exports to Martinique represent a large proportion of the sales of Grenadine fishers, representing a major income source. It is therefore crucial that the governments work to ensure that the infrastructure of markets is improved to meet European Union standards. Gill et al. (2007), however, caution that this could encourage more reliance on already overfished demersal stocks. Demand for less exploited (or popular) species could be created once relevant information on harvestable fish stocks and local, regional, and international marketing options is available.

Many fishers in the St. Vincent and the Grenadines believe the government is not concerned about the fishing industry. This perception is fueled by developments such as when fisheries complexes were built by the Japanese without consultation with fishers. Currently, these facilities are rarely used and are an economic burden for the sector. This waste of resources could have been avoided had management and planning been inclusive and transparent to fishers to ensure that the complexes were constructed in a way that met fishers' needs. It is critical that fisheries managers and decision-makers pay attention to the management of the fisheries sector, given its vital role in maintaining food security in the Grenadines.

### *12.2.4 Socioeconomic Monitoring of Small-Scale Fisheries in Southern Brazil*

#### 12.2.4.1 Overview

Growing attention has been paid to the role of marine protected areas (MPAs) as a means to foster fisheries co-management, especially in situations where previous co-management policies have failed, such as in Brazilian fisheries (Silva et al. 2013; Medeiros et al. 2013). In order to have a better connection between planning and management decisions, the Brazilian SocMon initiative adopted socioeconomic monitoring as a means to develop management tools as well as foster participatory planning and management in two MPAs in Southern Brazil (Table 12.2).

#### 12.2.4.2 Evolution of SocMon Brazil

The evolution of Brazil's experience with SocMon can be described in two phases. First, the methods described in the SocMon manual (Bunce et al. 2000) were incorporated into undergraduate teaching in oceanography course at the Federal University of Paraná (UFPR). Some of the results of these initial socioeconomic

**Table 12.2** SocMon Brazil case studies according to MPA characteristics

| | APA Anhatomirim | ESEC Guaraqueçaba |
|---|---|---|
| IUCN protected area category (Dudley 2008) | Environmental protected area—multiple use protected area (IUCN category V) | Ecological Station—no-take protected area (IUCN category Ia) |
| MPA management objectives | To protect resident population of estuarine dolphin *Sotalia guyanensis* and to promote sustainable use of aquatic living resources | To protect mangrove areas inside the estuarine complex of Paranaguá |
| Management body | Community-based fishing forums and MPA management board | Advisory technical body for fisheries management inside three different MPAs, including ESEC Guaraqueçaba |

**Table 12.3** SocMon Brazil case studies summaries

| MPA case study | APA Anhatomirim | ESEC Guaraqueçaba |
|---|---|---|
| Goal | To provide socioeconomic information on small-scale fisheries and bycatch dependence for fisheries management planning | To provide information to support the preparation of terms of commitment that will allow for the continuation of fishing livelihoods in traditional fishing villages affected by MPA restrictions |
| Objectives | To profile small-scale fisheries within the MPA to support management plan preparation (phase 1); to monitor the performance of fishing zone in management plan (phase 2) | To describe livelihoods related to mangrove and mangrove crab fishing; to monitor livelihood dynamics in fishing villages affected by restrictions to fishing |
| Methods | Participant observation, semi-structured interviews, surveys, timelines, seasonal calendars, demonstration fisheries | |
| SocMon team | Researchers, students, managers, extension agents, local government biologists | Researchers, students, managers |
| Findings | High socioeconomic dependency on bycatch. Woman participation is relevant and influences household dependency on bycatch and, consequently, discards rate. Willingness to adopt bycatch reduction strategies is affected by household characteristics, fleet size, and fish chain dynamics | High dependency on fishing for food and revenue. Women play a crucial role in all fish chain, including capture. Crab fishing is the main source of income. Most of fishing grounds are within no-take MPA |
| Partners | Brazilian MPA management agency (ICMBIO), local government, the Federal University of Paraná (UFPR) | Brazilian MPA management agency (ICMBIO), universities |

assessments were provided to fisheries management personnel of both MPAs. The second phase was the official launch of the SocMon Brazil node. During the latter part of 2013, a group of academics from the Transformar Network proposed the application of the SocMon approach for monitoring the performance of MPA management in Brazil.[3]

Assessments occurred with support from the *Instituto Chico Mendes de Conservação da Biodiversidade* (ICMBio), the national agency from the Ministry of Environment (MoE) and the authority for the management of national protected areas and of biodiversity conservation in Brazil. A SocMon workshop was held in March 2015 and included 32 participants from ICMBio (ranging from directors to MPA managers) and students from the participating universities. Following the workshop, two pilot sites were chosen as an opportunity for collective learning and sharing main lessons (Table 12.3), in order to expand to other sites. Those pilot sites (Fig. 12.5) would also provide outputs, such as guidelines to implementing management tools, for those trainees through SocMon within Brazilian MPAs under federal government authority.

[3] The Transformar Network is comprised of a group of researchers and students from four Brazilian universities: UNICAMP, UFSC, FURG, and UFPR.

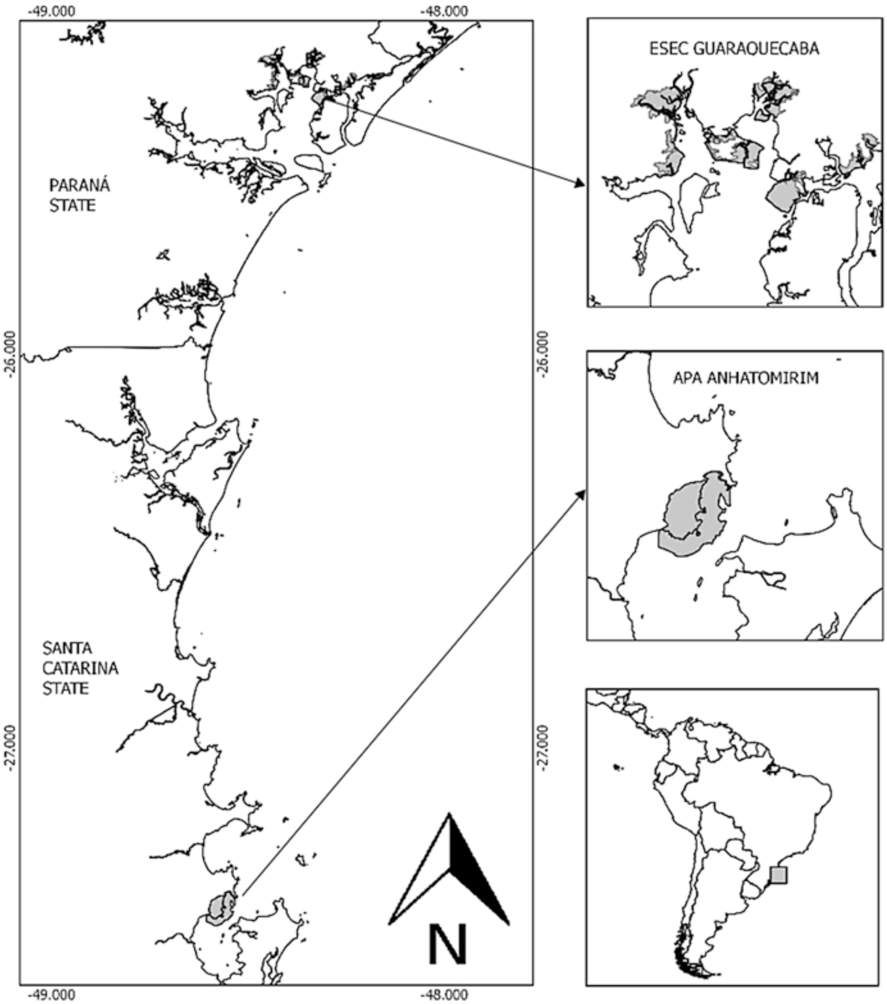



**Fig. 12.5** Location of SocMon Brazil case studies

#### 12.2.4.3 Assessment

**Anhatomirim** The environmental protected area (APA) of Anhatomirim was created primarily for biodiversity conservation without clearly addressing the issue of fishing livelihoods (Floriani 2005). This area is one of the main small-scale trawling regions in Southern Brazil, in terms of the number of fishers and fishing grounds, as well as the number of households dependent on trawling for food and income (Guanais et al. 2015) and number of conflicts (Steenbock et al. 2015). The first iteration of SocMon collected information on the type of fisheries, number of boats and fishing gears, target catch and bycatch, fishing strategies, participation of women in fisheries, households' sources of income, information on the fish chain, and ethno-ecology. In a second cycle, SocMon aimed to understand the socioeconomic impacts of changing fishing gears by using bycatch reduction devices (BRDs), with the planned adoption of newly developed fishing regulation within MPA borders. The APA management plan is the first in Brazil to use bycatch reduction as a fisheries management tool and as a principle for promoting sustainability in a MPA.

**Guaraqueçaba** The Ecological Station (ESEC) of Guaraqueçaba is one of the three overlapping MPAs under the purview of the national authority that governs the estuarine area of Paranaguá (Faraco 2012). SocMon was designed to survey household dependency on mangroves inside ESEC. The focus was mainly on villages where crab fishers and gatherers live. The survey was used to collect information such as the seasonality of mangrove crab fishing and ethno-ecology, household demographic information (number of fishers, participation of women, sources of income), dependency on fishing for food security, mangrove areas used as fishing grounds, and similar indicators. The information would provide background to develop terms of commitment—an agreement between the resource user and MPA management agency that provides guarantees for people to maintain their traditional livelihoods. Determining which communities to survey, specific indicators, and assessment objectives to be used was decided based on input from fishing management bodies. Scientists and oceanographers, with support from ICMBio managers and local fishing leaders, mainly conducted the surveys. Results and outputs were shared within management bodies and through community workshops to determine follow-up for management, research, and monitoring.

#### 12.2.4.4 Key Findings

Survey results revealed that there are 169 boats operating within the limits of APA Anhatomirim. Of these, 32% were trawlers, and 68% were fish and shrimp gillnetters (Guanais et al. 2015). Among the trawlers, about 73% of fishers' households have women participating in the fishing chain, mainly by processing the catch (shrimp and by-products). Trawlers vary in spatial range and target species during harvest seasons, ranging to small- and medium-sized trawlers. Bycatch is divided into unwanted or discarded bycatch (mainly juvenile fishes, invertebrates, and noncommercial adult fishes) and by-product (juvenile and adult target species—including several sciaenid fishes, squid, and blue crabs). Small trawlers tend to use part of this by-product as a food source for the crew, in contrast to medium-sized trawlers that tend to sell the by-product after processing. When asked about the relevance of bycatch reduction strategies, fishers' opinions were mostly positive, with 57% indicating it would be relevant, while more than a quarter were indecisive ("it depends"). Fisher respondents from the small-sized fleets indicated that it would be worth reducing bycatch, whereas fishers from the medium-sized fleet were more cautious, with 50% stating "it depends" due to various factors such as the season and which portion of the bycatch would be reduced (Vessaz 2014).

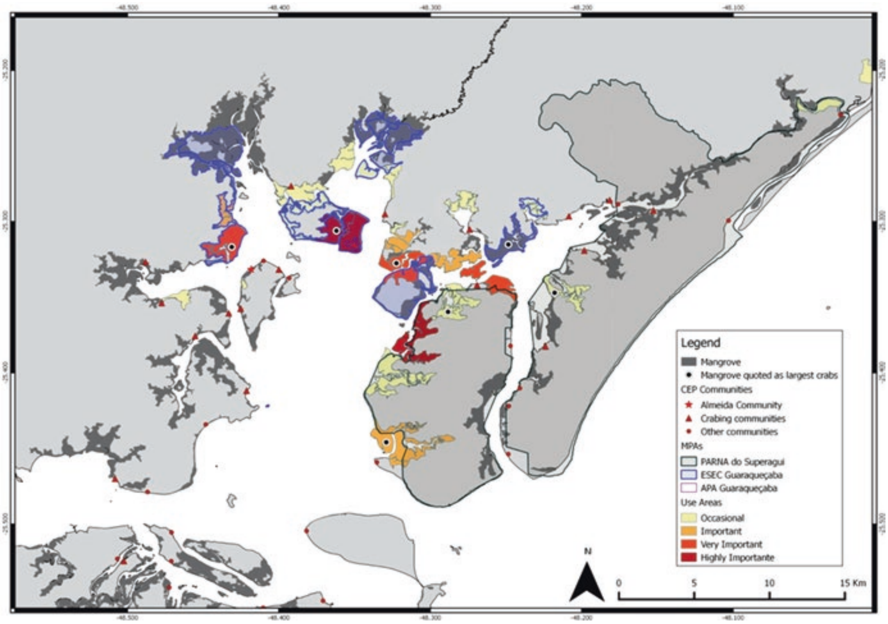



**Fig. 12.6** MPA boundaries and fishing grounds according to their relevance to crab fishing (Created by Gabriela Silva de Paula, based on number of citations by interviewed fishers)

A survey of the mangrove crab fishery was conducted in 4 of the 11 fishing communities dependent on crabbing at Paranaguá Bay. Most of them are islands and isolated fishing communities. This creates a higher dependence on fishing for food and income. More than 80% of households are dependent on fishing as the main source of income. Secondary activities are rarely present and often consist of fishing-related services such as boat and gear construction and repair and fish marketing. Fishing households rely mainly on mangrove-related resources such as mangrove crab, mangrove oyster, blue crab, and mussel, which are caught using low-cost fishing gear. Otherwise, 82% of the fishing grounds are mangroves located within no-take MPAs (Fig. 12.6) including ESEC Guaraqueçaba. Women in this area have high engagement in capture fisheries, either alone or with their husbands and sons. They go fishing, process the catch, and/or are engaged in the manufacture of handcrafted traps.

### *12.2.5 Selected Socioeconomic Indicators*

The case studies presented here highlight the kinds of selected socioeconomic indicators (Table 12.4) which were used at each site to provide readers with an overview of the information that can be collected using SocMon and the key learning that can be gained from the inclusion of this information in monitoring programs.

**Table 12.4** Socioeconomic indicators selected for Brazilian and Caribbean case studies

| Indicator | NMP | TGI | APA | ESEC |
|---|---|---|---|---|
| ***Community-level demographics*** | | | | |
| Study area (K1) | | x | x | |
| Population (K2) | | x | x | x |
| Number of households(K3) | | | | x |
| ***Coastal and marine activities*** | | | | |
| Coastal and marine activities (K14) | | x | | |
| Goods and services (K15) | | x | | |
| Types of use (K16) | | x | | |
| Value of goods and services (K17) | | x | | |
| Goods and services market orientation (K18) | | x | x | x |
| Use patterns (K19) | | x | x | |
| Levels and types of impact (k20) | | | x | x |
| Levels of use by outsiders (K21) | | | x | |
| Stakeholders (K23) | | | x | |
| ***Household demographics*** | | | | |
| Age (S1) | x | x | | x |
| Gender (S2) | x | x | | x |
| Ethnicity (S3) | | x | | |
| Education (S4) | x | x | x | |
| Religion (S5) | x | x | | |
| Occupation (S7) | x | x | x | x |
| Household size (S8) | x | | | x |
| Household income (S9) | x | x | | x |
| ***Household coastal and marine activities*** | | | | |
| Household activities (S10) | x | x | | x |
| Household goods and services (S11) | x | | x | x |
| Household uses (S14) | x | | x | |
| ***Attitudes and perceptions*** | | | | |
| Nonmarket and nonuse values (S15) | x | | | |
| Perceptions of resource conditions (S16) | x | | x | x |
| Perceived threats (S17) | x | | | x |
| Awareness of rules and regulations (S18) | | | | x |
| Participation in decision-making (S21) | x | | | |
| Membership in stakeholder organizations (S22) | x | | | |
| Perceived coastal management problems (S23) and solutions (S24) | | | x | x |
| Successes in coastal management (S26) | x | | | |
| Source of and access to credit (K17)[a] | | | | x |
| ***New indicators*** | | | | |
| Boat painting and engine servicing (*New*) | | x | | |
| Boat cleaning (*New*) | | x | | |

*NMP* Negril Marine Park, *TGI* the Grenadine Islands, *APA* environmental protected area of Anhatomirim, *ESEC* Guaraqueçaba Ecological Station. All indicators are based on Bunce and Pomeroy (2003b, Page 17); [a]indicator based on Malleret-King et al. (2006)

The socioeconomic indicators presented below represent a sample of the suite available in the Regional SocMon Caribbean Guidelines for monitoring (Bunce and Pomeroy 2003b). Indicator nomenclature includes a letter, "K" or "S," preceding a number. The letter represents the means of data collection most appropriate for the indicator—key informant or secondary data sources and surveys. The findings from the information from these indicators are discussed below.

## 12.3 Discussion

The cases examined here demonstrate the potential of SocMon for monitoring socioeconomic characteristics and conditions of small-scale fisheries that are crucial to fisheries management and governance. Although each case study highlights only select socioeconomic information at each site, it should be apparent that applying SocMon to small-scale fisheries can provide fisheries and coastal managers with a better understanding of the contribution of small-scale fisheries to food security, sustainable and alternative livelihoods, poverty alleviation, local culture and tradition, and other dimensions of sustainable development. SocMon information has the potential to assist fisheries managers in identifying coastal fishing areas and fisheries that may be stressed or at risk of overexploitation. In addition, the methodology aids in recognizing fishers' vulnerability to natural and anthropogenic shocks and guiding and informing adaptation to impacts and shocks for building more resilient small-scale fisheries-based communities. SocMon can inform the planning and design of appropriate fisheries conservation and management strategies that also sustain fisheries livelihoods.

The case studies highlight the varying geographical scale of applicability from local to subregional fisheries, the intentional participatory and collaborative design of the research for support with buy-in from diverse stakeholders, and the potential for SocMon to build and/or improve the capacity of both key institutions such as fisheries and MPA management authorities and community actors such as NGOs, community-based organizations (CBOs), and individual resource users in support of socioeconomic monitoring. Across all study sites, there is a high dependence on fishing for food security and income. Fisheries are primarily dominated by older males in the Caribbean, whereas in Brazil there is high participation by females in activities ranging from harvest to postharvest. Limited options exist for the pursuit of secondary occupations or alternative livelihoods, especially given the age of fishers, due to a number of factors, and, in some cases, the isolation of communities. In these areas, fishing is a family tradition and part of local culture. Fish catches have declined due to habitat degradation by both anthropogenic and natural causes. Fishers need to be encouraged to participate in resource management and stewardship for the sustainability of their livelihoods and protection of the resources on which they depend.

There has been varied use of the socioeconomic information collected at each of the study areas. Although utilization has been limited in the Caribbean, socioeconomic data have been referenced in Jamaica in the updated draft Negril Marine Park plan 2015–2020 (NEPA 2015) and the interim Negril Marine Park Zoning Plan 2013–2018 (NEPA 2012). SocMon was subsequently utilized by one management agency to collect additional data to inform the NMP zoning plan revision. In the Grenadines, the socioeconomic fisheries profile information is accessible to stakeholders (government, NGOs, and researchers) and has informed transboundary marine spatial planning (Baldwin et al. 2006).

In Brazil, the participatory approach and collaborative design of research and information were crucial. Fishers agreed to be part of the knowledge generation process. In addition, many stakeholders agreed to pursue a better connection between research and decision-making. In the past, resistance to research and university or NGO project implementation has tended to be high at the SocMon pilot sites. However, the SocMon approach was observed to encourage a more collaborative perspective on research and decision-making. The focus on socioeconomic information and resource users' perceptions highlighted the importance of the human dimensions of MPA management (Charles and Wilson 2009). Information exchange and negotiation with fishers contributed to a redesign of marine zoning within the management plan for APA Anhatomirim (Guanais et al. 2015). Also, fishers have gradually become open-minded to the adoption of bycatch reduction strategies (Vessaz 2014; Medeiros et al. 2015), since SocMon was the main approach undertaken as part of the management actions. Based on the spatial dynamics of mangrove uses, ICMBio managers are reevaluating which communities should be considered to have the right to "terms of commitment." Before SocMon, only villages inside MPA boundaries were considered to benefit from the mangroves. Most importantly, serious consideration is being given to using SocMon for building a national program for monitoring the performance of MPA governance. The two pilot sites will serve as first experiences in the plan to expand the monitoring grid, with additional SocMon sites coming in the near future, covering samples from Brazilian marine ecosystem and institutional diversity.

Implementing SocMon in the Caribbean is not without its challenges. Initiating SocMon is relatively easy, but sustained monitoring has proven to be difficult (Pena and McConney 2014). These challenges are partly due to (1) lack of sustainable financing mechanisms for monitoring activities resulting in the ad hoc implementation of SocMon only when project funding opportunities are available; (2) missing or inadequate links in the information management chain between data and decision-making, possibly due to the lack of implementation of various management plans (e.g., for fisheries or MPAs) that would guide data use; and (3) lack of fully functional integratedcoastal management decision-making mechanisms for determining how socioeconomic information will be used in coastal management at the local, national, and regional levels in the Caribbean. MPA management authorities and fisheries divisions within the region exhibit high staff turnover rates due in most cases to poor remuneration. As a result, regional SocMon capacity is impacted by these personnel changes since these agencies are primary partners in SocMon projects and research.

For Brazil, the main challenge is also to ensure sustained monitoring. Based on the success of the pilot sites, the SocMon Brazil team will be able to follow up with similar assessments in other MPAs. A continued process of capacity development is required, especially with regard to participatory methods and facilitation skills. Although data analysis and application to decision-making are not perceived as challenges yet, they may soon become challenges in the future. In this case, the challenge will depend on the ability of the SocMon team and ICMBio managers to collaborate and clearly address preliminary findings for inclusion into decision-making. Despite enormous and surprising support from ICMBio national coordination (Ministry of Environment), potential tendencies of instability of national government regarding support for these initiatives demand a certain level of independence for SocMon monitoring sites. Empowering management boards and resource users to develop a sense of ownership of the information generated by SocMon is also a great challenge that, if successful, can lead to a stronger co-management process and improved ecosystem stewardship (Medeiros et al. 2014).

The continued success of the SocMon approach will be dependent on the ability to demonstrate the effectiveness of social science information in natural resource management. Integrated research and monitoring may provide information that can inform decision-making, adapt management to contemporary challenges, and improve the governance of small-scale fisheries, resulting in the improved well-being of fisheries-dependent communities globally.

## 12.4 Conclusion

Initiatives such as the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) recognize the contribution small-scale fisheries make to poverty alleviation and food security worldwide. However, limited reliable and comprehensive statistics for these SES contribute to failures in management and policy-making directed at preventing overexploitation, stock decline, rural food insecurity, and poverty (FAO 2014). Schemes for participatory monitoring and evaluation utilizing SocMon and similar approaches can promote social and institutional learning aimed at expanding socioeconomic data collection and increasing adaptive capacity within fisheries systems. SocMon can increase institutional learning and management performance when better integration is developed with the management process, such as the MPA management timeframe and workplan. The Brazilian experience shows that when it is included in management, SocMon could be a source for institution building, stakeholder engagement, and more robust management overall. It can also reveal the institutional and communication gaps and other challenges that need to be addressed to improve management. The democratization of the knowledge generated through SocMon, in which learning was not limited to researchers and NGOs, but extended to fisherfolk, managers, and other diverse stakeholders, is a compelling example of the potential of this approach. Due to the adaptability of the SocMon methodology to each site's needs, there are few limitations of the approach in small-scale fisheries site assessment or monitoring goals and objectives. Based on the suite of tools the SocMon methodology utilizes as well as our experience with implementing the methodology globally, we highly recommend this participatory approach for monitoring the socioeconomic characteristics of small-scale fisheries in order to inform and adapt management, increase adaptive capacity and resilience, and reduce vulnerabilities to certain shocks and impacts.

## References

Baldwin K, Gill D, Cooke A, Staskiewicz T, Lizama D, Mahon R, McConney P, Oxenford HA (2006) A socio-economic and space-use profile of Grenadine marine resource users. Centre for Resource Management and Environmental Studies, University of the West Indies, Cave Hill

Barbados Fisheries Division (2004) Barbados fisheries management plan 2004–2006. Schemes for the management of fisheries in the waters of Barbados. Barbados Ministry of Agriculture and Rural Development, Bridgetown

Berkes F, Mahon R, McConney P, Pollnac R, Pomeroy R (2001) Managing small-scale fisheries: alternative directions and methods. International Development Research Centre, Ottawa

Blackman K (2005) Information for the Negril Marine Park's fisheries management plan. Unpublished MSc research paper, Centre for Resource and Environmental Studies, University of the West Indies, Cave Hill Campus, Barbados

Bunce L, Pomeroy B (2003a) Socio-economic monitoring guidelines for coastal managers in the Caribbean: SocMon Caribbean. World Commission on Protected Areas and Australian Institute of Marine Science, Townsville

Bunce L, Pomeroy B (2003b) Socio-economic monitoring guidelines for coastal managers in Southeast Asia: SocMon SEA. World Commission on Protected Areas and Australian Institute of Marine Science, Townsville

Bunce L, Townsley P, Pomeroy R, Pollnac R (2000) Socioeconomic manual for coral reef management. Australian Institute of Marine Science, Townsville

CARICOM Fisheries Resource Assessment Management Program (2000) Jamaica national marine fisheries atlas (Caribbean fishery report no 4), 53p

Charles AT, Wilson L (2009) Human dimensions of marine protected areas. ICES J Mar Sci 66:6–15

Chuenpagdee R (2011) A matter of scale: prospects in small-scale fisheries. In: Chuenpagdee R (ed) World small-scale fisheries contemporary visions. Eburon Academic Publishers, Delft, pp 21–36

Cooke AL, Mahon R, McConney P (2007) A livelihoods analysis of the water taxi operators in the Grenadines. CERMES technical report no. 9. CERMES, Cave Hill

Dudley R, Nurhidayali T, Pameungkas H, Cahyo TN (2000) Segara Anakan fisheries management plan (Segara Anakan Conservation and Development Project Components B & C, Consultant's Report). https://www.researchgate.net/publication/242305023_Segara_Anakan_Conservation_and_Development_Project_Components_B_C_Consultant%27s_Report_Segara_Anakan_Fisheries_Management_Plan. Accessed 24 Apr 2017

Dudley N (ed) (2008) Guidlines for applying protected area management categories. IUCN, Gland. x + 86pp

Edwards P (2014) Global socioeconomic monitoring initiative for coastal management (SocMon/SEM-Pasifika) Strategic Plan: 2015–2019. NOAA Coral Reef Conservation Program, Washington, DC

English S, Wilkinson C, Baker V (1997) Survey manual for tropical marine resources Townsville, Australia. Australian Institute of Marine Science, Townsville

Espeut P, Grant S (1990) An economic and social analysis of small-scale fisheries in Jamaica. Institute of Social and Economic Research (ISER), UWI, Mona, Kingston

FAO (2014) The state of world fisheries and aquaculture 2014. Rome. FAO, Rome

FAO (Food and Agricultural Organization of the United Nations) (1997) FAO technical guidelines for responsible fisheries, no. 4: fisheries management. FAO, Rome

FAO, World Fish Center (2008) Small-scale capture fisheries – a global overview with emphasis on developing countries. A preliminary report of the big numbers project. World Bank, Washington, DC

Faraco LFD (2012) Vulnerabilidade de pescadores paranaenses às mudanças climáticas e os fatores que influenciam suas estratégias de adaptação. In: Andriguetto-Filho JM, Teixeira CaF, da Cunha Lana P (eds) Universidade Federal do Paraná. Programa de Pós-Graduação em Meio Ambiente e Desenvolvimento

Floriani D (2005) Situação atual e perspectivas da Área de Proteção Ambiental do Anhatomirim. Universidade Federal de Santa Catarina. Programa de Pós-Graduação em Geografia

Francis SKY (2002) An assessment of the impacts of two successfully implemented marine protected areas on the livelihoods of stakeholders in Jamaica and the Turks and Caicos Islands. Master's thesis, University of the West Indies, Barbados

Garaway C, Esteban N (2002) The impact of marine protected areas on poorer communities living in and around them: Institutional opportunities and constraints. Appendix 5- Case study of Negril Marine Park, Jamaica. MRAG Ltd, London

Geoghegan T, Smith AH, Thacker K (2001) Characterization of Caribbean marine protected areas: An analysis of ecological, organisational, and socio-economic factors, CANARI technical report N°. 287. CANARI, Leventille

Gill D, McConney P, Mahon R (2007) A socio-economic profile of fisheries in the Grenadine Islands, CERMES technical report no. 11. CERMES, Cave Hill

Goreau T, Brown J, Gordon E, Gordon G, Guthrie V, Ruddock N, Evans R, Thacker K (1995) Negril & Green Island area environmental protection plan. Negril Environment Protection Trust (NEPT), Negril

Guanais JHDG, Medeiros RP, McConney PA (2015) Designing a framework for addressing bycatch problems in Brazilian small-scale trawl fisheries. Mar Policy 51:111–118

Hoon V, Sriskanthan G, Townsley P, Cattermoul B, Bunce L, Pomeroy R (2008) Socio-economic monitoring guidelines for coastal managers of South Asia, SocMon South Asia. IUCN/CORDIO, Bangkok

Jackson JBC, Donovan MK, Cramer KL, Lam VV (eds) (2014) Status and trends of Caribbean coral reefs: 1970–2012. IUCN Global Coral Reef Monitoring Network, Gland

Mahon R (1990) Fisheries management options for the Lesser Antilles countries, Food and Agriculture Organization (FAO) fisheries technical paper 313. FAO, Rome

Mahon R, McConney P (2011) The national fisheries department and small-scale fisheries management: 'fit for purpose?'. In: Chuenpagdee R (ed) World small-scale fisheries contemporary visions. Eburon, Delft, pp 261–271

Mahon R, Almerigi S, McConney P, Ryan C, Whyte B (2004) Coastal resources and livelihoods in the Grenadine Islands: facilitating change in self-organising systems. Proc Gulf and Caribbean Fish Inst 55:56–67

Malleret-King D, Glass A, Wanyonyi I, Bunce L, Pomeroy B (2006) Socio-economic monitoring guidelines for coastal managers of the western Indian Ocean, SocMon WIO. Mombasa, Kenya, CORDIO East Africa Publication (Version 1)

Medeiros RP, Guanais JHDG, de O, Santos L, Spach HL, Silva CNS, Foppa CC, Cattani AP, Rainho AP (2013) Estratégias para a redução da fauna acompanhante na frota artesanal de arrasto do camarão sete-barbas: perspectivas para a gestão pesqueira. Bol Inst Pesca 39:339–358

Medeiros RP, Serafini TZ, McConney PA (2014) Enhancing ecosystem stewardship in small-scale fisheries: prospects for Latin America and the Caribbean. Desenvolvimento e Meio Ambiente 32:181–190

Medeiros RP, McConney PA, Foppa CC, Faraco LFD (2015) Fishers and their knowledge in Brazil: from extractive uses to collaborative exchanges. In: Fischer J, Jorgensen J, Josupeit H, Kalikoski DC, Lucas C (eds) Fishers' knowledge and the ecosystem approach to fisheries: applications, experiences and lessons in Latin American, FAO Fisheries and Aquaculture Technical Paper N° 591. FAO, Rome, pp 191–208

Mohammed E, Lindop A (2015) Grenada: reconstructed fisheries catches, 1950–2010 (Working paper #2015–40). The University of British Columbia Fisheries Centre, Vancouver

Mohammed E, Straker L, Jardine C (2003) St. Vincent and the Grenadines: reconstructed fisheries catch and fisheries effort, 1942–2001. Fish Centre Res Rep 11(6):95–116

NCRPS (Negril Coral Reef Preservation Society) (2003) Business plan Negril Marine Park. NCRPS, Negril

NEPA (2015) Draft Negril Marine Park (NMP) management plan 2015–2020. NEPA, Kingston

NEPA (National Environment and Planning Agency) (2012) Interim Negril Marine Park Zoning Plan 2013–2018. NEPA, Kingston

NEPT, NRCA, & NGIALPA (Negril Environment Protection Trust, Natural Resources Conservation Authority & Negril-Green Island Area Local Planning Authority) (1997) Negril environmental protection plan. Update November 1997. USAID, Kingston

O'Sullivan CH (2002) A preliminary assessment of the ecological impacts of two marine protected areas in the wider Caribbean. Master's thesis, University of the West Indies, Barbados

Otuokon S (1997) Negril Marine Park management plan. Negril Coral Reef Preservation Society, Negril

Pena M, McConney P (2014) Socio-economic monitoring for coastal management (SocMon): application of participatory monitoring tool to small-scale fisheries. In: McConney P, Medeiros R, Pena M (eds) Enhancing stewardship in small-scale fisheries: practices and perspectives. CERMES, Cave Hill, pp 49–56

Pena M, Blackman K, Hanson C, McConney P, Miller M (2007) Socio-economic information for managing fisheries in the Negril Marine Park. Proc Gulf and Caribbean Fish Inst 58:329–336

Schrading E, O'Connell T, Michels S, Perra P (1998) Fishery management plan for the horseshoe crab (Fishery management report of the Atlantic states Marine Fisheries Commission)

Silva CNS, Broadhurst MK, Medeiros RP, Guanais JHDG (2013) Resolving environmental issues in the southern Brazilian artisanal penaeid-trawl fishery through adaptive co-management. Mar Policy 42:133–141

SocMon (n.d.) http://www.socmon.org/. Accessed 21 Apr 2017

Staskiewicz T, Mahon R (2007) A livelihoods analyses of fishers in the Grenadine Islands, CERMES technical report no. 12. CERMES, Cave Hill

Steenbock W, Aguiar Dos Santos R, Schulz Macedo H, Gracindo De Almeida E, Cesar Da Silva M, Pereira Medeiros R, Pinto Vizuete E (2015) Até onde posso arrastar? – construindo acordos sobre os limites da pesca artesanal de arrasto na Baía Norte de Florianópolis frente à legislação ambiental [Till where can we trawl? – Building agreements on the limits of traditional trawling of Florianopolis' North Bay front of environmental legislation]. Revista CEPSUL – Biodiversidade e Conservação Marinha 4(1): 29–45

Thacker K, Hanson C (2003) Negril Marine Park Management Plan. Negril Coral Reef Preservation Society

Vessaz F (2014) In: Medeiros RP (ed) Human dimensions of bycatch in small-scale shrimp trawl fisheries: implications for bycatch reduction devices in Southern Brazil. EMBC/UFPR, Ghent/Pontal do Paraná

Waite RE, Cooper NZ, Burke L (2011) Coastal capital: Jamaica. The economic value of Jamaica's coral reef-related fisheries (Working Paper). World Resources Institute and The Nature Conservancy, Washington, DC

Wongbusarakum S, Loper C (2011) Indicators to assess community-level social vulnerability to climate change: an addendum to SocMon and SEM-Pasifika regional socioeconomic monitoring guidelines. The Nature Conservancy and the NOAA Coral Reef Conservation Program, Washington, DC

Wongbusarakum S, Pomeroy R (2008) Socio-economic monitoring guidelines for coastal managers in Pacific island countries. SEM-Pasifika, Apia

Wood J, Baldwin K, Pena M, McConney P (2013) Incorporating GIS into socioeconomic monitoring for coastal managers (SocMon). In: McConney P, Medeiros R, Pena M (eds) Enhancing stewardship in small-scale fisheries: practices and perspectives. CERMES, Cave Hill, pp 57–64

**Peter Edwards** is a Natural Resource Economist and Social Science Coordinator for the National Oceanic and Atmospheric Administration (NOAA)'s Coral Reef Conservation Program (CRCP), based in Silver Spring, Maryland, USA. He is responsible for implementing various socioeconomic research and long-term monitoring efforts for NOAA's Coral Reef Conservation Program. He also serves as the coordinator for the Global Socioeconomic Monitoring Initiative (SocMon), where he provides technical support to various international partners involved in small-scale localized socioeconomic data collection in coastal areas. He is also engaged in research on incorporating the economic values of coral reefs and their associated ecosystem services.

**Maria Pena** is a Project Assistant and Researcher in the Centre for Resource Management and Environmental Studies (CERMES) at the University of the West Indies, Cave Hill campus in Barbados. Her research interests are on the biological and socioeconomic aspects of marine resource management. She currently serves as the Regional Coordinator for the Global Socioeconomic Monitoring Initiative (SocMon) for the Caribbean. Her activities with the Global SocMon initiative include managing externally funded socioeconomic monitoring projects in the region, conducting numerous trainings in support of these projects, and promoting the use of the socioeconomic monitoring approach in the region.

**Rodrigo Pereira Medeiros** is an Adjunct Professor in the Center for Marine Studies (CEM) at the Federal University of Paraná in the city of Pontal do Paraná, State of Paraná, Brazil. His research interests include participatory monitoring, small-scale fisheries socioeconomics, and ecosystem approaches to fisheries and marine protected areas management in South Brazil.

**Patrick McConney** is a Senior Lecturer in the Centre for Resource Management and Environmental Studies (CERMES) at the University of the West Indies Cave Hill Campus in Barbados. His applied research includes resilience, socioeconomics, and governance related to small-scale fisheries and marine protected areas in the Caribbean.

# Chapter 13
# Values Associated with Reef-Related Fishing in the Caribbean: A Comparative Study of St. Kitts and Nevis, Honduras and Barbados

**David A. Gill, Hazel A. Oxenford, and Peter W. Schuhmann**

**Abstract** A critical component of any fishery is its economic viability, and understanding the underlying socioeconomic factors that affect fishing activity and profitability allows for more informed management. Nevertheless, data on small-scale fisheries in the Caribbean are limited, potentially inhibiting informed and appropriately scaled policy implementation. In an attempt to better understand the economics of reef-associated fisheries across the Caribbean, interviews were conducted with over 182 commercial reef fishers in three types of communities (heavily dependent on reef fishing, on reef tourism and on both) in each of three contrasting countries (St. Kitts and Nevis, Honduras and Barbados). For each of the nine study sites, estimated annual net revenues from reef-associated fishing ranged from US PPP$0.03–0.95 million. Reef fishing was most profitable in St. Kitts and Nevis, where fishers have access to productive lobster and conch fishing grounds and an export market. In the Bay Islands (Honduras), most reef-related revenues were derived from snapper and grouper fisheries (for export), whereas in Barbados, where these high-value species (conch, lobster, snapper and grouper) are rare, revenues were comparably low. The reef fishery also represented an important social safety net across all communities, providing employment and a potentially critical source

D. A. Gill (✉)
Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies, Cave Hill Campus, Wanstead, Barbados

Present Address: The Betty and Gordon Moore Center for Science and Oceans, George Moore University/Conservation International, Arlington, VA, USA

H. A. Oxenford
Centre for Resource Management and Environmental Studies (CERMES), UWI Cave Hill Campus, Wanstead, Barbados
e-mail: hazel.oxenford@cavehill.uwi.edu

P. W. Schuhmann
Department of Economics and Finance, University of North Carolina Wilmington, Wilmington, NC, USA
e-mail: schuhmannp@uncw.edu



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_13

of protein to many low-income persons. These results demonstrate the current socioeconomic benefits of reef-associated fishing to coastal communities as well as the diversity of economic values among Caribbean sites. This site diversity highlights the need for fisheries policy and management to be guided by site-specific information rather than generalized assumptions about the industry.

**Keywords** Economic valuation · Small-scale fisheries · Caribbean · Coral reefs · Coastal communities

## 13.1 Introduction

Since pre-Columbian times, reef fishes have supported coastal communities in the Caribbean, especially on smaller islands with few other food sources (Wing and Wing 2001). In the Wider Caribbean Region today, small-scale reef fisheries continue to support livelihoods and food security in many coastal communities by providing employment opportunities where few alternatives exist, supplemental income for those with seasonal employment and a local supply of protein (Mumby et al. 2014). In 2010, artisanal and subsistence fishing were estimated to account for almost 80% of the 467 metric tons of fish landed within the Wider Caribbean, which had a landed value of US$828 million (Sea Around Us 2015). These small-scale fisheries also likely contributed almost all of the 151 metric tons of reef-associated catch landings (i.e. reef fish, spiny lobster and conch) in that same year.

A significant threat to the future value of reef-associated fisheries in the Caribbean is the dramatic decline in coral reef health over the last three decades, as indicated by declines in live coral cover (Bruno et al. 2009), as well as reef fish populations (Paddack et al. 2009). In addition to drivers such as land-based sources of pollution (Fabricius 2005), climate change (Hoegh-Guldberg et al. 2007; Oxenford and Monnereau 2017) and marine invasive species (Green et al. 2012), *coral reef decline* has also been driven by decades of fishing overexploitation (Jackson et al. 2014), which has dramatically reduced fish stocks and compromised overall reef ecosystem health (Mumby et al. 2006). These factors are likely to have contributed to the 20% decline in landings of reef-related catch between 2000 and 2010 in the Caribbean (Sea Around Us 2015) and highlight a definitive need to improve fisheries management in the region to stem these negative trends.

The continuing decline of Caribbean reef fisheries will likely have considerable impacts on livelihoods and food security in coastal communities (Burke et al. 2011; Monnereau and Oxenford 2017). In addition, the national economies of Caribbean nations could also be affected by lost foreign exchange from declines in export-driven fisheries (Box and Canty 2010) and the need to import fish to supplement local food resources.

### *13.1.1 Need for Information to Inform Management*

Despite their importance for fisheries policy and management, data on small-scale fisheries in the Caribbean are limited (Salas et al. 2007; Dunn et al. 2010). Although regional and national fisheries statistics in reports by the Food and Agriculture Organization (FAO) and other agencies have applications for management, the small-scale fisheries data generally exist in aggregated form. National-level, grouped landings data provide little information about local fishing activity which can vary greatly between communities and fisheries within a given country, leaving a significant knowledge gap for local-area reef and fishery management (Berkes et al. 2001; Heileman 2011).

### *13.1.2 Importance of Local-Scale Socioeconomic Data*

Critical components of any fishery are its socioecological sustainability and economic viability, and understanding the underlying factors that affect fishing activity and profitability at multiple scales can allow for more informed management (Agar et al. 2008). Communities in the Caribbean are highly diverse (CARSEA 2007), suggesting that an in-depth economic analysis of Caribbean reef fisheries at multiple sites can improve our understanding of not only the values that reef fishing represents in Caribbean communities but also how these values vary by community type. Data on individual- and community-level variations can provide resource managers with context-specific information on local exploitation rates and economic activity which are essential for implementing effective policy at the appropriate scale.

Various studies have utilized both primary and secondary data sources to gather estimates of the cost and revenues associated with Caribbean reef fisheries at the scale of individual fishers (e.g. Agar et al. 2005; Hargreaves-Allen 2010) or the fishery or country (e.g. Chávez 2008; Wielgus et al. 2010). Nonetheless, the economic contributions of reef fishing to local communities and the reasons why these contributions vary between communities remain largely unknown.

## 13.2 Study Objectives

In this study, we investigated the value of reef-associated fishing within nine coastal communities across the Caribbean to illustrate the diversity of reef-associated fishing values across the region and explore some of the main drivers of fishing activity and profitability at each site. Within each case study community, we describe the socioeconomic characteristics of the reef fishers and fisheries, estimate the current economic (market) value and determine how site and fisher characteristics contribute to the variation in fishing activity and economic value among sites. These data

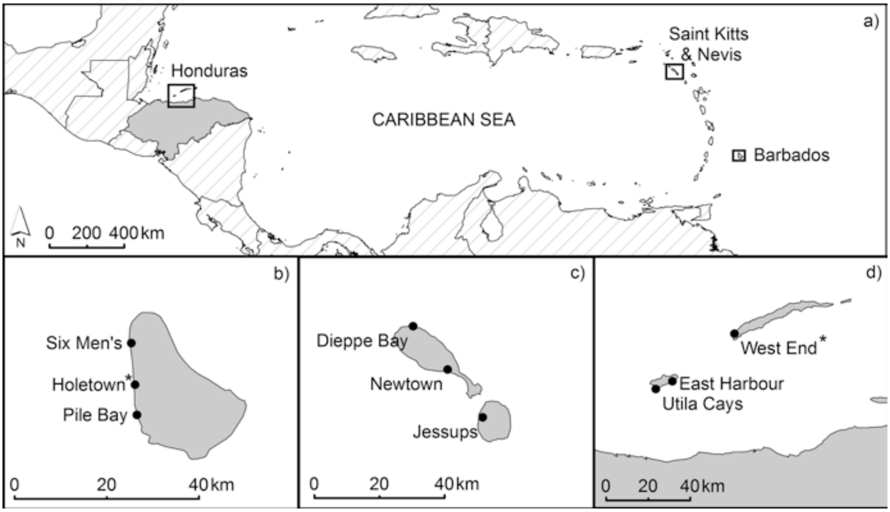



**Fig. 13.1** Locations of the three study countries across the Caribbean (**a**) and the nine study sites in Barbados, (**b**) St. Kitts and Nevis (**c**) and the Bay Islands, Honduras (**d**). * indicates sites with marine protected areas (MPAs)

illustrate the diversity of reef fisheries across the Caribbean, highlighting the need for local-scale data to provide context-specific information for effective policy and management.

### *13.2.1 Approach*

Between March 2011 and March 2012, we conducted face-to-face interviews with 182 commercial reef fishers within three types of communities in three Caribbean countries (St. Kitts and Nevis, Bay Islands (Honduras) and Barbados (see Fig. 13.1)) with the purpose of describing the reef fisheries at each site and estimating their current economic (market) value. The sampling design provided three replicates per country and per coastal community type (fishery-dependent community, tourism-dependent community and a mixed fishing and tourism-dependent community), in order to capture some of the complexity and diversity of reef fishing in the Caribbean. We chose these three countries given their substantial variation in terms of size, per capita gross domestic product (GDP), geography (location, geomorphology), marine legislation, major fisheries, social development, population demographics and dependence on tourism (Peterson et al. 2014a, b, c).

In this study, reef-associated species were defined as those that spend most of their life history on or near shallow coral reefs, and therefore we excluded data on deep-slope (>50 m depth) and offshore pelagic fishery species. The focal species in this study (Table 13.1) were consistent with those used in (Newton et al. 2007) and FishBase (Froese and Pauly 2010) to describe reef-associated species.

**Table 13.1** Classification of reef fishing based on type of fishing and target species

| Category | | Description of fishing activity/gear/species |
|---|---|---|
| Fishing type | Diving (free) | Fishers use a speargun, sling or similar device to capture fish and/or to manually harvest benthic species such as conch, lobster, crab or octopus by free-diving or wading. May use a boat or swim from shore |
| | Diving (SCUBA) | Fishers use a speargun, sling or similar device to capture fish and/or to manually harvest benthic species such as conch, lobster, crab or octopus with the assistance of SCUBA gear. Most use a boat |
| | Line/bottom fishing | Fishers use a handline, weight and hooks to target reef species near the seafloor or in mid-water. Fishers may set from a boat or cast from shore with very few using a fishing rod |
| | Trolling | Fishers use a line towed behind a moving vessel where the line remains close to the surface and targets epipelagic reef-associated species |
| | Net/seine fishing | Fishers use a net (such as a gill net, cast net or seine net). Nets may be cast or set from a boat or from the shore and usually target schooling pelagic or demersal reef fish species |
| | Trap fishing | Fishers use a trap or 'pot' usually made of wire mesh with a wooden or metal frame and at least one specially shaped entrance funnel. These traps are usually placed on the seafloor and left to 'soak' for a few days to attract and trap fish and/or lobster |
| Target species/species group | Demersal reef finfish | Benthic reef fish species captured in depths of less than 50 m (e.g. snappers (Lutjanidae), groupers (Serranidae), parrotfishes (Scaridae), yellowtail snapper (*Ocyurus chrysurus*) and grunts (Haemulidae)). Vulnerable to multiple gear types including lines, spears, nets and traps |
| | Reef-associated pelagic finfish | Coastal pelagic species found and caught on or in close proximity to reefs. Usually harvested while trolling or with a net (e.g. horse-eye jacks, scad (Carangidae), barracuda (Sphyraenidae)) |
| | Conch | Conch (usually *Strombus gigas*) gathered from seafloor by free-diving or SCUBA diving |
| | Lobster | Lobster (mainly *Panulirus argus*) gathered from seafloor by free-diving, SCUBA diving or in traps |
| | Other | Mainly invertebrate species found in and around reefs or near shore (e.g. octopus, whelks, crabs), gathered by free-diving/wading, SCUBA diving or in traps (whelks not vulnerable to latter gear) |

#### 13.2.1.1 Interviews

An initial scoping exercise at each site produced a preliminary list of local fishers. A 'snowball sampling' approach was subsequently used to identify and interview the majority of reef fishers within each community. All interviews were conducted face to face and acquired data on (inter alia) fishing activity, costs and revenue, market orientation and fishers' demographic information. This research formed part of an interdisciplinary project titled the "Future of Reefs in a Changing Environment (FORCE)," and more information on the social science field data collection and the study sites can be found in Peterson et al. (2014a, b, c).

Given the multi-gear, multispecies nature of Caribbean reef fisheries, single-species data collection was considered inappropriate and was not attempted. Instead, two classification schemes were developed to describe and compare the reef fisheries. These were based on (1) fishing (activity/gear) type (referred to hereafter as fishing type) and (2) target species group (Table 13.1). Care was therefore taken to collect data on each type of gear used and species/species group targeted by each individual fisher.

#### 13.2.1.2 Data Treatment

Some fishers had difficulty providing estimates of their fishing costs and effort, which created considerable variability within the data. We therefore used measures of centrality other than means (e.g. trimmed mean), as appropriate to derive 'representative' values. Trimmed mean (hereafter denoted by $\bar{x}_{0.10}$) represents the sample mean after removing the extreme (upper and lower) 10% of the data.

#### 13.2.1.3 Exchange Rates

All values reported in this study are in US dollars. To determine exchange rates, we used the midpoint of the buying and selling price of the US dollar to the local currency, averaged over the previous 3 years. This is to account for the volatility in market exchange rates within some locations such as Honduras. Purchasing power parity (PPP) values were calculated using the International Monetary Fund's implied PPP conversion rates for 2011. The conversion factors to convert from local currency to US PPP were 2.207, 9.526 and 1.245 for St. Kitts and Nevis, Honduras and Barbados, respectively. To reflect the local cost of living conditions in the Bay Islands, which is higher than that on the Honduran mainland (Lord 1975; Stonich 1998; Canty 2007), we used a midpoint of the PPP conversion factors between Honduras and Belize. This was seen as a favourable alternative to the standard Honduran national rates (Canty, personal communication, 19 February 2013)[1] given

[1] Personal communication (2013); Steve Canty, Fisheries Researcher, Centro de Ecologia Marina, Tegucigalpa, Honduras.

the strong historical economic ties that the Bay Islands had to English-speaking nations (Lord 1975), their similar reef tourism economy and development and proximity to Belize.

#### 13.2.1.4 Linear Mixed-Effects Model

Exploratory analyses were performed to assess the association between a wide range of socioeconomic factors, and other conditions, and the profitability of reef-associated fishing at the nine study sites. Due to the potential effects of a host of latent factors that vary both within and between sites, the analysis required was beyond the scope of most generalized linear models (Pinheiro and Bates 2000), thus requiring more powerful statistical techniques. Linear mixed-effect (LME) models allow the researcher not only to examine the effects of fixed predictors within a model but also to make inferences about the unobserved variability between different groups or, in this case, sites (Pinheiro and Bates 2000). LME models permit the correlation and/or nesting of fishers of a similar group (or at the same site) and drawing of inferences based on the population of sites rather than from the sample sites alone (Pinheiro and Bates 2000; Agresti 2007). The LME model takes the form shown in Eq. 13.1.

$$\begin{aligned} y_{ij} &= \beta' x_i + b' z_i + \varepsilon_{ij} \\ \text{where } b' &\sim \left(N\left(0,\sigma_b^2\right)\right) \text{ and } \varepsilon_{ij} \sim \left(N\left(0,\sigma^2\right)\right) \end{aligned} \quad (13.1)$$

**Eq. 13.1** Linear mixed-effects model used in the study

In the equation above, $\beta'$ represents a vector of fixed effect coefficients, and $b'$ represents a vector of random effects (in this case, for sites) and is the deviation of the group mean from the population mean (Pinheiro and Bates 2000). $\varepsilon_{ij}$ represents the deviation of observation (fisher) $j$ from the mean of group (site) $i$. $b'$ is correlated within but independent among groups, and $\varepsilon_{ij}$ is the independent, identically distributed error terms that are independent of $b'$.

The models were estimated using the *nlme* package in the R statistical software (R Development Core Team 2015; Pinheiro and Bates 2016). Given the wide range of values, the response variable (annual fisher profit (PPP dollars) was transformed using the natural log for a more normal distribution (Daw et al. 2012). More details can be found in Gill (2014).

## 13.3 Results

A total of 74, 60 and 48 commercial reef fishers were interviewed in St. Kitts and Nevis, the Bay Islands and Barbados, respectively (Table 13.2). The sample represented (on average) over half of all commercial reef-associated fishers identified in each of the sampled communities.

**Table 13.2** Descriptive statistics of commercial reef fishers interviewed at the nine sites in St. Kitts and Nevis, the Bay Islands (Honduras) and Barbados

| | | Country | St. Kitts and Nevis | | | Bay Islands | | | Barbados | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site | Dieppe Bay | Newtown | Jessups | Utila Cays | West End | East Harbour | Pile Bay | Holetown | Six Men's |
| | | Community type | F | T | M | F | T | M | F | T | M |
| Descriptors | | n | 27 | 24 | 23 | 43 | 8 | 9 | 16 | 10 | 22 |
| Individual variables | Demographics | # of occupations | 2.0 | 1.6 | 2.1 | 1.8 | 1.5 | 2.8 | 2.2 | 2.6 | 2.0 |
| | | Age (years) | 43.4 | 42.5 | 42.8 | 46.0 | 54.4 | 53.4 | 51.4 | 42.0 | 53.5 |
| | | Years fishing | 20.7 | 19.7 | 22.9 | 26.5 | 38.0 | 33.5 | 28.2 | 20.0 | 20.2 |
| | | Household wealth[a] | 0.28 | 0.29 | 0.33 | −0.81 | −0.22 | 0.07 | 0.30 | 0.48 | 0.51 |
| | | Subsistence (kg/trip) | 4.8 | 4.5 | 4.1 | 5.0 | 6.2 | 6.8 | 5.9 | 3.5 | 5.9 |
| | | Income from reef fishing (%) | 44.1 | 69.3 | 69.0 | 61 | 50 | 31 | 54 | 50.4 | 48.1 |
| | Role | Boat owners (%) | 29.6 | 20.8 | 52.2 | 55.8 | 87.5 | 55.6 | 62.5 | 70.0 | 54.5 |
| | | Crew member (%) | 48.1 | 75.0 | 43.5 | 44.2 | 12.5 | 44.4 | 37.5 | 20.0 | 31.8 |
| | | Shore fishers (%) | 22.2 | 4.2 | 4.3 | 0 | 0 | 0 | 0 | 10.0 | 13.6 |
| | Gear | # of gears per fisher | 2.2 | 1.9 | 1.9 | 1.6 | 1.3 | 1.0 | 1.3 | 1.2 | 1.3 |
| | | Line fishers (%) | 88.9 | 70.8 | 47.8 | 100 | 100 | 88.9 | 31.3 | 30.0 | 22.7 |
| | | Trap fishers (%) | 44.4 | 16.7 | 69.6 | 14.0 | 0 | 0 | 56.3 | 50.0 | 72.7 |
| | | Free diving fishers (%) | 48.1 | 4.2 | 17.4 | 23.3 | 0 | 0 | 12.5 | 20.0 | 22.7 |
| | | SCUBA diver fishers (%) | 0 | 70.8 | 47.8 | 9.3 | 0 | 11.1 | 18.8 | 0 | 0 |
| | | Net/seine fishers (%) | 30 | 20.8 | 8.7 | 7.0 | 13 | 0.0 | 6.3 | 10.0 | 13.6 |
| | | Trolling fishers (%) | 11.1 | 4.2 | 0 | 4.7 | 12.5 | 0.0 | 6.3 | 10.0 | 0.0 |
| | Target sp. | Reef demersal (%) | 100 | 83.3 | 100 | 100 | 100 | 88.9 | 100 | 100 | 90.9 |
| | | Reef pelagics (%) | 48.1 | 29.2 | 8.7 | 32.6 | 25.0 | 44.4 | 18.8 | 30.0 | 36.4 |
| | | Conch (%) | 14.8 | 58.3 | 56.5 | 25.6 | 0 | 11.1 | 0 | 0 | 9.1 |
| | | Lobster (%) | 48.1 | 45.8 | 65.2 | 25.6 | 0 | 11.1 | 12.5 | 10.0 | 4.5 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site variables | Export market access[b] | 1 | 2 | 2 | 2 | 0 | 2 | 0 | 0 | 0 |
| | Tourism development[c] | 0 | 3 | 2 | 1 | 3 | 3 | 0 | 3 | 2 |
| | Landing site[d] | 0 | 2 | 1 | 2 | 0 | 0 | 1 | 0 | 1 |
| | Community infrastructure[e] | 0.4 | 0.6 | 0.4 | 0.3 | 0.6 | 0.9 | 0.2 | 0.7 | 0.2 |
| | MPA (adjacent/ proximate) | N | N | N | Y | Y | Y | N | Y | N |
| Country variables | Reef area ($km^2$)[f] | 160 | | | 1120 | | | 90 | | |
| | Shelf area ($km^2$)[g] | 845 | | | 67,366 | | | 407 | | |
| | Per capita fish consumption (kg/year)[h] | 9.0 | | | 1.3 | | | 12.3 | | |

Values represent the averages or proportions for fishers at each site. As fishers target multiple species and use multiple gear, some site totals are >100%. Site-level variables (derived from field observations) and country-level variables (derived from secondary sources) are also provided

*F* fishing site, *T* tourism site, *M* mixed site

[a]Household wealth index – Single factor for various indicators of household material style of life items (e.g. electricity, telephone, vehicle, etc.) derived using principle component analysis (Peterson et al. 2014a)

[b]Export market access – 0, none or very little access; 1, some indirect access but few in the community sell for export; 2, many fishers contributing to the export market either directly or through middlemen

[c]Tourism development – Scale of 0–3 based on infrastructure directly related to tourism (e.g. watersport centres, duty-free shopping centres)

[d]Landing site – 0, little or no fish processing infrastructure. No sheltered area for processing, may have a slab or table present for cleaning; 1, some form of sheltered structure. No storage or refrigeration facilities; 2, established (permanent) infrastructure present: enclosed areas for processing fish, refrigeration and storage facilities, possible boat haul-out and repair area (adapted from (Fisheries Division 2004))

[e]Community infrastructure index – Single factor for various indicators of community/development (e.g. banks, schools, clinics, road access) identified during field observations and derived using principle component analysis

[f,g,h]Country variables – [f]Reefs at Risk (2004): St. Kitts /Nevis, Barbados, Healthy Reefs Initiative (2011): Bay Islands; [g]Agostini et al. (2010): St. Kitts/Nevis, Sea Around Us Project (2015): Bay Islands, Barbados; [h]FAO Yearbook (2010): all countries

### *13.3.1 Catch and Effort*

#### 13.3.1.1 Fishing Activity

Line fishing was the most widespread activity, practiced by over 65% of all interviewed fishers and by more than 20% of fishers at any given site (Table 13.2). This is likely due to the low capital investment required for this type of fishing. St. Kitts and Nevis fishers appear to be the most diverse in terms of fishing gears/activities, while the Bay Islands fishers show the least diversity. Differences appear to be driven by the availability of lobster and conch, which are the primary species taken via free- or SCUBA diving in St. Kitts and Nevis, and by gear regulations, such as a ban on the use of traps, net/seines and diving in fishing areas close to the Bay Islands sites. Non-reef fishing activities also affect gear choice. For example, in Barbados, trap fishing is quite popular as fishers can leave their traps for several days at a time while they engage in offshore pelagic fishing. At all sites, fishing trips usually lasted 1 day or less.

Fishing ranges were generally no greater than a few kilometres from the fishing communities in Barbados, whereas Bay Islands and St. Kitts and Nevis fishers ventured further away to remote or offshore reef locations (Fig. 13.2).

## 13.4 Catch Rates

Mean trip and annual yield per vessel (or per fisher for shore fishers) for each of the reef-associated fishing activities are summarized in Table 13.3. Some fishing activities were practiced by only a few fishers, and thus limited data were available for some activities (indicated by asterisks in Table 13.3). Diving activities, primarily targeting conch and lobster, account for the majority of landings in St. Kitts and Nevis. High catch rates were also reported from seine fishing which usually targets schooling pelagic (reef-associated) species such as gars (Belonidae), jacks (mainly *Selar crumenophthalmus*) and ballyhoo (Hemiramphidae). Snappers and groupers were the main target species for most Bay Islands fishers, usually caught using handlines. In the Utila Cays, trolling is primarily for non-reef species such as small tuna, which is sold as bait for the local and commercial fleets (Box and Canty 2010); however jacks (Carangidae) and barracuda (*Sphyraena barracuda*) are also targeted. Although high yield values are reported in Table 13.3 for trolling, these are based on the responses of only two fishers with unusually high trip frequency for fish that are considered a secondary target species. In Barbados, seine fishers (targeting coastal pelagic and demersal reef fish) reported the highest annual landings, averaging just over 140 kg per trip. The low reported catch rates for trolling in Barbados occur because this fishery targets mainly offshore pelagic species (not included in the analysis) but also catches reef-associated species (e.g. barracuda).

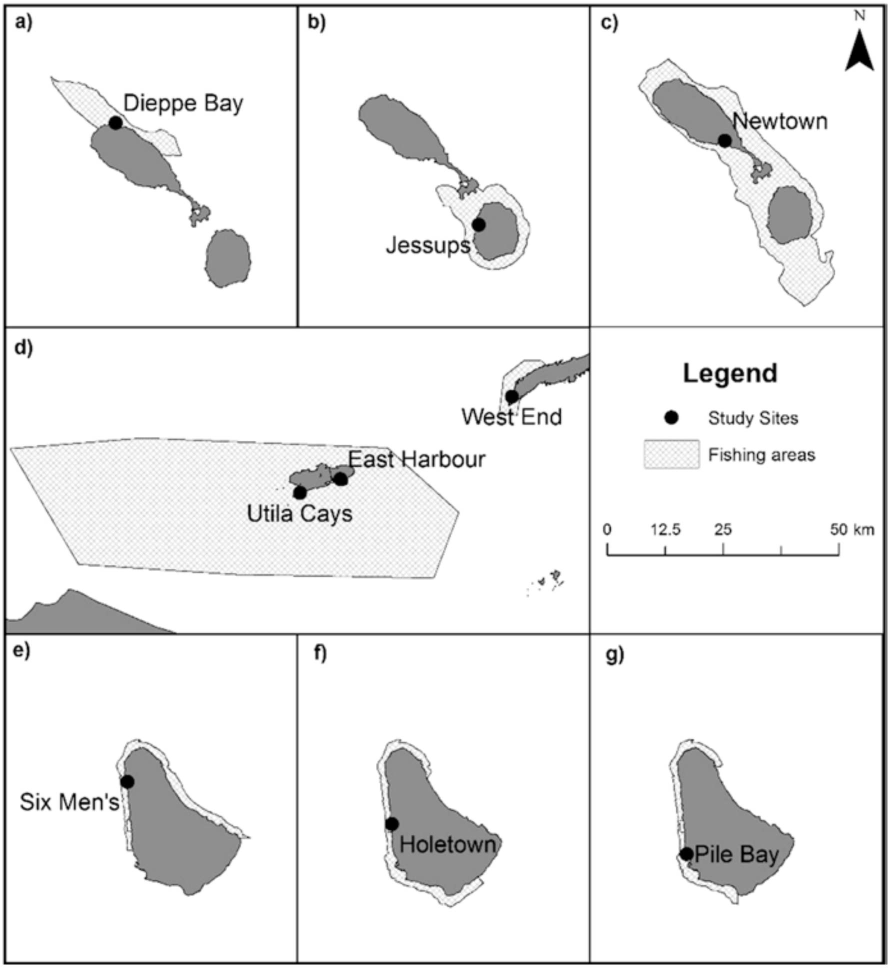



**Fig. 13.2** Approximate fishing areas utilized by commercial reef fishers as indicated by the fishers in St. Kitts and Nevis [top row, Dieppe Bay (**a**), Jessups (**b**) and Newtown (**c**), Bay Islands, Honduras; middle row, Utila Cays, East Harbour and West End (**d**) and Barbados; bottom row, Six Men's (**e**), Holetown (**f**) and Pile Bay (**g**)]. Additional spatial data on fishing grounds in St. Kitts and Nevis and Utila (Utila Cays, East Harbour) obtained from Agostini et al. (2010) and the Centre for Marine Ecology, Honduras, respectively

The catch rates reported here are inclusive of subsistence catch, that is, catch for household consumption. Some catch is also used as crew payment, gifts, or donations. Fishers reported subsistence catch rates of 3.5–6.8 kg/trip (Table 13.2) which in some cases (e.g. West End) represented over 70% of reported trip catch. It was not always clear, however, whether or not fishers take home the reported subsistence catch after every trip despite being explicitly asked. Nonetheless, for many West End and East Harbour fishers, fishing for home consumption was just as important

**Table 13.3** Trimmed mean of trip catch (kg), trips per year and annual yield (kg) by fishing activity/gear type (described in Table 13.1)

| | | St. Kitts and Nevis | | | | Bay Islands | | | | Barbados | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fishing type | Parameter | Dieppe Bay (F) | Newtown (T) | Jessups (M) | Country average | Utila Cays (F) | West End (T) | East Harbour (M) | Country average | Six Men's (F) | Holetown (T) | Pile Bay (M) | Country average |
| Diving (free) | Trip catch (kg) | 12.2 | 14.7[a] | 35.6 | 13.9 | 2.6 | | | 2.6 | 6.4 | 7.5[a] | 2.7[a] | 6.2 |
| | Trips per year | 125.6 | 104.0[a] | 85.8 | 112.7 | 139.1 | – | – | 139.1 | 105.2 | 117.0[a] | 95.3 | 104.4 |
| | Annual yield (kg) | 1647.7 | 1529.3[a] | 2344.2 | 1814.4 | 463.0 | | | 463.0 | 471.9 | 867.2[a] | 283.6[a] | 572.3 |
| Diving (SCUBA) | Trip catch (kg) | | 46.3 | 35.5 | 43.3 | 7.9 | | 11.4[a] | 8.4 | | | 11.4 | 11.4 |
| | Trips per year | – | 162.9 | 217.9 | 179.6 | 134.9 | – | 12.0 | 104.1 | – | – | 199.3 | 199.3 |
| | Annual yield (kg) | | 7298.7 | 8830.1 | 7661.0 | 1067.5 | | 136.4[a] | 951.1 | | | 2403.0 | 2403.0 |
| Line | Trip catch (kg) | 13.8 | 12.3 | 24.6 | 14.7 | 32.7 | 8.7 | 24.8 | 27.1 | 7.3 | 10.6 | 7.7 | 7.9 |
| | Trips per year | 102.2 | 148.9 | 55.0 | 103.8 | 87.1 | 137.6 | 43.0 | 86.8 | 122.1 | 174.2 | 202.6 | 169.0 |
| | Annual yield (kg) | 1415.9 | 1579.1 | 1486.0 | 1433.3 | 2653.5 | 892.6 | 978.9 | 1981.0 | 1121.4 | 1483.8 | 1176.8 | 1248.7 |
| Net/seine | Trip catch (kg) | 132.5 | 28.6 | 107.3[a] | 88.7 | 19.5 | | | 19.5 | 150.7 | 61.5[a] | 172.3[a] | 141.1 |
| | Trips per year | 67.6 | 154.7 | 139.0[a] | 94.0 | 49.3 | 259.9[a] | – | 102.0 | 39.0 | 39.0[a] | 12.0[a] | 34.5 |
| | Annual yield (kg) | 4866.2 | 5302.4 | 27,894.8[a] | 5483.7 | 873.2 | | | 873.2 | 5782.5 | 2399.8[a] | 2067.7[a] | 4599.6 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Traps | Trip catch (kg) | 27.7 | 19.2 | 20.8 | 23.6 | 42.1 | | | 42.1 | 14.2 | 9.6 | 15.9 | 13.7 |
| | Trips per year | 71.2 | 50.7 | 105.3 | 83.5 | 43.0 | – | – | 43.0 | 51.9 | 63.9 | 75.0 | 59.7 |
| | Annual yield (kg) | 1724.0 | 882.0[a] | 2739.7 | 1991.0 | 1558.2 | | | 1558.2 | 718.7 | 457.6 | 1526.0 | 834.8 |
| Trolling | Trip catch (kg) | 13.6[a] | 17.1[a] | | 15.3 | 63.0[a] | 5.7[a] | | 34.4 | | | | |
| | Trips per year | 104.0[a] | 52.0[a] | – | 78.0 | 216.7[a] | – | – | 216.7 | – | 151.7[a] | – | – |
| | Annual yield (kg) | – | 886.4[a] | | 886.4 | 12,539.1[a] | | | 12,539.1 | | | | |

Shown as reported by interviewed commercial fishers at the nine sites, along with the country averages. Values are per vessel or, in the case of shore fishers, per fisher and include subsistence catch

*F* fishing site, *T* tourism site, *M* mixed site

[a]Values possibly unrepresentative due to low sample size; note however that the small sample sizes in Holetown and Pile Bay include all or almost all of the identified seine fishing vessels in these communities given that there was only one or two seine vessels at these sites. Annual yield represents the average annual yield per vessel/fisher and not the multiple of the average site-level catch and effort values

as fishing for sale. During data collection, there were more recreational and subsistence fishers (not reported on here) encountered at these sites than commercial fishers.

### 13.4.1 Sale of Catch

In St. Kitts and Nevis, sale prices varied among species, from PPP $4.99 per kg for whelks to $15.91 per kg for lobsters, but varied little among study sites (Table 13.4). A large quantity of the lobster and conch is purchased by middlemen for export to neighbouring islands such as Guadeloupe and St. Maarten. Some middlemen export fish themselves, and some sell directly to local restaurants and hotels.

In the Bay Islands, prices also varied considerably among species and sites, with prices in West End over twice those in East Harbour and the Utila Cays for demersal and pelagic reef fish (Table 13.4). Many West End fishers sell their non-subsistence catch directly to restaurants, whereas many East Harbour fishers sell their catch to the community or occasionally to restaurants. Others sell to buyers on the Utila Cays, who receive the majority of fish landed there and act as middlemen for export and Honduran mainland markets.

In Barbados, there was little variation in the price of catch between sites (Table 13.4). Lobster, conch and octopus were the highest valued species (PPP $14.15–31.40 per kg) with the latter two sold primarily to individuals within the community. Likewise, demersal reef fish often bypass official markets and landing sites and are mainly sold in the community. Up until the time of this study, there were no reports of an export market for reef-associated species.

### 13.4.2 Cost of Fishing

Fishing costs comprised capital investment costs (e.g. boat, engine, or gear purchases) and recurring costs, which included annual maintenance costs (e.g. boat repair, depreciation) and more frequent trip costs (e.g. fuel). These costs were mostly borne by the boat owners, who often recuperated these costs through an extra share of the earnings from catch sales. The depreciation of capital assets (boat and engine) and the total annual recurring costs reported here were used to estimate net revenues (see Sect. 13.4.3).

#### 13.4.2.1 Capital Investment Costs

Investment in boats and engines was generally proportional to the distance travelled to fishing grounds. Fishers in St. Kitts and Nevis and the Bay Islands who travel to distant fishing grounds (Fig. 13.2) use larger boats ($\bar{x}$ = 6.2 and 8.3 m, respectively)

**Table 13.4** Average prices received (US$ per kg) and main markets for sale of catch as given by commercial reef fishers interviewed in St. Kitts and Nevis, the Bay Islands (Honduras) and Barbados

| Site/species group | Avg. US$ per kg | Avg. PPP $ per kg | Main market(s)[a] |
|---|---|---|---|
| *St. Kitts and Nevis* | | | |
| Conch | 7.11 | 8.64 | Middlemen (mostly for export), local community |
| Demersal reef fish | 7.82 | 9.51 | Local community, middlemen (for local buyers), fisheries complex/market (Newtown) |
| Lobster | 13.08 | 15.91 | Hotels and restaurants, middlemen (for export/hotels and restaurants) |
| Other shellfish/molluscs (whelks) | 4.10 | 4.99 | Local community |
| Pelagic reef fish | 6.88 | 8.37 | Local community |
| Turtle | 5.75 | 6.99 | Local community |
| *Bay Islands, Honduras* | | | |
| Utila Cays/East Harbour | | | |
| Conch | 4.66 | 9.24 | Middlemen (for export), restaurants, local community |
| Demersal reef fish | 3.52 | 6.98 | Middlemen (for export), restaurants |
| Lobster | 17.48 | 34.65 | Middlemen (for export), restaurants |
| Pelagic reef fish | 1.52 | 3.00 | Middlemen (for export and for mainland population), local community, local stores and restaurants |
| West End | | | |
| Demersal reef fish | 7.58 | 15.02 | Local community, restaurants |
| Pelagic reef fish | 4.37 | 8.66 | Local community, restaurants |
| *Barbados* | | | |
| Conch | 9.95 | 15.92 | Local community |
| Demersal reef fish | 5.80 | 9.28 | Local community |
| Lobster | 19.62 | 31.40 | Hotels and restaurants |
| Octopus | 8.84 | 14.15 | Local community |
| Pelagic reef fish | 6.08 | 9.73 | Local community |

Shown by main species groups (see Table 13.1). Markets are listed in the general order of preference

[a]Local community includes sales to local stores, small establishments that sell cooked seafood along with grocery goods. See methods for details on exchange rate calculations

with more powerful engines ($\bar{x}$ = 67.1 and 66.3 hp, respectively) than those in Barbados ($\bar{x}$ = 5.2 m), where many fishers use smaller engines ($\bar{x}$ = 28.2 hp) and fish closer to landing sites ($\bar{x}_{0.10}$ boat and engine costs, PPP $8724, $19,372 and $7158, respectively). This is especially true for Utila Cays and East Harbour fishers, who use diesel engines which are more expensive but also more efficient for longer trips. Of all fishing types, net fishing required the greatest capital investment ($\bar{x}_{0.10}$ country, PPP $875–10,084) followed by SCUBA gear (PPP $725–1842). The large range in net prices is explained by the range in net types used, from small inexpensive cast nets to very large seine nets (>450 m in length).

#### 13.4.2.2 Maintenance Costs

Average annual boat and engine maintenance costs were highest in St. Kitts and Nevis ($\bar{x}_{0.10}$ = PPP $1723) and lowest in the Bay Islands ($\bar{x}_{0.10}$ = PPP $867). Furthermore, fishers in the Bay Islands were able to maintain a vessel in working order for longer (mean boat age = 12 years) than those in the other countries ($\bar{x}$ = 8.2 years), probably due to the greater use of diesel inboard engines in the Bay Islands rather than the gasoline outboard engines used elsewhere. Very few fishers provided gear-specific maintenance costs, and those that did provided values that were highly variable, ranging tenfold in magnitude. Nonetheless, it was clear from both quantitative and qualitative information that net fishing incurred the highest annual maintenance costs.[2]

#### 13.4.2.3 Trip Costs

Trip costs varied significantly by the type of fishing both within and across countries. Average trip costs for St. Kitts and Nevis, the Bay Islands and Barbados were estimated at PPP $78, $54 and $29, respectively (trimmed mean). Fuel represented the most significant trip cost, accounting for around 87%, 91% and 95% of expenses in St. Kitts and Nevis, the Bay Islands and Barbados, respectively. Additional (smaller) costs included equipment-related expenses such as those associated with replacement lines, hooks and weights for line fishers or compressed air tank fills for SCUBA divers. The popularity of SCUBA diving (requiring compressed air fills) and distant fishing grounds (requiring more fuel) and the use of gasoline engines (many using the less fuel-efficient two-stroke engines) all contribute to high average trip costs for SCUBA fishing in St. Kitts and Nevis ($\bar{x}_{0.10}$ = PPP $103). Conversely, Bay Islands line and Barbados trap fishers, the most popular reef fishing types in these countries, enjoy lower trip costs ($\bar{x}_{0.10}$ = PPP $52 and PPP $57, respectively) on average due to the use of inboard diesel engines in the Bay Islands (which have low fuel consumption) and small fishing ranges in Barbados.

[2] Annual maintenance costs for net fishing ranged from PPP $908 to $20,104 based on the responses of two fishers in St. Kitts and Nevis and Barbados.

## 13.4.3 *Profits from Fishing*

### 13.4.3.1 Profits by Type of Fishing

Table 13.5 summarizes the average annual costs and revenues per vessel/shore fisher associated with different fishing activities at each of the nine study sites and provides estimates of annual net revenue (profit). Gross and net revenue values include the value of catch for sale and subsistence. Given the amount of missing cost data at the site level, it should be noted that country-level values for individual vessels/shore fishers were derived from the best available data from all fishers using that gear within the three sites studied in each country. For example, the country-level value for annual net/seine fishing costs in St. Kitts and Nevis was derived from trip information from the average number of trips for all net/seine fishers interviewed across all three sites in the country and the cost information given only by those in Dieppe Bay (cost information not available in other sites). Also, given the low response rates for maintenance costs, average boat and engine maintenance costs from all fishers were applied to all fishing types. Thus, country- and site-level averages may differ (Table 13.5).

There is considerable variation in profitability among the various types of fishing and also among sites (community types) and countries. The highest annual profits per vessel are seen in the diving (SCUBA) and seine/net fisheries in St. Kitts and Nevis, with average values close to PPP $60,000 per year, and in Barbados, with values of PPP $17,000 and $14,000, respectively (Table 13.5). A significant contributor to the profits in the SCUBA fishery in St. Kitts and Nevis is the fact that much of the spearfishing/diving activity in Newtown and Jessups is associated with landing large quantities of high-value conch for export, resulting in gross revenues that are higher than any other fishery examined across the three countries (Table 13.5). The net/seine fishery is typically a high-grossing fishery across all sites where the gear is used and is driven largely by the use of large seine nets operated by large crew sizes that are capable of very large catches. It should be noted, however, that there were too few data, particularly cost data, to consistently estimate fishing profits from net/seine fishing at the site level and that the very high gross values for Jessups were based on values from just two individuals. This type of fishing was reported anecdotally to have high net purchase costs and recurring maintenance costs, which is not surprising given the large net sizes and susceptibility to damage during hauling and retrieval.

In contrast to most sites, line/bottom fishing and trolling in the Bay Islands (especially the Utila Cays) were high-grossing fisheries and earned the highest net revenues, with profit margins at 58% and 68% of gross revenues, respectively. This is largely due to the restrictions on other types of gear around the study sites. Line fishing is the most widely practiced fishing type being used by fishers in all nine sites, but it is a relatively low-income-earning gear type in St. Kitts and Nevis and Barbados (Table 13.5). On the other hand, trolling is not a commonly used method of fishing for reef species and shows negative profits in St. Kitts and Nevis, where

**Table 13.5** Summary of (trimmed) average annual estimates of gross revenue, costs and net revenue (profit) (US$ PPP 2011 rates)

| Costs and revenues (PPP $) | Fishing type | St. Kitts and Nevis | | | | Bay Islands | | | | Barbados | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dieppe Bay (F) | Newtown (T) | Jessups (M) | Country average | Utila Cays (F) | West End (T) | East Harbour (M) | Country average | Pile Bay (F) | Holetown (T) | Six Men's (M) | Country average |
| Gross annual revenue | Diving (free) | 17,159 | 14,421 | 23,829 | 18,598 | 8532 | – | – | 8532 | 2631[a] | 8476[a] | 5114 | 5821 |
| | Diving (SCUBA) | – | 76,178 | 84,050 | 78,779 | 15,073 | – | 1051 | 12,268 | 27,480 | – | – | 27,480 |
| | Line | 13,476 | 14,915 | 14,813 | 13,816 | 18,411 | 13,583 | 8016 | 15,383 | 10,995 | 14,007 | 11,215 | 11,833 |
| | Net/seine | 47,807 | 52,855 | 278,056[a] | 75,073 | 2623 | – | – | 2623 | 20,094 | 22,261 | 48,786 | 37,742 |
| | Traps | 19,607 | 8695 | 29,482 | 22,795 | 10,142 | – | – | 10,142 | 14,459 | 4351 | 7025 | 8069 |
| | Trolling | – | 8835 | – | 8835 | 37,657[a] | – | – | 37,657 | – | – | – | – |
| Annual costs | Diving | 7861 | 8681 | 12,902 | 10,655 | 8685 | – | – | 8739 | 3148[a] | 10,477[a] | 2285 | 5113 |
| | Diving (SCUBA) | – | – | 21,755 | 22,023 | 14,255 | – | – | 13,387 | 10,780 | – | – | 10,148 |
| | Line | 7147 | 19,964 | 10,108 | 10,353 | 6673 | 5951 | 6175 | 6463 | 7385 | – | 2330 | 5233 |
| | Net/seine | 10,329 | – | – | 14,161 | – | – | – | – | – | – | 22,527 | 23,525 |
| | Traps | 7701 | – | 17,333 | 13,244 | 3443 | – | – | 3496 | – | – | 3976 | 4011 |
| | Trolling | 22,582 | 18,112 | – | 18,855 | 15,559[a] | – | – | 12,086 | – | – | – | 5130 |
| Annual net revenue | Diving | 9297 | 5740 | 10,927 | 7943 | −154 | – | – | −207 | −517[a] | −2002[a] | 2829 | 708 |
| | Diving (SCUBA) | – | – | 62,294 | 56,756 | 818 | – | – | −1119 | 16,701 | – | – | 17,332 |
| | Line | 6329 | −5049 | 4705 | 3463 | 11,738 | 7631 | 1841 | 8920 | 3610 | – | 8885 | 6601 |
| | Net/seine | 37,478 | – | – | 60,912 | – | – | – | – | – | – | 26,258 | 14,218 |
| | Traps | 11,906 | – | 12,149 | 9551 | 6699 | – | – | 6646 | – | – | 3049 | 4058 |
| | Trolling | – | −9277 | – | −10,020 | 22,098[a] | – | – | 25,571 | – | – | – | – |

Rates are calculated across all commercial fishers interviewed at the nine study sites, shown by fishing type. Values are per vessel or per shore fisher
*F* fishing site, *T* tourism site, *M* mixed site
[a]Values possibly unrepresentative due to low sample size. Country averages were calculated across all fishers interviewed within the country. Due to low sample sizes, average annual fishing costs per country include the average vessel maintenance costs from all boat fishers across all types of fishing. Therefore, site- and country-level averages may vary. See methods for details on exchange rate calculations

additional income is earned from the sale of offshore pelagic species not accounted for in this study. Free-diving fishers in Holetown and Pile Bay are estimated to be experiencing annual losses from this fishery. However, these values were based on the responses of one or two fishers at each site. It is also possible that these fishing activities were subsidized by other fisheries. Trap fishing, although widely practiced in Caribbean reef fisheries and despite its status as a high- to medium-grossing fishery in the study sites, was not among the top profit earners at any of the sites (Table 13.5).

#### 13.4.3.2 Profits Per Fisher

Given the amount of missing data, net revenues (in terms of annual income from reef-associated fishing) for fishers in each role, including owners, crew and shore fishers, were calculated using the profit margins of the subset of fishers who supplied comprehensive data (n = 99). Further, because few fishers provided comprehensive information, profit margins were averaged by country, and values for captains and crew members were combined.

There is a very large range in annual earnings by individual reef fishers. St. Kitts and Nevis fishers earned the highest annual income from reef-associated fishing regardless of community type, earning severalfold more per year than their counterparts in Barbados and in the Bay Islands (Honduras), even when more conservative measures of centrality are used (Fig. 13.3). Fishers from the fishing-dependent community of the Utila Cays appeared on average to earn slightly more than the other Bay Islands tourism-dependent and mixed communities, although there was considerable overlap in their ranges. In Barbados, however, Six Men's and Pile Bay fishers (mixed site and fishing site) earned approximately the same.

#### 13.4.3.3 Profits by Site

Using individual fisher net income and estimates of the number of boats and shore fishers at each site,[3] the estimated total/aggregate annual gross and net revenues from reef-associated fishing in each of the nine sites are listed in Table 13.6. Site-level gross revenues and profits indicate that reef fishing contributes significant revenue to these coastal communities, ranging from PPP $56,000 to over $2 million in gross earnings per year (Table 13.6).

Net present values (NPV) over a 10-year horizon were calculated using 10% and 15% discount rates to avoid overestimating the future value of reef fisheries. Both

[3] Estimates of the number of fishers at each site in St. Kitts and Nevis and in the Bay Islands were validated by key informants. Estimates for numbers of fishers at each site in Barbados are based on the number of fishers interviewed and the number of fishers who were identified in the scoping exercise, but not interviewed. As these values were rough estimates, they were rounded off to the nearest five fishers.

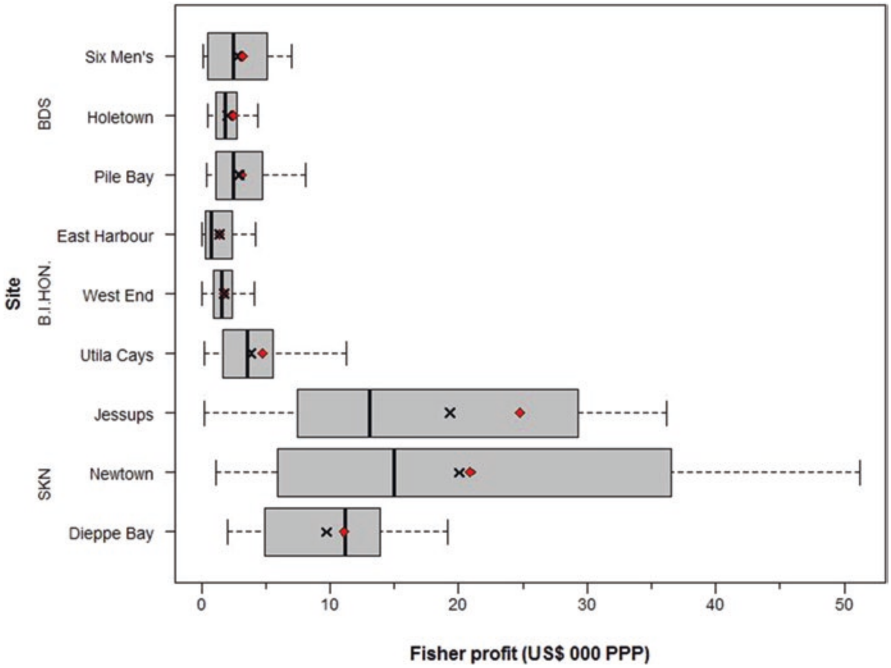



**Fig. 13.3** Annual fisher profit (PPP $) derived from interviews with commercial reef fishers at each of nine sites in St. Kitts and Nevis (SKN), Bay Islands, Honduras (B.I.HON) and Barbados (BDS). The red diamonds, crosses and vertical lines within the boxes represent the mean, trimmed mean and median values, respectively. Boxes represent the interquartile range, and whiskers represent 1.5 times the interquartile range. Outlier values are not shown in the plot

values show that reef fishing is expected to provide large benefits to the communities over the next decade (ceteris paribus).

### *13.4.4 Individual (Fisher)-Level Factors*

We used linear mixed-effects models to help explain the variability in reef-related income at the nine study sites. For more details on these methods or results, see Gill (2014). Some of the factors found to account for variation between fishers were:

- *Target Species and Fishing Type*. Fishers engaged in SCUBA diving, lobster fishing and/or using large crews earned significantly more than those using other gears or targeting other species. Also, fishers who used more fuel (a potential proxy for trip distance) also earned higher annual profits. It is possible that these fishers travel farther to access less exploited areas (Caddy and Carocci 1999; Daw 2008), thus enjoying higher catch rates.

**Table 13.6** Estimated average annual gross revenue per vessel/shore fisher and net fisher revenue (income) (US$) from reef-associated fishing for all commercial boat fishers, shore fishers, as well as the total for each of the nine sites

| | | St. Kitts and Nevis | | | Bay Islands | | | Barbados | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fisher role | Parameter | Dieppe Bay (F) | Newtown (T) | Jessups (M) | Utila Cays (F) | West End (T) | East Harbour (M) | Pile Bay (F) | Holetown (T) | Six Men's (M) |
| Boat fishers | Avg. annual vessel gross revenue ($) | 43,949 | 86,969 | 76,929 | 13,340 | 5622 | 4643 | 10,824 | 6520 | 12,458 |
| | Avg. annual fisher net revenue ($) | 10,267 | 17,589 | 20,946 | 2387 | 892 | 719 | 1933 | 1159 | 1894 |
| | Boat fishers at site (approx.) | 35 | 35 | 25 | 65 | 15 | 19 | 27 | 19 | 30 |
| | Site annual gross revenue ($) | 747,132 | 2,174,213 | 1,000,075 | 533,598 | 56,220 | 69,639 | 162,362 | 84,763 | 224,247 |
| | Site annual net revenue ($) | 359,338 | 615,618 | 523,641 | 155,159 | 13,385 | 13,655 | 52,178 | 22,028 | 56,832 |
| | Site annual net revenue (PPP $) | 437,044 | 748,745 | 636,878 | 307,551 | 26,532 | 27,066 | 83,498 | 35,250 | 90,946 |

(continued)

**Table 13.6** (continued)

| Fisher role | Parameter | St. Kitts and Nevis | | | Bay Islands | | | Barbados | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Dieppe Bay (F) | Newtown (T) | Jessups (M) | Utila Cays (F) | West End (T) | East Harbour (M) | Pile Bay (F) | Holetown (T) | Six Men's (M) |
| Shore fishers | Avg. annual fisher gross revenue ($) | 7178 | 11,382 | 10,859 | – | – | – | – | 5676 | 3196 |
| | Avg. annual fisher net revenue ($) | 5169 | 8197 | 7820 | – | – | – | – | 4851 | 2731 |
| | Shore fishers at site (approx.) | 15 | 20 | 8 | 0 | 0 | 0 | 0 | 5 | 10 |
| | Site annual gross revenue ($) | 107,668 | 227,641 | 86,869 | – | – | – | – | 28,382 | 31,958 |
| | Site annual net revenue ($) | 77,539 | 163,939 | 62,560 | – | – | – | – | 24,257 | 27,314 |
| | Site annual net revenue (PPP $) | 94,306 | 199,390 | 76,088 | – | – | – | – | 38,818 | 43,709 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Estimated site totals | Avg. annual gross revenue ($) | 854,800 | 2,401,854 | 1,086,944 | 533,598 | 56,220 | 69,639 | 162,362 | 113,144 | 256,204 |
| | Comm. fishers at site (approx.) | 50 | 55 | 33 | 65 | 15 | 19 | 27 | 24 | 40 |
| | Avg. annual net revenue ($) | 436,876 | 779,557 | 586,201 | 155,159 | 13,385 | 13,655 | 52,178 | 46,285 | 84,146 |
| | Avg. annual net revenue (PPP $) | 531,351 | 948,135 | 712,967 | 307,551 | 26,532 | 27,066 | 83,498 | 74,068 | 134,655 |
| Net present value (NPV): 10 years | 15% discount rate (PPP $) | 2,666,726 | 4,758,473 | 3,578,214 | 1,543,525 | 133,158 | 135,836 | 419,059 | 371,728 | 675,803 |
| | 10% discount rate (PPP $) | 3,264,919 | 5,825,882 | 4,380,871 | 1,889,765 | 163,028 | 166,306 | 513,062 | 455,114 | 827,397 |

PPP: US purchasing power parity dollars (2011 rates). See methods for details on exchange rate calculations
*F* fishing site, *T* tourism site, *M* mixed site

- *Fisher Role and Experience*. Boat owners (and in some cases, shore fishers) earned significantly more than crew members, indicating that investment in boat and gear is justifiable. More experienced fishers also earned more on average than less experienced fishers and likely benefit from greater knowledge and efficiency, either through personal experience or through established social networks with other efficient fishers (Turner 2010).

#### 13.4.4.1 Site-Level Effects

The linear mixed-effects models were also used to identify site-level variables that explained variation in fishing profits.

- *Export Market*. Results indicated that fishers at sites with access to export markets earned greater profits. In St. Kitts and Nevis, dependency on the export and tourism markets by the lobster and conch fisheries was evident, where fishing intensity increases with seasonal demand in import countries and the tourism high season. Revenues generated in these two fisheries (SCUBA dive and trap fishery) are considerably higher than others at the same site (Table 13.5).[4] In the Utila Cays, shipments of at least 455 kg of demersal reef-associated fish are made approximately every 3 days to exporters on Roatan and the Honduran mainland, with larger shipments during certain periods such as the mutton snapper migration (Box 2011). West End fishers (where revenues were relatively low), on the other hand, have limited access to the export market since the main middleman in Roatan refuses to buy fish caught in the West End area in order to limit exploitation around the marine park (Box 2011). In Barbados (where revenues were also relatively low), there were no recorded reef fishery exports at any of the sites. These observations corroborate with other studies that found market access to be a significant driver of reef fishing effort (Brewer et al. 2012; Cinner et al. 2013).
- *Marine Protected Areas (MPAs) and tourism*. Revenues at the MPA study sites were significantly lower than at other sites. This may be counter-intuitive to general expectations that MPAs will result in more profitable fishing in adjacent areas. At these sites, however, there was limited reef-associated fishing, as fishers preferred offshore pelagic fishing to supply hotels and restaurants. Fishers near MPAs also tended to be more involved in marine tourism activities (e.g. tourist fishing trips). It is unclear whether or not fishers use these alternative income sources to compensate for reef fishing or if they were even reliant on reef fishing before the establishment of the MPA. Anecdotally, one West End fisher mentioned that there was traditionally low reliance on reef fisheries in the area given the close proximity to deep water, where they can access larger pelagic species.

[4] Despite the fact that the estimated seine fishing profits were also high, there were very few (or only one) seine fishers at some sites.

While accounting for many of these individual- and site-level factors, significant heterogeneity was observed both between and within sites. This signifies that, even if fishing activity and fisher demographics are similar within a site or community, considerable variation in fisher income can be expected.

### *13.4.5 Discussion*

The findings of this study concur with the assertion of Salas et al. (2007) that the complexity of small-scale fisheries in Latin America and the Caribbean makes it difficult to provide a general assessment of fisheries across the region. Many fishers use multiple gears and target multiple species (at times on the same trip), thus confounding the disaggregation of costs and revenues associated with a particular species group or gear (Heileman 2011). Nevertheless, the economic benefits of reef-associated fishing to coastal communities are clearly demonstrated here, as is the considerable heterogeneity within the fishery both within and across sites. Despite limitations due to missing data and resulting high variability, the economic values reported here also appear to be within the range of those previously found at similar locations (Box 2011; Schuhmann et al. 2011a) and in other Caribbean reef fishery studies (Agar et al. 2005; Hargreaves-Allen 2010; Schep et al. 2012).

### *13.4.6 Social Drivers of Reef Fishing Activity*

Within the literature, factors reported to affect fisheries production include capital and labour inputs (Gustavson 2002), target species, choice of fishing gear (Guingand 2008; Box 2011), market demand, proximity to MPAs (Pezzey et al. 2000; Anderson 2008), the fisher's role in the fishery (e.g. boat owner), local economic conditions and individual fishing strategies (Salas and Gaertner 2004; Cinner et al. 2009, 2011). Many of these factors were identified in the mixed-effects model (e.g. export market access, adjacent MPAs); however other key social factors also influenced fishing activity at the study sites.

#### 13.4.6.1 Food Security

The role of reef-associated fisheries in food security has been noted in many studies (Whittingham et al. 2003; CRFM 2012). This role was apparent in this study given the high subsistence values reported by fishers, especially in poorer segments of the communities in East Harbour and West End, Honduras (Table 13.2). Interestingly, these are the two sites where revenues from reef fishing by boat owners were the lowest, suggesting that the primary purpose of reef fishing at these sites may not be to generate profit but to provide food for subsistence.

At all sites, pelagic reef fish were primarily sold at low cost to members of the local community. For example, although these and similar species are 'exported' from the Utila Cays (i.e. off the island to the mainland), the primary consumers of pelagic reef fish are members of the Honduran mainland population who may not be able to afford more expensive sources of protein (Box 2011). Further investigation into the relative importance and management of the pelagic reef fishery seems warranted as this fishery could be serving as a critical source of protein for many low-income persons in the Caribbean.

#### 13.4.6.2 Livelihood Security

The role of reef fishing as an important social safety net was quite apparent in this study. This was especially so in communities such as the Utila Cays, where few employment alternatives exist (Box and Canty 2010), and in St. Kitts, where there was a noticeable increase in the number of fishers after the closure of the sugar industry in 2005 (Peterson et al. 2014c). Many reef fishers are involved in informal employment (e.g. part-time construction), and some indicated that fishing represents a supplemental income source. Nonetheless, at the majority of study sites, reef-associated fishing, on average, accounted for more than half of fishers' annual income (Table 13.2). In Honduras, many poorer persons from the mainland migrate to the Bay Islands to participate in reef-associated fishing (Box and Canty 2010) or depend heavily on nearshore reef fish for subsistence. In Barbados, it has been noted that trap fishing potentially acts as a 'retirement' fishery, providing a source of income for elderly persons who retire from more demanding occupations including other fisheries (Parker and Franklin n.d.).

### *13.4.7 Management and Policy Implications*

The Caribbean-wide decline in reef fish populations has had serious socioecological impacts. This decline has not only reduced profits per unit effort (Heileman 2011) but also compromised the health of many reef ecosystems (Mumby et al. 2006). Although significant revenues are garnered from reef fishing at some of the study sites, considerable doubt remains as to their sustainability. For example, the St. Kitts and Nevis dive fishery benefits greatly from available lobster and conch stocks, where vessels targeting these species could be receiving up to $70,000 annually. Nevertheless, despite high catch rates observed in St. Kitts and Nevis as far back as 25 years ago,[5] fishers now indicate they are diving deeper than before. Therefore, it is possible that increasing fishing effort could be masking stock declines in these fisheries.

---

[5] St. Kitts and Nevis national fisheries database.

Given the lack of biological data on stock health at the study sites (and the Caribbean in general (Salas et al. 2007), traditional management approaches such as total allowable catches set based on maximum sustainable yield (MSY) are not feasible (Mumby et al. 2014). The management challenge is, therefore, how to use the limited data to make management decisions that achieve the societal goals of food and livelihood security while at the same time conserving reef health. Given the complex challenge that reef fisheries present, many have called for a shift towards an ecosystem approach to fisheries (EAF) and ecosystem-based fisheries management (EBFM) (Appeldoorn 2011; Mumby et al. 2014). EAF 'strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries' (Garcia et al. 2003, p. 6). These approaches not only focus on controlling and maximizing the economic potential of fisheries but also on maintaining their ecosystem function and health by addressing the stressors that may compromise the overall health of the reef ecosystem and its long-term productivity (Appeldoorn 2011). How, then, can fisheries and economic data, such as those collected in this study, be used to support a holistic ecosystem approach to fisheries management? Here are some examples:

*Identifying the Economic Incentives that Influence Fisher Behaviour* Understanding the incentives that drive fishing activity is a necessary prerequisite for effective management (Schuhmann et al. 2011b). Fishers that are heavily reliant on reef fish for food and income have few incentives to comply with management or regulatory changes if they perceive the changes to limit their access to the resource, particularly if they were not included in the decision-making process (Mascia 2004; Oracion et al. 2005). Thus, if new management measures are to be put in place in Newtown, Jessups and the Utila Cays, where there is high fishing dependency, it is recommended that managers collaborate closely with these fishers to explore alternative income opportunities through livelihood diversification programs and/or economic incentives that can promote sustainable behaviour. For example, in cases where livelihood diversification is not feasible, awarding property or fishing rights to the more dependent fishers can provide those with the lowest opportunity costs (i.e. those with fewer economic alternatives) with the incentives to fish sustainably (Schuhmann et al. 2011b) and reduce the number of less dependent fishers who already have viable alternative sources of income. Having secure fishing or property rights reduces the uncertainty of future harvest and wealth, which allows these highly dependent fishers to practice stewardship over the resource given the expectation of long-term gains (Wilen 2006). In order to reach an equitable solution, however, community consultation is vital to determining the appropriate and fair distribution of rights and access (Mascia 2004).

*Identifying and Managing Perverse Outcomes from Economic Incentives* EBFM will risk failure if the fisheries, and thus fishers themselves, are not seen as part of the socioecological system that makes up coral reefs (McConney and Salas 2011).

Fishing practices that harm the reef ecosystem and also compromise the long-term well-being of the fishers must be addressed. While legislation prohibits fishing with SCUBA gear in St. Kitts and Nevis without the permission of the Chief Fisheries Officer (Daley, personal communication, 13 March 2012),[6] these rules are not enforced. It seems apparent that the economic incentives to disregard the regulations appear to outweigh the legal and health risks for many fishers. In recent years, there have been a number of dive-related accidents (Daley, personal communication, 13 March 2012), as a result of some fishers carrying out multiple, daily dives to 24 m or deeper. To reduce fisher morbidity and mortality, we recommend improved monitoring and enforcement of the regulations in this dive fishery, particularly those in Jessups and Newtown. While tighter controls may reduce the short-term economic benefits from reef fisheries, such actions stand to improve both the occupational safety of fishers and the sustainability of stocks.

*Utilizing Market Forces* Market forces can also play a vital role within fisheries management. The export markets in St. Kitts and Nevis and parts of the Bay Islands provide considerable incentives for high levels of exploitation. Guadeloupe is a major target market for the conch export industry in St. Kitts and Nevis, where increases in conch fishing activity coincide with the seasonal opening of the conch fishery in Guadeloupe. This is a clear example of how policies in one country affect another and highlights the need for multilateral cooperation even when stocks are not necessarily shared. Another Caribbean example of the effect of legislation in import countries was observed in the artisanal fisheries of the Grenadines (Gill et al. 2007). There, import standards for Martinique prohibited the purchase of undersized fish, which had an impact on the composition of sales to the export trading vessels in the Grenadines. The middleman was responsible for ensuring regulatory compliance, highlighting the fact that market pressures can be used to support sustainable fishing practices (Berkes et al. 2006; Crona et al. 2010). For sites with strong export market linkages (e.g. Jessups, Newtown, Utila Cays; Table 13.2), fisheries managers should actively engage middlemen and regulatory agencies in import countries to develop sustainable management initiatives.

*Parrotfish Fisheries Management* Of particular concern to all sites are the ecologically important and heavily exploited parrotfish species. As one of the key grazers on coral reefs, parrotfish play a significant role in supporting coral reef resilience from climate and other acute and chronic disturbances (Kennedy et al. 2013). As a result, a resolution to address the taking of parrotfishes and other reef herbivores in the Caribbean has been adopted (ICRI 2013), and several Caribbean countries have already banned parrotfish fishing, while in the absence of a ban some have recommended strict size and catch limitations to be put in place (Bozec et al. 2016). Parrotfishes are not a preferred target in the Bay Islands; however they are targeted by most gears used in Barbados and St. Kitts and Nevis, including traps, nets and

[6]Personal communication (2012) Dr. Kelvin Daley, Permanent Secretary in the Ministry of Agriculture, Nevis.

spears. For these countries to impose restrictions or bans on parrotfish fishing, managers will need to consider the socioeconomic implications of this action, given that gear restrictions may be necessary due to the low selectivity of some gears (e.g. traps, nets). From the results of this study, we can see that a parrotfish ban would have a significant impact on Barbados fishing communities, given the high proportion of trap and dive fishers (who usually target parrotfishes) and the low diversity of gears used (Table 13.2). Trap and dive fishers in St. Kitts and Nevis, on the other hand, generate most of their revenue from lobster and conch rather than demersal reef fish. Seine fishers in both Barbados and St. Kitts and Nevis would also be less affected, given that they primarily target pelagic reef species. Maraj et al. (2011) estimate that demersal reef fish (mostly herbivorous parrotfishes and acanthurids) constitute 8–10% of seine fish landings in Barbados, suggesting that a halt on demersal fishing with seine nets would not have a dramatic economic impact on these fishers while making a significant contribution towards the restoration of reef herbivores. Further research on the economic implications of these restrictions could facilitate the more effective implementation of management interventions that does not compromise the well-being of fishers.

## 13.5 Conclusion

Effective management of Caribbean reef fish resources is urgent, given the overexploited state of many reef fisheries, as well as the high resource dependency within coastal communities. The results of this study demonstrate the size and variability in economic benefits that communities derive from reef fishing. Regardless of the scale of economic activity, however, addressing the current drivers of coral reef degradation in the Caribbean is paramount since reef fisheries would ultimately benefit from management actions that enhance or restore reef fish habitat and populations. Data collected in studies such as this one can serve as a valuable input for policymakers where information on the level of exploitation, economic gains, markets and incentives can be used to guide effective policy at the appropriate scale. Further, managers can also be made aware of the dissimilarities in socioeconomic factors that incentivize fishing activity within coastal communities, given that these are likely to affect fishers' responses to management interventions and thus management success.

## References

Agar JJ, Shivlani M, Waters JR, Valdes-Pizzini M, Murray T, Kirkley J, Suman D (2005) US Caribbean fish trap fishery costs and earnings study (NOAA technical memorandum NMFS-SEFSC-534). Florida

Agar JJ, Waters JR, Valdés-Pizzini M, Shivlani M, Murray T, Kirkley J, Suman D (2008) U.S. Caribbean fish trap fishery socioeconomic study. Bull Mar Sci 82(3):315–331

Agostini VN, Margles SW, Schill SR, Knowles JE, Blyther RJ (2010) Marine zoning in Saint Kitts and Nevis: a path towards sustainable management of marine resources. The Nature Conservancy, Florida

Agresti A (2007) Categorical data analysis, 2nd edn. Wiley Series in Probability and Statistics, New York

Anderson LG (2008) A bioeconomic analysis of marine reserves. Nat Resour Model 15(3):311–334

Appeldoorn RS (2011) Reef resources, the "fog of fisheries" and EBM. In: Fanning L, Mahon R, Mcconney P (eds) Towards marine ecosystem-based management in the wider Caribbean. Amsterdam University Press, Amsterdam, pp 147–156

Berkes F, Mahon R, McConney P, Pollnac R, Pomeroy R (2001) Managing small-scale fisheries: alternative directions and methods. International Development Research Centre (IRDC), Ottawa

Berkes F, Hughes TP, Steneck R, Wilson JA, Bellwood DR, Crona B, Folke C, Gunderson LH, Leslie HM, Norberg J, Nyström M, Olsson P, Österblom H, Scheffer M, Worm B (2006) Globalization, roving bandits, and marine resources. Science 311(5767):1557–1558

Box S (2011) An evaluation of the socioeconomics of yellowtail snapper in the small-scale and industrial fisheries of the Honduran Caribbean (Future of reefs in a changing environment; EU 7th framework programme. no. deliverable no. 8.5). Centro de Ecología Marina de Utila, Honduras

Box S, Canty S (2010) The long and short term economic drivers of overexploitation in Honduran coral reef fisheries. In: Proceedings of the 63rd Gulf and Caribbean Fisheries Institute, vol 63, November 1–5, 2010. San Juan, Puerto Rico, pp 1–9

Bozec Y-M, O'Farrell S, Bruggemann JH, Luckhurst B, Mumby PJ (2016) Tradeoffs between fisheries harvest and the resilience of coral reefs. Proc Natl Acad Sci 113(16):201601529

Brewer TD, Cinner JE, Fisher R, Green A, Wilson SK (2012) Market access, population density, and socioeconomic development explain diversity and functional group biomass of coral reef fish assemblages. Glob Environ Chang 22(2):399–406

Bruno JF, Sweatman H, Precht WF, Selig ER, Schutte VGW (2009) Assessing evidence of phase shifts from coral to macroalgal dominance on coral reefs. Ecology 90(6):1478–1484

Burke L, Reytar K, Spalding M, Perry A (2011) Reefs at risk revisited. World Resources Institute, Washington D.C.

Caddy JF, Carocci F (1999) The spatial allocation of fishing intensity by port-based inshore fleets: a GIS application. ICES J Mar Sci 56(3):388–403

Canty S (2007) Positive and negative impacts of dive tourism: the case study of Utila, Honduras. Master's thesis, Lunds University, Lunds, Sweden

CARSEA (Caribbean Sea Ecosystem Assessment) (2007) A sub-global component of the millennium ecosystem assessment (MA) (Caribbean marine studies, Special edition). (Agard J, Cropper A, Garcia K, eds). Institute of Marine Affairs, Trinidad

Chávez EA (2008) Socio-economic assessment for the management of the Caribbean spiny lobster. In: Proceedings of the 60th Gulf and Caribbean Fisheries Institute. November 5–9, 2007, Punta Cana, Dominican Republic, pp 193–196

Cinner JE, Daw TM, McClanahan TR (2009) Socioeconomic factors that affect artisanal fishers' readiness to exit a declining fishery. Conserv Biol 23(1):124–130

Cinner JE, Folke C, Daw T, Hicks CC (2011) Responding to change: using scenarios to understand how socioeconomic factors may influence amplifying or dampening exploitation feedbacks among Tanzanian fishers. Glob Environ Chang 21(1):7–12

Cinner JE, Graham NAJ, Huchery C, MacNeil MA (2013) Global effects of local human population density and distance to markets on the condition of coral reef fisheries. Conserv Biol 27(3):453–458

CRFM (Caribbean Regional Fisheries Mechanism) (2012) Diagnostic study to determine poverty levels in CARICOM fisheries communities: technical document. (CRFM technical & advisory document, number 2012/3), vol 1, CRFMs, Belize

Crona B, Nyström M, Folke C, Jiddawi N (2010) Middlemen, a critical social-ecological link in coastal communities of Kenya and Zanzibar. Mar Policy 34(4):761–771
Daw TM (2008) Spatial distribution of effort by artisanal fishers: exploring economic factors affecting the lobster fisheries of the Corn Islands, Nicaragua. Fish Res 90(1–3):17–25
Daw TM, Cinner JE, McClanahan TR, Brown K, Stead SM, Graham NA, Maina J (2012) To fish or not to fish: factors at multiple scales affecting artisanal fishers' readiness to exit a declining fishery. PLoS One 7(2):e31460
Development Core Team R (2015) R: a language and environment for statistical computing, version 3.2.3. R Foundation for Statistical Computing, Vienna
Division F (2004) Barbados fisheries management plan 2004–2006: schemes for the management of fisheries in the waters of Barbados. Fisheries Division, Ministry of Agriculture and Rural Development, Barbados
Dunn DC, Stewart K, Bjorkland RH, Haughton M, Singh-Renton S, Lewison R, Thorne L, Halpin PN (2010) A regional analysis of coastal and domestic fishing effort in the wider Caribbean. Fish Res 102(1–2):60–68
Fabricius KE (2005) Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis. Mar Pollut Bull 50(2):125–146
FAO (Food and Agricultural Organization of the United Nations) (2010) 1961–2009 fish and fishery products: world apparent consumption statistics based on food balance sheets. In: FAO yearbook. Fishery and aquaculture statistics 2010. FAO yearbook. Fishery and aquaculture statistics, FAO, Rome, p 401
Froese R, Pauly D (2010) Fishbase. World Wide Web electronic publication. www.fishbase.org. Accessed 1 Dec 2010
Garcia SM, Zerbi A, Aliaume C, Do Chi T, Lasserre G (2003) The ecosystem approach to fisheries: issues, terminology, principles, institutional foundations, implementation and outlook, FAO fisheries technical paper. no. 443. FAO, Rome
Gill DA (2014) The economic value of reef fishes to the fishing and dive tourism industries in the Caribbean. Doctoral dissertation, University of the West Indies, Cave Hill Campus, Barbados
Gill DA, McConney P, Mahon R (2007) Socio-economic profile of fisheries in the Grenadine Islands (CERMES technical report 11). Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies, Cave Hill Campus, Barbados
Green SJ, Akins JL, Maljković A, Côté IM (2012) Invasive lionfish drive Atlantic coral reef fish declines. PLoS One 7(3):e32596
Guingand A (2008) Combining environmental protection and poverty alleviation: an economic valuation of the Portland bight protected Area in Jamaica. Master's thesis, University of Auvergne, France
Gustavson K (2002) Economic production from the artisanal fisheries of Jamaica. Fish Res 57(2):103–115
Hargreaves-Allen V (2010) Economic values, distributional impacts and conservation outcomes for coral reef marine protected areas. Doctoral dissertation, Imperial College London, London
Heileman S (2011) Reef & pelagic ecosystems transboundary diagnostic analysis. Caribbean Large Marine Ecosystem and Adjacent Areas (CLME) Project, Cartagena
Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS, Greenfield P, Gomez P, Harvell CD, Sale PF, Edwards AJ, Caldeira K, Knowlton N, Eakin CM, Iglesias-Prieto R, Muthiga N, Bradbury RH, Dubi A, Hatziolos ME (2007) Coral reefs under rapid climate change and ocean acidification. Science 318(5857):1737–1742
ICRI (International Coral Reef Initiative) (2013) Recommendation on addressing the decline in coral reef health throughout the wider Caribbean: the taking of parrotfish and similar herbivores. Adopted at 28th general meeting of the international coral reef initiative, Belize
Jackson JBC, Donovan MK, Cramer KL, Lam V (2014) Status and trends of Caribbean coral reefs: 1970–2012. (Jackson JBC, Donovan MK, Cramer KL, Lam W, eds), vol 958. Global Coral Reef Monitoring Network, IUCN, Gland, Switzerland

Kennedy EV, Perry CT, Halloran PR, Iglesias-Prieto PR, Schönberg CHL, Wisshak M, Form AU, Carricart-Ganivet JP, Fine M, Eakin CM, Mumby PJ (2013) Avoiding coral reef functional collapse requires local and global action. Curr Biol 23(10):912–918

Lord DG (1975) Money order economy: remittances in the island of Utila. Doctoral dissertation, University of California at Riverside

Maraj V, Cox S-A, Oxenford HA (2011) The small-scale seine fishery of Barbados: description and current contribution to the fishing industry (CERMES technical report 42). Centre for Resource Management and Environmental Studies (CERMES), UWI, Cave Hill Campus, Barbados

Mascia MB (2004) Social dimensions of marine reserves. In: Sobel J, Dahlgren C (eds) Marine reserves: a guide to science, design, and use. Island Press, Washington D.C., pp 164–186

McConney P, Salas S (2011) Why incorporate social considerations into marine EBM? In: Fanning L, Mahon R, Mcconney P (eds) Towards marine ecosystem-based management in the Wider Caribbean. Amsterdam University Press, Amsterdam, pp 99–109

Monnereau I, Oxenford HA (2017) Impacts of climate change on fisheries in the coastal and marine environments of Caribbean Small Island Developing States (SIDS). Caribbean marine climate change report card: science review 2017, pp 124–154

Mumby PJ, Dahlgren CP, Harborne AR, Kappel CV, Micheli F, Brumbaugh DR, Holmes KE, Mendes JM, Broad K, Sanchirico JN, Buch K, Box S, Stoffle RW, Gill AB (2006) Fishing, trophic cascades, and the process of grazing on coral reefs. Science 311(5757):98–101

Mumby P, Flower J, Fitzsimmons C, Forster J, Stead S, Newman S, Cortes-Nunez J, Polunin N (2014) Towards reef resilience and sustainable livelihoods: a handbook for Caribbean coral reef managers. University of Exeter, Exeter

Newton K, Côté IM, Pilling GM, Jennings S, Dulvy N (2007) Current and future sustainability of island coral reef fisheries. Curr Biol 17(7):655–658

Oracion EG, Miller ML, Christie P (2005) Marine protected areas for whom? Fisheries, tourism, and solidarity in a Philippine community. Ocean Coast Manag 48(3–6):393–410

Oxenford HA, Monnereau I (2017) Impacts of climate change on fish and shellfish in the coastal and marine environments of Caribbean Small Island Developing States (SIDS). Caribbean marine climate change report card: science review 2017, pp 83–114

Paddack MJ, Reynolds JD, Aguilar C, Appeldoorn RS, Beets J, Burkett EW, Chittaro PM, Clarke K, Esteves R, Fonseca AC, Forrester GE, Friedlander AM, García-Sais J, González-Sansón G, Jordan LKB, McClellan DB, Miller MW, Molloy PP, Mumby PJ, Nagelkerken I, Nemeth M, Navase-Camacho R, Pitt J, Polunin NVC, Catalina Reyes-Nivia M, Robertson DR, Rodríguez-Ramírez A, Salas E, Smith SR, Spieler RE, Steele MA, Williams ID, Wormald CL, Watkinson AR, Côté IM (2009) Recent region-wide declines in Caribbean reef fish abundance. Curr Biol 19(7):590–595

Parker C, Franklin G (n.d.) Characterisation of the fish pot fishery of Barbados: historic trends, present status and recommended management directions. Fisheries Division, Ministry of Agriculture and Rural Development, Barbados

Peterson A, Turner R, Gill DA, Forster J, Fitzsimmons C, Mahon R, Oxenford H Stead S (2014a) Future of reefs in a changing environment: an ecosystem approach to managing Caribbean coral reefs in the face of climate change. Barbados country profile. (CERMES technical report no. 69). Centre for Resource Management and Environmental Studies (CERMES), The University of the West Indies, Barbados

Peterson A, Turner R, Gill DA, Forster J, Fitzsimmons C, Mahon R, Oxenford H, Stead S (2014b) Future of reefs in a changing environment: an ecosystem approach to managing Caribbean coral reefs in the face of climate change. Honduras country profile. (CERMES technical report no. 72). Centre for Resource Management and Environmental Studies (CERMES), The University of the West Indies, Barbados

Peterson A, Turner R, Gill DA, Forster J, Fitzsimmons C, Mahon R, Oxenford H, Stead S (2014c) Future of reefs in a changing environment: an ecosystem approach to managing Caribbean coral reefs in the face of climate change. St Kitts and Nevis country profile. (CERMES techni-

cal report no. 70). Centre for Resource Management and Environmental Studies (CERMES), The University of the West Indies, Barbados
Pezzey JCV, Roberts CM, Urdal BT (2000) A simple bioeconomic model of a marine reserve. Ecol Econ 33(1):77–91
Pinheiro JC, Bates DM (2000) Mixed effects models in S and S-PLUS. Springer, New York
Pinheiro JC, Bates DM (2016) Linear and nonlinear mixed-effects models, R package version 3.1-128
Salas S, Gaertner D (2004) The behavioural dynamics of fishers: management implications. Fish Fish 5(2):153–167
Salas S, Chuenpagdee R, Seijo JC, Charles A (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fish Res 87(1):5–16
Schep S, Johnson AE, van Beukering P, Wolfs E (2012) The fishery value of coral reefs in Bonaire: applying various valuation techniques. IVM Institute for Environmental Studies, Amsterdam
Schuhmann PW, Oxenford HA, Staskiewicz T, Gill D (2011a) Economic valuation of the fisheries of Barbados: landings, costs, net profit and return on investment in two contrasting fisheries (Part 2: the trap fishery. Third project report on the economic valuation of fisheries in Barbados). Fisheries Division, Ministry of Agriculture, Food, Fisheries, Industry, & Small Business Development, Barbados
Schuhmann PW, Seijo JC, Casey JF (2011b) Economic considerations for marine EBM in the Caribbean. In: Fanning L, Mahon R, McConney P (eds) Towards marine ecosystem-based management in the wider Caribbean. Amsterdam University Press, Amsterdam, pp 111–121
Sea Around Us (2015) Sea around Us project. Sea Around Us Project, Vancouver. http://wwwseaaroundusorg/Accessed 6 June 2015
Stonich SC (1998) Political ecology of tourism. Ann Tour Res 25(1):25–54
Turner RA (2010) Social and environmental drivers of fishers' spatial behaviour in the Northumberland lobster fishery. Doctoral dissertation, Newcastle University, Newcastle
Whittingham E, Campbell J, Townsley P (2003) Poverty and reefs, vol 1. DFID-IMM-IOC/UNESCO, Exeter
Wielgus J, Cooper E, Torres R, Burke L (2010) Coastal capital: Dominican Republic. In: Case studies on the economic value of coastal ecosystems in the Dominican Republic (Working paper). World Resources Institute, Washington D.C.
Wilen JE (2006) Why fisheries management fails: treating symptoms rather than the cause. Bull Mar Sci 78(3):529–546
Wing S, Wing E (2001) Prehistoric fisheries in the Caribbean. Coral Reefs 20(1):1–8

**David A. Gill** is a David H. Smith Post-Doctoral Fellow, jointly affiliated to George Mason University and ConservationInternational. David Gill's research focuses on identifying the linkages between marine management, human well-being and ecosystem health. His research includes global assessments of marine conservation performance and impacts, economic valuation of Caribbean coral reefs and developing cost-effective approaches for marine monitoring. Dr. Gill's work has been published in journals such as *Nature*, *Ecological Economics*, *Coral Reefs* and *Ocean & Coastal Management*. Much of his work presented in this volume was derived from his PhD, which he received at the University of the West Indies, Barbados.

**Hazel A. Oxenford** is Professor of Marine Ecology and Fisheries, University of the West Indies, Cave Hill. Hazel's research focuses on applied marine science issues within the Caribbean, specifically on sustainable small-scale fisheries and management in a changing environment. This includes work on pelagic fish ecology and implications for fisheries management, changing patterns in coral reef health including the impacts of coral bleaching and identification of reef fish community responses to fishing pressure. Hazel's work has been published in *Science*, *Fish and Fisheries*, *Molecular Ecology*, *Proceedings of the Royal Society B*, *Climatic Change*, *Coral Reefs*, *PLoS ONE*, *Environmental Management*, *Microbial Ecology* and *Marine Ecology Progress Series*, inter alia.

**Peter W. Schuhmann** is a Professor of Economics at the University of North Carolina, Wilmington. Dr. Schuhmann received his PhD in Economics from North Carolina State University. His research analyses the non-market valuation of environmental goods and services, largely focused in North Carolina and the Caribbean. His research includes analysis of willingness to pay for coastal and marine resource quality, including beach width, reef health and species diversity, as well as the costs and benefits of fisheries policy and shoreline management. Dr. Schuhmann's work has been published in journals such as *Ecological Economics*, *Land Economics*, *Marine Resource Economics*, *Marine Policy*, *Natural Resource Modeling* and *Journal of Environmental Management*.

# Chapter 14
# The Contribution of Small-Scale Fisheries to Food Security and Family Income in Chile, Colombia, and Peru

**Javier Villanueva García Benítez and Alejandro Flores-Nava**

**Abstract** Small-scale fisheries in Chile, Colombia, and Peru contribute directly to the livelihoods of more than 400,000 fisherfolk. Direct interviews were conducted, and focus groups with fishers, their families, and official authorities in selected fishing communities in these countries were organized. Along with a survey conducted to estimate the contribution of small-scale fisheries to family protein consumption and income, the results showed wide differences among fishing communities. While in the Colombian Pacific the average family income derived from small-scale fishing activities is around $200 USD per month, less than the official minimum wage in Colombia, in Southern Chile small-scale fisheries-derived family income averages $728 USD per month, more than three times the official national minimum wage. A common major concern among most fishing families is the lack of social healthcare protection. As far as family consumption of protein is concerned, the results of the study show that family fish consumption depends on capture volume, cash disposal, and access to sources of protein other than fish. However, by far the major source of protein of the families involved in small-scale fisheries is fish, regardless of family purchasing power and the availability of other sources of protein. Fish consumption in small-scale fisheries-dependent families ranged between 20–291 Kg/person/year in Colombia, 104–156 Kg/person/year in Chile, and 39–218 Kg/person/year in Peru, each of which are higher than official nationally reported averages. Moreover, when capture volumes decrease or during seasonal closures, families prefer to buy fish locally or in neighboring communities rather than consume beef, chicken, or pork, regardless of price.

**Keywords** Small-scale fisheries in South America · Food security · Family income in small-scale fisheries · Fish consumption

J. Villanueva García Benítez (✉) · A. Flores-Nava
FAO Regional Office for Latin America and Caribbean, Santiago, Chile
e-mail: Javier.villanueva@fao.org; alejandro.flores@fao.org



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_14

## 14.1 Introduction

In the Latin American region, the small-scale fisheries sector directly employs at least 2 million people, according to official national statistics (FAO 2016). However, the inability for accurate data collection in all of the geographically dispersed fishing-dependent communities and the low reliability of available data suggest that, in reality, this figure may be significantly higher (FAO 2012).

While small-scale fisheries have been widely recognized for its contribution to overall fish production and to the economy of Latin American countries, no successful attempt has been made to fully estimate its contribution to food security on communities highly dependent upon fish as food or its impact on rural family incomes in Latin America (Belton and Thilsted 2014).

This chapter documents a preliminary attempt to study the direct impact of small-scale fisheries on both cash income and animal protein consumption in fishing-dependent families within the Latin American context. This study conducted a qualitative open-ended semi-structured survey in rural fishing communities of the Pacific and Caribbean coasts of Colombia, Chile, and Peru. The results of the interviews to fisherfolk and their family members are presented, as well as the major conclusions that were drawn from this study, which are shown toward the end of the chapter.

## 14.2 Characterization of the Small-Scale Fisheries Sector in the Selected Countries

### *14.2.1 The Chilean Small-Scale Fisheries Sector*

In 2014, the total national marine capture fisheries in Chile amounted to 2.5 million metric tons (MMT) (Fig. 14.1). This annual production placed the country within the top ten world producers of marine fish (FAO 2016), as well as the second largest producer of fish in the American continent. Nationally, the contribution of small-scale fisheries to total catch in Chile has ranged between 1.2 and 1.9 MMT from 2013 to 2015, thus accounting for nearly 60% of national fish production (SERNAPESCA 2016).

Even though small-scale fisheries provide a considerable number of jobs and have been described as a relevant sector within the sea produce exportation business, its relative economic contribution to the national economy is still considered to be low. Small-scale fisheries represent only 1.8% of the GNP of Chile and employs only about 1% of the workforce of the country (SUBPESCA 2016).

Unlike in other countries of the region, the small-scale fisheries sector of Chile has had an important socioeconomic evolution over the past 20 years. This progressive change has been illustrated by the shift from the usage of a rudimentary-geared, low-yield, and local market-oriented activity, to a highly productive activity with

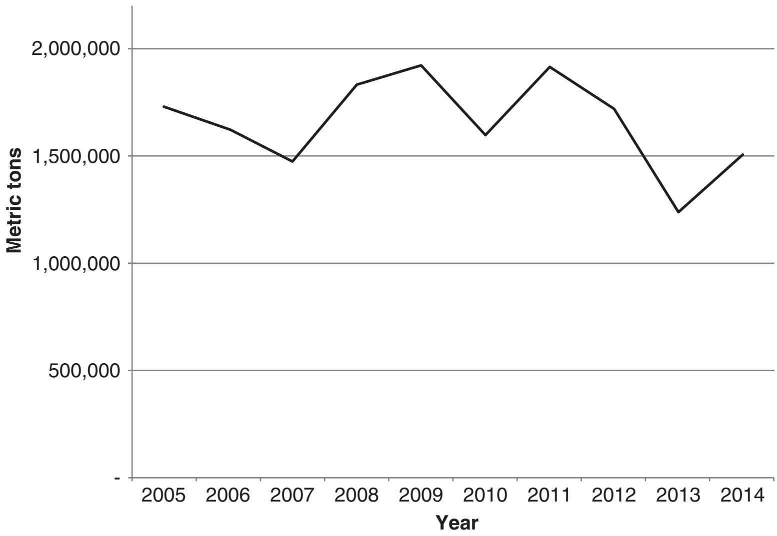



**Fig. 14.1** Small-scale fisheries harvesting in Chile (reproduced from statistical yearbooks from 2004 to 2014, SERNAPESCA)

high level of technology involved, a high level of organization, and mainly export-oriented activity (González et al. 2013).

The development of Chilean small-scale fisheries appears to be at a critical juncture, since this sector has been experiencing a sustained decreasing trend in recent years. This decrease could potentially be explained by the influence of global markets over fisheries businesses operating at the small scale. However, it is worth noting that, despite the precautionary approach to fisheries management that was taken into account by the Chile's Fisheries Act of 1991, it was not until 2013, with the enactment of the new *Law 20657*, when some adequate fisheries governance measures were finally taken. These actions came as a reaction to the requirements of the new law, which also spurred the introduction of scientifically based management decisions taken from an ecosystemic approach (SUBPESCA 2014). The trend followed by small-scale fisheries in Chile within the last 10 years is illustrated in Fig. 14.1.

Currently, the legal frameworks regulating Chilean fisheries define small-scale fisheries as "an activity directly realized by individuals on a daily basis, which demands the necessity to register both, fishers and boats under the national small-scale fisheries registry authority" (SUBPESCA 2014). This legal instrument also states that "Their fishing practices may or may not involve the use of a boat. And that small-scale fisheries is practiced by small enterprises where registered small-scale fisherfolk operate, according to the characteristics established within the Fisheries Act" (SUBPESCA 2014).

In order to fully understand this definition of small-scale fisheries, it is necessary to take into account the legal characteristics presented by the small-scale fishing boats, as well as the geographic and environmental conditions of the fishing grounds that are used exclusively by small-scale fisheries. In that light, the Chilean law defines multiple protections for small-scale fisheries, including an exclusive small-scale fishing ground, a 5-mile strip counted from the coastal shoreline, and a 1-mile strip fishing ground, for exclusive use of boats under 12 m length. Additionally, the law defines as a "Small-scale fishing vessels, those up to 18m length which possess a storage capacity of up to 80 MT." The requirement for these vessels to be registered is also enforced by the national maritime authority (SUBPESCA 2014).

In addition to providing a legal characterization of the small-scale fisheries sector, the Fisheries Act of Chile recognizes four different types of variations within the small-scale fishing activities: (1) small-scale fishing boats owned by someone who may be directly involved in fishing, or a boat that may be hired by other fisherfolk, in order to fish using someone else's boat; (2) small-scale fishers (also known as artisanal fishers) who fish independently; (3) diving fishers; and (4) intertidal collectors (or seafood gatherers) who search for mollusks and macro algae. According to official records, in 2014, there were 91,632 registered small-scale fisherfolk, of which 23% were women (mostly intertidal collectors), a marked increase since 2004, when women involved in small-scale fishing-related extractive activities represented only 7% (SERNAPESCA 2016). These figures show that, despite important shifts toward gender balance in fisheries have been experienced, the limited presence of women in fisheries arenas is still an important challenge for the sector. Fishing extractive activities are still highly dominated by men, while women's involvement is chiefly concentrated in postharvest activities. Nonetheless, official records show that women are apparently involved in fisheries activities, through diving fishing and as members of fishing parties.

### *14.2.2 The Colombian Small-Scale Fisheries Sector*

The small-scale fisheries sector in Colombia is estimated to employ about 150,000 fishers. National records identify an estimated 400,000 people who depend indirectly upon this activity for cash income and food sources. However, the national fishery authorities' records report that there were only 10,586 fishers officially registered in 2014 (SEPEC 2015).

From the total number of marine fishers registered in Colombia in 2014, only 6% were women. However, it is estimated that women's participation in small-scale fisheries is higher, particularly in postharvest-related activities. In inland fisheries, on the contrary, the participation of women seems to be more active, with women taking part in a variety of activities along the value chain. Women are also involved in activities ranging from the knitting and repairing of fishing gear to fishing and fish trade. As an important note, women usually conduct all these fishing-related activities in parallel to daily housekeeping activities.

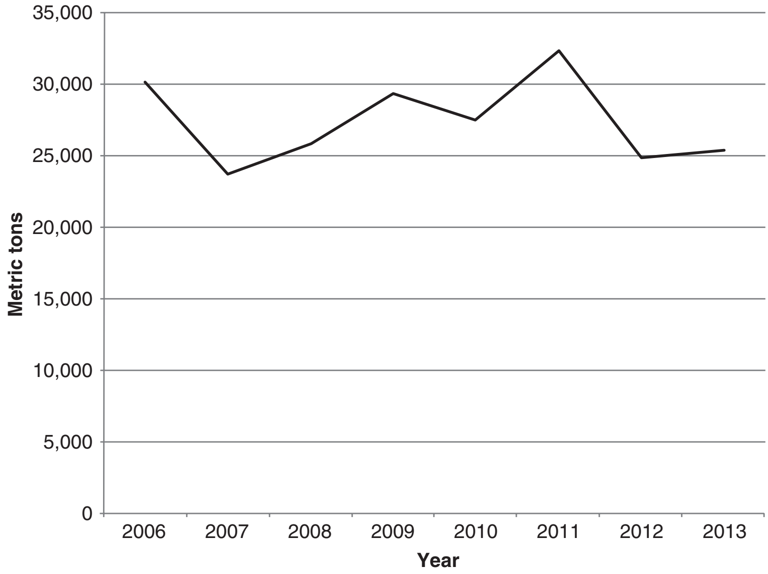



**Fig. 14.2** Small-scale fisheries production in Colombia. Reproduced from Marine Fisheries 2006–2011 INVEMAR statistical yearbooks (SEPEC 2012–2013) and inland fisheries (FAO-FishStat 2016)

The trend encountered in fishing communities of the Colombian Caribbean coast is distinct. In that region, women participate almost exclusively in postharvest activities, including commercialization. Additionally, with tourism being an important asset for the economy of this region, with many families depending heavily on tourism-related incomes, there is a large proportion of women who also own and run small restaurants.

On the Pacific Colombian coast, official statistics indicate that there are approximately 12,000 digging women who gather black clam (*Anadara tuberculosa* and *Anadara similis*), who are regularly involved in sea produce harvesting. Also in this case, women are often the head of household. For these families, the clam digging activity is their primary source of income (Delgado et al. 2010). Figure 14.2 shows this trend, followed by fishing catch by the small-scale fisheries sector in Colombia during the past decade.

Additionally, the contribution of small-scale fisheries, from inland, Caribbean, and Pacific coastal regions is shown in Fig. 14.3, where the role of the freshwater inland fisheries is explicitly presented as of high relevance.

These data suggest that inland fisheries are very important in addressing food security in Colombian rural areas, where agricultural communities are typically settled along the watersheds of inland water bodies. This observation corresponds to the affirmation that the small-scale fisheries sector is diverse, complex, and dynamic. Unfortunately, these characteristics often lead to the weakness of small-scale fisher-

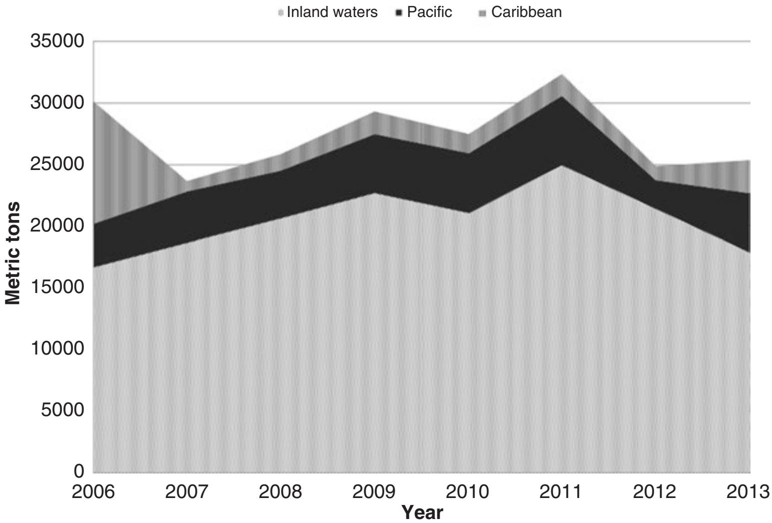



**Fig. 14.3** Contribution to small-scale fisheries production by geographic region in Colombia. Reproduced from Marine fisheries 2006–2011 INVEMAR statistical yearbooks (SEPEC 2012–2013) and inland fisheries (FAO-FishStat 2016)

ies governance policies and practices, according to 85% of data collected through the interviewees of the present study. Along with these results, it was also found that inland fishers also face many non-fishing-related difficulties, such as the displacement of fishing communities due to personal insecurity, pressure from urban expansion into rural zones, decreased prices within fish markets, and the scarcity of fish. This last factor is particularly problematic in inland fisheries, which is more vulnerable to the impacts of industrial-scale mining and oil exploitation activities.

In 2014, Colombia ranked as the ninth highest producer of capture fisheries in Latin America and the Caribbean (FAO 2016). At the national scale, the fisheries sector contributed to 40% of overall fish production, of which the small-scale fisheries sub-sector's share was only 11% (IICA 2013). In 2013, the small-scale fisheries sector in Colombia reported landings of 25,357 tons (Fig. 14.2), 71% of which was from inland fisheries, with the Caribbean Colombian coastal region contributing 11% and the Pacific littoral representing 19% (IICA 2013; SEPEC 2015) of the total national fisheries production (Fig. 14.3). However, stakeholders who participated in this study were in consensus that these figures underestimate the fact that a large proportion of this production is utilized for self-consumption and for local markets only and hence are not officially recorded.

Within the small-scale fisheries sector in Colombia, a wide range of species are targeted. In inland fisheries activities, the "bocachico" (*Prochilodus magdalenae*) is one of the most consumed and contributes to 22.9% of the total national catch, followed by the tilapia (*Oreochromis* spp.), the striped Amazonian catfish (*Pseudoplatystoma magdaleniatum*), the "nicuro" (*Pimelodus blochii*), and the barred sorubim (*Sorubim cuspicaudus*). These species constitute the most demanded fish species from inland origin.

Along the Caribbean littoral, the crevalle jack (*Caranx hippos*) and the black "cojinúa" (*Caranx crysos*) are the primary fish species in terms of capture volume, fishing effort, and market value. On the Pacific coast, the most targeted fish species are the sierra mackerel (*Scomberomorus sierra*) and the skipjack tuna (*Euthynnus lineatus*).

The boats used by the small-scale fisheries sector in marine environments have an average length between 5.5 and 11 m. This fleet has limited capacity, in terms of fuel, water, and other supplies, for the fishing crew to conduct long trips. These boats operate within 5 miles of the coast, generally employing manually operated fishing gear. There is a wide range of fishing boats, concerning type and vessel size, which mainly vary on the materials they are made of (i.e., tree trunks, wood planks, and fiberglass). Most of the boats have outboard engines of between 25 and 50 HP. Each boat carries two to four crew members on average, depending on the type of fishery being conducted (IICA 2013). Conversely, in inland fishing activities, the predominant vessels are small canoes and canoe-shaped tree trunks of up to 7–8 m in length. These vessels are generally equipped with small outboard engines or oars.

In the Colombian context, small-scale fisheries are defined within the *Fisheries Act No. 13 of 1990* as "fishing practiced by an individual, a fishing association, a cooperative or a small enterprise, through personal and collective manpower, that employ fishing gear and vessels legally permitted for small-scale fishing" (Minagricultura 2014). The *Act* also restricts small-scale fisheries within territorial waters, to Colombian citizens, and mandates that these practices should be "chiefly oriented to catch fish for direct human consumption."

### *14.2.3 The Peruvian Small-Scale Fisheries Sector*

Peru is one of the top five fish producers worldwide and ranks as the largest fish producer in Latin America, with 3.6 MMT caught in 2014. This amount is equivalent to 4.3% of the total global fishing catch and 32% of the total regional fish production (FAO 2016).

The production of small-scale fisheries in Peru is destined exclusively for direct human consumption, following the *General Fisheries Law* of the country. Landings of this sector in 2014 amounted to 1,327,797 MT (Fig. 14.4), which represented 37% of the total national fisheries production (PRODUCE 2014). However, the small-scale fisheries sector contributed to only 0.7% to the GNP, given that there is no value added to the small-scale fisheries captures. This figure represents a decrease in the contribution of fisheries to the national economy, which in the previous year contributed 1.6% of GNP, due to reduced captures (PRODUCE 2014).

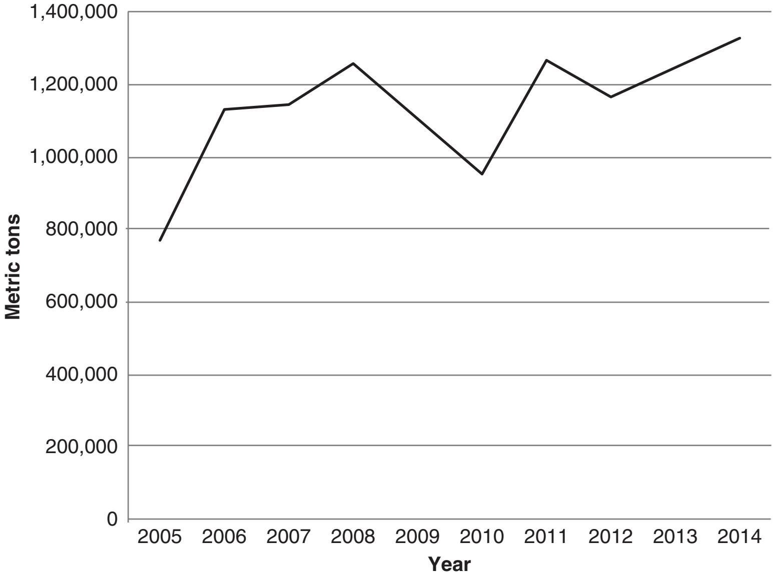



**Fig. 14.4** Small-scale fisheries production in Peru. Reproduced from statistical yearbooks from 2005 to 2014 (Ministry of Production Peru)

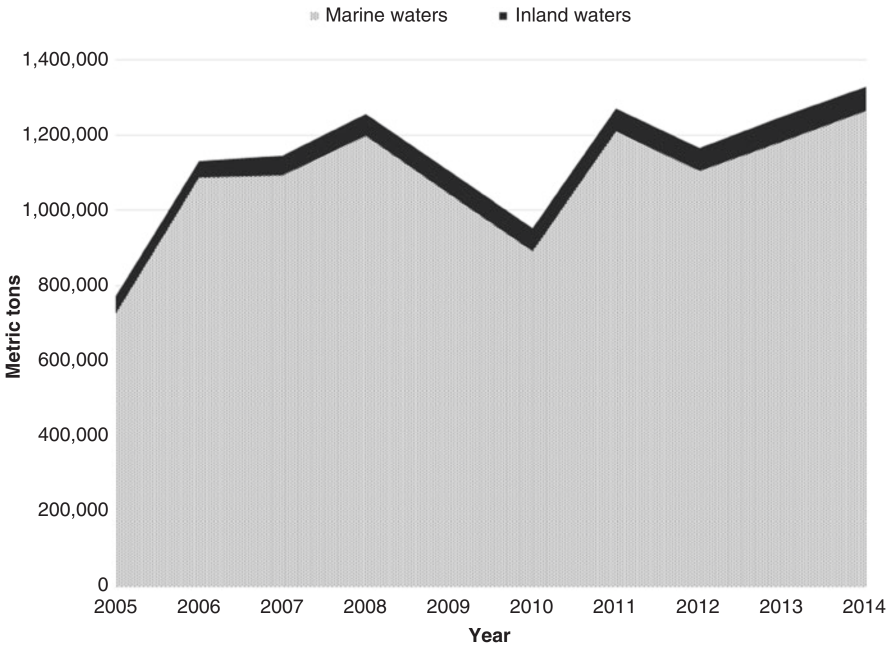



**Fig. 14.5** Contribution to small-scale fisheries production by area in Peru. Reproduced from Statistical yearbooks from 2005 to 2014 (Ministry of Production, Peru)

The volume of capture in Peruvian small-scale fisheries has followed a cyclical tendency. Data on overall production are strongly influenced by the squid fishery's capture, which in 2014, represented 36% of the total small-scale fisheries catch (PRODUCE 2014). Inland fisheries, on the other hand, contributed only 5% of the overall small-scale fisheries catch in the same year (Fig. 14.5).

Along the coastline of Peru, the main fish species captured by the small-scale fisheries sector include anchovy (*Engraulis ringens*), squid (*Dosidicus gigas*), and scallop (*Argopecten purpuratus*). The share of these three species together represented 52% of the total small-scale fisheries catch in Peru (Fig. 14.5). However, in recent years a substantial increase in the landings of the latter two species has been experienced, stimulated by a concomitant rise in market prices.

In terms of inland small-scale fisheries in Peru, the Amazonian river basin region contributes nearly 92% of the total small-scale fisheries catch. The principal species in terms of catch volume are the black prochilodus (*Prochilodus nigricans*), the "palometa" (*Mylossoma duriventre*), and the wolf (or tiger) fish (*Hoplias malabaricus*). In Peru, the inland fisheries of the highland regions are chiefly subsistence-oriented. The most commonly targeted species by this sector are river shrimp (*Cryphiops caementarius*), rainbow trout (*Oncorhynchus mykiss*), and the "carachi" (*Orestias luteus*).

The *General Fisheries Law* (Supreme Decree No. 25977) in Peru defines small-scale fisheries as "the type of fishing practiced with or without the use of small fishing crafts through manual labor" (MINAM 2014). This definition is complemented by the rules of application of the same Law, which state that small-scale fisheries is "the type of fishing practiced by individuals, families or small-scale companies that employ small fishing crafts, basic technology and manual labor, whose production is assigned for direct human consumption." The maximum allowable length of a fishing craft is 13 mt and a storage capacity limit of 32.6 $m^3$ (FAOLEX 2014).

In Peru, small-scale fisheries crafts have the exclusive right to fish within five nautical miles off the shoreline, notwithstanding their right to fish beyond that limit. Inland fisheries, in turn, are conducted in the country's three major water bodies, namely, the Pacific, the Amazonian, and the Lake Titicaca.

The Peruvian normative legal framework recognizes some attributes used to differentiate main actors in small-scale fishing activity, including small-scale fishers, fishing craft owners, and fish processors. Between 2012 and 2013, a national census took place focusing on the small-scale fisheries sector. The total number of fisherfolk registered in Peru was 76,285, of which 42% corresponded to inland fishers. Of all the fishers officially recorded by the census, only 8% were women. Women work chiefly in postharvest-related fishing activities, especially in the processing and commercialization of fish. However, there are other zones, such as Lake Titicaca, where women also take part in fishing activities.

According to the *General Fisheries Law*, all fish derived from small-scale fisheries must be allocated for direct human consumption purposes (MINAM 2014). Fish caught through small-scale fishing activities are traded in small harbors where crew family members and local workers participate in basic fish processing and trade. In inland fisheries, nearly 90% of fisherfolk linked to this fish activity for household consumption purposes; thus the fish that are sold represent the surplus that remains once they have satisfied their own food requirements. The trade of small-scale fisheries catches is conducted in harbors and targets local markets and intermediaries. Often, the middlemen are relevant actors in fish chain production who provide financial aid to fishers for conducting fishing activities. This support entails a reciprocity bond between middlemen and fishers that obligates fisherfolk to sell their catches exclusively to the financer agent upon landing their catch. Middlemen then sell the fish to local processors or regional markets. Only squid (*Dosidicus gigas*) and corvina drum (*Cilus gilberti*) are exported by intermediaries or brokers.

## 14.3 Methodological Approach

Inputs for the analysis were derived from two sources: (a) primary data drawn from direct semi-structured interviews and focus groups and (b) secondary information obtained from the analysis of available grey literature in the form of technical reports and official documents provided by national small-scale fisheries authorities.

The primary data collection followed a semi-open-ended questionnaire format and was applied through a series of face-to-face interviews with fisherfolk and national fisheries authorities. Fishing communities in Chile, Colombia, and Peru were chosen as the study areas where the interviews were conducted (Table 14.1). These areas were selected based on a set of criteria that included (a) density of small-scale fishing-dependent families, (b) presence of alternative economic activities to fishing, and (c) the permanent nature of the fishing population (excluding seasonal fishing camps). Interviews were conducted with both fishers and their family members. Additionally, focus groups with representatives of certain fishing communities were conducted. The questionnaire and focus groups attempted to document interviewees' perceptions about the reality of the small-scale fisheries sector and also obtain quantitative data about their consumption of fish and fish produce. When possible, data about cash incomes were also collected.

In each study site, we intended to interview a representative sample of at least 10% of the fishing-dependent families within the community. However, the reluctance of some potential interviewees to take part in the interviews resulted in a lower number of interviewees than the number expected at the beginning of the research. The selection of families to be interviewed within each fishing communities was conducted via random sampling. In cases where the households declined to participate, alternative families – from their neighborhood – were recruited. There were 255 fishers and family members in total that were interviewed. The questionnaire was focused on the following general aspects:

1. Characteristics of the housing environment
2. Contribution of small-scale fishing activity to family food security
3. Contribution of small-scale fishing activity to family cash income

**Table 14.1** Fishing communities and municipalities that participated in the study in Chile, Colombia, and Peru

| Country | Municipality | Fishing community |
|---|---|---|
| Chile | Casablanca | Quintay |
| | Chiloé | Ancud |
| | | Dalcahue |
| | Puerto Montt | Anáhuac |
| | | Calbuco |
| | | Maullín |
| | Valdivia | Amargos |
| | | Niebla |
| | | Valdivia |
| Colombia | Bolívar | Cartagena |
| | Magdalena | Santa Marta |
| | Santander | Barrancabermeja |
| | Valle del Cauca | Buenaventura |
| Perú | Arequipa | Camaná |
| | | Quilca |
| | Lima | Pucusana |
| | Loreto | Punchana (Iquitos) |
| | | Santa Clara de Nanay |
| | Moquegua | Ilo |
| | Puno | Puno |
| | | Laguna Umayo |

In order to set comparable currency-related variables, national information on prices and cash income values were converted into US dollars, which in this case was used as the referential currency. It followed the United Nations agreed system for operational exchange rate for June 2015. The obtained conversions were as follows:

- $1 USD = 503 Chilean pesos
- $1 USD = 1913 Colombian pesos
- $1 USD = 2771 Peruvian nuevos soles

## 14.4 Results

### *14.4.1 The Case of Chile*

Results of this study show that between 80% and 100% of family cash incomes in families within fishing communities are derived from fishing-related activities, regardless of the number of family members involved in the generation of that cash income.

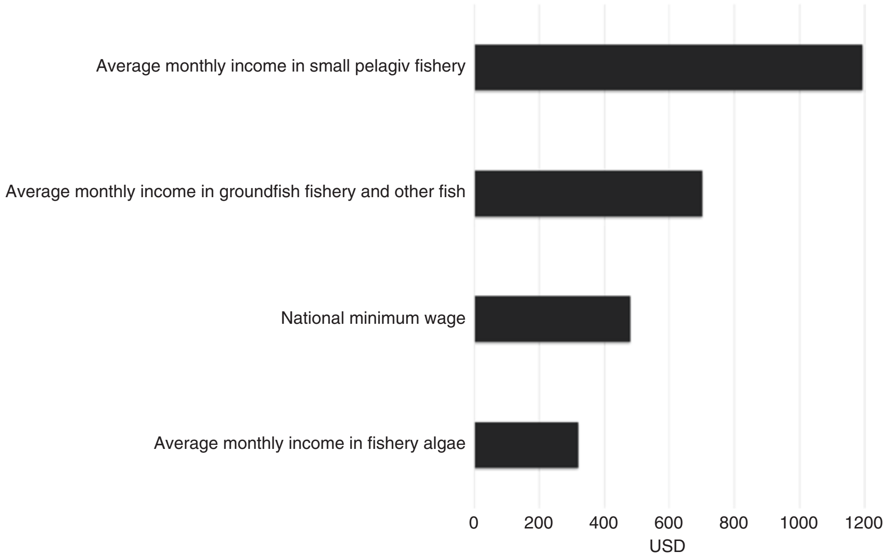



**Fig. 14.6** Average monthly income by fisherfolk and national official minimum wage in Chile in 2015 (reproduced from calculations based on survey results and national minimum wage established by Law No 20,763 on July 1, 2015)

The cash income of the families surveyed is highly correlated to the species they target in their fishing activity. In that sense, the study revealed a dynamic path in the monthly average incomes of families derived from small-scale fisheries. For instance, families that harvested the macrophye "*pelillo*" (*Gracilaria chilensis*) in intertidal zones, where the highest participation of women occurs, earn an average income of $318 USD per month, while those fisherfolk targeting demersal species such as conger (*Genypterus* sp.) or southern bream (*Brama australis*) report monthly incomes between $600 and $800. At the top of the income range, due to the high volumes they catch, are the fishers who target pelagic species, such as sardines (*Sardinops sagax*), with a reported average monthly cash income of up to $1193 (Fig. 14.6).

It is worth noting that there seemed to be a correlation between poverty and female participation in fishing. We observed that, in general, the lower the cash income of fishing-dependent families, the higher the participation of women as an additional cash income generator of the family. This occurs particularly in postharvest (processing) activities, but also in harvesting fishing activities. In order to help complement family cash income, in fewer cases (20%), other members of the household (i.e., women or other family members) do not engage in fishing activities, but instead operate small family-run business like rural grocery stores, restaurants, small-scale agriculture practices, or livestock harvesting.

In Chile, we found that at least 75% of fisherfolk belong to households that have engaged in marine fishing for two or three generations. Generally, the cash income that is directly derived from small-scale fisheries in Chile is significantly higher than the official national minimum wage. An exception of this trend is the macro algae collectors and fisherfolk who complement their livelihoods with non-fishing-related activities.

In Chile, the commercialization of daily fish catches takes place in small-scale fisheries harbors known as "*caletas*." The family members of harvesters usually sell the catch. According to the results of this study, 67% of fishers sell their catch to intermediaries who then transport and further sell the fish to wholesalers and retailers at regional and national markets. The remainder (33%) have developed different sale arrangements with brokers and/or family members who own means of transportation to jointly sell the fish catch in nearby urban centers.

Concerning social protection schemes for small-scale fisherfolk, the results of the study showed that about 74% are covered by the social public welfare system, which in general is limited to providing basic medical services for the family. Moreover, none of the interviewees who were employed by the owner of the fishing boat in which he/she works were officially "hired," since no official labor contracts were signed that regulate his/her job. The implications of this situation are that none of these fishers will have access to a pension or retirement fund or to leave benefits for illness or maternity. This condition seems to be worsened by the prohibitively high costs associated with private medical insurance plans, which are not commonly used by fishers (only 25% of the interviewees reported having one). In contrast, all respondents reported having savings for contingency purposes, although in many instances, this is not enough to face immediate crisis such as long periods without fishing-related gains.

Regarding food security, fish is by far the highest source of animal protein intake for fishing-dependent families. The average annual per capita consumption of fish in this study was found to be between 104 and 156 kg (Fig. 14.7). Some respondents expressed that even when they could not go out fishing for more than3 days, they prefer to buy fish than to purchase other locally available animal sources of protein such as chicken or beef. In contrast, in non-fishing-dependent families, the annual average per capita fish consumption in fishing communities was similar to the amount officially reported as the national average, around 6–7 kg (SUBPESCA 2016).

### *14.4.2 The Case of Colombia*

Results of this study showed a wide variation of family incomes derived from small-scale fisheries in Colombia. This aspect fluctuates depending on the region where the community is located and even among communities within the same region (Fig. 14.8). Along the Caribbean Colombian coast, the small-scale fisheries sector has been affected by the expansion of the oil industry and, to a lesser extent, by tourism. In the Santa Martha region, where communities are located close to oil rigs, the interviewees mentioned that around 10 years ago, their monthly income provided

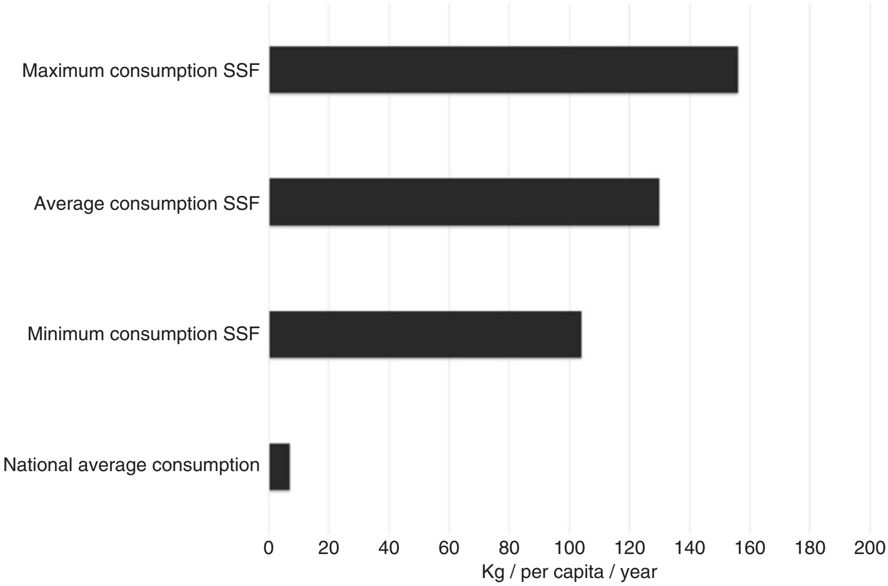



**Fig. 14.7** Fish consumption in fishing-dependent families of Chile. Reproduced from calculations based on the present survey results

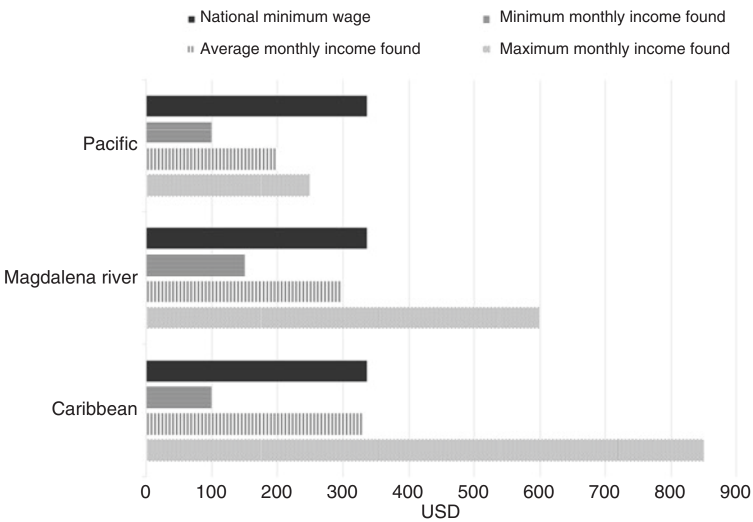



**Fig. 14.8** Average monthly cash income of small-scale fisheries in Colombia. Reproduced from calculations based on survey results and national minimum wage on July 1, 2015

by the fishing activity reached over $1000, while nowadays it ranges between $100 and $330, depending on the season. This decrease in earnings of between 30% and 90% has brought their incomes lower than the official national minimum wage. In contrast, fishers from communities located near the touristic city of Cartagena reported monthly incomes of up to $850, often derived from working in both fishing and tourism.

In the watershed of River Magdalena, the life conditions of fishing-related interviewees were different from other regions. Since most of the fisherfolk capture fish for family's own consumption, only very little surplus of fish is left for selling in local markets. Their monthly cash income, according to this study, varied between $150 and $300. Thus, many of the families surveyed lived under the poverty line, considering the high rate of inflation externalized by the presence of oil industry activities in the region. In a few sites, however, monthly cash incomes were reported to be up to $600, although often this income is only earned during a 3-month period. This short-term earning option is due to the seasonality of the striped catfish (*Pseudoplatystoma* sp.) fishery, which has a significantly higher price in local markets.

Regarding the fishing communities along the Pacific littoral, the monthly cash income of fishers, as suggested by the results of this survey, varies between $200 and $250, which is also below the official national minimum wage. Nonetheless, most of the fishers interviewed (75%) reported to exercise complementary productive activities such as small-scale agriculture and/or livestock harvesting, whose products are used as a direct food source.

In all the Colombian study sites, a common element found was that the younger members of the family who participate in fishing are likely to remain fishing and are more inclined to drop out of school in order to become part of the family's labor force. Additionally, a characteristic commonly found was that nuclear family members or close relatives from the same community usually practice fishing collectively. This is also true for postharvest and trading activities. In most cases, men are devoted to extractive activities, whereas women are dedicated to selling the fish in local markets.

Most of the fisherfolk interviewed (84%) in all three Colombian regions reported that they dedicated all their time to fishing activities. Only a minority reported having alternative complementary non-fishing economic activities, which were particularly conducted to offset bad fishing seasons.

Fish from small-scale fisheries in Colombian coastal communities is chiefly sold in local markets (82%) and to a lesser extent in national markets. No exports were reported, which is thought to be due to the lack of adequate facilities to ensure proper quality and food safety conditions that are generally required by international markets. Market chains usually involve middlemen who provide fisherfolk with gear as well as upfront cash for fuel and other inputs. In many cases, these costly assets are inaccessible to fisherfolk, who are forced to become indebted to the middlemen. On the other hand, this economic dependency on intermediaries, which allows to fisherfolk to access to cash to operate, significantly reduces their income. This is due to the fact that the prices paid by middlemen are usually much lower

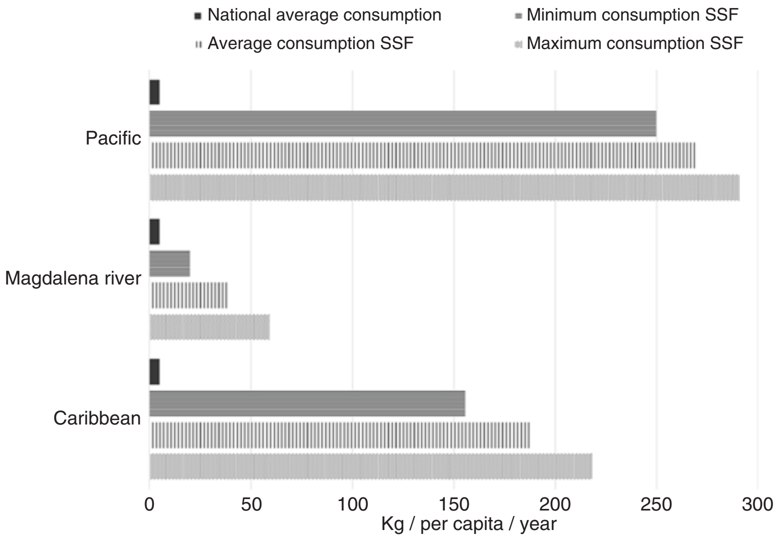



**Fig. 14.9** Average per capita fish consumption of fishing-dependent families of inland and coastal fisheries of Colombia (reproduced from calculations based on survey results)

than the current market prices that would represent higher incomes if they sold their catch directly in the market.

In terms of social welfare protections for Colombian fishers, 97% of the interviewees stated that they do not enjoy of any sort of pension fund or have access to any type of coverage through life or accidents insurance. Very few (less than 2%) expressed having sufficient cash income to pay for a private insurance or pension fund.

This situation is aggravated by the fact that, although the right to access to basic healthcare is legally granted through official programs of the Ministry of Health in Colombia, 28% of the interviewees mentioned that their families were not covered by such social protection schemes. This was mainly due to the lack of knowledge on the part of fishing families about the administrative procedures required to be eligible for these benefits.

In Colombia, the national average annual per capita fish consumption is only 4.5 kg. This amount ranks well below the average consumption of other sources of animal protein such as beef (23.8 kg) and chicken (19.6 kg) (IICA 2013). Within coastal fishing communities, the annual per capita fish consumption ranges between 156 and 218 kg on the Caribbean Coast and between 291 and 250 kg on the Pacific coast. In both cases, the average frequency of consumption is twice a day, 5 days a week (Fig. 14.9). Fish consumption in fishing-dependent families is also high. The present study revealed that, in fishing communities dependent on inland water bodies, fish consumption ranges between 20 and 59 kg per year, with an average frequency consumption of three times a week.

### 14.4.3 The Case of Peru

Family cash income derived from small-scale fisheries in Peru greatly differs between inland and coastal fishing communities. This situation is mostly due to higher yields and prices of marine fish species compared to their freshwater counterparts. In the Amazonian city of Iquitos, the results of the present study revealed that the average monthly cash income of fisherfolk was $300, with a minimum of $200 and a maximum of $400. These levels of cash income fall within the official regional minimum wage. Women of Iquitos, similarly to women in other Peruvian fishing communities, actively participate in processing and selling fish produce and thus contribute to the improvement of their family cash income. Moreover, in most cases (76%), fishers also engage in supplementary alternative economic activities in order to improve their household cash income (PRODUCE 2012).

Men and women alike practice fishing in Lake Titicaca's watershed. Men perform the actual capture activities, whereas women collect the fish and prepare the fishing gear. Average cash incomes earned from fishing activities in this region were found to be below the minimum official national wage of Peru (Fig. 14.10). Overall, fisherfolk in Peru complement their cash incomes with other agricultural and livestock activities.

In contrast, fisherfolk of coastal fishing communities earn as much as $1400 per month, which is far above the minimum official wage both regionally and nationally. Nonetheless, quite often the presence of adverse conditions such as fish scarcity, adverse climatic conditions, and seasonal fishing regulations (e.g., bans) reduces their earnings to as little as $100 per month, thus obliging them to rely heavily on savings for their subsistence.

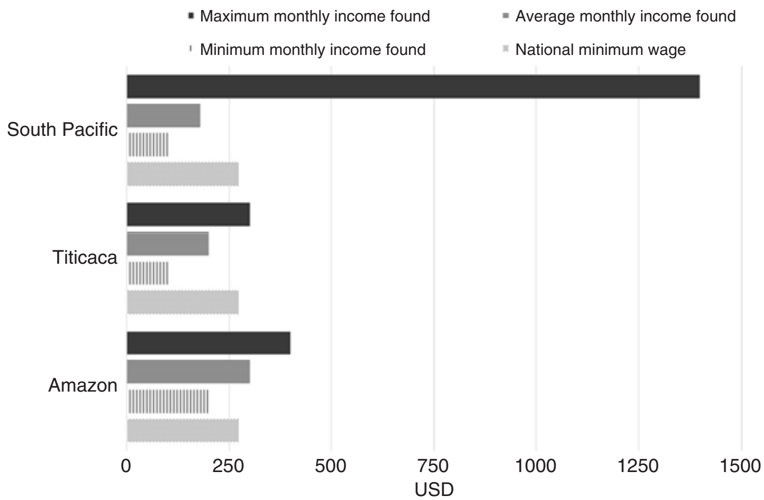



**Fig. 14.10** Average monthly cash income of small-scale fisherfolk in Peru (reproduced from calculations based on the results of this survey and national minimum wage on July 1, 2015)

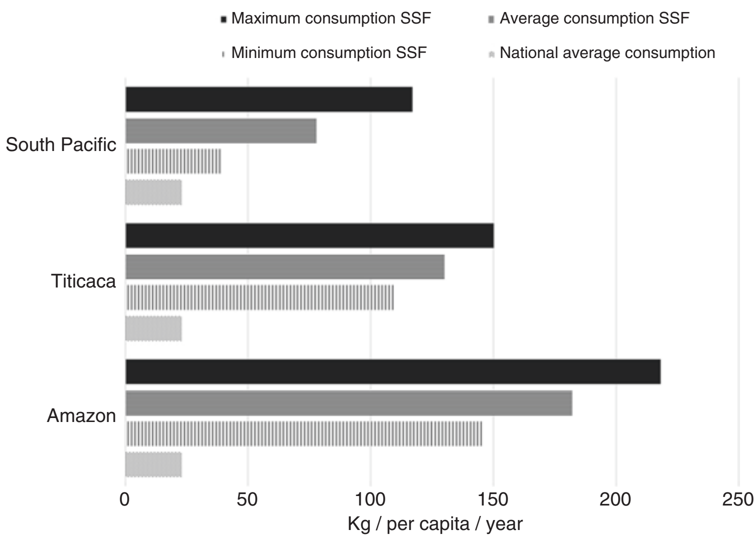



**Fig. 14.11** Average annual per capita fish consumption in Peru (reproduced from calculations that correspond to small-scale fisheries are based on the results of the present survey. National average consumption based on PRODUCE 2014)

Regarding social protection, this study revealed that 70% of the interviewed fishers lack access to social welfare in coastal communities of the Pacific. Interviewees mentioned that they can afford their own medical expenses and can receive medical attention at either public or private clinics if minor illnesses occur. Out of the more than 13,000 fishers in the Pacific coastal communities, only 3613 (30%) have some type of public (state-provided) medical welfare scheme, and only 757 (5.7%) are affiliated with a pension fund.

The Government of Peru has recently created a small-scale fisherfolk and processor Social Security System, which is still at a very preliminary stage of development. It allows fisherfolk to get access to medical care, economic aid during illness or maternity, and life insurance in case of fatalities. The Peruvian case, together with Ecuador where a similar system has been introduced, is the first social protection schemes for small-scale fishers in Latin America. Despite the advantages of this progressive system, the fact that families are required to pay monthly fees still limits access to coverage to only those fishers who can afford the payments.

Fisheries products in Peru represent the main source of animal protein intake for the entire population, which contributes to 53% of national consumption (FAO-FishStat 2016). The gastronomic preferences of the Peruvian population are oriented toward fish and seafood, which influence the relative prices and accessibility of these products at local markets. Moreover, over the past 10 years, the Peruvian Government has implemented various policies and programs to enhance national fish consumption, particularly in remote areas of the country. As a result, the average per capita consumption of fish in Peru has reached 23 kg per year (Fig. 14.11).

As it was expected, this study found a higher average of fish consumption among fishing-dependent families than non-dependent families. In the Amazonian communities, for instance, the average individual fish consumption was found to be as high as 218 kg per year, which is explained as it is fish the most readily available source of animal protein. Communities adjacent to the Lake Titicaca also present a high consumption (between 110 and 150 kg per capita per year), revealing their fish-dependent culture. Lastly, fishing communities on the Pacific littoral also exhibit high levels of fish consumption, although lower than the rest of the communities surveyed. This feature reflects a wider diversity and accessibility of other sources of animal protein.

## 14.5 Discussion and Lessons Learned

The importance of the small-scale fisheries sector in Chile, Colombia, and Peru transcends the sole economic value of the activity in terms of its contribution to national economic growth, reflecting strong social, cultural, symbolic, and nutritional and food security dimensions. The latter, unfortunately, has been largely ignored and underestimated. Findings of this research show that fish is the staple diet and the major component in the regular food intake of thousands of families in coastal and riverine communities in Chile, Colombia, and Peru where this research was conducted. At the same time, it has been observed that fish greatly contributes to a relatively improved nutritive condition in fishing-dependent populations in these localities. This situation markedly contrasts with other poor rural communities in these countries, where access to fish as a source of protein is rather limited. While this finding might has seemed obvious, the observed results show that the level of fish consumption in those communities was found to be even higher than the average reported for traditional fish-dependent societies, such as those of Southeast Asia and sub-Saharan Africa (FAO 2016). Preliminary research on the nutritional conditions of inhabitants in poor indigenous coastal communities of Guatemala, for instance, shows that communities who have regular access to fish as food exhibit significantly lower levels of chronic undernourishment (<5%) than their counterparts in the highlands, where there is limited access to fish as source of protein intake. In this case, we support the assumption of FAO (Lasso Alcalá 2011) that a factor that fish protein likely plays a critical role in achieving better nutritional conditions in coastal communities.

Additionally, the small-scale fisheries sector in the study areas has been shown to be a major source of employment both locally and nationally. While official figures report that there are more than two million small-scale fisherfolk in Latin America (FAO-FishStat 2016), the common perception found among national fisheries authorities, academics, and researchers interviewed is that these numbers do not represent the reality of the sector. In fact, these stakeholders mentioned two main reasons for the underestimation of the fishing population. First, they argued, the highly geographic dispersion of fisherfolk within poorly accessible communities makes the regular and systematic register and control of the fishing populations impossible. Second, interviewees felt that the official registration systems of each country that are used to characterize the fishing activity are inaccurate, imprecise, and underscore the actual numbers of fishers and fishing catches, which are expected to be much higher that the official numbers suggest.

The fishing communities examined in this study showed to be fostering a great diversity of fishing practices, gears, and vessel types. Additionally, the high relevance of cultural, symbolic, and socioeconomic dimensions were found in the small-scale fisheries sector, related to the realities of those fishing villages in the three countries. This aspect demonstrates that the high diversity encountered in the small-scale fisheries sector within these three Latin American countries is intrinsically linked to the high complexity implicit in this sector. We thus argue that, by integrating other regions and micro-regions where small-scale fisheries are a significant sector, more diversity would be added to the already diverse and complex small-scale fisheries sector of the Latin American region.

This research has examined three small-scale fisheries cases in three Latin American countries, thus making a great contribution to improving knowledge about the small-scale fisheries sector in the region. Similarly, this study represents an important attempt to better interpret the challenges and opportunities that this sector addresses both locally and regionally. We argue that this knowledge could enable more appropriate decision- and policy-making related to fishing-dependent communities that experience similar challenges regarding their access to fish as food and other fishery-related problems. However, we are aware that some contestation could arise about the representativeness of the communities that have been sampled for making generalizations or policy recommendations for the whole region. In response to this concern, we argue that our selection of these case studies was done with a recognition that the likeliness that other fishing-dependent communities would share similar social, economic, cultural, historical, and fishing technology characteristics. By doing so, it would be feasible for us to describe the small-scale fisheries sector of these areas as an appropriate approach to look at the small-scale fisheries in the entire region. However, further studies would be advisable in other countries, to ensure that these findings can be generalized to the whole region.

This case study research approach has also allowed us to record and analyze micro-region-specific problems faced by small-scale fisheries in these countries, such as the low cash income often earned by fishers. This precarious resilience of inland and some coastal fisherfolk, in Colombia and Peru, is hence one critical attribute that diminishes their likeliness to achieve sustainability. In these cases, cash income was found to be lower than the minimum national monthly salary. This situation is aggravated by the fact that more than 70% of fishing-dependent households do not have access to public welfare supports. Both attributes worsen the already difficult situation of the small-scale fisheries sector and thus aggravate the viability of fishing communities.

Additionally, the findings on average individual cash incomes of fisherfolk in some Peruvian and Chilean coastal communities are worthy of further consideration.

In some cases, the reported cash income of Chilean fisherfolk was almost four times the official national minimum wage. Furthermore, some commonalities regarding cash income were found:

1. High seasonal catch variability poses a threat to the family economy of fisherfolk, who need to save cash for non-fishing and/or fish scarcity periods. While this is a common practice in the majority of coastal fisherfolk households, it is unaffordable for many others, particularly those depending on inland fisheries.
2. Cash income is less important in remote inland fishing communities since fish catch is destined to family consumption. On the other hand, surplus fish is exchanged for other goods locally, making cash earnings less relevant.
3. Women contribute substantially to household cash incomes throughout the region. Their contribution varies according to whether they are directly involved in fishing practices, such as in Lake Titicaca, or participate indirectly through processing or sales, as seen in coastal localities in the three countries. Moreover, some fisheries, such as the black clam fishery along the Pacific Colombian littoral, depend entirely on women.
4. The current tendency to shift from one species to another, in small-scale fisheries practices, highly depends on the availability of species which possess higher market value in local markets and, thus, can make a greater contribution to household incomes.
5. Household cash income in fishing-dependent communities is generally highly dependents on fishing activities. However, economic diversification has gradually become more important as a strategy to increase resilience and seize economic opportunities, particularly in micro-regions where tourism is growing.

Concerning the access of fisherfolk to social protection schemes, this study revealed that the great majority (>70%) of fishing-dependent families are not covered by social welfare programs. While there are some institutionalized non-fishing monetary incentives in Latin American countries, such as in Brazil and Paraguay (MAPA 2016; SAS 2016), such incentives are not present in Peru, Colombia, or Chile. However, the universal coverage of social welfare programs in Chile does reach fisherfolk. Other social programs in Peru and Colombia are also partially available to fisherfolk. Nonetheless, the lack of monetary compensations during the non-fishing season and the absence of life insurance and leave benefits accentuate the vulnerability of fishing families. As an example, specific welfare systems for small-scale fisheries are still at the pilot stage in Peru. In these cases, fisherfolk pays a monthly fee which entitles them to get access to better medical care and life insurance. However, this system is still inaccessible to low-cash-income inland fisherfolk.

One common issue encountered by small-scale fishers throughout the study sites, with the exception of Amazonian communities, is a high level of intergenerational succession. This condition, characterized by the high migration rate of younger individuals of the fishing population to urban areas in search of better opportunities (i.e., other work opportunities or study), is leading to an emptying of fishing communities at both the family and community scale. While this could indirectly diminish local fishing effort, and thus strongly affect fishing activity in the middle and long run, this trend also poses a major threat to the social and cultural assets that serve as the backbone of the entire small-scale fisheries sector in these communities. A concrete illustration of the consequences of this out-migration is the reduced ability of small-scale fisheries' harvesters to compete with larger boat owners who steadily increase the number of fishing craft for their own benefit.

In more remote fishing communities such as those of the inland fishing communities at the Amazonian region, the youth drop out of schools at an early stage to join family fishing activities. This condition aggravates their likeliness to improve their future well-being and also reduces their chances to further develop their capacities and contribute to local development.

## 14.6 Recommendations

Based on the results of this study, we recommend:

- To revisit and clearly define small-scale fisheries in the case study countries. It would also be desired to describe a typology of fisherfolk, taking into account varied dimensions like their objectives, scale, and limitations, so that sectoral policies might have a differentiated approach and thus would favor the most vulnerable families.
- To include indicators of the actual contribution of small-scale fisheries to food and nutrition security and to cash income of rural families in a broader scale (similar to the ones included in this study), within the Latin American context and also communicated to national sectorial statistics agencies and policy-makers.
- To improve the small-scale fisheries registries and statistical systems, since they are of outmost importance for informed fishery resource governance and the creation of policies to support the poor and marginalized sector of this activity.
- To develop transparent and inclusive market systems that allow small-scale fisheries to commercialize their catch directly. Another beneficial strategy would be the fostering of shorter production chains so that fishers can get a better profit and thus lower their economic risks. This also entails fostering fishers' capacities in order to trade safer and better products.
- To improve fiscal mechanisms to reduce illegal, unreported, and unregulated fishing practices. This will not only improve fisheries resource governance but also clearly define the policy strategies, targets, and mechanisms guiding management.
- To organize and promote the associativity of fisherfolk groups in order to strengthen their networks. This procedure will increase the resilience of both fishers and their communities. This can be achieved through improving and enhancing national extension mechanisms, particularly those based on self-aid approaches.

- To consider the integration of the entire small-scale fisheries sector into national social protection systems, based on the recognition of their vulnerability against a number of climatic and insecure labor conditions.
- To revisit policy formulations and foster the participation of small-scale fisheries in the policy cycle. This would aim to integrate the historical, cultural, and ethnic dimensions involved in fishing practices, as well as alternatives forms of knowledge, within the participatory policy formulation process and decision-making.
- To acknowledge, highlight, and make explicit the important contribution of women to the small-scale fisheries sector. This would ideally support and promote the design and formulation of gender-sensitive policies.
- To consider the interdependence of small-scale fisheries and other sectors, such as small-scale agriculture. For instance, when one sector is affected by external factors (e.g., market or climate-related), it must be taken into account the reality that fishing activity becomes a safety net for families. Concomitantly, small-scale agriculture is a compensatory strategy of fisherfolk who experience negative episodes in fishing.

## References

Alcalá L, Carlos A (2011) Consumo de pescado y fauna acuática en la cuenca amazónica venezolana: análisis de nueve casos de estudio entre comunidades indígenas. COPESCAALC Documento Ocasional N° 15, FAO, Roma, 28 pp

Belton B, Thilsted SH (2014) Fisheries in transition: Food and nutrition security implications for the global South. Glob Food Sec 3(1):59–66

Delgado MF, Gualteros W, Espinosa S, Lucero C, Roldan AM, Zapata LA, Cantera JR, Candelo C, Palacio C, Muñoz O, Mayor G, Gil Agudelo DI (2010) Cali, Colombia: "Pianguando – Estrategias para el manejo de la piangua" (Cartilla). INVEMAR, ASCONAR, WWF Colombia, Universidad del Valle, UAESPNN – PNN Sanquianga; Co-financiado por el Ministerio de Agricultura. Serie de publicaciones generales INVEMAR No. 45

FAO (2016) The state of world fisheries and aquaculture 2016: contributing to food security and nutrition for all. FAO, Rome

FAO (2012) Informe de la duodécima reunión de la Comisión de Pesca Continental y Acuicultura para América Latina y el Caribe (COPESCAALC). Cuernavaca, México, 21–24 de noviembre de 2011. Informe de Pesca y Acuicultura de la FAO N°993. Santiago, Chile, p 18

FAO Fishstat (2016) Estadísticas pesqueras. FAO Fisheries and Aquaculture Department. http://www.fao.org/fishery/statistics/es. Accessed 26 May 2016

Food & Agriculture Organization Legal Department (FAOLEX) (2014) Reglamento Ley de Pesca de Perú. http://faolex.fao.org/docs/pdf/per2920.pdf. Accessed 08 July 2014

González Poblete E, Cerda D'Amico R, Quezada Olivares J, Martínez González G, López Araya E, Thomas Álvarez F, Merino Díaz J (2013) Propuesta de política pública de desarrollo productivo para la pesca artesanal "Estudio para la determinación de una Propuesta de Política Pública de Desarrollo Productivo para la Pesca Artesanal". Pontificia Universidad Católica de Valparaíso, Escuela de Ciencias del Mar a encargo de la Subsecretaría de Pesca, Valparaíso

IICA (Instituto Interamericano de Cooperación para la Agricultura) (2013) Agenda Nacional de Investigación en Pesca y Acuicultura. Dirección de Pesca y Acuicultura del Ministerio de Agricultura y Desarrollo Rural, Bogotá. ISBN-958-57254, 2011-2012

MAPA (Ministério da Agricultura) (2016) Sitio Oficial del MAPA, Brasil. http://www.agricultura.gov.br/. Accessed 02 June 2016

Minagricultura (Ministerio de Agricultura y Desarrollo Rural) (2014) Sitio oficial de Miniagricultural. Reglamento de la Ley de Pesca, Decreto 2256 de 1991 por el que se reglamenta la Ley 13 de 1990. https://www.minagricultura.gov.co/Normatividad/Decretos/Decreto%202256%20de%201991.pdf. Accessed 10 July 2014

MINAM (Ministerio de Medio Ambiente) (2014) Ley General de Pesca de Perú. http://cambioclimatico.minam.gob.pe/decreto-ley-n%C2%BA-25977-ley-general-de-pesca/. Accessed 10 July 2014

PRODUCE (2012) I Censo Nacional de la Pesca Artesanal Ámbito Marítimo, Primeros Resultados. Despacho Viceministerial de Pesquería, Perú

PRODUCE (2014) Anuario Estadístico Pesquero y Acuícola 2013. Despacho Viceministerial de Pesquería, Perú

SAS (Secretaría de Acción Social) (2016) Secretaría de Acción Social – Paraguay. http://www.sas.gov.py/. Accessed 22 May 2016

SEPEC (Servicio Estadístico Pesquero Colombiano) (2015) Sitio Oficial de SEPEC. Autoridad Nacional de Acuicultura y Pesca, Universidad del Magdalena. sepec.unimagdalena.edu.co. Accessed 3 Feb 2015

SERNAPESCA (Servicio Nacional de Acuicultura y Pesca) (2016) Anuarios Estadísticos de Pesca 2005–2014. Ministerio de Economía, Fomento y Turismo, Departamento Sistemas de Información y Estadísticas Pesqueras del SERNAPESCA, Chile. http://www.sernapesca.cl/. Accessed 3 Feb 2015

SUBPESCA (Subsecretaría de Acuicultura y Pesca) (2014) Sitio oficial de la SUBPESCA. Ministerio de Economía, Fomento y Turismo. Ley General de Pesca y Acuicultura de Chile. http://www.subpesca.cl/normativa/605/w3-article-516.html. Accessed 17 July 2014

SUBPESCA (2016) Sitio oficial de la Subsecretaría de Pesca y Acuicultura. Ministerio de Economía, Fomento y Turismo. http://www.subpesca.cl. Accesed 10 Feb 2016

**Javier Villanueva García Benítez** is a FAO Consultant of the Regional Office for Latin America and Caribbean. He is a Natural Resource Manager (Marist University, Merida, Mexico) and holds a Master’s in Public Policy. He has been a member of a fisheries advisory committee in Yucatan, Mexico, and fisheries inspector and coordinator of fisheries inspectors in Mexico. Currently, he is a FAO consultant supporting activities related to the sustainability of small-scale fisheries in Latin America. He coordinates a regional project to combat illegal, unreported, and unregulated fishing. He has been involved in national and regional projects aimed at strengthening the contribution of small-scale fisheries to food security and poverty eradication.

**Alejandro Flores-Nava** holds a PhD in Aquaculture from Stirling University, UK. He has served as Full Professor, Head of the Marine Resources Department, and Director of the Center for Research and Advanced Studies (CINVESTAV, Mérida, Yucatán, Mexico), as well as Director of the School of Natural Resources and Rector of the Marist University of Merida, Mexico. He joined FAO in 2008, where he served as coordinator of the multidisciplinary team for South America and FAO Representative in Argentina and Chile, and is currently Senior Fishery and Aquaculture Officer for Latin America and the Caribbean and Secretary of the Commission for Inland Fisheries and Aquaculture of Latin America and the Caribbean (COPESCAALC).

# Chapter 15
# Seafood Supply Chain Structure of the Fishing Industry of Yucatan, Mexico

**Carmen Pedroza-Gutiérrez**

**Abstract** Today's small-scale fisheries contribute more than half of the total marine fish catch to the world's fishing industries, but they are facing overexploitation, increases in demand, overcapitalization, and new challenges imposed by fish markets and climate change. This work examines how the Yucatan region's fishing industry has organized its resources to face new hurdles and maintain its position in the market. The chapter considers a resource-based view perspective and uses a qualitative-exploratory methodology based on interviews with the Yucatan's leading fishing entrepreneurs. This methodology allowed the study to describe the nature of the main industry processes and relationships which give place and continuity to the fish trade. The main findings show that the ownership of major fishing capital such as vessels, boats, and processing plants is not enough to ensure access to seafood in every season but rather suggests that what is needed is the development of different levels of relations which are long term and seasonal in nature across different supply chain members (fishers, middlemen, and skippers). Furthermore, firm owners' ability to organize fishing effort according to the fish available each season and to link with traders and suppliers according to market demand has been a key resource to maintain this industry in the market. Finally, the chapter shows how small-scale fisheries are part of an important supply chain for large processing plants and make a key contribution to their existence and continuity in the market. At the same time, small producers' participation in the market is limited and controlled by these fishing businesses.

**Keywords** Seafood supply chain · Yucatan

C. Pedroza-Gutiérrez (✉)
Unidad Académica de Estudios Regionales, Coordinación de Humanidades,
Universidad Nacional Autónoma de México, Jiquilpan, Michoacán, C.P, Mexico



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_15

## 15.1 Introduction

Today's competitive markets are constantly changing, presenting new hurdles for supply chain management (SCM) that must be overcome to ensure effective inter-organizational strategies. In the case of the fishing sector, these hurdles are imposed by market specialization based on increasing consumer knowledge and awareness regarding food quality and environmentally friendly products (Miles and Munilla 1997; Wagner and Alderdice 2006), the variety of products and actors that intervene in the fish trade, the shelf life of products (Anderson 2003), recruitment variability (Sissenwine 1984), natural phenomena such as hurricanes and red tides, natural resource depletion (Mullon et al. 2005), and fisheries management and regulations such as closed seasons or quotas. These common factors, which affect multiple markets, as well as increasing competition, demonstrate a clear need for building dynamic strategies for adapting the seafood supply chain to the changing conditions of supply and demand.

Challenges imposed by market dynamics are also major concerns to be considered in the well-being of the Mexican fishing industry. Mexican fish markets are heterogeneous, given that coastal and inland states do not share the same knowledge about eating fish and that fish markets have specialized and nonspecialized consumers. Mexican fish markets are also affected by many of the same problems identified in the fishing sector. Most Mexican fisheries are considered artisanal and small scale (Salas et al. 2006) and currently face challenges such as biological overexploitation, overcapitalization, monopoly in commercialization, obsolete fishing capital, social problems associated with fish resources (Hernández and Kempton 2003), and climate change (Arreguín-Sánchez et al. 2015).

In Yucatan, a state in the southeast of Mexico, the commercial fishing industry started to develop in the 1940s and has become an increasingly important part of the economy. The most important seafood products by volume are octopus (*Octopus maya* and *Octopus vulgaris*) and fish (mainly grouper, *Epinephelus morio*), representing 40% and 30% of the state's total catch, respectively. *Octopus vulgaris* has been identified as capable of expansion in effort (Pérez-Pérez et al. 2006; CNP 2012), but the *Octopus maya* has been reported as fully exploited (Solana et al. 2005; CNP 2012), with observed tendencies of catch decrease (Salas et al. 2008), suggesting that stocks may be overexploited (Jurado-Molina 2010). In the case of grouper, overexploitation was already reported years ago (Giménez-Hurtado et al. 2005). Thus, concern about scarcity among fishing entrepreneurs is not uncommon. In spite of these concerns, Yucatan's commercial fishing industry has been able to maintain a strong position in the market, currently representing 31% of the wealth generated in the state's coastal region (INEGI 2009).

Considering this context, the aim of this chapter is to identify and explain how Yucatan's fishing industry has been able to organize its resources in order to face these hurdles and maintain its position in the national and international fisheries market. This analysis will help improve the understanding of the important contributions of small-scale fisheries to large processing plants' existence and continuity in the market.

To accomplish this aim, the main resources of the fishing industry of Yucatan are identified in the following sections. Then, the paper draws upon a theoretical framework rooted in a resource-based view perspective that is used to analyze the regional fishery. The research methodology is presented, followed by the results from Yucatan's supply chain. Finally, a discussion and final reflections are presented in light of the different dimensions and organization of the seafood supply chain.

## 15.2 The Seafood Supply Chain and Organizational Resources

In light of the complexity that currently characterizes the composition and organization of fish markets, and small-scale fisheries' role within them, it is necessary to consider a theoretical approach suitable to framing the dynamics of fish trade phenomena. The resource-based view perspective can be helpful in understanding and explaining how Yucatan's fishing industry has been able to maintain its position in the market through the organization of its resources because firm resources are the base to create and implement strategies to facilitate the production and distribution of goods (Porter 1981).

The resource-based view (RBV) perspective has been mostly used as a framework in strategic management (Fernández et al. 2000; Rungtusanatham et al. 2003; Sepulveda and Gabrielsson 2013; Nieves and Haller 2014); however, small-scale fisheries are organizations that are also forced to implement new strategies or coping mechanisms to access or to adjust to changing market dynamics. The RBV framework is based on the argument that firms can gain and sustain competitive advantage through the implementation of strategies based on their strengths or assets (Barney 1991). This theoretical approach explains how competitive advantage can be achieved through the use of resources that a firm can acquire or control (Rungtusanatham et al. 2003; Hart and Dowell 2010). These resources can be tangible, such as equipment, or intangible such as processes, capabilities, knowledge, or information (Grant 1991). The sustainability of competitive advantage depends on the extent that resources can be valuable, rare, inimitable, and supported by tacit knowledge or organizational processes (Barney 1991).

Intangible resources have been classified as either people-dependent or people-independent (Hall 1993; Fernández et al. 2000). People-dependent resources are inseparable from the humans who bear these resources (i.e., employees' knowledge), while the second type refers to those that remain in the firm even if a particular employee leaves. Fernández et al. (2000) divide these resources into four categories: human, technological, relational, and organizational capital. Human capital is people-dependent because it refers to the knowledge and abilities an employee might have and contribute to the firm. Technological capital refers to the necessary knowledge to access, use, and innovate on production techniques and production technology. Relational capital consists of the potential derived from these types of resources related to the market place (reputation, brands, customers' long-term relationships, distribution channels, etc.). Organizational capital refers to the procedures and organizational knowledge a firm possesses, such as norms or guidelines, organizational routines, corporate culture, or cooperative agreements.

Organizational and relational capitals are resources that relate social factors to organizational strategies because they are derived from cooperative relationships. These cooperative relations can be expressed in supply chain linkages developed by the firm with supply chain partners in order to manage the supply chain (Rungtusanatham et al. 2003), according to the resource needs and social resource opportunities (Eisenhardt and Schoonhoven 1996), that a fishing firm might have while facing market changes.

Linkages, or supply chain interactions, can take the form of long-term relationships with suppliers and customers. According to Kalwani and Narayandas (1995), these interactions can help to reduce uncertainty and improve firm operations in terms of flexibility, costs, and quality (Narasimhan and Jayaram 1998). Supply chain interactions can develop strategic alliances that can be part of the social capital of a firm because they can provide access to strategic resources for alliance partners. This inter-organizational capability represents a form of social capital because it can create benefits from linking with suppliers or costumers according to the needs and opportunities given in the market place (Eisenhardt and Schoonhoven 1996). Furthermore, organizational capital can be a dynamic capability because it gives place to adapt to changes in the market place. The organizational capabilities that a firm develops are part of the dynamic capabilities that explain how firms can adjust their assets and adapt rapidly to competitive markets (Hart and Dowell 2010). These dynamic capabilities can be constructed through knowledge-based resources, which in turn are the central element to modify assets for adaptation (Nieves and Haller 2014).

Organizational capabilities can derive into organizational routines, which can be understood as a sequence of coordinated actions to face a regular or particular event (Nelson and Winter 1982). These routines can be static or dynamic: static routines follow a determined pattern to perform a task under a continuous repetitive action, and dynamic routines have to be more flexible and able to adapt to changing circumstances in order to improve or create new products or processes (Teece et al. 1994). Thus, supply chain interactions can create linkages with key actors, giving place to opportunities, and organizational routines can improve the flow of fish throughout the seafood supply chain because of the already created social structures that make information and resources available (Granovetter 1973).

In fishing activity, the structure of the seafood supply chain is organized through a number of stages, starting with raw materials (seafood in its primary form) to end consumers. This structure is based on firm resources (vessels, fishing, and processing technology) and the relationships between suppliers (fishers, cooperatives, skippers) and buyers (fishing firms, middlemen), through different types of contracts or trading agreements that can be the base of this organizational structure. In general, a fishing firm could be vertically engaged in harvesting, processing, and trading seafood. At the same time, a group of fishing firms can be horizontally allied to develop or improve the logistics needed to carry out these activities. There is a variety of studies that identify and analyze the different types of resources that enable a firm to develop strategies that create value. In this paper, I identify intangible and tangible resources that form the basis of competitive advantage and thus enable the Yucatan fishing industry to organize different strategies to respond to market changes.

## 15.3 Methodology

The complex interactions that influence Yucatan's seafood supply chain were analyzed through a qualitative case study approach (Yin 2003; Bernard 2006). The main objective of the case study was to illustrate how the different actors organize themselves to coordinate resources along the supply chain in order to get products to market. Multiple information sources were used in this investigation (Yin 2003), including specialized journals, official government statistics, newspapers, and websites. However, the main source of information came from two separate sets of interviews, conducted during fieldwork in 2009 in the main ports of Yucatan (Progreso, Celestún, Dzilam de Bravo, and Telchac Pto), as well as the state capital, Merida. The methodology was of a qualitative-exploratory nature, based on interviews addressed to Yucatan's leading fishing entrepreneurs, which allowed them to describe the nature of the main industry's processes and relationships. Considering that there are only a few previous works based on this source of information (e.g., Pedroza and Salas 2011) and addressed to Yucatan's fishing industry in general, this study represented a new research area that had not been well researched prior to the study.

The first phase of the fieldwork involved unstructured interviews with key stakeholders from the fishing sector, such as government officials and cooperative leaders. The aim of these interviews was to determine the origins, and to understand the socioeconomic context, of Yucatan's fishing industry. This set of interviews was also used to sketch the composition, location, and structure of the industry across the state.

For the second phase, the sample design was focused to target the leading fishing entrepreneurs with the most resource control in the industry. When fieldwork was carried out, Yucatan's fishing industry was supported by a fleet of 3771 units, including 633 large vessels and 3168 small boats, and 57 processing plants. The 20 selected firms own 65% of the large-scale fleet and 29% of the small-scale fleet and own the largest infrastructure with the capacity to freeze and preserve about 50% of the state production in an average fishing season. This ownership structure demonstrates that the interviewed fishing entrepreneurs control most of Yucatan's fishing industry resources.

In this phase, semi-structured interviews with an open-ended questionnaire (Bernard 2006) were asked to firm owners, all of whom act as the business managers in these family businesses. One of the main areas of interest in these interviews was to understand the company's organizational strategies at different levels that could have an impact on seafood supply chain performance. The questionnaire was divided into sections. Section 1 referred to how the fishing industry of Yucatan was formed, how each individual firm was created, and individual firm characteristics such as plant size and capacity, fleet size, and date of creation. From the information obtained, three categories of firms were defined, large firms (N = 7), medium-sized firms (N = 8), and small firms (N = 5), which were based on common characteristics held between firms, even though each firm has its own particularities. By knowing the plants' features, it was possible to identify firms' importance and position in the supply chain and identify key resources and the characteristics of advantage creation. Section 2 of the questionnaire was focused on understanding the nature and dynamics of relations by asking how these business managers operate their plants, how and when they interact with other channel members, and how they face unexpected changes in supply or demand. The aim of Section 3 was to identify the sources of internal and external uncertainties within the industry. Internal uncertainty was identified in terms of labor and tasks. Questions asked included how reliable are fishers participation and commitment with fishing firms, and which factors contribute to this reliability? and how are labor agreements and the different levels of relations developed? The interviews showed how business managers have built a few large processing plants and maintain their market position using the small-scale fisheries of Yucatan as a main source of human and raw materials.

In addition to documentary sources and interviews, direct observation of fish selling and receiving, processing, and administration was also employed on-site at individual plants (Yin 2003). This observation gave deeper understanding of each company's processes and organizational strategies.

## 15.4 Study Area

### *15.4.1 Yucatan's Main Fishing Ports*

Yucatan's fishing industry relies mostly on production from eight landing sites (Fig. 15.1), although the largest landings occur in the ports selected for study. Progreso is the most important port, followed by Celestún. Progreso has a pier, an inner harbor, 60% of the freezing factories in the state, and 30% of the state's fleet including 84% of the large-scale fleet and 20% of the small-scale fleet (Table 15.1). Progreso also has the largest processing plants in the state, with 12 out of 20 included in this study, which are considered the most important plants because of their production and sales capacities.

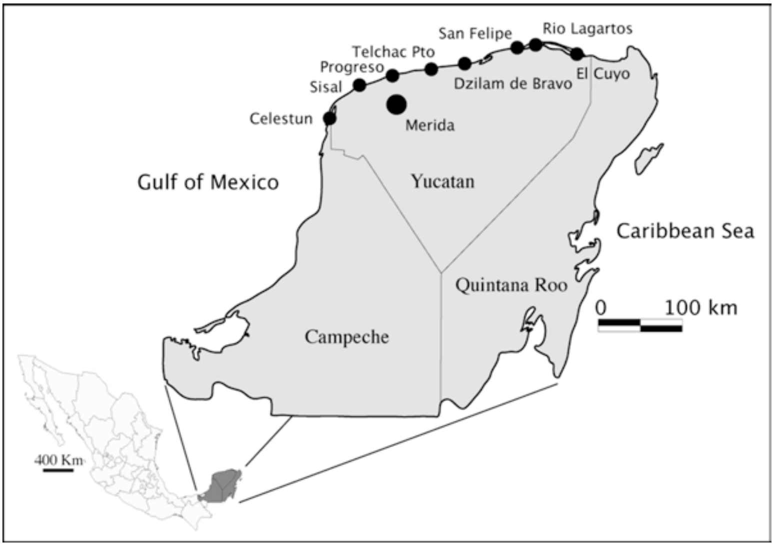



**Fig. 15.1** Yucatan's main fishing ports

**Table 15.1** Main resources of the port

| Ports | No. of fishers | Large fleet | Small fleet | Freezing factories | %Average landing |
|---|---|---|---|---|---|
| Progreso | 5631 | 518 | 634 | 35 | 52 |
| Celestún | 2292 | 35 | 994 | 5 | 14 |
| Dzilam | 2455 | 48 | 735 | 5 | 10 |
| Others | 5818 | 32 | 805 | 12 | 24 |
| Total | 16,196 | 633 | 3168 | 57 | 100 |

Source: CNP (2012), SAGARPA-CONAPESCA (2013)

## *15.4.2 Main Seafood Products*

Octopus is the most important fishery by volume, and second in terms of value, in the Gulf of Mexico. Yucatan is responsible for 80% of the total national octopus catch, and in this region, the most important products by volume are octopus (*Octopus maya* and *Octopus vulgaris*) and fish (mainly grouper, *Epinephelus morio*), representing 40% and 30% of the state's total catch, respectively. About 60% of the octopus catch goes to Europe and Japan, and about 80% of the grouper production goes to the US market.

As it can be observed in Fig. 15.2, octopus and grouper catch variability has been important in the last 20 years. Grouper has been in a trend of decline, while octopus catch can have an important variability from 1 year to the other.

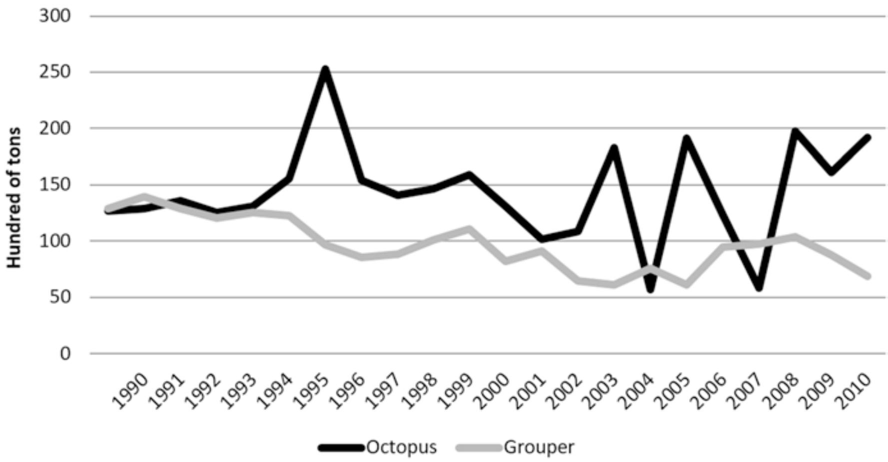



**Fig. 15.2** Octopus and grouper production in Yucatan from 1990 to 2010 (tons)

### *15.4.3 Fishing Firms*

Even though modern commercial fishing began to develop in the mid-1940s, most of the studied fishing firms were created during the 1980s and 1990s (Table 15.2). The growth of the fishing industry was delayed mostly because it was not until the 1970s that formal fishing infrastructure was built. The government considered it necessary to remove pressure from agriculture and support other sectors, leading to the transformation of fishing from being a marginal economic activity to a primary industry in the state of Yucatan (Pedroza and Salas 2011). Table 15.2 presents the main resources and characteristics of each of the studied firms.

Table 15.3 groups the firms according to size: large (7), medium (8), and small (5). For each group, data are presented on firm share of fleet ownership and the proportion of total catch and total sales per year (2008).

The annual average volume sold of octopus was 16% greater than the volume caught in 2008 in the state of Yucatan (Table 15.3). This can be explained because the studied firms control up to 90% of the total state octopus catch but also import octopus from the neighboring state of Campeche, which sells about 60% of its total octopus catch to Yucatan's freezing plants. Therefore, these firms can process and sell more octopus than can be caught in the state. They are able to do this because they are the owners of the export licenses and the infrastructure to freeze and preserve octopus. Moreover, they operate a dynamic and complex system of multiple and flexible sources of supply. These system and forms of organization are explained in the following section.

**Table 15.2** Main resources and characteristics of firms

| Group | Firm | Location | Period of creation | Fleet | | Infrastructure | | | Initiating capital | | AW[a] | Quality control | Brand | Export mks. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Large | Small | Freezing | International trading bureau | Ice factory | Own % | Credit % | | HACC P | | E | J | USA |
| Large | 1 | Progreso | 1980s | X | X | X | X | | 20 | 80 | 40 | X | X | X | | X |
| | 2 | Progreso | 1980s | X | | X | X | | 100 | | 12 | X | X | | | X |
| | 3 | Progreso | 1980s | X | X | X | | X | 40 | 60 | 30 | X | | X | X | X |
| | 4 | Celestún | 1990s | X | X | X | | | 100 | | 22 | X | X | X | X | X |
| | 5 | Progreso | 1990s | X | X | X | | | | 100 | 25 | X | | | X | |
| | 6 | Celestún | 1950s | X | X | X | | | 100 | | 25 | X | X | X | X | X |
| | 7 | Mérida | 1950s | | | X | | | 100 | | 110 | X | X | X | | X |
| Medium | 8 | Progreso | 1980s | X | | X | | | 20 | 80 | 21 | X | | | | X |
| | 9 | Progreso | 1980s | X | | X | | X | | 100 | 30 | X | X | | | |
| | 10 | Progreso | 1970s | X | | X | | X | 100 | | 23 | X | X | X | | X |
| | 11 | Telchac | 1970s | X | X | X | | X | 50 | 50 | 25 | X | | | | |
| | 12 | Progreso | 1990s | X | X | X | | | 50 | 50 | 20 | X | X | X | | X |
| | 13 | Progreso | 1970s | X | | X | | | 100 | | 16 | X | X | | | X |
| | 14 | Progreso | 1990s | X | X | X | | | 100 | | 21 | X | | | | |
| | 15 | Mérida | 1990s | | X | X | | | 100 | | 29 | X | | X | X | X |
| Small | 16 | Dzilam | 1980s | X | | X | | | 100 | | 27 | X | | | | X |
| | 17 | Celestún | 1990s | | X | X | | | 100 | | 7 | X | | | | X |
| | 18 | Progreso | 1990s | | X | X | | | 100 | | 8 | | | | | |
| | 19 | Celestún | 2000s | | X | | | | | 100 | 1 | X | | | | X |
| | 20 | Progreso | 1990's | | X | X | | | 100 | | 5 | | | | | X |

[a] *AW* administrative workers, during octopus season workers increases twofold, *E* Europe, *J* Japan, *USA* United States

**Table 15.3** Yucatan's main fleet ownership and proportion of total catch and sales

| Group of firms | Fleet ownership | Percentage (%) of total reported catch (2008) | Percentage (%) of total sales (2008) |
|---|---|---|---|
| Largest, 7 | 264 Large-scale fleets<br>604 Small-scale fleets | 57 octopuses<br>43 groupers | 81 octopuses<br>43 groupers |
| Medium, 8 | 127 Large-scale fleets<br>149 Small-scale fleets | 21 octopuses<br>16 groupers | 25 octopuses<br>16 groupers |
| Small, 5 | 27 Large-scale fleets<br>163 Small-scale fleets | 12 octopuses<br>8 groupers | 10 octopuses<br>8 groupers |

### *15.4.4 Supply Chain Partners*

In order to understand the organization and nature of human capital in Yucatan's seafood supply chain, it is necessary to identify the role of the main actors involved and their relation to the resources involved in fishing and trading. In Yucatan's fishing industry, there are three groups of actors who organize the production and trade of seafood (Fig. 15.3). The first is the producers, who are fishing entrepreneurs and also the owners of fleets and fishing permits. They range from large fleet owners to micro-fleet owners, depending on the number of vessels or boats they possess. Normally large, medium, and small fleet owners also own at least one processing plant, and they also harvest, process, preserve, and market seafood. The micro-fleet owners have very few vessels or boats and do not own processing plants. As a result, they fish and then sell their catch to one of the larger firms or to a middleman.

The second major group is the traders, who can be divided into two types. Type 1 consists of those who have the infrastructure (a processing plant) to collect, process, preserve, and market seafood. They range from small to large (Fig. 15.3). Type 2 includes middlemen who peddle seafood in an informal market setting. They do not possess the necessary infrastructure to preserve fish, so they must sell whatever they purchase the same day, offering fresh quality products. They buy any kind of seafood, even if it is under the legal size or out of season. None of these actors have fishing permits.

The third group is the fishers themselves, who work for firm fleet owners and cooperatives or operate independently as "free fishers." Fleet fishers work on boats or vessels owned by the producer group. Cooperatives or free fishers have their own fleet but normally sell their catch to firms and middlemen.

Each actor can supply different market segments (Fig. 15.3). Large firms export most of their products to the USA, Europe, or Japan and only sell a small part of their production on the local or national market. Medium-sized firms export or sell in local or national markets depending on price variability. In some cases, they sell to larger local firms. Meanwhile, small producers sell to local large firms or directly to local or national markets. The micro-traders, who engage mostly in informal trade, dominate the local market supply.

The interactions of the actors in this supply chain result in multiple levels of relationships, with the role and importance of each actor within the supply chain dependent on the resources they own and their ability to coordinate them.

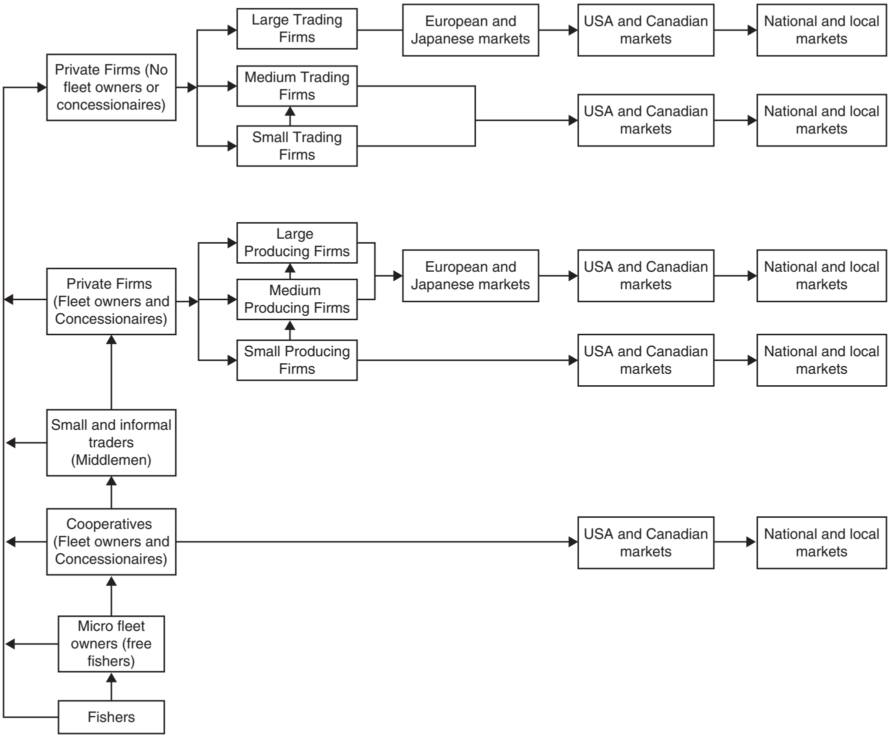



**Fig. 15.3** Actors in the seafood supply chain. Actors and markets in the supply chain structure: firms, cooperatives, informal traders, and fishers (*JM* Japanese market, *EM* European market, *US, C* US and Canadian markets, *NM* national market, *LM* local market)

## 15.5 Results

### *15.5.1 Supply Chain Processes*

The interviews with targeted fishing industry managers showed that the firms' main objectives have been to accumulate as much seafood as possible and sell it at the best possible prices. The 20 largest firms catch up to 90% of the allowed fishing quota in the state, while at the same time micro-producers also participate in fishing because they also hold fishing permits. In general, this trend suggests that competition for fish is intense in both the octopus and grouper fisheries and may also signal excess fishing capacity. Recruitment variability and an unpredictable demand environment motivate all the actors in the market to make use of their organizational and relational capital in order to adapt the fishing industry's assets and to use each of the different markets strategically to sell their catch quotas in the most favorable conditions.

These actions are carried out by the different levels of relationships within each step of the seafood supply chain: harvesting, processing, and trading. Here, all the actors of the supply chain organize and integrate in terms of fleet, permits, and infrastructure ownership, which are the industry's key tangible resources. Using these resources at different steps of the supply chain, each firm can create advantages through the development of organizational capabilities for their most efficient use. The purpose of this behavior is to interact and coordinate with fishers and traders in the supply chain and to manage information exchange in order to acquire the necessary knowledge to have access to fish.

### *15.5.2 Multiple Sourcing*

One way that the investigated companies respond to supply and demand variability is through the ownership and control of their resources. This strategy can influence the organizational structure of the seafood supply chain where different types of relationships configure different organizational strategies to have efficient sourcing mechanisms and to fulfil clients' demands. One important variable is the ownership of key tangible resources such as the possession and/or control of fishing fleets, permits, and plant infrastructure with conservation and processing facilities. The possession of a fleet and fishing permits requires the creation of sourcing routines, while holding a processing plant implies the development of adaptable processing routines. This section describes these sourcing routines, and the following section explains processing routines.

## 15.6 Sourcing Routines

The companies investigated in this study build competitive advantage by combining tangible and intangible resources. They created three configurations of sourcing routines by organizing coordinated actions for the use and control of supply links, fleets, and permits.

The first sourcing routines refer to firms that own fishing permits and a fleet and rely solely on them for their entire seafood supply, which implies a more static routine because they maintain a set of less variable supply patterns. All of their production and commercialization are based on their fleet's fishing capacity alone. In total, 35% of the largest companies belong to this category (Fig. 15.4). Their strategic advantage relies on the way they organize their fleet to go fishing, and they believe quality control is more reliable in this arrangement because there is only one source of supply. The second type of sourcing routine is more dynamic, involving firms that own fishing permits and fleets but who also buy seafood from different external suppliers such as smaller firms, fishers' cooperatives, micro-producers, free fishers, or middlemen

to increase their production. Fifty-five percent of the firms examined belong to this category of companies, which must be more flexible to adapt to the changing circumstances of supply and demand (Fig. 15.4). The most flexible sourcing routine was found in the third type, which includes firms without a fleet or permits that engage only in trading (10%, Fig. 15.4). They buy their entire production from dif-

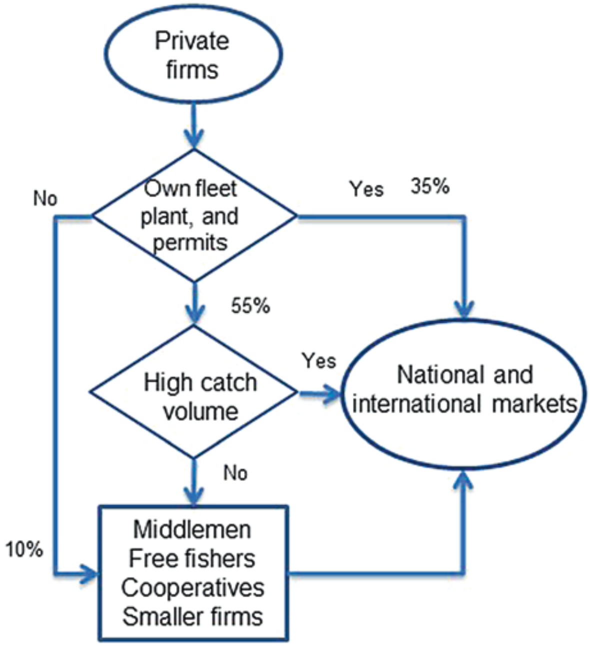



**Fig. 15.4** Sourcing routines in the fishing industry of Yucatan

ferent producing firms and any supplier in the market. In this case, their strategic advantage is mostly based on intangible resources such as sourcing capabilities.

In cases where a firm is both a producer and a buyer from external suppliers, the number of additional sources of external supply depends on the particular seasonal production level. When fish availability is low, sourcing routines require large- and medium-sized firms to link together to build a network of relationships with fishers and cooperatives to organize multiple sourcing, which is the only way to amass the necessary volume to supply their markets. By contrast, in years of high catch, firms spend more time on fleet maintenance, processing, and wholesaling their own products than trying to increase the number of external suppliers. Therefore, the advantages of these sourcing routines range from organizing multiple sourcing during resource shortage to in-house sourcing when there is enough fish available.

Consequently, in the fishing industry of Yucatan, the ownership of tangible resources such as a fleet or fishing permits does not necessarily assure a reliable supply of fish for continuous operation. Thus, linking with additional sources of supply and keeping inactive relations with suppliers which can become active at opportune times are key resources required to build strategic advantage and adapt to catch variability. For firms that have no fleet or also rely on external suppliers, developing dynamic supply routines through seasonal linking can be seen as a coordination and cooperative mechanism that allow them to access fish resources and achieve efficient levels of supply through multiple sourcing.

## 15.7 Processing Routines

Another important resource for firms is the ownership of a plant with processing and preservation facilities. Product processing is an important potential source of competitive advantage that starts in vessels since fishers typically gut and ice fish and octopus before returning to port. However, the type of processing that each firm performs in-house depends on its size and capacity, as well as the type of products and their market destinations, all of which influence the level of flexibility that individual firms develop in their processing routines. Small producers and micro-producers have normally developed more limited processing capabilities because they have less resources, which limits their ability to conduct more manufacturing processes. These producers typically only clean and ice seafood and sell it immediately to a larger producer or trader (Fig. 15.5).

Only large-sized (N = 7) and medium-sized (N = 8) firms that are certified to export fisheries products have developed more complete processing routines. Therefore, to be able to access export markets in Europe and Japan, companies must possess valuable resources such as fishing permits, the necessary infrastructure to process seafood, exporting licenses, as well as the ability to fulfil the long list of requirements asked by their international clients. These resources are used to build competitive advantage through product transformation and allow them to sell their

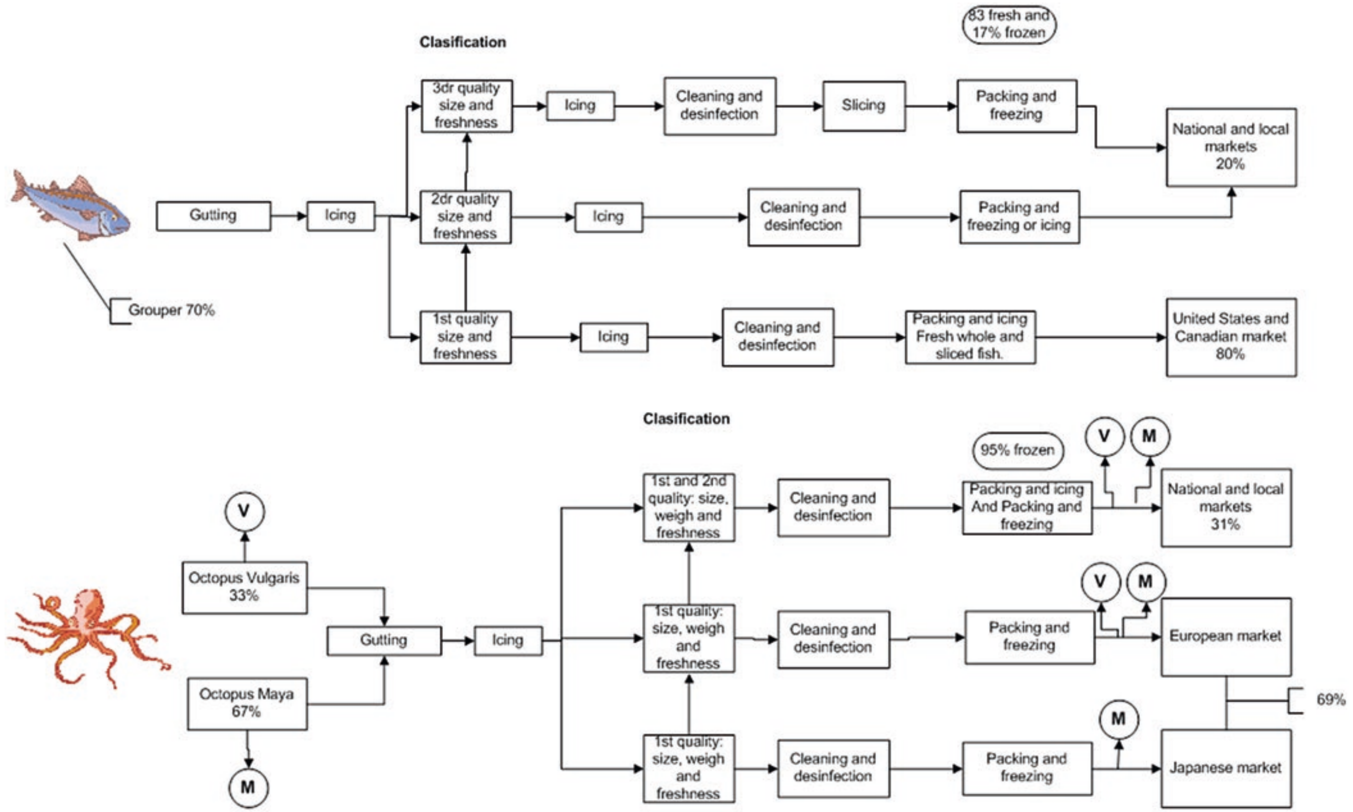



**Fig. 15.5** Manufacturing process for octopus and fish. Manufacturing process for octopus and fish considering quality differentiation and market destination (*Octopus vulgaris* = V, *Octopus maya* = M)

products wholesale to both national and international markets, in the form of frozen and fresh (about 90% of octopus is sold frozen and about 80% of fish is sold fresh) (Fig. 15.5).

Thus, large and medium firms have developed flexible processing routines, which allow them to influence supply chain organization by aligning their manufacturing strategy to clients' requirements. These producers must adjust their processing routines each season, processing fish from January to July and octopus from August to December. Each species requires different manufacturing processes, resulting in quality control procedures that must be adjusted according to each product and its final destination (Fig. 15.5). Thus, manufacturing strategies must be aligned with the external environment of the firm. For example, European and Japanese clients require quality controls to be based on the HACCP system (Hazard Analysis and Critical Control Points), whereas the US market specifically demands an analysis of water, ice, and plant environment, while the national market requires simpler quality standards based on cleanliness. Thus, processing routines must be adaptable to different types of products, quality controls, and catch variability.

### *15.7.1 Trading Relations Between Buyers and Suppliers*

In the fishing industry of Yucatan, relational capital is built through credits or loans used as a type of oral contract or trading agreement. These agreements are a linking mechanism that create commitment in the attempt to manage access to labor and multiple sourcing.

During the interviews, firm owners stressed that the way they build partnerships with fishers depends on the needs and availability of seafood. Fleet owners implement a strategy based on backup labor agreements to select and keep a permanent small crew composed of the best and most loyal fishers. In order to ensure their loyalty, they maintain this crew even during periods when fishing does not occur such as seasonal closures or seafood shortages. These agreements allow firm owners to keep long-term relationships and also recruit other fishers through this permanent crew at opportune times.

Firm owners pointed out that they employed multiple levels of relationships to have access to different sources of supply, including fishers working on the company's fleet, free fishers, cooperatives, and middlemen. For cooperatives and fishers who work in a company's small-scale fleet, firm owners give loans to these actors who use these loans to cover their expenses, purchase fishing gears, buy motorboats, or cover personal needs and illnesses. Large-scale fleet owners provide advance payments to skippers who use the money to recruit fishers and ensure their boats have crews. A partial advance payment is made before going to sea and is deducted from the fishers' payment upon returning.

Loans and advance payments commit fishers to work for the financing firm, with debt functioning as a control mechanism. Debt also gives fishing entrepreneurs bargaining power over fishers, and only free fishers without debt can obtain better selling prices for their catch than those committed to firm owners because they can sell their catch to whomever pays the best prices. In these informal contracts, penalties are not explicit, but implicit in price, and these credits have double returns for firm owners who profit from both higher prices and labor commitments.

During the octopus season, twice as many fishers are required than when fishing grouper, which leads to a large amount of seasonal octopus fishers. However, firm owners do not commit to recruit fishers, and unemployment can be high if the season is not good. These labor-credit relationships create commitment only for fishers while still affording considerable sourcing flexibility to firm owners which helps them reduce supply uncertainty by adding the necessary sources of supply whenever needed. Moreover, this linking strategy diminishes costs because firm owners do not have to maintain the whole crew during seafood shortages.

However, this type of control mechanism can also have a negative impact on firm owners when fishers try to evade or profit from firm owners' crew maintenance strategies. Some fishers take two or even three advance payments from different skippers but fish from a different ship, which leaves the skipper with a debt with the fleet owner. Accordingly, the skipper must promise part of the boat's production to a middleman, who usually pays a better price. The middleman becomes another source of credit by providing the skipper with the funds to complete advance payments, recruit a crew, and pay any debts. Fleet owners, however, decry this as a disloyal practice because they lose between 10% and 30% of production in this type of transaction.

Thus, middlemen represent another level of industry relationships with fishing enterprises. Besides being a competitor, middlemen can also be a trading partner because they sometimes supply firms directly. This happens especially during periods of seafood shortages, during which middlemen gain much higher importance. Middlemen are an itinerant link in the supply chain, representing higher transaction costs for firm owners since they ask for higher prices. Middlemen obtain a certain degree of bargaining power during resource shortages and, due to their itinerant nature, through their abilities to be flexible in commitment and sourcing. However, they are also another key resource in inter-organizational strategy because they are able to buy and sell large amounts of any kind of seafood. All these characteristics make them the actor with the most adaptable sourcing routines in the supply chain.

Furthermore, these dynamic organizational routines imply another shift of bargaining power during resource shortages, since middlemen are at the center of the supply chain and can affect the amount and time delivery of seafood. Integrating middlemen into the multiple sources of supply strategy gives firm owners more possibilities to bulk seafood and supply its markets. However, this can be seen as a reactive coordination mechanism, which represents a short-term vision of fisheries and business management strategy.

Thus, firm owners develop long-term relations and seasonal relations with different supply chain members. On the other hand, the decision whether to fish or buy relies not only on the availability of fish and the firm's ownership of tangible resources but also on firm owners' ability to coordinate the organization of multiple adaptable sources of supply, allowing them to control volume, storage, and freezing capacity, aligned with recruitment and market variability.

### *15.7.2 Horizontal Relations and Supply Chain Logistics*

One source of collaboration in Yucatan's fishing industry has been the fact that the industry consists of compounded family businesses. Most large firm owners inherited their plants and fleets from their parents or grandparents. In certain cases, these assets were divided among siblings. Under these conditions, some partial owners decided to establish separate firms, whereas others continue to work together, increasing their capacity by organizing horizontally with family members. This familial organization has been one of the sources of capital or richness transactions that has sustained the economic structure of the industry. Thus, family business organization has been a key resource for accumulating capital and bargaining power because large firm owners, many of which have benefited from intergenerational capital accumulation, normally have more political power and dominate industry decision-making, limiting small producers' participation.

In addition, firm owners have also created three different and horizontally related organizations as a corporate strategy to face new challenges in the fishing industry. These organizations are the *Asociación de Armadores* (Large-Scale Fleet [LSF] Owners Association, LSFOA), *Cámara Nacional de la Industria Pesquera* (CANAINPESCA) (National Chamber of the Fishing Industry), and the *Asociación de Exportadores* (Exporters Association). This group of firms is a logistic alliance that aims primarily to improve source supply mechanisms such as fishing regulations and permitting, as well as lower fishing costs. Secondly, they wish to improve and assure space in airfreight shipping and the necessary sanitary, quality, and administrative measures to improve the efficiency of the flow of products to national and international markets. Thirdly, they also manage volume variability because they have to negotiate prices in good years and must also decide where to channel surplus volumes of octopus. However, during seafood scarcity, these firms demand subsidies of the local government, which they use to support a joint marketing plan especially to gain visibility in export markets. Moreover, it is within these organizations that information, technology, and data from international customers are exchanged.

This logistic alliance, in addition to working to improve some processes and lower costs, is another source of control over the fishing industry for large and medium firm owners. Through this control, they can limit the participation of smaller stakeholders (e.g., small firms, cooperatives, micro-fleet owners) in the industry and maintain their status as the major leaders in the sector. Thus, in this form of horizontal collaboration, firm owners share resources (family business networks) and capabilities (associations) to improve the fishing industry's performance and satisfy client demands.

## 15.8 Discussion

This case illustrates the characteristics and challenges that the fishing industry is currently facing as its small-scale fisheries base struggles to maintain a reliable seafood supply chain while confronting volatile supply conditions and new market requirements. The analysis of the relationship structure and use of firm resources in the seafood supply chain in Yucatan's fishing industry has allowed us to understand the interactions among the complex array of actors competing for seafood and the nature of control exerted by the studied firms over the fishing activity, which allow us to understand the importance of competitive and cooperative relations in the seafood supply chain. This analysis also shows how small-scale fisheries play an important role in sourcing for large processing plants, thus allowing them to exist and continue in the market. At the same time, the analysis has revealed that small producers' participation is limited and controlled by large fishing firm owners.

The RBV approach allowed us to frame the organizational responses that serve as the adjustment of firm resources, both tangible and intangible, to the dynamic and unpredictable conditions of recruitment variability. Thus, firms organize and adapt the resource base and relationship strategies according to fish availability. The key organizational strategies that have been identified as responsible for maintaining this fishing industry in the market are multiple sourcing, flexible processing routines, and linking mechanisms.

Multiple sourcing systems are maintained through dynamic sourcing routines, which at the same time depend on multiple levels of relationships expressed in long-term relations or seasonal linking. This relational capital in the form of inter-organizational capabilities has served as a dynamic capability that has allowed firms to maintain their competitive advantage by modifying their assets in order to adapt to the changing environment (Helfat and Raubitschek 2000).

In order to develop the necessary partnership links with fishers and assure the required sources of supply, firm owners develop different types of trading relations. They create debt through loans and advance payments as an appropriation mechanism that substitutes formal legal contracts (Fernández et al. 2000). This type of commitment provides firm owners leverage over fishers and access to seafood. Through this relational social capital, firm owners construct a portfolio of suppliers and can sometimes increase their bargaining power as debtors are more likely to be committed and accept lower payment for fish. This is a strategy to bulk seafood but is not intended to centralize access to fish because all producers, both large and small scale, engage in both fishing and selling to fleet owners. This practice is not an accumulation of harvest rights but rather a way of increasing control in access to markets.

At the same time, processing routines have proved to be flexible and adjustable to sourcing routines, the product, the quality required by each market, and the particular nature of each season. The supply management system adopted by each company must consider the different features of each season and act accordingly. Thus, through knowledge, which is the central element to modify assets for adaptation (Nieves and Haller 2014), business managers have been able to remain in the market by making use of experience acquired through generations of fishing entrepreneurs. Using this knowledge, they have been able to coordinate the use of all the fishing capital they possess (including vessels, boats, and processing plants) while availing of their social capital.

Therefore, fish recruitment variability acts as a source of uncertainty (Sissenwine 1984), influencing the organizational structure of the seafood supply chain because different types of sourcing and processing routines have to be rearranged accordingly. These routines are based on the ownership and control of tangible and intangible resources. Thus, the organization of these types of resources depends on fish availability, but also on firms' organizational knowledge, because they have to decide how to arrange fishing effort according to each fishing season's characteristics as well as link with traders according to market demand.

This situation also shows how tangible resources can become integral to decision-making because the way they can be organized can make them unique and inimitable (Rungtusanatham et al. 2003). At the same time, coordinating intangible resources such as multiple sourcing, carried out through multiple levels of relationships, shows how the base of competitive advantage also relies on capability development through partnering and managing relations as a value-adding activity (Fernández et al. 2000; Francis and Bessant 2005).

The capacity to make decisions over the use and organization of resources is based on knowledge, which is the greatest ability that contributes to differentiation and thus the development of competitive advantage (Nieves and Haller 2014). Thus, knowledge and the ownership of tangible and intangible resources facilitate the exertion of more control over the fishing industry. Therefore, the logistic alliances formed by large firm owners provide these actors with more elements to control small producers who would have to adjust to recruitment variability and demand, in addition to the control mechanisms (e.g., debt) imposed by large firm owners.

In Yucatan's fishing industry, horizontal relations have been developed to design and reinforce the industry's logistics, demonstrating that collaboration between independent firms is key to creating superior value-adding solutions (Mason et al. 2007). This logistic alliance has contributed to the maintenance of catch levels and distribution channels and has allowed firm owners to remain major leaders in the industry.

### *15.8.1 Management Implications and Recommendations*

Firm owners are so busy trying to keep their system functioning that they have dedicated no attention to incorporating alternative ideas which could be more environmentally friendly and thus would allow fishing activity to be a more sustainable and resilient business. This oversight is a result of the failure of firms to engage in self-critical examination, which allows their unintended and potentially negative effects to be overlooked (Lotti 2010). Probably the most important threat to fishing activity has been that business managers have considered fish variability without considering its biological characteristics, since they have cared only about fishing but not about maintaining fish availability. The supply chain system, supported by vertical and horizontal relations, continues to focus on mass production and in maintaining the quality required for the export markets without due regard to considerations of volume and supply management over the long term.

One of the most important management implications is that the mass production strategy carried out so far enhances overexploitation because, in order to keep this system functioning, fishing quotas are routinely exceeded (Salas et al. 2006). In addition, the supplying mechanism through middlemen works under informal conditions, which allows for unregistered catch that is not considered in the fishing quota issued by the National Fisheries Institute. Therefore, this informal supply channel might be enhancing illegal, unregulated, and unreported (IUU) fishing (Pedroza 2013).

Seafood supply chain management can be the source to reconfigure opportunities for competitive advantage by using firm owners' ability to organize. Firm owners could also use their predominant controlling position in the fishing activity to guide fisheries management toward sustainability instead of focusing only on capital transactions and reinforcing logistics to improve seafood flows. The strategic use of resources and capability development should consider ecosystem conservation as a new dimension affecting organizational capital in the management of the seafood supply chain.

Business managers should actively participate in fisheries management since they exert an important level of control on fishing activity. Their control can influence the industry's profitability and fisheries sustainability since proper management of the seafood supply chain requires the participation not only of fishers but also of business managers and government officials in resource-use policy measures and market demands.

Firm owners are making efforts to change from a production-oriented to a customer- or market-oriented business philosophy, but much work must still be done to make this a reality (see Pedroza and Salas 2011 for more details). Firm owners work to satisfy their clients by maintaining the quality required by international markets, but they have failed thus far in implementing a traceability system based on sustainable practices which can contribute to biodiversity conservation.

Nonetheless, new strategies should include conservation measures in addition to market-oriented mechanisms. It is necessary to find new approaches that respond to the new challenges imposed by this sector. To face the challenges coming from both within and outside the fishing industry, not only is intervention of large fishing businesses necessary but also the involvement of governmental and social institutions such as fisher's cooperatives.

Fishing entrepreneurs need to implement a market-oriented approach based on customer satisfaction, considering the growing customer awareness about sustainable fisheries products and practices. A new approach informed by environmental and social aspects in the fisheries could address some of the problems associated with natural resource overexploitation while simultaneously meeting customer demand (Faulkner et al. 2005). An environmental marketing orientation has proved to be beneficial while at the same time having the potential to attract more customers with an environmental conscience who are willing to support environmentally friendly production (Miles and Munilla 1997).

New strategies could consider the already adaptable mechanisms that have worked for the industry thus far, such as multiple sourcing, flexible processing routines, and linking mechanisms, while also adding a sustainable perspective. There are opportunities to learn from alternative movements such as the Slow Food movement, which might contribute to the design of a sustainable market-oriented strategy. The Slow Food movement seeks to safeguard food and agricultural heritage (Jones et al. 2003), promoting a preservation and education function by stressing preservation to producers and education to consumers. The preservation function refers to the need to catalogue and safeguard animal breeds, plant varieties, and agricultural methods and techniques in danger of extinction; the educational function aims to educate people about improving their tasting ability and increasing their knowledge about food (Nosi and Zanni 2004). In the case of fisheries, this approach has been used for the preservation of the Delaware Bay oyster and the Loire salmon. Part of the ideas from this movement might be borrowed and adapted to propose actions for a sustainability marketing plan for Yucatan's fishing industry. Some of the following ideas have been inspired in some of the activities carried out within the Slow Food movement.

In Yucatan's fishing industry, an innovation in sales is required. This could be achieved by targeting different national market segments, since people are becoming aware of fish consumption benefits and the increase in fish consumption is creating new opportunities for the industry. Market diversification by targeting new market levels might provide new opportunities even for low-value species which currently are not economically attractive. Instead of continuing with a mass production approach, new products should be identified that can be suitable for market segmentation based on people's lifestyles rather than demographic criteria. Informing and educating consumers about fish qualities and how to cook different species might be an important marketing strategy. In Mexico, many people do not eat fish either because they do not know the wide variety of fish that exist in the country, they think it is expensive, they do not know how to prepare it, or fish is not available in some areas. A simple example is sardines, which are a cheap, tasty, and nutritious fish that are impossible to find fresh in the market.

A new design of distribution channels with reduced intermediation might reduce transaction and travel costs. This might include more direct participation in the market from small producers, such as small producers selling directly to final consumers. Multiple sourcing should be built into a traceability system where all producers participating must commit to respect conservation measures and avoid participating in IUU fishing activities to contribute to the preservation of Yucatan's fisheries. Targeting new species might also help to reduce travel costs and overcapitalization. A very important measure to be considered within a new multiple sourcing approach, as it has already been suggested, would be to extend the grouper seasonal closure to 90 days instead of 45 as it is now. This extension would be more consistent with the reproduction period of these species, thus protecting the future of these stocks (DOF 2014). In the case of octopus, measures would be more related to the prevention of IUU fishing, since at least the *Octopus vulgaris* has been reported as capable of expansion in effort.

Flexible processing routines should also include better technologies and transformation processes to position the industry as a socially and environmentally responsible business cluster. These routines should also consider innovations in processing raw materials to diversify products instead of only offering fresh fish. In other words, an approach based on more food design and less fishing should be considered, and quality should also be focused not only on the freshness of products but on the defense of biodiversity.

Horizontal collaboration among business partners should consider the creation of a regional brand highlighting the characteristics of regional seafood with the aim of showing people why they are buying value when they are buying seafood from Yucatan. At the same time, products should be distinguished by incorporating their main characteristics and highlighting that fish is a fundamental product to maintain human health. Yucatan's heritage in fishing traditions, as well as new commitments to the environment, should be considered among these characteristics. Firm owners should keep in mind that the ability to diffuse information therefore represents a valuable asset that influences the potential business development of the organization (Nosi and Zanni 2004). However, it is perhaps most important that all actors consider the implications of their actions in these fisheries and collaborate in the enforcement of the already implemented rules and management practices to avoid IUU fishing activities. Without collaborative efforts to prevent these activities, any attempt for the enforcement of sustainable measures might be unsuccessful.

## 15.9 Final Remarks

This case study explains how Yucatan's fishing industry functions in terms of its supply chain organization and shows the interdependency between small producers and the owners of large processing plants. The chapter also shows how these fishing entrepreneurs have the necessary resources (tangible and intangible) to limit and control most actors involved in fishing activity.

Organizational routines, in terms of number of sources of supply, processes, technology, and quality, mostly depend on firm needs for seafood, capabilities, resources, and supply and market changes. Firm owners have developed several coordination mechanisms to access multiple sources of supply in an attempt to balance catch variability and maintain their dominance in the industry. However, even though the current business management model has achieved balance thus far, little has been done to maintain the ecosystems and fish resources upon which this industry depends or the well-being of fishers. Firm owners most likely will remain in the activity as long as they can obtain benefits from their participation because even in times of scarcity, no formal initiative has been proposed from them.

This lack of a common vision toward the implementation of sustainable practices continues to have negative impacts on fish resources. These implications will be reflected in future biological and socioeconomic impacts. Some of the current high-value species might disappear, and others of less economic value will be targeted. In Yucatan, this shift is already happening with red grouper (*Epinephelus morio*) being substituted by black grouper (*Mycteroperca bonaci*). Fishing less commercially value species will decrease fishers' income and might motivate overfishing as fishers try to compensate for the lower prices with higher fishing volumes. Scarcity will be a larger problem for small producers or micro-producers, who are highly dependent on fishing, but probably will not be as detrimental for large firm owners who have already developed other economic activities.

These vertical and horizontal relations have influenced the adaptability of fishing firms' organizational structure in order to respond to unpredictable sources of supply and market specialization. Nevertheless, this set of strategies has failed to address fisheries management problems and fishers' conditions which are key to the survival of the industry and the overall sustainability of the region.

**Acknowledgments** The research upon which this paper is based was funded by the Universidad Nacional Autonóma de México (UNAM) through projects PAPIIT IA300215 and IN210915. The author would like to acknowledge the valuable suggestions made by the editor and the anonymous reviewers.

## References

Anderson JL (2003) The international seafood trade. CRC Press, Florida

Arreguín-Sánchez F, del Monte-Luna P, Zetina-Rejón MJ (2015) Climate change effects on aquatic ecosystems and the challenge for fishery management: pink shrimp of the southern Gulf of Mexico. Fisheries 40(1):15–19

Barney J (1991) Firm resources and sustained competitive advantage. J Manag 17(1):99–120

Bernard HR (2006) Research methods in anthropology, qualitative and quantitative approaches. Altamira Press, New York

CNP (Carta Nacional Pesquera) (2012) CONAPESCA-SAGARPA. Diario Oficial de la Federación DCCVII 18

DOF (Diario Oficial de la Federación) (2014) Acuerdo por el que se da a conocer el Plan de Manejo Pesquero de Mero (Epinephelus morio) y especies asociadas en la Península de Yucatán. Diario Oficial de la Federación. Martes 25 de noviembre de 2014, Ciudad de México

Eisenhardt KM, Schoonhoven CB (1996) Resource-based view of strategic alliance formation: strategic and social effects in entrepreneurial firms. Organ Sci 7:136–150

Faulkner D, Carlisle YM, Viney HP (2005) Changing corporate attitudes towards environmental policy. Manag Environ Qual Int J 16(5):476–489

Fernández E, Montes JM, Vázquez CJ (2000) Typology and strategic analysis of intangible resources: a resource-based approach. Technovation 20:81–92

Francis D, Bessant J (2005) Targeting innovation and implications for capability development. Technovation 25(3):171–183

Giménez-Hurtado E, Coyula R, Luch-Cota SE, González-Yañez A, Moreno-García V, Burgos R (2005) Historical biomass, fishing mortality, and recruitment trends of the Campeche Bank red grouper (*Epinephelus morio*). Fish Res 71:266–277

Granovetter M (1973) The strength of weak ties. Am J Sociol 78(6):1360–1380
Grant RM (1991) The resource-based theory of competitive advantage: implications for strategy formulation. Calif Manag Rev 33:114–135
Hall R (1993) A framework linking intangible resources and capabilities to sustainable competitive advantage. Strateg Manag J 14(4):607–618
Hart SL, Dowell G (2010) A natural-resource-based view of the firm: fifteen years after. J Manag 37(5):1464–1479
Helfat CE, Raubitschek RS (2000) Product sequencing: coevolution of knowledge, capabilities and products. Strateg Manag J 21(10/11):961–979
Hernández A, Kempton W (2003) Changes in fisheries management in Mexico: effects of increasing scientific input and public participation. Ocean Coast Manag 46(6–7):507–526
INEGI (Instituto Nacional de Estadística Geografía e Informática) (2009) Censos económicos. Instituto Nacional de Estadística Geografía e Informática, México
Jones P, Shears P, Hillier D, Comfort D, Lowell J (2003) Return to traditional values? A case study of slow food. Br Food J 105(4/5):297–304
Jurado-Molina J (2010) A Bayesian framework with implementation error to improve the management of the red octopus (*Octopus maya*) fishery off the Yucatán Peninsula. Cienc Mar 36(1):1–14
Kalwani MU, Narayandas N (1995) Long-term manufacturer-supplier relationships: do they pay off for supplier firms? J Mark 59(1):16
Lotti A (2010) The commoditization of products and taste: slow food and the conservation of agrobiodiversity. Agric Hum Values 27(1):71–83
Mason R, Lalwani C, Boughton R (2007) Combining vertical and horizontal collaboration for transport optimization. Supply Chain Manag Int J 12(3):187–199
Miles M, Munilla L (1997) The eco-marketing orientation: an emerging business philosophy. In: Polonsly MJ, Mintu-Wimsatt AT (eds) Environmental marketing, strategies, practice, theory, and research. The Haworth Press, New York, pp 23–36
Mullon C, Fréon P, Cury P (2005) The dynamics of collapse in world fisheries. Fish Fish 6:111–120
Narasimhan R, Jayaram J (1998) Causal linkages in supply chain management: an exploratory study of north American manufacturing firms. Decis Sci 29:579–605
Nelson RR, Winter SG (1982) An evolutionary theory of economic change. Belknap Press of Harvard University Press, Boston
Nieves J, Haller S (2014) Building dynamic capabilities through knowledge resources. Tour Manag 40:224–232
Nosi C, Zanni L (2004) Moving from “typical products” to “food-related services”: the slow food case as a new business paradigm. Br Food J 106(10/11):779–792
Pedroza C (2013) Middlemen, informal trading and its linkages with IUU fishing activities in the port of Progreso, Mexico. Mar Policy 39:135–143
Pedroza C, Salas S (2011) Responses of the fishing sector to transitional constraints: from reactive to proactive change, Yucatan fisheries in Mexico. Mar Policy 35(1):39–49
Pérez-Pérez M, Wakida A, Solana R, Burgos R, Santos J (2006) La pesquería de Pulpo. In: Sustentabilidad y pesca responsable en México evaluación y manejo. INP, México, pp 525–543
Porter M (1981) The contributions of industrial organization to strategic management. Acad Manag Rev 6:609–620
Rungtusanatham M, Salvador F, Forza C, Choi TY (2003) Supply-chain linkages and operational performance: a resource-based-view perspective. Int J Oper Prod Manag 23(9):1084–1099
SAGARPA-CONAPESCA (2013) Anuario Estadístico de Acuacultura y Pesca 2013. SAGARPA-CONAPESCA, Mazatlán
Salas S, Mexicano-Cíntora G, Cabrera MA (2006) ¿Hacia dónde van las pesquerías en Yucatán? Tendencias, retos y perspectivas. Mérida, CINVESTAV Unidad Mérida
Salas S, Cabrera MA, Palomo L, Bobadilla F, Ortega P, Torres E (2008) Plan de manejo y operación del comité de administración pesquera de escama y pulpo. Informe Final. Cinvestav IPN Unidad Mérida, Mérida

Sepulveda F, Gabrielsson M (2013) Network development and firm growth: a resource-based study of B2B Born Global. Ind Mark Manag 42(5):792–804

Sissenwine MP (1984) The uncertain environment of fishery scientists and managers. Mar Resour Econ 1(2):1–30

Solana S, Pérez M, Wakida A, Burgos R, Santos J (2005) Evaluación de la población de pulpo (*Octopus maya*) en la Península de Yucatán. SAGARPA, INP. CRIP- Yucalpetén, CRIP- Lerma, Yucalpetén

Teece DJ, Rumelt R, Dosi G, Winter S (1994) Understanding corporate coherence: theory and evidence. J Econ Behav Organ 23:1–30

Wagner BA, Alderdice ADG (2006) Managing the distribution channel: the case of scot trout and Salmon. Supply Chain Manag Int J 11(2):104–107

Yin RK (2003) Case study research, design, and methods, 3rd edn. Sage, London

**Carmen Pedroza-Gutiérrez** is currently working as a full-time researcher at the *Unidad Académica de Estudios Regionales* of the *Universidad Nacional Autónoma de México*. She has a PhD in *Socio-économie du développement*, given by the *Ecole des hautes études en sciences sociales*, Paris, France. She also holds two master's degrees, one in international relations from the University of Sussex and another in development studies from the University of East Anglia. Her research interest is in inland and marine fisheries supply chains, social networks and fish trade dynamics, and women'sroles in fishing activity.

# Chapter 16
# Analyzing Fishing Effort Dynamics in a Multispecies Artisanal Fishery in Costa Rica: Social and Ecological System Linkages

**Helven Naranjo-Madrigal and Andrew B. Bystrom**

**Abstract** Research on fishery fleet dynamics and fisher behavior often rely on rational economic assumptions to explain decision-making processes based on cost and income expectations as an input to management strategies. However, understanding the complexity of small-scale fisheries, which are defined by their importance as a source of income, employment, food security, and cultural traditions, requires the use of emerging systemic thinking concepts to face the challenges involved in their management. In this study, fishing effort dynamics and two types of diver behavior are analyzed within the multispecies fishery at Playa Lagarto, Costa Rica. We sought to answer whether or not the allocation of fishing operations that defines fishing effort responds to only the rational economic theory or to other dynamics related to the fishery's social and ecological systems. Also, given different dive methods, tactics, and factors that define catch variability, fisher behavior drivers were explored. A combination of surveys, interviews, and a participatory diagnostic approach were used to collect data during fishing trips. Although some target species were common to both dive methods, differences in the spatial and temporal allocation of fishing effort were evident due to different fishing tactics. When facing environmental constraints, social interactions fostered cooperative tactics in order to maintain or even increase their catches. Given these results, a set of recommendations were outlined that could improve sustainability and strengthen the socio-ecological resilience of the fishery.

H. Naranjo-Madrigal (✉)
Consultant Services Department, ALNA S.A, San José, Costa Rica

Programa de Maestría en Ciencias Marinas y Costeras, Universidad Nacional, Heredia, Costa Rica

A. B. Bystrom
Unidad de Investigación Pesquera y Acuicultura (UNIP), Centro de Investigación en Ciencias del Mar y Limnología (CIMAR), Universidad de Costa Rica, San Pedro, San José, Costa Rica



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_16

**Keywords** Bentho-demersal artisanal fishery · Fishing effort allocation · Participatory diagnostic approach · Resampling-based hypothesis testing · Socio-ecological fishery system

## 16.1 Introduction

Fisheries research increasingly recognizes that underlying social and ecological systems are complex and adaptive (Ommer et al. 2012; Kittinger et al. 2013). In each connected system, individual fishers are able to learn from their experiences and alter their actions in response to changes in the relative abundance of the resource. In this scenario, fishers compete for limited resources while demonstrating behaviors of exploitation, competition, parasitism, and also cooperation (Levin 1999). Important challenges are associated with modeling these complex socio-ecological fisheries systems (SFSs). Pioneering work by Ommer et al. (2012) on SFS thinking and modeling proposes a comprehensive research framework focusing on three frontiers: (1) external drivers of change, (2) social-ecological traps, and (3) diagnostic approaches and multiple outcomes in socio-ecological systems in fisheries. Kittinger et al. (2013) provide a conceptual approach for modeling SFS. In addition to compiling knowledge of marine SFS, Österblom et al. (2013) have produced an interdisciplinary framework for marine scenario building whereby quantitative process-based marine models from biogeochemical and ecological disciplines are coupled with qualitative studies on the processes of governance and social change.

Evaluating SFSs requires accurate, timely, and detailed information on links between social and ecological components such as resource dynamics, environmental variability, catch composition, spatiotemporal dynamics of fishing effort allocation, fishers' traditional ecological knowledge, fishing behavior, and social interactions (Ommer et al. 2012; Hunt et al. 2013; Kittinger et al. 2013). Most of these links result in nonlinear socio-ecological relationships that extend across scales in space and time and affect a range of tangible SFS outcomes (i.e., catch rates and harvest for desirable fish species, spawning stock biomass, fisher satisfaction, and others). Some outcomes of focal SFSs may be considered externalities that affect other SFSs, such as water use for irrigation (Hunt et al. 2013). However, certain links which form a positively perceived social perspective in the short term may lead to feedback into the ecological system, thereby eroding the resilience of the wider social-ecological system (Cinner et al. 2011). For example, fishers' responses to declining local stocks may include increasing effort targeting different stocks by fishing further afield or changing gear, as well as responses that all have the potential to sequentially deplete fish stocks and amplify marine resource depletion on a larger scale (Wilson 2006).

Artisanal fishers often make short-term decisions that determine their selection of target species, fishing gears, and fishing grounds. Fishers' decisions have been associated mostly with their experience, expected catches, and income (Béné and Tewfik 2001; Salas et al. 2004). There are also socio-cultural drivers involved in artisanal fishers' activities, such as cultural keystone species and seafood consumption traditions, which guide their decision-making processes (Garibaldi and Turner 2004). The fishing method employed, along with fluctuating climatic events, can also influence fishers' decisions (Eriksson et al. 2012). Two examples of these factors are water temperature and turbidity, which can constrain dive-based fishing operations (Arceo and Seijo 1991). In this context, analyzing how fishers respond to changes in environmental conditions and resource biomass, as well as which drivers are involved in effort allocation and species targeted, can provide an important basis for the development of viable management strategies (Katsanevakis et al. 2010).

A commonly used research approach for assessing multispecies and multigear fishery effort dynamics has been the identification of métiers and fishing strategies (Katsanevakis et al. 2010). Examples of this include the analysis of effort allocation using choice models with underlying profit maximization assumptions (Salas et al. 2004) that rely on quantitative data without incorporating qualitative information inherent to fishers' behavior and social interactions (e.g., job satisfaction, peer pressure, or cultural assets). Other studies have been conducted on mono-species or limited species fisheries and include a wide range of drivers of effort dynamics and fisher behavior (Béné and Tewfik 2001; Daw 2008). However, few reports exist concerning the allocation of multi-species, artisanal, dive-based fishery effort (Shester 2010).

Thus, the present study considers the dynamics of artisanal dive fishing effort and fisher behavior as a linkage between social and ecological systems (Fig. 16.1). The bentho-demersal dive-based fishery on the North Pacific coast of Costa Rica provided empirical data to gain an understanding of fisher decision-making processes when allocating their effort. Detailed fisher surveys, daily landing records, and participatory observation techniques enabled the analysis of the hidden factors

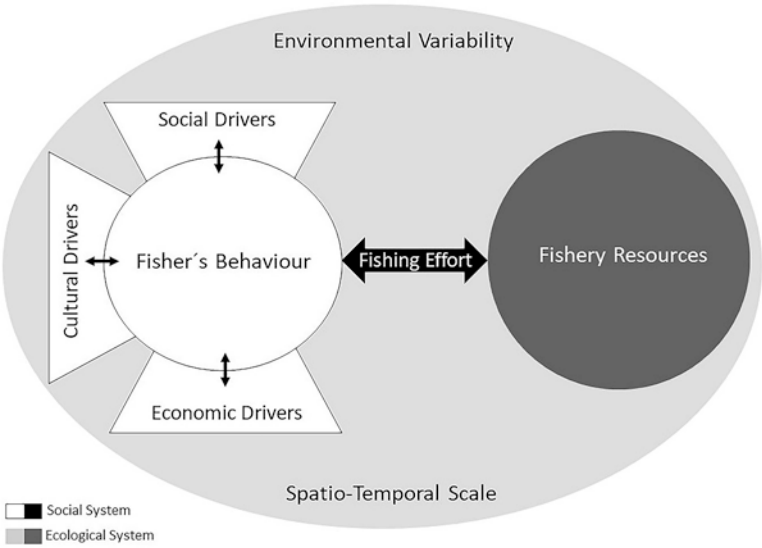



**Fig. 16.1** Heuristic model for analyzing fishing effort dynamics as a linkage between social and ecological systems

behind the spatiotemporal dynamics of fishing effort as linkages with the ecological system (i.e., catch composition and environmental variability) in this fishery. It is hypothesized that fishing effort allocation is driven by factors belonging to social (i.e., fisher's behavior, social, cultural, and economic drivers) and ecological (i.e., uncertainty in resource abundance, environmental variability) systems. Fisher behavior as it relates to effort allocation over time, space, and species is dynamic, context-dependent, and influenced by multiple factors. It is also assumed that fishers' decision-making processes can be explained by wider approaches than profit maximization (i.e., well-being), and an understanding of these aspects could lead to improved SFS resilience (Cinner et al. 2011; Stevenson et al. 2011).

## 16.2 Methods

### *16.2.1 Description of Study Area: The Artisanal Bentho-Demersal Fisheries in Costa Rica*

The present study was conducted in Playa Lagarto (Fig. 16.2), located in the province of Guanacaste on Costa Rica's northern Pacific coast (N 10°07′23″, W 85°47′97″). In Costa Rica, bentho-demersal species are primarily located in Pacific waters with 80% of the fleet being artisanal (Naranjo 2014). Fishing bento-demersal species is commonly done by diving, but changing environmental conditions can

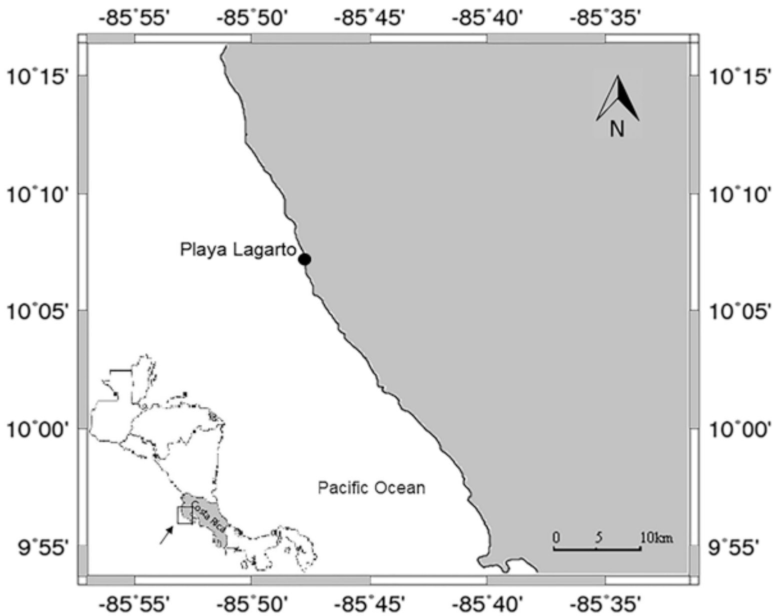



**Fig. 16.2** Study site: location of Playa Lagarto's fishing port, northern Pacific Costa, Guanacaste, Costa Rica

create uncertainty regarding resource availability and the conditions within which this fishery operates (Eriksson et al. 2012). Hence, fishers will adapt their fishing tactics as conditions dictate. In addition, alternative employment options, poverty, and market conditions can influence fishers' decisions regarding the strategies they develop to maintain their economic livelihoods. Fishing on Costa Rica's northern Pacific coast is often combined with traditional economic activities in the region, such as land clearing, farming, and ecotourism.

The most common fishing methods used in Playa Lagarto are hookah diving (H) and free diving (FD). Harpoons and hooks are commonly used gear types for both of these methods (Naranjo 2010). Free diving, mainly undertaken in more easily accessible shallow areas for commercial and subsistence purposes, has been practiced in the region since the 1960s (Naranjo 2010). Boats are not used in FD. Hence, a fishing trip is defined by the distance travelled by the divers from the port to the fishing ground on foot, the subsequent swimming and diving in the selected spot (typically involving multiple short dives), and the return distance to the port where the catch is landed.

Hookah diving has only been practiced for an estimated 20 years. Divers commonly use a vessel of up to 12 m in length to reach their dive site. This method has enabled fishers to expand diving activities to deeper regions and less exploited habitats, allowing for longer dive times that, on the one hand, increase the fishery's efficiency and yields, but on the other hand occasionally lead to accidents including barotraumas, embolisms, the bends, and other health-risk conditions (Naranjo 2010).

Regarding the location of both fisheries' fishing grounds, Costa Rica's narrow continental shelf limits the area where divers can operate, especially those practicing FD. Even though H divers have access to larger areas than FD divers, there is an overlap in the fishing areas in which they operate (Naranjo 2014). Although regulations to control effort (system of licenses) and catch exist for some species in the North Pacific (e.g., size limits for the green lobster – *Panulirus gracilis*), limited local enforcement results in many instances of illegal, unreported, and unregulated (IUU) fishing (Naranjo 2011). In addition, there are no stock assessments for bentho-demersal species in the area, and management regulations do not include total allowable catch limits for any species.

### 16.2.2 Data Collection and Participatory Diagnostic Approach

Interviews, surveys, and the participatory diagnostic approach (onboard sampling, participant observation) were used to document the process and assess fishers' activities from November 2007 to October 2008. Data from 285 H fishing trips (representing 55.6% of the total trips done during the time period) and 103 FD trips (comprising 81% of the total trips done during the time period) were recorded through the use of two onboard observers. In September 2008, there were no fishing trips due to adverse weather conditions, and in June no free diving trips were recorded due to heavy rain which affected visibility in shallow areas where fishers commonly operate.

### 16.2.3 Interviews and Surveys

The entire population of H (N = 38) and FD (N = 21) fishers were interviewed in order to collect information on catch volumes, species composition, economic data (including price per species and trip costs), fishing methods, number of fishing trips, and fishing time. Qualitative information was also recorded in the surveys including fishers' job description (boat driver or diver), fishing methods, fishers' perception of the fishing sites, heads of household, and years in the fishery.

### 16.2.4 Participatory Diagnostic Approach

A participatory diagnostic approach (PDA) was used to record qualitative details about fisher activity for 3 weeks of each month for 11 months. The first component of the PDA was participant observation undertaken during landings and onboard fishing boats. The second component of the PDA was onboard sampling. Data recorded onboard boats during fishing trips included the following variables: catch (kg) per species, price per species, subsistence catch, depth at the fishing ground (m); diving time (hours); visibility/water clarity (recorded by Secchi disk); number of FD divers per trip; number of dives per trip for H divers; and time of fishing operation and location of the fishing areas (using a GPS, Garmin®). FD divers do not use boats to reach fishing sites. Onboard informal conversations with divers provided additional information regarding the common names and characteristics of the fishing sites and tactics developed during their fishing journeys, especially regarding environmental constraints, for instance, water visibility, currents, and tides.

### 16.2.5 Data Analysis

#### 16.2.5.1 Social Interactions and Subsistence Catch

Qualitative information acquired by the PDA helped to define fishers' behavior patterns and identify little-known social interactions that act as drivers of fishing effort allocation. Fisher behavior during fishing trips was characterized according to the fishing method used. Social interactions such as peer pressure, cooperation, traditional ecological knowledge (TEK), and cultural values related to cultural keystone species were identified through onboard observations and informal conversations during daily fishing operations. Particular behaviors were categorized according to criteria described in Naranjo-Madrigal et al. (2015). The number of social interactions that occurred during fishing trips was recorded and calculated as a percentage.

Additionally, the role of social interactions during fishing operations and effort allocation was discussed.

In order to quantify a causal relationship between the amount of subsistence catch and fishers that were heads of their households or fishers without spouses and/or children (these fishers were assigned the name of "other condition"), a nonparametric Kruskal–Wallis analysis of variance (K-W; $p = 0.05$) was performed using the subsistence catch (kg) as a reference variable. It is assumed that fishers' family structure influences the amount of catch retained for subsistence purposes.

#### 16.2.5.2 Target Species

Catch composition previously identified by Naranjo (2014) was subjected to the following statistical procedure. To identify differences in the contribution of catch per species during fishing trips conducted in the dry and rainy seasons for both diving methods, binomial regressions using generalized linear models (GLMs) were fitted separately for catch and catch value for each species with fishing trips per season as a binary (dry and rainy season) response variable (Binomial Equation GLM.1). We assume that $Y$ was 1 if the trip was conducted in the dry season and 0 if it was not. This is clearly a binomial GLM as the response variable is coded as 0–1 (see Zuur et al. 2009), where $\pi_i = \mu_{\text{trip per season } i}$ and $\beta_i$ = catch or catch value. The analyses were conducted in R (R Core Team 2015), using the *manyglm* function within the *mvabund* package. The *manyglm* function fits a separate, univariate, generalized, linear model to the recorded trips by season and relates each trip by season to the catch for each species. The function uses resampling-based hypothesis testing to compare statistics significance based on likelihood ratio statistic as a measure of strength of between-group effect (see Warton et al. 2012). The calculation of $p$-values by the resampling procedure allowed assessing the significance of the likelihood ratio statistic (see Zar 1996). The likelihood ratio statistical test compared the log likelihoods of the models. Catch volume and catch value were used as predictive variables given the differences in volume and price of species; hence, the catch composition could change if catch value was used instead of catch volume.

**Binomial Equation GLM.1**

$$Y_i \sim \beta\left(n_i, \pi_i\right)$$

$$\in\left(Y_i\right) = \pi_i \times n_i \text{ and } \operatorname{var}\left(Y_i\right) = n_i \times \pi_i \times \left(1 - \pi_i\right)$$

$$\log\left(\pi_i\right) = \beta_0 + \beta_i + \varepsilon$$

#### 16.2.5.3 Spatiotemporal Patterns of Fishing Effort

Fishing effort applied by divers using FD was based on the dive time (hours). Effort for divers using H was based on the number of dives per trip. The selection of the units of fishing effort was based on the response of catch variability as a result of the generalized additive models (GAMs) included in the previous section.

Given that water visibility changes throughout the year (between the rainy and dry seasons defined by in situ observations during fishing activity), it was thought that these conditions could affect diving activities. To determine whether H diving patterns changed between seasons, a nonparametric Kruskal–Wallis analysis of variance (K-W; $p = 0.05$) was performed using the number of dives as a reference variable. It was hypothesized that during the dry season, as a result of better visibility, divers tend to increase their number of dives to maximize their catch.

The effect of environmental conditions on the spatial allocation of fishing effort for both diving methods was analyzed in the dry and rainy seasons. Effort in terms of density was mapped using the Spatial Analyst extension of the Geographic Information System program ArcGIS 9.3. The number of divers per trip and the effective fishing time per trip were used for the spatial analysis. To determine the impact of water visibility and season on divers' behavior regarding the spatial allocation of their fishing effort, Riolo's (2006) procedure was followed. In this method, density surfaces are generated using a kernel density function, allowing for the calculation and visualization of discrete characteristics over space (e.g., the density of visits to the dive site per season) or the attribute characteristics (e.g., density of fishing hours at each dive site per season). For FD, the density was expressed as the number of divers per km$^2$, whereas, for H, the density was expressed as the number of hours diving per km$^2$.

*Catch Variability* An analysis of the factors that influence catch variability was performed separately for the main common target species between the two diving methods. These species were defined previously through the resampling-based hypothesis testing procedure. It was assumed that given the multispecies nature of the fisheries in Playa Lagarto, environmental and fishing operation factors can affect target species catch amounts.

The response variable was represented by the catch (kg) per species per immersion. The explanatory variables (an explanatory variable is one that explains changes in the response variable) were comprised of the geographic location of the fishing ground (latitude and longitude), depth at the fishing area (m), water visibility (m), number of divers per trip, effective fishing time (hours), and monthly average price per target species (FD only). In the case of H, the number of dives performed in a single fishing trip and the fuel cost associated with the trip were included, in addition to the aforementioned variables. Monthly catch prices and costs were calculated in US dollars.

GAMs were employed using the R software package, version 2.15.0 (2013). Graphics procedures and a fit test followed the approach proposed by Zuur et al. (2009). The selected models for each fishing method were developed for the main target species and a gamma error distribution was fitted (Maunder and Punt 2004) with a logarithmic link function to ensure that the fitted values were positive (Zuur et al. 2009). To select the best model, the generalized cross-validation (GCV) procedure score was used to compare the variables that exhibited the best performance (Wood 2006). Variables were removed from the models if they complied with the following criteria: (1) the estimated degrees of freedom were close to 1; (2) the confidence intervals were equal to zero; and (3) the GVC score decreased when the variable was dropped. The models with the lowest GCV score were chosen for further analysis (Murase et al. 2009).

Variable interaction was added to the model in order to determine the effect on catch variability. The level of fit (GCV score) determined the form in which the variables were included in the model to avoid collinearity (Wood 2006). Three types of interactions were added in the following analysis: (1) water visibility × number of divers per trip, (2) water visibility × fishing time, and (3) latitude × longitude (geographic location of the fishing ground). Once the model with the best fit was identified for each species, each variable or interaction was individually analyzed to compute its proportion of explained variance.

## 16.3 Results

### *16.3.1 Social Interactions and Subsistence Catch*

The results of the PDA social interactions analysis are presented in Fig. 16.3 and 16.4 (see methodological procedure presented below). Complex social interactions were present during daily fishing trips for both diving methods, as FD and H fishers used TEK to evaluate ocean conditions (e.g., visibility, water color, wave level, currents) along with decision-making regarding the spatial allocations of their trips. The influence of peer pressure on fishers' behavior was a common tendency observed in greater proportion for H (51.9%) than for FD (36%) (Fig. 16.3). This type of social interaction among fishers influenced their decision-making process in terms of choosing a convenient fishing method according to oceanographic conditions and/or equipment availability, deciding whether or not to go fishing (a decision made according to oceanographic conditions), performing additional immersions, and retaining large amounts of subsistence catch.

Fishing operations for all H fishers (100%) required the collaboration of every crew member in activities such as boat departure and docking and the hauling of equipment and fishing gear (e.g., outboard engine, hoses, and compressor). For both diving methods (lower percentage for FD), cooperation also occurred underwater in activities such as fishing tactics in complex reef configurations, searching for target species aggregations, and the moving of heavy catch loads. Free divers tended to conduct most of their trips (57.2%) without a partner, resulting in a lower percentage of cooperation for this diving method (Fig. 16.3).

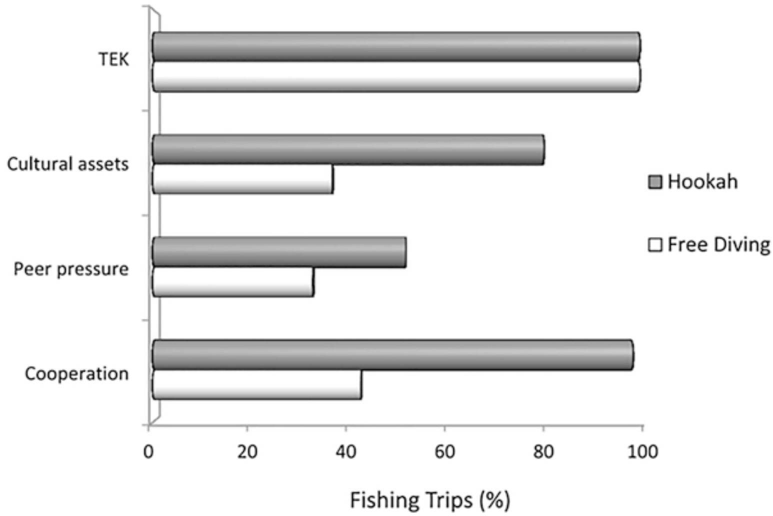
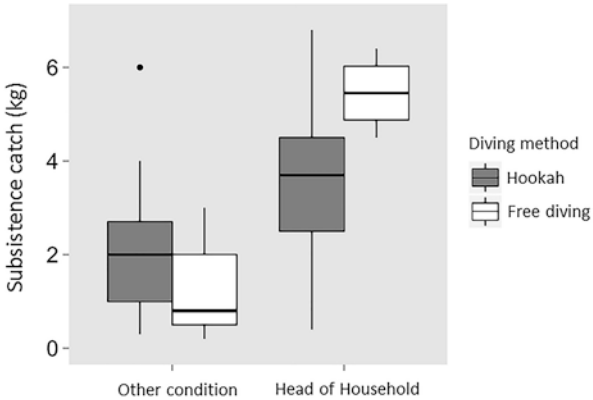



**Fig. 16.3** Proportion of social interactions during fishing trips for free and hookah diving between November 2007 and October 2008, Playa Lagarto, Costa Rica

**Fig. 16.4** Box plot comparing the amount of subsistence catch retained for each diving method and fishers' family condition between November 2007 and October 2008, Playa Lagarto, Costa Rica




Cultural aspects were primarily associated with the retention of subsistence catch and the way fishers viewed traditionally consumed species, evidenced by the high proportion of H trips (83%) that were influenced by local perceptions and superstitions about the collection of certain species. These species included snails (*Strombus galeatus*, *Fasciolaria princeps*) for their perceived aphrodisiac properties, and an increase in the retention of subsistence species during Holy Week (the week prior to Easter). The small amount of subsistence catch collected by free divers suggests that these cultural drivers do not influence its retention to the extent they do in the hookah fishery (Fig. 16.3).

Subsistence catch exclusively retained for local consumption was recorded in large amounts among fishers who were heads of household or who had other family to care for (K-W, $p < 0.05$, H: 67.7) regardless of the diving method employed. FD divers with families had a tendency to retain larger amounts of subsistence catch than H divers that presented the same condition (Fig. 16.4).

### *16.3.2 Target Species*

The results from the GLM resampling procedure (see methodological procedure presented below) that evaluated the contribution of catch per species during fishing trips conducted in the dry and rainy seasons identified eight target species for H divers (see Table 16.1). However, when catch value is taken into account, only seven of these target species were identified (*Isostichopus fuscus* did not contribute substantially to catch value due to its low price of $1 per ½ kg). Divers using FD caught few conch (*Strombus galeatus, Fasciolaria princeps*), and no oysters or black snappers were caught because of their low presence in shallow areas where divers operate. The subsistence category shows an important contribution to catch and catch value in H trips because it consisted of species of high economic value, such as conch (*Strombus galeatus, Fasciolaria princeps*) and green lobster *Panulirus gracilis* ($7 per kg). In the case of FD, the subsistence category contributed little in terms of catch and catch value.

**Table 16.1** Results from the GLM resampling procedure fitted for catch and catch value for free diving and hookah catch composition between November 2007 and October 2008, Playa Lagarto, Costa Rica

| | FD | | | | H | | | |
|---|---|---|---|---|---|---|---|---|
| | Catch | | Catch value | | Catch | | Catch value | |
| Statistic test | LR value | *p* value | LR value | *p* value | LR value | *p* value | LR value | *p* value |
| Intercept | 9.25 | <0.001*** | 9.23 | <0.001*** | 337.74 | <0.001*** | 339.09 | <0.001*** |
| Octopus | 3.37 | 0.034* | 3.74 | 0.044 * | 5.28 | 0.041* | 1.92 | 0.02* |
| Lobster | 3.32 | 0.024* | 3.32 | 0.014 * | 25.59 | <0.001*** | 25.55 | <0.001*** |
| Parrotfish | 2.03 | 0.41 | 2.28 | 0.038* | 3.81 | 0.009* | 2.52 | 0.005** |
| Rock scallop, spiny oyster | | | | | 4.23 | 0.037* | 4.38 | 0.025* |
| Subsistence | 0.56 | 0.548 | 0.556 | 0.548 | 2.78 | 0.008** | 2.25 | <0.001*** |
| Sea cucumber | 0.01 | 0.973 | 0.003 | 0.969 | 1.54 | 0.228 | 1.49 | 0.66 |
| Snail | 0.34 | 0.531 | 0.339 | 0.531 | 37.64 | <0.001*** | 37.61 | <0.001*** |
| Black snapper | | | | | 0.82 | 0.38 | 0.83 | 0.39 |
| Mother-of-pearl oyster | | | | | 2.01 | 0.14 | 2.06 | 0.15 |

Significance: ***0.001; **0.01; *0.05

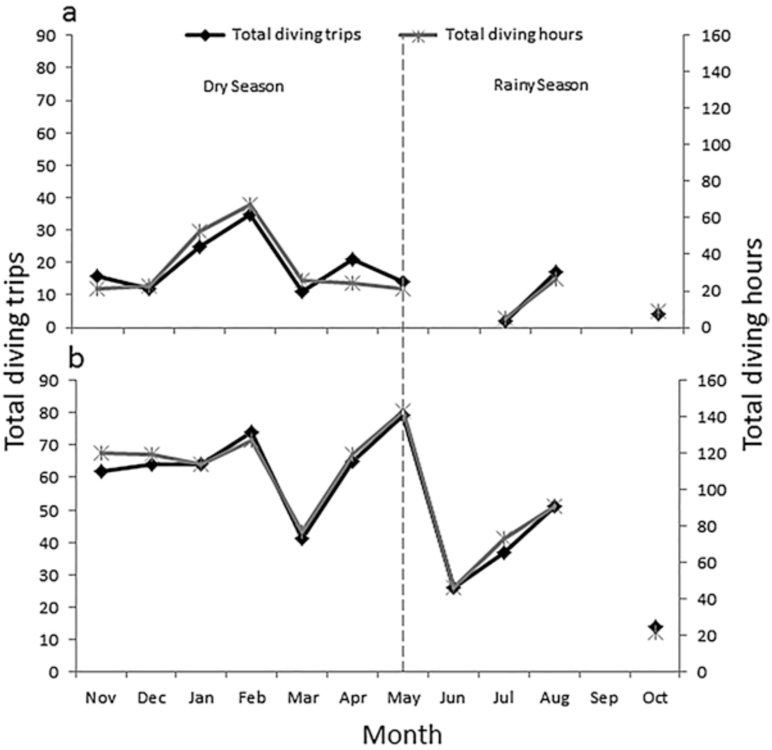



**Fig. 16.5** Total number of diving trips and diving hours per month for free diving (**a**) and hookah (**b**), between November 2007 and October 2008, Playa Lagarto, Costa Rica. The dashed lines separate the rainy and the dry seasons

### *16.3.3 Spatiotemporal Trends in Fishing Effort Allocation*

As expected, diving activities varied through the year according to environmental conditions such as season and visibility (see methodological procedures). For both methods, the total number of diving hours was proportional to the total number of dives per trip (Fig. 16.5). One hundred three trips were undertaken by 21 free divers totaling 277 fishing hours over a 10-month period. Two hundred eighty-five trips were performed by 38 hookah divers totaling 1053 fishing hours over 11 months. FD divers exhibited shorter diving times (2.7 h on average) compared with those who employed H (3.7 h on average). Regarding FD, multiple successive dives were performed in a specific area chosen a priori during one trip. Even when the sites visited were recorded using a GPS, the number of dives were not counted in situ, and therefore, it was not possible to analyze the number of dives in each trip and between dry and rainy season.

There was a significant difference (K-W, H = 2.5, $p < 0.05$) in the total number of H dives during the dry season and the rainy season (224 and 61, respectively), but no significant difference in the average number of diving hours per trip during the different seasons (K-W, H = 1.6, $p > 0.05$). There was also no significant difference in the average number of diving hours per trip during the different seasons for FD (K-W, H = 0.5, $p > 0.05$).

Both H and FD activities took place parallel to the coastline (100–3000 m from the coastline). The geographic area in which H divers operate was larger than that of FD divers (Fig. 16.6), since the availability of a boat gives H divers the opportunity to explore larger zones. For FD, a scale of low density represented 1–2 divers per $km^2$ and high density 3–4 divers per $km^2$ and for H 1–3.7 h per $km^2$ represented low density and 3.8–7 h per $km^2$ represented high density.

Both H and FD were performed at sites with rocky or partially rocky bottoms and reef barriers. Divers never operated in areas with sandy bottoms. A direct relationship exists between diving effort at rocky sites and the capture of the fishery's target species (*Panulirus gracilis*, *Octopus* sp., *Spondylus calcifer*, *Spondylus princeps*, *Strombus galeatus*, *Fasciolaria princeps*).

Figure 16.6a depicts the spatial distribution of the number of divers (FD) per $km^2$. The divers who worked in places with a visibility above 5 m were distributed over approximately 11 $km^2$. It was observed that if water visibility was less than 2 m, the total area where divers operated decreased by approximately 63% (a total of 7 $km^2$). A slightly large density of divers was found at a site known as "zurco de piedras" (stone furrow) due to the rocky bottom substrate that exists in this area. During the rainy season, divers restricted their trips to zones closer to the Playa Lagarto port, resulting in a reduction in the total area that was used by divers by 27% (3.8 $km^2$) with respect to that found during the dry season (Appendix Aa).

Regardless of water visibility or season, free divers were more likely to operate in areas close to the port because most of them walked to the beaches and then swam to their diving areas. There were a few exceptions where a small number of free divers used motorcycles to reach distant beaches.

The total fishing area exploited by H divers was approximately 70 $km^2$ when the water visibility was above 5 m. If the visibility decreased to less than 2 m, the area was reduced by 42% (30 $km^2$). A considerable decrease in diving hour density was also observed with a decrease in visibility (Fig. 16.6b). However, in areas northwest of the fishing port of Playa Lagarto, more variability in the fishing time was observed.

During the rainy season, the spatial distribution of hookah fishing effort decreased and resulted in smaller areas of operation, falling by 20.3% to an area of 13.6 $km^2$. It was observed that divers' hour density increases within sites further from the coast during rainy season months than they do during the dry season because of the turbidity caused by runoff and increased river flow into the coastal zone (Appendix Ab).

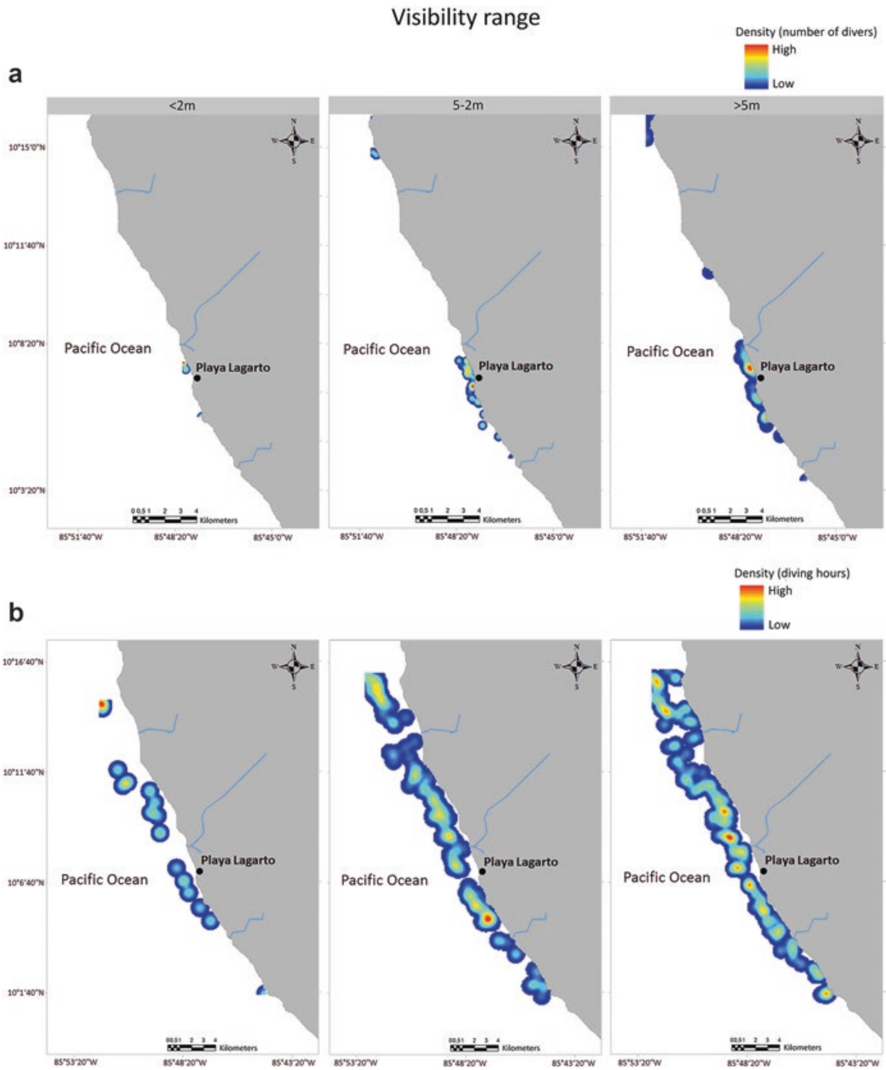



**Fig. 16.6** Spatial allocation of fishing effort by free diving and hookah between November 2007 and October 2008, Playa Lagarto, Costa Rica. (**a**) Concentration of fishing effort allocated by free divers for different ranges of visibility defined as number of divers (minimum = 1, maximum = 4) per km$^2$. (**b**) Concentration of fishing effort allocated by Hookah divers as number of diving hours (minimum = 1, maximum = 7) per km$^2$ for different ranges of visibility. A high density of effort is indicated in red. The landing port of Playa Lagarto is indicated as a reference

### *16.3.4 Catch Variability of Target Species*

Appendix B shows the results of the selected models that explain catch variability for FD target species (see methodological procedures). The variability of *Octopus* sp. catch was explained by the combined effect of water visibility and the number

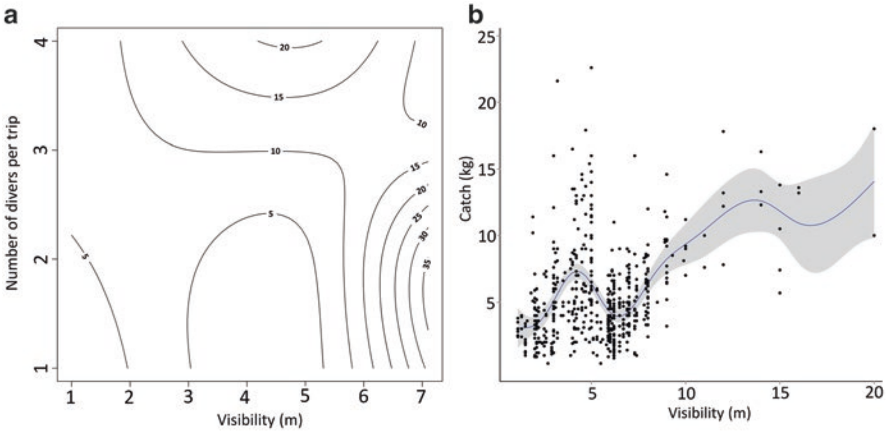



**Fig. 16.7** (**a**) The predicted combined effect of the number of divers and the visibility on the *Octopus* sp. catch from free diving from November 2007 to October 2008 in Playa Lagarto, Costa Rica is shown in the isoclines plots. (**b**) Effects of visibility on the hookah diving lobster catch. The black dots are the observed data, and the confidence intervals are shown in gray

of divers per trip operating in shallow areas (46%). The model fitted values show a considerable increase in the *Octopus* sp. catch when observed horizontal visibility reaches at least 4 m because of increased participation by divers (Fig. 16.7a). However, increased diver activity when the observed visibility was over 6 m did not always represent an increase in *Octopus* sp. catch due to factors such as spatial allocation or resource availability. The smoothed line depicted in Fig. 16.7b shows a positive relationship between the catch of this species and water visibility.

The PDA revealed changes in fishing gear used and different cooperation strategies between divers who formed groups when faced with uncertainty due to changes in environmental conditions (e.g., water visibility, tide, currents). This observation was confirmed through informal discussions with divers as they considered how to plan their trips in light of different weather and ocean conditions (e.g., tide, currents).

The formation of dive groups had an important effect on the parrotfish catch, similar to the *Octopus* sp. and lobster catches. The interaction between visibility and the number of divers explained 45.4% of the variance in the model, with a fit value of 0.6 GCV (Appendix B). Geographical location explained a large proportion of the variance for lobster (44.5%). This relationship suggests that divers prefer to concentrate their fishing effort on rocky reef patches where this species tends to concentrate.

For all target species caught using H, water visibility best explained catch variability. According to the GAMs, the weight for water visibility in the models was above 25% (see Appendix B). For *Octopus* sp., the interaction between water visibility, effective fishing time, and geographic location of the fishing grounds explained 35.1% and 3.3% of the variance, respectively. The deviation explained in this model was 38.4%.

The GAM with the highest explained deviation was the green lobster (*Panulirus gracilis*) catch at 43.6%. The catch showed a positive response to water visibility above 10 m (Fig. 16.7b), explaining 26.3% of the variance. The lobster catch also was influenced significantly by the fishing ground's geographic location (9.3%). Other variables with less weight in this model were price (4.2%), fuel cost (3.2%), and the number of dives (0.6%; Appendix B).

## 16.4 Discussion

### *16.4.1 Social Interactions and Subsistence Catch*

Most of the H and FD fishery effort drivers belong to the social domain, although ecological system linkages were identified through the analysis of these fisheries' social dynamics. According to Salas and Gartner (2004), a vital piece of information when studying fishing effort allocation is the knowledge of drivers that influence fishers' behavior. For H and FD, crucial fisher interactions with the ecological system were based on intricate information networks which were characterized by fisher perceptions about the environment (TEK), market value of the catch, peer pressure, and cultural assets. For example, the effect of water column visibility promoted cooperative actions between divers when visibility was low. The integration of groups increased the searching area over reef patches, the total catch, and mitigated diver safety concerns, as stated in informal conversations. Given the human effort needed for diving, the size of the crew was shown to contribute to catch variability. For FD, the number of divers appears to strongly influence catch (see Results). In the case of H, the number of dives and effective fishing time had an effect on catch variation for *Panulirus gracilis* and *Octopus* sp., respectively (see Results). Although under conditions of high visibility, catches were high and did not require cooperation. Overall, fishing effort increased (e.g., diving hours and number of divers or dives) for both hookah and free divers during the dry months when water visibility and thus catches were higher. Stevenson et al. (2011) found similar results in Hawaii, where an increase in the number of groups of divers positively influenced the amount of ornamental fish caught.

This type of cooperation has been reported in other artisanal fisheries (Salas and Gartner 2004; Stevenson et al. 2011). In the present case study, groups of divers were formed on the basis of existing friendships, family ties, or casual encounters at the fishing port. Sharing information and fishing gear was also common among divers as they discussed the ocean conditions and defined actions according to their knowledge and experience. Other forms of cooperation were observed when groups of divers gathered to sell their catch. Some divers who fished more than the rest shared their profits with those who fished less and also shared part of their subsistence catch. This behavior differed from the cooperative mechanism reported by Salas and Gartner (2004) in Mexico, where fishers worked in groups in order to better overcome environmental constraints, sharing catches during the windy season but not at other times. In Playa Lagarto cooperative behavior observed between divers seems to be associated with the sociocultural context, maintaining a level of well-being in the community. These findings reinforce the importance of studying individual fisher behavior and looking beyond simple profit maximization assumptions (Béné and Tewfik 2001; Daw 2008).

The sociocultural dimension related to livelihood strategies is an example of how people from fishing communities make use of their environment and natural resources (Allison and Ellis 2001). The existence of specific livelihood strategies was observed in the dynamics of social interactions for the allocation of fishing effort in Playa Lagarto. In the case of H, there were particular immersions which were for the sole purpose of catching species for personal consumption. In both methods, peer pressure played a crucial role in the amount of catch retention and fishing site choice. For example, head of household fishers compelled others to retain more catch or perform additional immersions for this purpose. This highlights the importance and relevance of marine habitats that contribute to these fishers' food security and points to the importance of protecting these areas while at the same time ensuring resources conservation, resource access, and sustainable livelihood strategies (McClanahan et al. 2015).

The presence of "cultural keystone species" (Garibaldi and Turner 2004) like snail, whose consumption is linked to traditions and religious beliefs, and recreational diving trips all reinforce the idea that deep-rooted culture drivers of fishing effort shape the identity of the fishers from Playa Lagarto's fishing port. Social scientists argue that fishing activities are bound up in relational processes resulting in the creation of social networks that define particular individual and community identities linked to a fishing way of life (Acott and Urquhart 2014). In this regard, the sustainability of SFSs should include cultural ecosystem services to provide a policy-relevant context within which community well-being can be articulated (Tengberg et al. 2012).

### *16.4.2 Catch Variability*

The effect of seasonal environmental conditions (e.g., visibility) on the day-to-day operation of dive fisheries has also been reported in trawl, gillnet, and line fisheries (Lopes 2011). Salas et al. (2004) reported how environmental conditions influence fishers' decisions to change gear, particularly for diving. Béné and Tewfik (2001) also reported that changes in environmental conditions dictated the dive patterns of fishers targeting conch in Turks and Caicos Islands. Included in these environmental conditions, water visibility explained part of the catch variability in most of the models obtained with the GAMs, although other variables were also important depending on the species targeted. For example, the catch of highly mobile species, such as parrotfish (*Scarus ghobban*, *S. perrico*), could not be explained by the models, which could have been due to the fact that high dispersion across the fishing area could have caused low contribution in catch variability.

At the spatial scale, the operational dynamics examined had an important effect on catch yields. Although fishing effort appeared to increase with more favorable environmental conditions, economic factors also had an effect. For example, an increase in the price of *Panulirus gracilis* between March and July led to a slight increase in H fishing effort (see results Appendix B). In the case of FD, during the dry months and when visibility was high, fishers travelled to fishing areas in search of better *Octopus* sp. catch (see results in Sect. 16.3.4). This confirms that catch expectations and prices act as a trigger for fishing effort fluctuations not only in the long term (e.g. Eales and Wilen 1986) but also in the short term.

Fishing location also explained catch variation for both H and FD. This aspect is particularly relevant and also supported by several authors (e.g., Ríos-Lara et al. 2007; Shester 2010) for bentho-demersal species such as green lobster (*Panulirus gracilis*). Diver effort was concentrated on reef patches with structural and ecological characteristics that favor aggregations of bento-demersal species (Ríos-Lara et al. 2007). Ríos-Lara et al. (2007) found similar patterns in the case of spiny lobster from the Yucatan coast, Mexico. It is important to consider that, in the case of divers using H, fishing trips were distributed over a larger area compared with the area used by FD divers. The distance effect was reflected in the GAMs calculated for green lobster, which is fished in areas far from the fishing port, as more fuel was required and trip costs increased (see results in Appendix B).

The reason for the low values of subsistence catch for FD was mainly a consequence of the landing process carried out by FD divers (see Results). After FD divers had finished their fishing trips, their subsistence catch was taken home before they went to the fishing ports where they sold their commercial catch. As a consequence, the amount of subsistence catch recorded for FD in the fishing port was negligible. This means that, in fact, there was an amount of subsistence catch retained for FD divers that could not be recorded. Generally, the category "subsistence" for both methods indicates that the fishers are willing to forgo a percentage of their profits and allocate these species for personal consumption. This behavior clearly points out a mismatch between the economic theory of rationality and fishers' community traditions (Plagányi et al. 2013).

### 16.4.3 Spatiotemporal Allocation of Fishing Effort

Before planning their fishing trips, divers in Playa Lagarto assess oceanographic conditions and share information on catches obtained by other divers the previous day. They also share information regarding the sites that traditionally yield high catches, as was confirmed through PDA observations. Several authors have indicated that fishers' site selection and targeting of species is not a random process (Daw 2008; Shester 2010). Information sharing about location and target species between fishers can be a common practice aimed at improving the potential trip catch. For example, Eales and Wilen (1986) found that site selection to fish shrimp in Northern California was not random but was influenced by catch information shared between fishers. Spatial allocation of fishing effort in Playa Lagarto also involves individual diver TEK and social interactions, such as information sharing between divers.

During dry months, fishers tend to visit more sites in search of greater catches. Fewer dives were observed during the rainy season due to water turbidity and strong currents associated with large waves. This tactic reflects the effects of environmental changes associated with seasons and the subsequent fishing effort redistribution that result (Shester 2010). A disadvantage of this tactic is that fishers face potential health risks by not following the rules of diving, such as decompression stops.

It is worth noting that the location selection process in Playa Lagarto, within a range of 50–100 m, involved the avoidance of places previously visited by other divers, as was confirmed through PDA observations. Divers preferred to move to nearby sites on the same reef patch rather than fish a currently exploited site, thus avoiding the chance of running into other divers. This decision was motivated by the expectation of better catches at an unvisited site. Where information on site visitations was available, the distribution of dives over small spatial scales resulted in an optimal use of the area by all divers. In order to save time and fuel expenses, and avoid visiting sites with low catch probability, divers tended to use hand signals to inform others that water conditions were not good for diving. Sometimes boats come together to share information about catches and water visibility conditions in previously visited fishing grounds. Shester (2010) found that lobster fishers that use traps take into account sites that have previously recorded high catches, habitat characteristics, and oceanographic conditions in order to define the spatial distribution of their effort.

## 16.5 Conclusion and Management Implications

Understanding the complex relationship that exists between small-scale fishers and coastal ecosystems is paramount to the development of effective management guidelines aimed at achieving environmental and socioeconomic sustainability within this sector. To this end, traditional management approaches, including natural resource optimization and rational economy theory, should give way to strategies based on resilience thinking and other systemic paradigms (Walker and Salt 2006). It is well known that effective SFS management mediations, under the context of change and adaptation, demand meaningful information regarding the interdependence of social and ecological systems. As stated by several human dimensions in fisheries' authors, a better understanding of fishers' activities and their response to changes in regulations or environmental conditions is required for fisheries assessment and management (Salas et al. 2004; Fulton et al. 2011).

In contrast to economics-oriented studies in which profit maximization is proposed as a main assumption guiding short-term decision-making processes regarding fleet dynamics and fishers' behavior (e.g., Salas et al. 2004), this study demonstrated how multiple factors from social systems (e.g., social interactions) and ecological systems (e.g., environmental conditions) are dominant forces in artisanal fishery contexts from developing countries which are constrained to poverty traps, deep-rooted cultural values, low employment availability, weak institutional support, and the lack of efficient management interventions (Andrew et al. 2007).

The PDA was a powerful tool for defining effort dynamics and social interactions representing connections between social and ecological systems. This research approach helped to scrutinize the nature of fishing activities as well as describe social interactions, contextual factors, and conditions crucial to management (Kittinger et al. 2013). The PDA allowed researchers to get involved in daily fishing activities and characterize fishers' behavior. Through the use of PDA, it was demonstrated how dive-based multispecies artisanal fisheries in developing countries represent important commercial and subsistence outlets for coastal community members. These results are similar to those of Kronen (2004) and Busilacchi et al. (2013), which studied artisanal fisheries in Africa and Australia. The inherent social-cultural values that are embedded in the exploitation of natural resources by small-scale fishers should encourage managers to include this information in marine policies to ensure community livelihoods and well-being in the long term (McClanahan et al. 2015; Plagányi et al. 2013).

Measures that could improve sustainability and strengthen the resilience of the local SFS in Playa Lagarto include the following:

(1) Treduce fishers' dependence on diving activity by promoting alternative livelihoods (e.g., ecotourism and agroecological subsistence);
(2) implement environmental education plans to foster a gradual change in behavior regarding the use of cultural keystone species and marine resources;
(3) begin a community management process within the framework of Responsible Marine Fishing Areas (Naranjo-Madrigal et al. 2015), that includes a program to improve post-harvest management strategies such as Community Markets for Conservation (Lewis et al. 2011), in order to increase revenue;
(4) pursue poverty reduction programs and integrated community development;
(5) improve collection of population dynamics data for vulnerable species, such as parrotfish and octopus, in order to implement precautionary principle recommendations based on findings from Naranjo (2014).

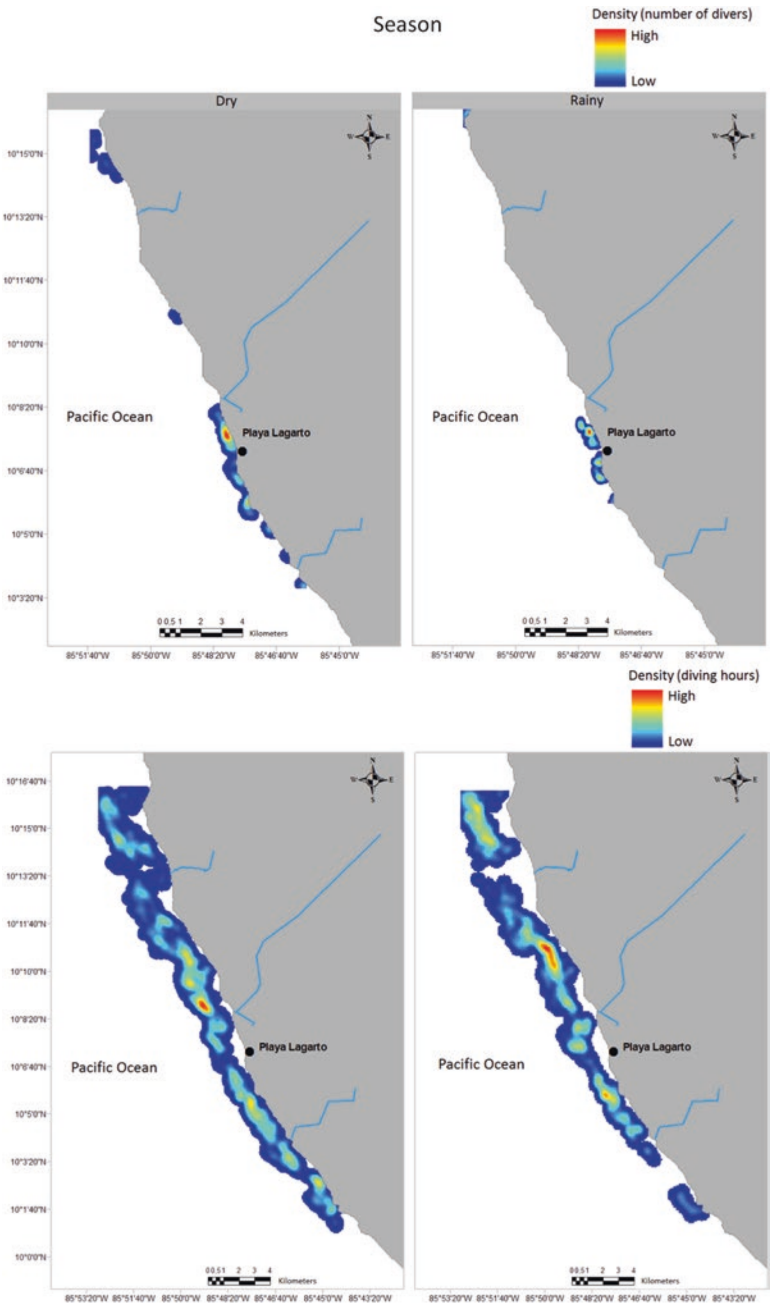
There is a need to propose management plans that may allow the implementation of these measures. The viability of such plans could be evaluated using PDA as a tool to integrate information from different components of SFS.

Over the course of time, more emphasis has been placed on the search for tools, such as closures and marine protected areas that can impact fishing pressure and improve resource availability (Lester et al. 2005). The viability of these tools is possible if information is known about fishers' operations in time and space (Salas and Gartner 2004; Fulton et al. 2011). Looking forward, future small-scale SFS research should focus on potential ecosystem impacts and the key factors that drive fisher decision-making processes. In order to gather information on these themes, an analytical modeling framework that allows for the identification of environmental processes and fisher relationships, much like the one presented in this study, should be used. The implementation of the PDA as a tool to amass information from different components of SFS would allow for what Folke et al. (2005) and Österblom et al. (2013) refer to as "SFS policy-relevant scenario building" in an attempt to deal with uncertainty and increase management capacity through the concept of adaptive governance.

**Acknowledgments** We thank the fishers of Playa Lagarto who made this study possible. We also thank the local seafood buyers and all of those who collaborated in this study in one way or another. We warmly thank Ingrid van Putten at CSIRO for her remarkable editing work and valuable comments on the manuscript. We have received helpful reviews from Silvia Salas in early versions of this paper. The authors would also like to thank the anonymous referees for their constructive comments. This study forms part of the doctoral thesis of the first author at CINVESTAV U. Mérida. Financial support from ALNA S.A and CONACYT is acknowledged by the first author.

# Appendices

**Appendix A** Spatial allocation of fishing effort by season for free diving and hookah occurring between November 2007 and October 2008, Playa Lagarto, Costa Rica. (**a**) Spatial variability in the density of divers (number of divers per km$^2$, minimum = 1, maximum = 4) who use FD. (**b**) Spatial variability in the density of hours (number of diving hours per km$^2$, minimum = 1, maximum = 7) worked by divers who use H



**Appendix B** Variables that fit the best models for the catch variation for the three main species (*Octopus* sp., *Panulirus gracilis*, *Scarus ghobban* and *S. perrico*) targeted by free and hookah divers

| *Free diving* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parameter | Octopus | | | Green lobster | | | Parrotfish | | |
| Deviance explained (%) | 46 | | | 53.6 | | | 45.4 | | |
| Intercept | 1.4 | | | 0.6 | | | 0.9 | | |
| Standard error | 0.1 | | | 0.2 | | | 0.3 | | |
| Adjusted $r^2$ | 0.5 | | | 0.6 | | | 0.7 | | |
| GCV score | 0.4 | | | 0.7 | | | 0.6 | | |
| Covariates | Df | *p*-value | Partial deviance explained (%) | Df | *p*-value | Partial deviance explained (%) | Df | *p*-value | Partial deviance explained (%) |
| Visibility × number of divers per trip | 9 | <0.001 | 46 | 8 | 0.01 | 9.1 | 3 | <0.001 | 45.4 |
| Fishing ground | | | | 3 | 0.008 | 44.5 | | | |
| *Hookah diving* | | | | | | | | | |
| Deviance explained (%) | 38.4 | | | 45 | | | 28.4 | | |
| Intercept | 1.8 | | | 1.5 | | | 0.9 | | |
| Standard error | 0.02 | | | 0.02 | | | 0.02 | | |
| Adjusted $r^2$ | 0.3 | | | 0.5 | | | 0.3 | | |
| GCV score | 0.3 | | | 0.2 | | | 0.2 | | |
| Covariates | Df | *p*-value | Partial deviance explained (%) | Df | *p*-value | Partial deviance explained (%) | Df | *p*-value | Partial deviance explained (%) |
| Visibility | | | | 8 | <0.001 | 26.3 | 8 | <0.001 | 26.9 |
| Price | | | | 4 | <0.001 | 4.2 | | | |
| Number of immersions per trip | | | | 3 | 0.02 | 0.6 | | | |
| Depth | | | | | | | 2 | 0.008 | 1.5 |
| Fuel cost | | | | 7 | <0.001 | 3.1 | | | |
| Visibility × effective time | 13 | <0.001 | 35.1 | | | | | | |
| Fishing ground | 7 | 0.02 | 3.3 | 8 | <0.001 | 10.8 | | | |

## References


Acott T, Urquhart J (2014) Sense of place and socio-cultural values in fishing communities along the English Channel. In: Urquhart J, Acott TG, Symes D, Zhao M (eds) Social issues in sustainable fisheries management, MARE publication series, vol 9. Springer, London, pp 257–277

Allison E, Ellis F (2001) The livelihoods approach and management of small-scale fisheries. Mar Policy 25(2):377–388

Andrew N, Béné C, Hall S, Allison E, Heck S, Ratner B (2007) Diagnosis and management of small-scale fisheries in developing countries. Fish Fish 8:227–240

Arceo P, Seijo J (1991) Fishing effort analysis of the small-scale spiny lobster (Panulirus argus) fleet of the Yucatan shelf, FAO fisheries report 431. FAO, Rome, pp 59–74

Béné C, Tewfik A (2001) Fishing effort allocation and fishermen's decision making process in a multi-species small-scale fishery: analysis of the conch and lobster fishery in Turks and Caicos Islands. Hum Ecol 29:157–186

Busilacchi S, Russ G, Williams A, Sutton S, Begg G (2013) The role of subsistence fishing in the hybrid economy of an indigenous community. Mar Policy 37:183–191

Cinner J, Folke C, Daw T, Hicks C (2011) Responding to change: using scenarios to understand how socioeconomic factors may influence amplifying or dampening exploitation feedbacks among Tanzanian fishers. Glob Environ Change 21:7–12

Daw T (2008) Spatial distribution of effort by artisanal fishers: exploring economic factors affecting the lobster fisheries of the Corn Islands, Nicaragua. Fish Res 90:17–25

Eales J, Wilen J (1986) An examination of fishing location choice in the pink shrimp fishery. Mar Resour Econ 2:331–351

Eriksson H, de la Torre-Castro M, Olsson P (2012) Mobility, expansion and management of a multi-species scuba diving fishery in East Africa. PLoS ONE 7(4):e35504. https://doi.org/10.1371/journal.pone.0035504

Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social–ecological systems. Annu Rev Environ Resour 30:441–473

Fulton E, Smith A, Smith D, van Putten I (2011) Human behaviour: the key source of uncertainty in fisheries management. Fish Fish 12:2–17

Garibaldi A, Turner N (2004) Cultural keystone species: implications for ecological conservation and restoration. Ecol Soc 9(3):1

Hunt L, Sutton S, Arlinghaus R (2013) Illustrating the critical role of human dimensions research for understanding and managing recreational fisheries within a social-ecological system framework. Fish Manag Ecol 20:111–124

Katsanevakis S, Maravelias C, Vassilopoulou V, Haralabous J (2010) Boat seines in Greece: Landings profiles and identification of potential métiers. Scientia Marina 74:65–76

Kittinger J, Finkbeiner E, Ban N, Broad K, Carr MH, Cinner JE, Gelcich S, Cornwell ML, Koehn JZ, Basurto X, Fujita R, Caldwell MR, Crowder LB (2013) Emerging frontiers in social–ecological systems research for sustainability of small-scale fisheries. Curr Opin Environ Sustain 5:352–357

Kronen M (2004) Fishing for fortunes? A socio-economic assessment of Tonga's artisanal fisheries. Fish Res 70:121–134

Lester S, Halpern BS, Grorud-Colvert K, Lubchenco J, Ruttenberg BI, Gaines SD, Airamé S, Warner RR (2005) Biological effects within no-take marine reserves: a global synthesis. Mar Ecol Prog Ser 384:33–46

Levin SA (1999) Fragile dominion: complexity and the commons. Perseus Books, Reading

Lewis D, Bell SD, Fay J, Bothi KL, Gatere L, Kabila M, Mukamba M, Matokwani E, Mushimbalume M, Moraru CI, Lehmann J, Lassoie J, Wolfe D, Lee DR, Buck L, Travis AJ (2011) Community markets for conservation (COMACO) links biodiversity conservation with sustainable improvements in livelihoods and food production. Proc Natl Acad Sci 108:13957–13962

Lopes P (2011) Decision-making processes by small-scale fishermen on the southeast coast of Brazil. Fish Manag Ecol 18:400–410

Maunder M, Punt A (2004) Standardizing catch and effort data: a review of recent approaches. Fish Res 70:141–159

McClanahan T, Allison EH, Cinner JE (2015) Managing fisheries for human and food security. Fish Fish 14(3):1467–2979

Murase H, Nagashima H, Yonezaki S, Matsukura R, Kitakado T (2009) Application of a generalized additive model (GAM) to reveal relationships between environmental factors and distributions of pelagic fish and krill: a case study in Sendai Bay, Japan. ICES J Mar Sci 66:1417–1424

Naranjo M (2010) Caracterización de los sistemas operacionales, modalidades y artes de pesca utilizados para la captura de la langosta *Panulirus gracilis* (Streets, 1871) en Guanacaste, Costa Rica. Revmar 2:73–82

Naranjo M (2011) Biología pesquera de la langosta *Panulirus gracilis* (Streets, 1871) en Playa Lagarto, Guanacaste, Costa Rica. Revista de Biolología Tropical 59:619–633

Naranjo M (2014) Análisis espacio-temporal de las operaciones de pesca de las pesquerías artesanales bento-demersales en Playa Lagarto, Costa Rica (doctoral dissertation). Centro de Estudios Avanzados del IPN. CINVESTAV, México

Naranjo-Madrigal H, van Putten I, Norman-López A (2015) Understanding socio-ecological drivers of spatial allocation choice in a multispecies artisanal fishery: a Bayesian network modeling approach. Mar Policy 62:102–115

Ommer R, Perry R, Murray G, Neis B (2012) Social–ecological dynamism, knowledge, and sustainable coastal marine fisheries. Curr Opin Environ Sustain 4(3):316–322

Österblom H, Merrie A, Metian M, Boonstra WJ, Blenckner T, Watson JR, Rykaczewski RR, Ota Y, Sarmiento JL, Christensen V, Schlüter M, Birnbaum S, Gustafsson BG, Humborg C, Mörth C, Müller-Karulis B, Tomczak MT, Troell M, Folke C (2013) Modelling social-ecological scenarios in marine systems. BioScience 63:735–744

Plagányi EE, van Putten I, Hutton T, Deng RA, Dennis D, Pascoe S, Skewes T, Campbell RA (2013) Integrating indigenous livelihood and lifestyle objectives in managing a natural resource. Proc Natl Acad Sci 110:3639–3644

R Development Core Team (2015) R: a language and environment for statistical computing. In: R foundation for statistical computing, Vienna, Austria. http://www.R-project.org. ISBN 3-900051-07-0. Accessed 16 Mar 2016

Riolo F (2006) A geographic information system for fisheries management in American Samoa. Environ Model Softw 21:1025–1041

Ríos-Lara V, Salas S, Javier B, Ayora P (2007) Distribution patterns of spiny lobster (*Panulirus argus*) at Alacranes reef, Yucatan: spatial analysis and inference of preferential habitat. Fish Res 87:35–45

Salas S, Gaertner D (2004) The behavioural dynamics of fishers: management implications. Fish Fish 5:153–167

Salas S, Sumaila U, Pitcher T (2004) Short-term decisions of small-scale fishers selecting alternative target species: a choice model. Can J Fish Aquat Sci 61:374–383

Shester G (2010) Explaining catch variation among Baja California lobster fishers through spatial analysis of trap-placement decisions. Bull Mar Sci 86:479–498

Stevenson T, Brian NT, Dierking J (2011) Fisher behaviour influences catch productivity and selectivity in West Hawaii's aquarium fishery. ICES J Mar Sci 68:813–822

Tengberg A, Fredholm S, Eliasson I, Knez I, Saltzman K, Wetterberg O (2012) Cultural ecosystem services provided by landscapes: assessment of heritage values and identity. Ecosyst Serv 2:14–26

Walker B, Salt D (2006) Resilience thinking. Island Press, Washington D.C

Warton D, Wright S, Wang Y (2012) Distance-based multivariate analyses confound location and dispersion effects. Methods Ecol Evol 3:89–101

Wilson J (2006) Matching social and ecological systems in complex ocean fisheries. Ecol Soc 11(1):9

Wood S (2006) Generalized additive models: an introduction with R. Chapman & Hall/CRC, Boca Raton

Zar JH (1996) Biostatistical analysis. Prentice Hall, Upper Saddle River

Zuur F, Leno E, Walker N, Saveliev A, Smith G (2009) Mixed effects models and extensions in ecology with R. Springer, New York

**Helven Naranjo-Madrigal** has worked for over 15 years as a research director at ALNA S.A and more recently as a part-time professor at Costa Rica's National University. As a fisheries scientist and interdisciplinary researcher, he has identified suitable management tools for different fishery contexts and has also participated in management decision-making processes together with interested parties. He is interested in developing holistic and systemic frameworks that assess and provide management advice for small-scale and large-scale fisheries, as well as the possibility of understanding the effects of driving forces that lead to regime shifts in the marine environment.

**Andrew B. Bystrom** is an environmental consultant based in Costa Rica. He is passionate about developing solutions that address the dire need to improve the integrity of marine ecosystems so that they will continue to support the socioeconomic resilience of human life around the planet. He has designed, fundraised for, and managed local and international campaigns for marine conservation, sustainable development, and research for a variety of nonprofit organizations, universities, and governments throughout the Americas. His current work includes small-scale fisheries development and United Nations high seas marine biodiversity protection policy.

# Chapter 17
# The Embrace of *Liwa Mairin*: Lobster Diving and Sustainable Livelihoods on the Nicaraguan Miskito Coast

**Miguel González**

**Abstract** This chapter seeks to explore the governance challenges associated with lobster diving on the Caribbean Coast of Nicaragua. Driven by external market pressure, commercial lobster diving has become a dangerous activity for Miskito men due to the inadequate equipment used by indigenous divers, the precarious working conditions under which they operate, and the environmental effects that this fishery has on the resource base. Against the backdrop of relatively recent and progressive domestic legislation promising to prohibit lobster fishing through diving, current policy debates are delaying meaningful actions to protect Miskito divers and the livelihoods of coastal communities that depend on multiple target fisheries. The chapter contends that the governance and viability of the lobster fishery would be better served through a combined strategy of law enforcement mechanisms, human rights protections, responsible labor-capital practices, and the careful consideration of alternative livelihoods for fishing communities.

**Keywords** Miskito · Nicaragua · Commercial lobster fishing · Governance · Livelihoods

> The liwa [mairin] tries to seduce men and then injures them or drowns them. These attacks are a punishment by the liwa for taking too many of her lobsters. Divers know that the industry is decimating lobster populations and believe the liwa, owner of all sea creatures, is very angry about the situation. She thus inflicts paralysis and death on the divers. (Dennis 2004, p.142)

M. González (✉)
York University, Toronto, ON, Canada
e-mail: migon@yorku.ca



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_17

## 17.1 Introduction

Research on small-scale fisheries has widely considered the economic viability of the sector, the sustainability of the resource base through management alternatives, the specific governance challenges, and the competition over fisheries resources between small-scale fisheries and large-scale industrial fisheries sectors (Berkes et al. 2001; Bundy et al. 2008; Chuenpagdee 2011a, b). More recently, a wide array of studies has been devoted to understanding the interactions of small-scale fisheries with poverty, vulnerability, climate change, and resilience (Allison and Elllis 2001; Béné and Friend 2011). These studies have highlighted the multiple obstacles faced by small-scale fisheries-reliant communities in developing countries at generating and maintaining sustainable livelihoods and food security in light of rapidly changing ecosystems. This research has also considered the impact of global economic processes and dynamics over local practices and the sociopolitical marginalization of small-scale fisheries-related organizations which excludes them from participating in relevant policy decision-making (Chuenpagdee 2011b; Jentoft and Eide 2011).

Recently, more attention has been placed on aspects related to health, safety measures, and risks associated with labor conditions encountered in the small-scale fisheries sector. For instance, some studies have shown the prevalence of HIV-AIDS infection in fishing communities, with potential causes such as unprotected transactional sex in periods of harvest and food shortages (Béné and Merten 2008). Additionally, other studies have examined the incidence of accidents associated with risky practices in certain fisheries, for example, in the extraction of lobsters and sea snails using diving practices that do not respect safety intervals or use proper equipment. These practices are the causes for decompression accidents that cause death or permanent disabilities (Barattand and Van Meter 2004). Moreover, research has demonstrated that the absence of safety regulations in small-scale fisheries practices has an impact on the health and labor conditions for the laborers of the sea, particularly on poor and vulnerable communities that depend on aquatic resources for their survival and well-being (Ferreira et al. 2002). Finally, some studies have also examined the implications of perceptions of safety among fisherfolk over resource spaces, which have major significance for management intervention programs particularly in marine protected areas (Teh et al. 2012).

In 2005, the Food and Agriculture Organization (FAO) of the United Nations technical report entitled *Increasing the contribution of small-scale fisheries to poverty alleviation and food security* highlighted the need to enhance social securities and workers' rights in small-scale fisheries. The report stated that "[l]egislation should ensure that small-scale fishers and fishworkers receive the same access to, and coverage under, insurance schemes, pensions, and unemployment benefits as other sectors of the economy" (FAO 2005). It continues by stating that "the issue of workers rights and labor law is also an area usually dealt outside of fisheries legislation. It is important for those working in processing factories (usually women), as well as for men in capture fisheries, to be covered under national laws, rather than being considered a 'special case' given the nature of the work in terms of its hours and conditions, with a resulting lack of legal protection" (FAO 2005). The "special case" status commonly assigned in many national contexts to fishworkers in small-scale fisheries has often overlooked the particular labor conditions of fisherfolk and therefore has had a damaging effect on their human and labor rights. This report came in partial response to emerging criticisms of waged fishing activities and civil organizations within states that are disengaged from their responsibility to ensure functional social protection systems, often spurred on by national and international policy agendas that promote labor "flexibility" and market-oriented economic reforms.

Internationally, Article 24 of the International Labour Organization (ILO) agreed on the 169 ILO Convention concerning the rights of indigenous and tribal peoples, which specifies that "social security schemes shall be extended progressively to cover the peoples concerned, and applied without discrimination against them, which placed substantial responsibilities on states for the well-being of natural resource-based communities" (ILO 1989).

In this chapter, I explore the health-risk-associated factors linked to ongoing commercial lobster diving on the Nicaraguan Caribbean Coast and discuss the governance challenges for achieving sustainable livelihoods derived from these practices. This study focuses on Miskito male divers involved in artisanal (small-scale) and industrial commercial lobster fishing in coastal communities of the North Caribbean region in Nicaragua.

The Caribbean Coast of Nicaragua – the eastern part of the country that corresponds to roughly 50% of the national territory –is inhabited by a culturally diverse population including indigenous communities such as the Miskito, Rama, and Mayangnas, Afro-descendant populations of Garifunas and Black Creoles, and Spanish-speaking Mestizos. This human population occupies diverse ecosystems and resides in approximately 250 scattered rural and coastal communities in this region of the country (PNUD 2005; Christie et al. 2000; Hostetler 2005). The Miskito community comprises the largest indigenous group, representing around 17% of the total population on the coastal region (Williamson and Fonseca 2007). Inhabitants of the Miskito communities located along the coastline are vastly involved in commercial lobster diving (mainly *Panulirus argus*). This extractive activity is performed by conducting relatively short fishing trips (6–15 days) to coral reef areas located on the vicinity of the shoreline and around the Corn Islands and the Miskito Keys (Fig. 17.1). In both the industrial and small-scale fishing fleet, commercial lobster fishing is conducted by diving and the use of traps. Diving is thus considered a widespread fishing practice in this region (Monnereau and Helmsing 2011).

Small-scale, artisanal commercial divers work on boats that range from vessels ≥10 m length powered by outboard motors, to sail boats (i.e., *duri tara*), to boats with small inboard diesel motors. Labor and investment mostly depend on family-based business and community networks. The industrial fleet operates larger boats and which usually are "decked steel vessels of 12 – 25 m length, powered by diesel inboard engines of 50-400 hp" (World Bank 1999). The industrial vessels that use


**Fig. 17.1** Area where short-term fishing activities are developed by Miskito community

diving as their main fishing strategy typically employ crews of about 52 fishers – half of whom are boatmen (who remain onboard and follow the divers while they capture lobsters underwater) and around 16 of which are crewmembers. The owners of these industrial boats are national and foreign investors who designate the captain or manager of the vessel.

Commercial lobster fishing is considered a dangerous activity for fishers due to the frequent decompression accidents suffered by divers; the activity is also criticized for its negative impact on the sustainability of lobster populations. It is important to note that the negative effects of commercial diving on the resource's sustainability is not due to diving alone but instead is a consequence of the inability of existing regulations to limit capture and thus keep the fisheries sustainable. For these reasons, lobster diving has been banned in many countries around the world, including five Central American countries. Yet, Nicaragua still allows this practice under the rationale that its complete prohibition, without introducing alternative income-generating activities, might compromise the ability of Miskito divers to sustain their livelihoods. However, these livelihood activities are very dangerous for small-scale divers and are affected by social inequities between small-scale and industrial fleets. Small-scale divers, on the one hand, have continued working under precarious labor conditions and have been increasingly suffering of decompression accidents in recent years. The industrial fleet, on the other hand, which contributes to almost 37.12% of the total lobster catch, is complicit with this state of affairs because it has lobbied the Nicaraguan state (including local and regional governments and the national congress) to secure a 2-year exemption of the law that prohibits commercial lobster diving. Thus, there is a great need for a full account of the current situation, including an analysis of the interactions of the multiple actors at play and the exploration of the consequences of maintaining the status quo, in order to better understand the governance challenges pertaining to the lobster fishery on the Nicaraguan Coast.

One particular aspect that has been taken into account in addressing the lobster fishery in the context of the Miskito community is the notion of the *Liwa Mairin*, a mythical creature which in Miskito spirituality is said to appear as a white female being and harasses fishermen who abuse the aquatic fauna. I hereby evoke the idea of embracing *Liwa Mairin*, as a female spiritual being within the Miskito worldview that oversees water resources, by being both zealously protective and also deadly in a context of increasing asymmetrical relationships with regard to the use of natural resources (Dennis 2004; Jamieson 2007). In a sense, this locally based image captures this complex dilemma very well, as currently observed in commercial lobster diving. I argue that this metaphor helps to bring clarity to the seemingly conflicting goals of sustaining the resource and ensuring the well-being of Miskito communities who are trapped in a context of limited opportunities for earning a decent income and the risks associated to this fishing practice.

### *17.1.1 Theoretical Implications: Governance*

Small-scale fisheries around the world have become a subject of increasing academic and policy interest in recent decades, with the growing recognition of their contribution to livelihoods, food security, and national economic growth (Berkes et al. 2001; FAO 2005, 2010; Salas et al. 2011). At the same time, the exploitation of aquatic resources has increased substantially, with a shift in the demand from developed to developing countries due to changes in their consumption patterns and existing free-trade regimes (Butcher 2004; Bavinck 2011; Eide et al. 2011). Such intensive exploitation of aquatic resources has brought to the forefront major environmental considerations related to the loss of endangered marine species and biodiversity (Worm et al. 2006), as well as social and economic risks associated with resource depletion (Berkes et al. 2006). These concerns are most relevant to those working in the small-scale fisheries sector, whose livelihoods, well-being, and food security are closely tied with the availability of fisheries resources (Symes and

Phillipson 2001). Further, as various authors have pointed out, small-scale fisheries have been marginalized in policy-making with the prevailing tendency for governments to favor industrial, large-scale commercial fishing operations (Chuenpagdee 2011a). This situation magnifies the effects of governance issues on small-scale fisheries by aggravating the already substantial challenges and moral dilemmas facing policy-makers (Jentoft and Eide 2011). On the one hand, regulatory mechanisms aimed at resource protection face critical challenges due to the diversity, complexity, and dynamics of small-scale fisheries (Chuenpagdee 2011b). On the other hand, this protection might limit the access of small-scale fishers to a critical livelihood resource and restrict their freedom (González 2011). For poor fishers, fishing is often the occupation of last resource (Béné 2003; Béné and Friend 2011), and these management decisions would likely contribute to extreme poverty and its attendant vicious cycle of resource depletion (Onyango 2011; Béné et al. 2010).

Despite their global significance, small-scale fishers, their fishing activities, and their well-being have not been properly addressed in many regions of the world, particularly in developing countries (WorldFish Centre/FAO 2005). Policy-makers and scientists alike have allocated the bulk of their efforts to managing the large-scale export-oriented fishing sector, with many of their decisions having negative consequences on small-scale fishers and their communities across the world (Pauly 2006). While this marginalization is politically and economically oriented, the lack of attention to small-scale fisheries is also due to the limited knowledge and understanding about the overall functioning of this sector. As has been previously argued, scientists alone will not be able to provide the solutions (Bundy et al. 2008; Jentoft and Chuenpagdee 2009) but rather a new approach to addressing issues concerning small-scale fisheries that transcends disciplinary boundaries. Drawing from an interactive governance perspective (Kooiman et al. 2005), I also submit that an innovative governance process is essential in navigating and mediating among the various positions, expectations, and goals that fisheries stakeholders hold. In this sense, commercial lobster diving, which is performed by both the industrial fleet and small-scale, community-based fisheries, highlights the significance of the interlinked governance dilemmas associated with the protection of livelihoods and the preservation of the resource base in small-scale fisheries.

People living in the coastal communities of Nicaragua's Caribbean region – such as the Miskito communities – target several species such as shrimp (*Penaeus vannamei*), lobster, and fish (various species), but they also capture sea turtles (*Chelonia mydas*), mainly for subsistence (Lagueux 1998; Lagueux and Campbell 2005). Information about small-scale fisheries in Nicaragua is outdated, and few systematic efforts have been made to assess the contribution of small-scale fisheries to economic growth and food security on a national scale. Current Nicaraguan fisheries policies are aimed largely at the industrial fishing sector, virtually ignoring small-scale fisheries, while international development initiatives targeted toward small-scale fisheries have often lacked continuity and impact assessment methods (Salas et al. 2011). This state of affairs is of particular relevance, given that 75% of historically claimed indigenous territorial areas in the region have been titled to coastal and inland communities (UNDP 2011), leaving rights to aquatic resources unaddressed and, in several cases, still disputed among multiple claimants. Consequently, outstanding claims over who controls ownership and access over fishing areas within coastal communities have not received proper attention in policy-making or national development plans (FAO 2011; Larson et al. 2016). Unaddressed, outstanding, and overlapping property claims and disputes over resource use are increasingly becoming the reason for open and often violent conflicts between resource users (Larson et al. 2016). Further, national authorities have issued programs to protect endangered species, establish coastal and marine protected areas, and expand closed seasons for overexploited species. This has resulted in weak governance and a lax regulatory environment for small-scale fisheries. In coastal communities, there are multiple conceptual and practical disconnects between public policy and collective rights – rights that were granted over communal lands and aquatic rights to secure a sustainable resource base for indigenous communities – as well as the limited functionality of established marine protected areas and an overall disregard or inadequate policies aimed at poverty reduction (González and Jentoft 2010; González 2011).

### *17.1.2 Commercial Lobster Diving in the History of the Coast's Resource Extraction Economy*

Historically, lobster fishing has been a traditional subsistence activity for coastal communities in the Miskito Coast in Nicaragua (Nietschmann 1972, 1973). As an important source of protein, lobster has been captured in small-scale fisheries by using traditional fishing methods (e.g., the use of hooks), traps, and scuba diving gear. Lobsters are usually harvested in the reefs and cays surrounding the coast, as well as within the surrounding fishing grounds which are often common use areas shared by coastal communities (Roe 2006). However, for indigenous coastal communities, lobster consumption has alternated with other sources of protein, and therefore continuous access to fishing grounds and resource depletion associated with the overexploitation had not been reported until recently. Some observers have pointed out that the introduction of commercial lobster diving in the 1960s – which was led by an industrial fleet and experienced constant increases until the 1970s – produced a substantial transformation in the scale at which lobster was captured and therefore adversely affected the sustainability of this resource (World Bank 1999). Since indigenous divers saw lobster as a quick source of revenue in the context of an emerging cash-based economy, pressure over the resource base increased along with the frequency of decompression accidents (also called the bents) linked to immersion events without proper equipment and inattention to the security interval between immersions. Data from a World Bank-sponsored study in 1998 showed that 65% of lobster catches were done through diving methods, as Table 17.1 shows. Today, lobster diving account for approximately 71% of all catches (INPESCA 2016).

## 17.2 Shrimp and Lobster

These fisheries constitute a substantial proportion of catches for indigenous communities of Miskito origin. Industrial fishing also targets shrimp stocks in areas designated for exclusive use by indigenous communities. Due to weak law enforcement, tensions between small- and large-scale fisheries over gear types (e.g., diving versus trap fishing) and control and access to fishing areas have been growing over the last 5 years. Lobster fisheries, which are now mostly destined for export markets, are important sources of income for impoverished small-scale fishing families. Studies have shown that lobster fisheries might be at risk of resource depletion without proper protection measures (Adpesca 2003; Daw 2008). Further, lobster in small-scale fisheries is for the most part caught by diving, which has already been described as a dangerous activity resulting in hundreds of decompression accidents. Consequently, lobster diving accidents have become a public health concern for regional and national authorities (Acosta et al. 2002; CAED 2005). In this chapter, I aim to show the importance of regulating the lobster fisheries by evaluating the effectiveness of closed seasons, providing enforcement mechanisms, and paying attention to health-related problems for indigenous commercial lobster fishers.

## 17.3 Impact on the Local Economy

In the early 1990s, lobster became the single most important source of revenue of seafood production nationally. The end of the civil war opened up new possibilities that enhanced the resource extraction economy that has characterized the history of the coastal region of Nicaragua. Catch data reflect the increasing relevance of the lobster diving fishery in the total annual lobster fishing yield after 1989 (see Table 17.1).[1] At the same time, this period signaled a sudden shift for Miskito lobster divers who found opportunities for employment in the industrial fleet. Unfortunately, the rush for quick access and high returns expected from lobster fishing overshadowed the enforcement of proper labor regulations and working

**Table 17.1** Percentage contribution of trapping and diving fishing methods to the total annual lobster fishing yield of the Nicaraguan national industrial fishing fleet

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Method | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| Trapping | 42 | 62 | 36 | 42 | 27 | 34.5 |
| Diving | 58 | 38 | 64 | 58 | 73 | 65.5 |

Source: World Bank (1999), 19

[1] After 1990 licenses to the privately owned (national and foreign) industrial fleet increased significantly. In addition, the government that took office in 1990 lifted the ban on lobster diving which had been issued by the Sandinista government in 1984 (Metzoff and Schull 1999: 10).

conditions for divers, as well as any consideration of rigorous management principles for the protection of the resource. This situation has not changed significantly in the present day.

In the meantime, the relevance of the lobster fishery has continued to increase its contribution to the local economy. Recent estimates from an independent study suggest that around 6500 people depend on lobster fishing as their main source of income (Acosta 2013).[2] In 2015, official data from INPESCA provided a much smaller figure, estimating that in the North Caribbean Coast, there were 958 people involved in commercial lobster diving and 208 in lobster trapping. In the South, 912 fishermen were involved in lobster trapping, and no official data is reported about lobster diving.[3] Historically, commercial lobster diving has been more prevalent in the North due to the proximity of the fishing grounds including the Miskito Keys.

When the closed season for lobster is in place, divers resort to fishing other species, such as snails (*Strombus gigas*) and sea cucumber (*Isostichopus fuscus*), both of which are found in the same fishing grounds where lobsters are captured and both enjoying high demand in international markets.[4] In 2011, Nicaragua exported 2.6 million pounds of lobster tails, which represented approximately $37 million USD in total revenue. In 2015, exports increased to 5.5 million pounds, and a significant rise is being reported in exports of whole lobsters as well (from 0.5 million pounds in 2014 to 1.5 in 2015). In 2015, artisanal small-scale fisheries on the Caribbean Coast contributed 3.4 million pounds of the total production of lobster (INPESCA 2016), which represents around the 60% of the total national production, with some variance from year to year (INPESCA 2012). Overall, in 2012 Nicaragua reported a 15.1% increase in value added by the fishery sector, with substantial increase in value and volume for lobster, fish, and shrimp (BCN 2012). In 2015, the value added of fisheries declined 3.8% due in part from a decline in the capture of fish and shrimp, which was compensated by an increase in the capture of lobster (BCN 2015).

## 17.4 Contemporary Dimensions of Commercial Lobster Diving

International demand for lobster, particularly from the USA, has been on the rise. Even though this demand was slightly interrupted in 2008 due to the US economic crisis, it has now returned to its historical level. Nevertheless, the value chain

[2] Miskito people working in commercial lobster fishing are employed in a diversified labor structure: canoes operators, divers (approx. 3200), crew, operators of collection centers, and *pikineras* which are women who act as intermediaries by advancing cash to divers in return for a preferential purchase of lobster which is later commercialized in local markets.

[3] Brenda Brenes, Division of Planning, INPESCA, e-mail communication, September 29, 2016

[4] The exploitation of both species *Strombus gigas* and *Isostichopus fuscus* is being done under a regime of annual quotas.

continues to be unfavorable to divers, who are paid between 60 cents and $1 USD per lobster tail, while it is sold in the US retail market for a price that ranges between $13 and 15 per pound. These low prices received by harvesters have stimulated the formation of collective agencies by divers and their families to ensure that fishers receive a fair price from the intermediaries that purchase them, although these efforts have had limited success.

### *17.4.1 Resource Depletion*

Current research provides some degree of evidence regarding resource depletion relative to lobster (Metzoff and Schull 1999). However, anecdotal evidence gathered during field research in Sandy Bay Sheran, located in the Rio Grande delta, indicated a declining rate of lobster catches in both diving and trap fisheries, even when fishing effort had increased in traditional fishing grounds as well as in new areas. INPESCA reported a substantial increase in fishing effort over the past 2 years, particularly by the industrial fleet. Nonetheless, lobster diving continues to produce higher catch per unit effort (CPUE) compared to fishing by trapping as compared to the industrial fleet (INPESCA 2016).

### *17.4.2 Impacts on Human Health*

The impact of commercial lobster diving has been widely documented (Acosta et al. 2002). Frequent immersions in deeper waters without proper training, equipment, and safety practices have caused hundreds of decompression accidents resulting in death, partial or complete paralysis, and permanent neurological disability (Baratt and Van Meter 2004). It has also been documented that divers use recreational drugs such as cocaine (or its derivatives), as well as marijuana and rum to ease the pain of previous accidents or to increase their tolerance to exhausting working conditions (Acosta et al. 2002). In the period between 1996 and 2007, the *Nuevo Amanecer* hospital of Bilwi reported that 1042 divers were admitted due to decompression accidents.[5] Media reports documented eight to ten divers admitted to medical facilities every month in 2013, except for the closed season (El Nuevo Diario 2013). At the same time, owners of the industrial fleet for the most part disregard safety measures while on board and, in order to avoid liabilities with workers, use subcontractors to hire local divers. The final result is at best ambiguous concerning

[5] The hospital in Bilwi houses the only hyperbaric chamber that exists in Nicaragua. According to the hospital authorities the chamber needs to be replaced since it has been used since the early 1990s and therefore is dated. Medical personnel assigned to operate the chamber also believe that the hospital provides an indirect and unpaid insurance to the industrial fleet since it treats divers who have suffered decompression accidents while working at sea for private owners of the fleet.

legal responsibilities to divers in relation to labor-related accidents. In fact, divers who have had accidents and therefore are unable to return to work for the rest of their lives are left on their own with little or no support from employers or the state.[6] ABALCA (*Asociación de Buzos Activos y Lisiados de la Costa Atlántica*) reported that 520 divers who have suffered permanent injuries due to labor-related accidents at sea receive neither pensions nor compensation by their employers or the Nicaraguan Social Security Institute (INSS, in its Spanish acronym). The INSS reports that only around 569 or 12% of active divers are registered to the system and are therefore protected – although in a very limited way – if they suffer a work-related accident. It also reported that it has received 39 requests for death pensions over the last 5 years. However, many cases of relatively less severe decompression accidents go unreported.[7]

The frequency of decompression accidents has increased due to the fact that regulatory measures and labor inspections to ensure safe working conditions of divers are not adequately enforced by state agencies. This situation has worsened given that both artisanal and industrial fleets are increasing their effort by fishing in deeper waters. In addition, the lack of proper training, usage of inadequate equipment, and limited availability of safety information to divers limit the possibilities for guaranteeing their safety during immersions. These practices are very concerning in light of domestic and international norms and legal provisions that, at least in theory, should prevent these accidents from happening in the first place and provide provisions for dealing with the consequences of violations to labor rights protections.

In February 2007, the Nicaraguan National Assembly passed legislation concerning the protections and safety protocols for divers.[8] The law also prohibited commercial lobster diving, which was to be implemented in 2011 after the completion of a transitional period defined as the "reconversion" in fishing techniques (Asamblea Nacional de Nicaragua 2007). In fact, the law states that lobster harvesters in the Caribbean Coast are only allowed to use traps and nets. In drafting this norm, legislators considered the need for both strict labor safety measures for divers and the conservation of the resource base. Nevertheless, in practice, commercial lobster diving has not stopped, while at the same time, National Assembly, in response to petitioning by the industrial fleet and divers' organizations, has postponed the implementation of this legislation in three ocassions (2011, 2013 and 2006).[9] In September 2009, the North Caribbean Regional Council – the regional

[6] For instance, media reports have mentioned that the industrial fleet takes divers who have suffered accidents to their own villages in order to receive traditional medicinal treatment.

[7] The communal judge of Sandy Bay, a coastal village in which diving is perhaps the most common form of employment for men, in 2010 reported that 100 local divers had been left with permanent neurological sequelae due to various forms of accidents suffered while working at sea.

[8] Law 613 *Ley 163, Ley de Protección y Seguridad para las Personas Dedicadas a la Actividad del Buceo* was passed by the National Assembly on February 7, 2007, and published in La Gaceta, Diario Oficial, No. 12 January 17, 2008. Later on, a reform postponed the prohibition of commercial diving: Law 753 published in La Gaceta, Diario Oficial No. 35, February 22, 2011.

[9] Some private owners of the industrial fleet, along with the Union of Miskito Divers of the RAAN (SIBUMIRAAN), have challenged the law in court with limited success.

governing authority – passed a resolution requesting the National Assembly to repel the prohibition to lobster diving included in the law. This situation produced an impasse, whereby neither conservation nor the well-being of Miskito divers was given serious consideration.

The competing interests of multiple stakeholders surrounding the lobster fishery, coupled with a limited state regulatory capacity, have impeded effective governance and adequate labor protections for Miskito commercial divers. While there is public recognition regarding the negative consequences of lobster diving for the sustainability of the resource base, as well as regarding the health effects for divers due to decompression accidents, priority has been given to maintaining the *status quo*. It is also equally critical to advance the "reconversion" program, although no indication of a clear policy or program with achievable targets has been implemented so far.[10] This situation illustrates the complexities and dilemmas often encountered at governing small-scale fisheries, which highlight the "wicked" nature of problems that have no easy solutions. In this specific case, access to sustainable livelihoods has been compromised due to the prioritization of short-term gains over long-term solutions, as well as the reluctance of some state agencies and policy-makers to appropriately engage the public in reviewing existing provisions in a consultative, deliberative framework that integrates the interests of various stakeholders involved in the lobster fishery.

As indicated above, some indigenous divers' organizations responded to the 2007 legislation by challenging the norm that banned commercial lobster diving. Miskito divers opposed the prohibition of diving by arguing that this measure threatened their right to earn an income and their traditional livelihoods. Although Miskito divers welcomed the idea of a "reconversion" program through alternative economic activities, they suggested that diving should only be banned if alternative livelihoods had been secured that had been proven effective and far-reaching. In the absence of a firm commitment by state agencies to meet this condition, Miskito divers turned to protesting the law. They did so by taking the streets in public demonstrations and through legal strategies, such as requesting the national assembly to repeal the law. In fact, mobilizing against the law represented a new facet within the vibrant history of Miskito organization over the last two decades. This new wave of self-organization was significantly different from previous social movements as it rallied across political divides and gained support from political parties of various ideological persuasions. Facing difficult choices between reluctant state agencies that showed indifference to the "reconversion" program on one hand and powerful lobbyists representing the industrial fleet on the other, divers sought accommodation toward maintaining the status quo. Neither the price paid for lobster tails to

[10] In 2016 the government of Nicaragua ratified its commitment towards a "definitive closure" of the commercial lobster fishery through diving while it mandated INPESCA with the task of designing and implementing an "Action Plan" in coordination with the autonomous regional governments. No specific targets or timeline were mentioned in the legislation. Law 923 published in La Gaceta, Diario Oficial No. 48, March 9, 2016.

divers has increased, nor have safe working conditions been established.[11] INPESCA, the state agency that oversees fisheries, proposed a reconversion program that is underfunded and was therefore deemed as unfeasible, and thus, divers were allowed to continue their unsafe work at sea. Maintaining the status quo has aggravated the conditions of those placed at the weakest end of the lobster fishery's value chain, including divers, their families, and the resource base. It is especially illustrative that official data show no penalties issued to the industrial fleet since 2008 despite the fact that working and hygienic conditions on board are still precarious.

On the other hand, limited efforts have been allocated to enforce the closed season (March–June) for the lobster fishery. This gap is partially due to the fact that the overseeing national authority on fisheries management, INPESCA, has a limited institutional capacity for conducting regular inspections on the coast (Personal communication, Bluefields, April 13, 2014). Its regulatory mandate focuses on the industrial fleet, whereas regulation, control, and recording of small-scale fisheries belong to a shared jurisdiction with local municipalities. The latter, as a norm, have limited capacity to monitor fishing effort or to appropriately enforce the closed seasons. Recently, it has been observed that inspections of illegal trade are rarely conducted on sea turtle meat and undersized lobster tails within inter-municipal trade. It is thus not uncommon to find lobster caught by artisanal fishermen listed in local restaurant menus during the closed season. Moreover, INPESCA authorities have noted that no concrete evidence exists regarding the fishing effort conducted near the coastal municipalities, where the systematic recording of small-scale fisheries seems incomplete. An illustration of this limited evidence is provided by the existing law that only requires the official registration of *pangas* (fiberglass skiff run by outboard, ranging from 20 to 30′) and *lanchas* (32′ wooden boats with inboard engines), without requiring the registration of dories (small dugout canoe paddled by one or two people), which are often used for lobster diving.

The incoherent management principles, limited research on the lobster population and stocks, and the top-down approach in policy-making (from national, regional, and municipal scales) have all had negative implications for lobster fisheries governance. As a norm, the only management action regularly conducted by national and regional government authorities regarding the lobster fishery is the closure of fishing seasons. Although studies have pointed out the risks to overfish the resource, policy-makers often ignore that condition and communicate the image of a healthy lobster stock and even suggest the unlikeliness for the lobster resource to be depleted.[12] In a 1999 report, the World Bank cautioned the Nicaragua and

[11] The Nicaraguan Ministry of Labor has recently reported that employers do not issue job contracts to divers, and they have also failed to report decompression accidents at sea. The port authority issues departure permission to the industrial fleet without due in situ inspection of safety measures on board. All of the above violate what INPESCA has made mandatory through multiple resolutions. For the 2013 resolution, see INPESCA (2013a).

[12] An INPESCA technical report submitted to MARENA on June 5, 2013, "recommends" lobster and the coastal shrimp to be classified as "underexploited" species. In response, MARENA approved this recommendation by the end of the same month. Based on this approval, INPESCA issued a resolution that declares lobster and coastal shrimp as underexploited species under the regime of open access (INPESCA 2013b).

Honduras governments about the risks implicit in the lax regulation observed by both governments with regard to the lobster fishery (World Bank 1999). The report pointed to evidence that suggest the fall of catch per unit effort. It also observed that, in light of the limited knowledge concerning the ecological dynamics of lobster reproduction and distribution, there may be a need for a regional, coordinated approach to monitor, evaluate, and manage the lobster fishery jointly between the two countries.

Empirical data produced by our own research conducted in 2014 in Sandy Bay, which is perhaps the most active coastal lobster fishing community in the Southern Caribbean Coast, corroborated these reports of overfishing of the lobster resource. Xenubia Chow Smith, a 44 year-old Miskito fisherwoman who owns a *panga* and catches lobster with traps, states:

> Over the last four years I have seen changes when it comes to fishing lobster. Today we are going farther to get the same catch; at the same time lobsters are smaller. I think the reason is that the industrial fleet comes at night to fish in our exclusive artisanal territory. These boats carry 3–5 thousand traps. Our fishermen here just carry 50 to 60 traps per panga. We are at a disadvantage with the industrial fleet. I think this is what has depleted our resources. The government, which has the power to solve this situation is doing nothing. (Personal communication, Sandy Bay Sirpi, April 12, 2014)

## 17.5 Concluding Remarks

This chapter began by suggesting that the viability of the lobster fishery would require concerted efforts aimed at enforcing regulatory measures. This intervention, coupled with effective considerations of the provisions found in international law regarding the human rights of laborers at sea, is highly relevant for addressing the challenges facing lobster fisheries. The implementation of alternative livelihoods for Miskito divers, for whom the closed season of lobster represents dire conditions for earning a decent living, is also of extreme importance as a prerequisite to achieve the sustainability of the lobster fishery. The approved legislation that prohibits the practice of lobster fishing via diving is not likely to result in permanent solutions if not accompanied by alternative occupational choices that enable the transition to more sustainable practices. Recent demonstrations by organized divers, who have ironically found a common voice with the industrial sector, have demanded the postponement of the implementation of the law. This action indicates the adoption of a *band-aid* solution that will negatively impact the sustainability of the lobster resource and will increase the risk of more decompression accidents by divers.

In the same vein, the lobster stock faces the impending risk of depletion, requiring stringent evidence-based conservation and management strategies to be taken immediately. The dilemmas examined in this chapter regarding the lobster fishery speak to the contrasting and unresolved tensions regarding indigenous livelihoods and well-being on the one hand and the possibility of resource depletion on the other, which in this case is prompted by external demand. These dilemmas, in our view, need to be addressed through a comprehensive governance framework that takes into consideration varied strategies like the enforcement of domestic and international legislation regarding occupational safety of workers at sea (mostly of indigenous communities); the locally conceived-and-controlled alternative economic activities (through reconversion) that can drive pressure away from lobster catches; the gradual substitution of fishing techniques aimed to target a realistic substitution of commercial lobster diving, after a consensus-based agreement for adoption of a transitional period; and finally, the initiation of ecologically based research on a regional scale to better estimate the current ecological conditions of lobster population in the Caribbean Coast.

The consequence of prolonging the status quo found in the lobster fishery, which affects both human lives and lobster resources, will force these communities to bear the brunt of unsustainable practices in the Miskito Coast. In that case, only *Liwa Mairin* would help by continuing its deadly embrace.

## References

Acosta ML (2013) Diagnóstico sobre la Situación del Buceo en la Costa Atlántica. (Unpublished manuscript). Managua, Nicaragua

Acosta ML, Moreno E, Weil D (2002) Condiciones laborales de los buzos miskitos en la costa atlántica de Nicaragua. Oficina Internacional del Trabajo, San José

Adpesca (2003) Anuario Pesquero y Acuicola de Nicaragua 2002. Administracion Nacional de Pesca y Acuicultura del Ministerio de Fomento, Industria y Comercio, Managua

Allison EH, Elllis F (2001) The livelihoods approach and management of small-scale fisheries. Mar Policy 25:377–388

Asamblea Nacional de Nicaragua (2007) Ley 613. Ley de Protección y Seguridad para las Personas Dedicadas a la Actividad del Buceo. La Gaceta, Diario Oficial, No. 12. Managua

Banco Central de Nicaragua (2012) Informe anual 2012. Managua: Banco Central. http://www.bcn.gob.ni/publicaciones/anual/index.html?&val=0. Accessed 25 Feb 2017

Banco Central de Nicaragua (2015) Informe Anual 2015. Managua: Banco Central. http://www.bcn.gob.ni/publicaciones/periodicidad/anual/informe_anual/informe_anual_2015.pdf. Accessed 22 Feb 2017

Baratt DM, Van Meter K (2004) Decompression sickness in Miskito Indian divers: review of 229 cases. Aviat Space Environ Med 75(4):350–353

Bavinck M (2011) The mega-engineering of ocean fisheries: a century of expansion and rapidly closing frontiers. In: Brunn SD (ed) Engineering earth: the impacts of mega-engineering projects. Kluwer, Dordrecht, pp 257–273

Béné C (2003) When fishery rhymes with poverty: a first step beyond the old paradigm on poverty in small-scale fisheries. World Dev 31(6):949–975

Béné C, Friend RM (2011) Poverty in small-scale fisheries: old issue, new analysis. Prog Dev Stud 11(2):119–144

Béné C, Merten S (2008) Women and fish-for-sex: transactional sex, HIV/AIDS and gender in African fisheries. World Dev 36(5):875–899

Béné C, Lawton R, Allison EH (2010) Trade matters in the fight against poverty: narratives, perceptions, and (lack of) evidence in the case of fish trade in Africa. World Dev 38(7):933–954

Berkes F, Mahon R, McConney P, Pollnac R, Pomeroy R (2001) Managing small-scale fisheries: alternative directions and methods. International Development Research Centre, Ottawa

Berkes F, Hughes TP, Steneck RS, Wilson JA, Bellwood DR, Crona B, Folke C, Gunderson LH, Leslie HM, Norberg J, Nyström M, Olsson P, Österbloom H, Scheffer M, Worm B (2006) Ecology – globalization, roving bandits, and marine resources. Science 311(5767):1557–1558
Bundy A, Chuenpagdee R, Jentoft S, Mahon R (2008) If science is not the answer, what is? An alternative governance model for the world's fisheries. Front Ecol Environ 6(3):152–155
Butcher JG (2004) The closing of the frontier – a history of the marine fisheries of Southeast Asia c. 1850–2000. KITLV Press, Leiden
Central American Commission for the Environment and Development (CAED) (2005) Trans-border Biosphere Reserve Project: social and indigenous evaluation. CAED, Managua
Christie P, Simmons B, White N (2000) CAMPLab: the coastal area monitoring project and laboratory. In: Christie P, Bradford D, Garth R, González B, Hostetler M, Morales O, Rigby R, Simmons B, Tinkam E, Vega G, Vernooy R, White N (eds) Taking care of what we have: participatory natural resource management on the Caribbean Coast of Nicaragua. CIDCAIDRC, Ottawa, pp 99–126
Chuenpagdee R (2011a) World small-scale fisheries: contemporary visions. Eburon, Delft
Chuenpagdee R (2011b) Thinking big on small-scale fisheries. In: Christensen V, Maclean J (eds) Ecosystem approaches to fisheries: a global perspective. Cambridge University Press, Cambridge, pp 226–240
Daw TM (2008) Spatial distribution of effort by artisanal fishers: exploring economic factors affecting the lobster fisheries of the Corn Islands, Nicaragua. Fish Res 90:17–25
Dennis PA (2004) The Miskitu people of Awastara. University of Texas, Austin
Eide AH, Bavinck M, Raakjaer J (2011) Avoiding poverty – distributing wealth in fisheries. In: Jentoft S, Eide AH (eds) Poverty mosaics: realities and prospects in small-scale fisheries. Springer, Dordrecht/London, pp 13–25
El Nuevo Diario (2013) "Buzos están en las manos de Dios". http://www.elnuevodiario.com.ni/nacionales/278668-buzos-estan-manos-dios/. Accessed 1 Oct 2016
FAO (Food and Agricultural Organization of the United Nations) (2005) Increasing the contribution of small-scale fisheries to poverty alleviation and food security, FAO technical guidelines for responsible fisheries. no. 10. FAO, Rome
FAO (2010) The state of world fisheries and aquaculture 2010. FAO, Rome
FAO (2011) Report of the FAO workshop on governance on tenure for responsible capture fisheries. FAO, Rome
Ferreira LL, Donatelli S, Reis A Jr (2002) Análise Coletiva do Trabalho de pescadores-mergulhadores de lagosta brasileira, Ministério do Trabalho e Emprego. Delegacia Regional do Trabalho, Natal
González M (2011) *To make a life* in Marshall point: community empowerment and small-scale fishery. In: Jentoft S, Eide A (eds) Poverty mosaics. A better future in small-scale fisheries. Springer, New York, pp 275–308
González C, Jentoft S (2010) MPA in labor: securing the pearl cays of Nicaragua. Environ Manag 47(4):617–629
Hostetler M (2005) Enhancing local livelihood options: capacity development and participatory project monitoring in Caribbean Nicaragua (doctoral dissertation). York University, Toronto
ILO (International Labor Organization) (1989) Indigenous and Tribal Peoples Convention, 1989 (No. 169), Geneve: ILO. http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::p12100_instrument_id:312314#A24. Accessed 4 Jan 2017
INPESCA (Instituto Nicaragüense de la Pesca) (2012) Anuario Pesquero y Acuicola 2011. INPESCA, Managua
INPESCA (2013a) Medidas de ordenacion para la extraccion de recursos pesqueros mediante el metodo del buceo. Resolucion Ejecutiva-PA-No004–2013 Managua, June 13 2013. http://www.inpesca.gob.ni/images/Resolucion%20Buceo.pdf. Accessed 31 July 2016
INPESCA (2013b) Declaracion de las pesquerias de langosta espinosa (Panuliris Argus) y camaron costero de la familia de Peneidos del Caribe como recursos sub-explotados bajo el regimen de libre accesso. Resolucion Ejecutiva-PA-No005–2013 Managua, June 21 2013. http://www.inpesca.gob.ni/images/Resolucion%20005-2013.pdf. Accessed 31 July 2016

INPESCA (2016) Anuario Pesquero y Acuicola 2015. INPESCA, Managua
Jamieson M (2007) Contrato con los dawanka y procesos productivos entre los miskitos de las comunidades costeras de la RAAS. Wani 56:15–25
Jentoft S, Chuenpagdee R (2009) Fisheries and coastal governance as a wicked problem. Mar Policy 33:553–560
Jentoft S, Eide A (2011) Poverty mosaics: realities and prospects in small-scale fisheries. Springer, New York
Kooiman J, Bavinck B, Jentoft S, Pullin R (2005) Fish for life: interactive governance for fisheries. Amsterdam University Press, Amsterdam
Lagueux CJ (1998) Marine turtle fishery of Caribbean Nicaragua: human use patterns and harvest trends (doctoral dissertation). University of Florida, Gainesville
Lagueux CJ, Campbell CL (2005) Marine turtle nesting and conservation needs on the south-east coast of Nicaragua. Oryx 39(4):398–405
Larson AM, Soto MF, Mairena D, Moreno E, Mairena E, Mendoza-Lewis J (2016) The challenge of 'territory': weaving the social fabric of indigenous communities in Nicaragua's northern Caribbean Autonomous Region. Bull Lat Am Res 35(3):322–337
Metzoff S, Schull J (1999) Miskito ethnic struggle over land and lobster: conserving culture and resources on Corn Island. Cult Agric 21(3):10–18
Monnereau I, Helmsing AHJ (2011) Local embedding and economic crisis: comparing lobster chains in Belize, Jamaica and Nicaragua. In: Helmsing AHJ, Vellema S (eds) Value chains, inclusion and endogenous development: contrasting theories and realities. Routledge, Abington, pp 178–197
Nietschmann B (1972) Hunting and fishing focus among Miskito Indians, eastern Nicaragua. Hum Ecol 1:41–67
Nietschmann B (1973) Between land and water: the subsistence ecology of the Miskito Indians, eastern Nicaragua. Seminar Press, New York
Onyango PO (2011) Occupation of last resort? Small-scale fishing in Lake Victoria, Tanzania. In: Jentoft S, Eide AH (eds) Poverty mosaics: realities and prospects in small-scale fisheries. Springer, Dordrecht/London, pp 97–124
Pauly D (2006) Major trends in small-scale marine fisheries, with emphasis on developing countries, and some implications for the social sciences. Mar Stud 4(2):7–22
PNUD (Programa de las Naciones Unidas para el Desarrollo) (2005) Informe de Desarrollo Humano 2005. Las egiones Autónomas de la Costa Caribe. ¿Nicaragua asume su diversidad? PNUD, Managua
Roe HK (2006) Indigenous ecological knowledge and marine resource management: perceptions within a Rama community. In: Gonzalez M, Koskinen A, Jentoft S, Lopez D (eds) The Rama: struggling for land and culture. URACCAN & University of Tromso-Norway, Nicaragua, pp 107–123
Salas S, Chuenpagdee R, Charles AT, Seijo JC (2011) Coastal fisheries of Latin America and the Caribbean. In: FAO fisheries and aquaculture technical paper 544. FAO, Rome
Symes SD, Phillipson J (2001) Inshore fisheries management. Kluwer Academic Publishers, Dordrecht/Boston
Teh LCL, Teh LSL, Meitner MJ (2012) Preferred resource spaces and fisher flexibility: implications for spatial management of small-scale fisheries. Hum Ecol 40:213–226
UNDP (United Nations Development Program) (2011) Experiences of titling of indigenous territories. main breakthroughs. UNDP-Caribbean coast program' preparatory meeting of the conclave of Latin America and the Caribbean. Managua, April 4–6, 2011
Williamson D, Fonseca G (2007) Compendio estadístico de las regiones autónomas de la Costa Caribe de Nicaragua. CIDCA-UCA, Managua
World Bank (1999) The lobster fishery of the Honduran and Nicaraguan Moskitia, draft final report. http://webcache.googleusercontent.com/search?q=cache:8hZlEmRozkoJ:ibrarian.net/navon/paper/HONDURAN_AND_NICARAGUAN_MOSKITIA.pdf%3Fpaperid%3D3312294+&cd=1&hl=en&ct=clnk&gl=ca. Accessed 1 Oct 2016

WorldFish Centre/FAO (2005) Towards an interdisciplinary approach to the assessment of small-scale fisheries and its role in food security and poverty alleviation and sustainable resource use: concept note. WorldFish Centre and the FAO FishCode-STF Project, Penang and Rome. http://www.fao.org/docrep/009/a0216e/A0216E08.htm. Accessed 26 Feb 2017

Worm B, Barbier E, Beaumont N, Duffy JE, Folke C, Halpern BS, Jackson JBC, Lotze HK, Micheli F, Palumbi SR, Sala E, Selkoe KA, Stachowicz JJ, Watson R (2006) Impacts of biodiversity loss on ocean ecosystem services. Science 314(5800):787–790

**Miguel González** (PhD, York University) is an Assistant Professor in the International Development Studies program at York University. His research examines indigenous self-governance and territorial autonomous regimes in Latin America, about which he has published extensively (see http://www.fygeditores.com/fgetnicidadynacion.htm) and co-edited special issues in this field (http://www.alternative.ac.nz). In 2016, Miguel co-edited a thematic issue of the Latin America and Caribbean Ethnic Studies Journal (LACES) on the topic of indigenous autonomies in Latin America. Miguel also investigates the governance of small-scale fisheries in the Global South, particularly in the Nicaraguan Caribbean Coast. Miguel is affiliated with TBTI and the Centre for Research on Latin America and the Caribbean (CERLAC) at York University.

# Part V
# Communities, Stewardship, and Governance

# Chapter 18
# Collaborative Coastal Management in Brazil: Advancements, Challenges, and Opportunities

**Cristiana Simão Seixas, Iain Davidson-Hunt, Daniela C. Kalikoski, Brian Davy, Fikret Berkes, Fabio de Castro, Rodrigo Pereira Medeiros, Carolina V. Minte-Vera, and Luciana G. Araujo**

**Abstract** In Brazil, during the past 20 years, several dynamic collaborative coastal management (CCM) arrangements have emerged in response to a variety of changing social and ecological conditions. These arrangements have led to an equally large range of outcomes, such as the fishing agreements in the Amazon basin and marine extractive reserves in coastal areas. This chapter describes the evolution of these collaborative management arrangements in coastal Brazil. We begin by introducing the major policies related to environmental management in Brazil, focusing particularly on the evolution of fisheries management and protected areas

C. S. Seixas (✉)
Environmental Study and Research Center, University of Campinas, Campinas, Brazil
e-mail: csseixas@unicamp.br

I. Davidson-Hunt · F. Berkes
University of Manitoba, Winnipeg, MB, Canada
e-mail: davidso4@cc.umanitoba.ca; berkes@cc.umanitoba.ca

D. C. Kalikoski
FAO, Rome, Italy

B. Davy
University of Ottawa, Ottawa, ON, Canada
http://www.c-foam.management.uottawa.ca

F. de Castro
University of Amsterdam, Amsterdam, The Netherlands
e-mail: F.deCastro@cedla.nl

R. P. Medeiros
Centro de Estudo do Mar, Universidade Federal do Paraná, Curitiba, Brazil
e-mail: rodrigo.medeiros@ufpr.br

C. V. Minte-Vera
State University of Maringa, Maringá, Brazil

L. G. Araujo
University of Campinas, Campinas, Brazil



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_18

management. We continue with an overview of (i) key events and issues that have shaped CCM in Brazil; (ii) the achievements for the advancement of CCM over the past years; and (iii) current challenges to the advancement of CCM. We conclude the chapter with our ideas and associated thinking about what lies ahead to promote CCM in Brazil.

**Keywords** Participatory management · Co-management · Fisheries · Protected areas

## 18.1 Introduction

Collaborative coastal management: what does it mean? A search in the Web of Science indicates that the term "collaborative coastal management" was initially used in the seminal article "Trends in development of coastal area management in tropical countries: from central to community orientation" by Christie and White (1997). Since then, the term has been used in some articles (e.g., Jorge 1997; Verheij et al. 2004; Lawless 2015) with little or no precise definition. Collaborative management, on the other hand, has been used many times in the scientific literature, often interchangeably with participatory management, joint management, co-management, or cooperative management (see Plummer and FitzGibbon (2004) for a review of this terminology).

In this chapter, we use the term *collaborative coastal management* (CCM) as an umbrella term to refer to *processes* encompassing a range of institutional arrangements (from highly formalized to informal) among different sets of stakeholders, including resource users, government agencies, government research institutes, universities, the private sector, and other civil society organizations (e.g., NGOs). Government is often, but not necessarily, a key player in CCM processes. We understand that CCM may develop whenever two or more different groups of interests (stakeholders) work together to improve coastal management. Hence, the "bottom-up" or "top-down" terminology is not sufficient to describe CCM initiatives, as some may emerge as horizontal or cross-scale initiatives, often leading to partnerships. Issues of inclusion (participation), representation, power-sharing, and decision-making are central to collaborative management (Plummer and FitzGibbon 2004). The principles of transparency, accountability, democracy, and sustainability are also behind most of these collaborative management efforts (Jentoft 2003). CCM has also been an important arena for knowledge sharing, exchange, and building in Brazil. Bridging and embedding knowledge in CCM is influenced by socio-political aspects such as knowledge holders' political positions, language and communication barriers, and the use of participatory approaches in facilitating CCM. As a political process, power relations play a key role in influencing how participation takes place and how new institutional architectures are shaped (Gasalla 2011; Castro 2012).

There are relatively few reviews of collaborative coastal management cases within a national context (e.g., Pomeroy and Carlos 1997) and none with a focus on Brazil. To explore how collaborative management in coastal Brazil has evolved over the years, we first present an overview of environmental management in Brazil, focusing particularly on the evolution of fisheries management and protected areas management. We then present how we have assessed CCM in Brazil and the lessons we have learned about it.

### *18.1.1 Environmental Management of the Coastal Zone in Brazil*

In the 1980s, Brazilian society started to experience a transition toward democracy that was consolidated in the last decade of the twentieth century. The emergence of new social identities and organizations, and of participatory and public decision-making arenas, resulted from this new political context. Enhanced engagement of civil society in decision-making seemed to reflect the increased participation of more left-leaning parties in government at all levels (including the presidency since 2003) as well as external influences from a globalized world (Avritzer 2007; Borba and Sell 2007; Hochstetler and Keck 2007). Such influences over the last 30 years resulted in an increase in the number of organizations of civil society, which have often operated in social movements at multiple scales, as well as in forums at local, regional, national, and international levels related to human rights, environmental protection, and civil rights (Scherer-Warren and Luchmann 2004).

This new democratic setting has favored the participation of civil society organizations in environmental management. Moreover, a diverse set of environmental policies and management tools in Brazil have allowed for societal influence and regulatory measures at national, state, and municipal levels. These include (i) environmental impact assessment, environmental licensing, and establishment of compensation measures for large-impact projects (potentially hazardous activities are increasingly monitored and evaluated according to criteria regulated by government/s); (ii) protected areas (management councils require the participation of civil society representatives, in some cases including resource users); (iii) environmental councils (at municipal, state, or regional levels; councils have different and evolving degrees of intervention on environmental management and socioeconomic development); (iv) watershed management committees (civil society, government, and technicians increasingly work together to solve conflicts over water use and to approve and monitor watershed management plans); and (v) Local Agenda 21 (motivated in particular by the global movement developed from the World Summit Rio conference in 1992; numerous Agenda 21 processes have been now initiated throughout Brazil).

Environmental management of the coastal zone, particularly through collaborative management models, has been mainly shaped by four interconnected sectors,

**Table 18.1** Leading organizations of sectors shaping coastal zone management in early 2015

| Sectors | Leading organizations | Collaborative management |
|---|---|---|
| Fisheries | Ministry of Fisheries and Aquaculture (MPA) | Co-management of fisheries resources [a]; Fisheries agreements [a] |
| | Ministry of Environment (MMA) | |
| Protected areas | Ministry of Environment | Through advisory and deliberative councils [b,c] |
| Coastal management | Ministry of Environment | Through national-, state-, or local-level coastal management committees [d,e] |
| Watershed management | Ministry of Environment | Through watershed management committees [f] |
| | National Agency of Waters (ANA) | |

[a]Federal Decree 6.981/2009 (MPA/MMA)
[b]According to the National System of Nature Conservation Units (SNUC) (Law N. 9985/2000), all protected areas shall have a council encompassing representatives of government at all levels (municipal, state, and federal) and representatives of civil society. Consultative Councils have limited decision-making power: management plans are elaborated after the Consultative Council input is heard, but all rules and management structures have to be approved by the government. Deliberative Councils, on the other hand, are allowed to design and approve management plans
[c]IBAMA IN 29/2002, Federal Law 9.985/2000 and Federal Decree 4340/2002
[d]Federal Law 7.661/1988 and Federal Decree 5.300/2004
[e]Federal Law 6.938/1981
[f]Federal Law 9.433/1997

namely, fisheries, protected areas, coastal management, and watershed management. These sectors are typically administered under different policies, institutional arrangements, and leading organizations (Table 18.1), with a variety of consequences that we summarize below. The Brazilian coastal management program (GERCO) started in 1988; nevertheless, due to several reasons, its collaborative initiatives have had limited success. In fact, only a few states have completed their ecological-economic zoning plan, required under the National Coastal Management Plan process (Scherer et al. 2009). Watershed management, on the other hand, is well advanced in Brazil, but mainly takes place outside of the coastal zone and is poorly connected to coastal management. Despite the importance of watershed management, our discussion regarding collaborative coastal management is rooted mainly in cases related to fisheries and protected areas management in Brazil.

### *18.1.2 Fisheries*

Over the years, fisheries management in Brazil has been conducted by different agencies of the federal government that can be divided into three stages of development. The first stage ended in 1962 and is characterized by the absence of a dedicated federal agency for the fisheries sector. Rather, the Brazilian Navy was in charge of fisheries from the late nineteenth century to the mid-1930s, at which point fisheries management was transferred to the Ministry of Agriculture. The first national-level legislation regarding fisheries – the Fisheries and Hunting Code – was issued in 1934. From the 1930s to the early 1960s, fisheries were under the Ministry of Agriculture (Dias-Neto 2003). The creation of an agency dedicated to the development of the fisheries sector (SUDEPE) in 1962 under the Ministry of Agriculture marked the second stage of fisheries management in Brazil. This stage can be further subdivided into four periods on the basis of the institutions and agencies in charge (Table 18.2).

The first period (1962–1989) involved the creation of the Superintendence for the Development of Fisheries (SUDEPE) in 1962 and the Fisheries Code (Federal Decree 221/1967) issued in 1967. This period was also distinguished by an abrupt change in organizational responsibilities and unbalanced levels of support between artisanal and industrial fisheries. For instance, government incentives mainly sought to develop a more industrialized fleet by seeking to transform artisanal fisheries (Diegues 1983; Dias-Neto 2003; Abdallah and Sumaila 2007). As a result, over the last 50 years, the proportion of artisanal fish landings dropped from more than 80% of total catch, to less than 20% along the southern coast of Brazil (Vasconcellos et al. 2007, 2011). This significantly influenced collaborative management initiatives, specifically creating a pattern of asymmetrical participation in management arenas between industrial and artisanal fishers that persists to this day. SUDEPE was closed in 1989 and, over the next 20 years, a sequence of federal agencies in charge of fisheries management in Brazil were created, closed, and branched out in a variety of ways until the creation of the Ministry of Fisheries and Aquaculture in 2009 (Table 18.2).

The third stage of development encompasses the period from 2009 to 2015, during which a Ministry of Fisheries and Aquaculture (MPA) was institutionalized in Brazil. In addition to the passing of the National Policy for Sustainable Development of Fisheries and Aquaculture (Federal Law 11.959/2009) (hereafter fishery policy) in 2009, a Technical Commission on Shared Fisheries Management was established, composed of representatives of the Ministry of Environment (MMA) and the Ministry of Fisheries and Aquaculture (MPA). MPA was dissolved in late 2015, when its authority was transferred to the Ministry of Agriculture, Livestock and Food Supply (MAPA).

Until recently, preconditions for fisheries co-management (Pomeroy and Berkes 1997; Jentoft 2003) on the Brazilian coast were rare or absent at the national level. The few cases that were documented have emerged from the bottom up (Vasconcellos et al. 2007; Kalikoski et al. 2009; Seixas and Kalikoski 2009). Fisheries policies were conducted under the 1967 Fisheries Code until 2009, when the new fishery policy became the guiding legislation. The ideology of "command and control" (Holling and Meffe 1996) has been dominant since 1962, although local efforts did provide lessons for new approaches, as will become apparent in the following sections.

As of 2010, a number of more formally recognized fisheries management tools were developed that included a collaborative perspective. Examples include the

**Table 18.2** History of fisheries management in Brazil and evidence of collaborative management

| Stages | Period | Key agencies at federal level | Decision-making | Evidence of collaborative management[a] |
|---|---|---|---|---|
| First | Before 1962 | Navy Ministry of Agriculture | Formally centralized; no impact on the ground | Little or no community-based fisheries management evident |
| Second | 1962–1989 | SUDEPE (Superintendence for the Development of Fisheries) – Ministry of Agriculture | SUDEPE is designated as the lead organization | Command and control is the dominating ideology |
| | 1989–1998 | IBAMA (Institute for the Environment and Renewable Natural Resources) – Ministry of Environment (MMA) | IBAMA regional offices play special roles in fisheries regulations for regional fisheries | Command and control persists but guided by scientific advisory committees |
| | 1998–2003 | IBAMA | Fishing resources are classified into the overexploited category (regulated by IBAMA) and underexploited and highly migratory fishes (regulated by DPA) | Research organizations (universities and fisheries institutes) play a role based on formal partnerships |
| | | DPA (Department of Fisheries and Aquaculture) – Ministry of Agriculture | | Collaborative management emerges (i) as fishing agreements are legitimized by the government, (ii) in some protected areas prior to 2000, and (iii) through a formal policy (SNUC[b]) after 2000, which required advisory and deliberative councils for each protected area |
| | 2003–2009 | SEAP (Special Secretary of Aquaculture and Fisheries) – Presidency of the Republic | SEAP has status of a ministry, replacing the roles of DPA | Emerging institutional arrangements, although not formally defined as fisheries policy strategies |
| | | IBAMA | Division of competences between IBAMA and SEAP remained | Rising number and consolidation of sustainable use protected areas (e.g., extractive reserves) as a functional institutional arrangement for collaborative fisheries management |
| | | ICMBIO (Chico Mendes Institute for Biodiversity Conservation) – Ministry of Environment (MMA) | Part of IBAMA is transformed into the ICMBio in charge of protected areas | |

(continued)

**Table 18.2** (continued)

| Stages | Period | Key agencies at federal level | Decision-making | Evidence of collaborative management[a] |
|---|---|---|---|---|
| Third | 2009– early 2015 | MPA (Ministry of Fisheries) | MPA is the lead in decision-making, regarding all fishing resources, although still shared with IBAMA | Participation and fisher's ecological knowledge are considered basic inputs to the new fisheries policy |
| | | IBAMA | Creation of national system for shared management of fisheries resources between MPA and MMA | |

Source: Modified from Silva et al. (2013)
[a]Based only on legislation and policies
[b]SNUC (National System of Nature Conservation Units)

fishing agreements (IBAMA IN 29/2002) and the Federal Decree (6981/2009), concerning shared responsibilities over fisheries management between the Ministry of Fisheries and Aquaculture (MPA) and the Ministry of Environment (MMA).

Fishing agreements often emerged from the demands of riverine communities and civil society organizations, for instance, in the Amazon Basin, who sought recognition via local institutions particularly since the 1970s (Castro 2000, 2002; Aquino et al. 2007; McGrath et al. 2007; Viana et al. 2007). In practice, fishing agreements have mainly resulted in the formal legitimization of community-based fishing management by the national government. However, it is important to note that in only a few cases have these agreements become part of management procedures in coastal zones (Vasconcellos et al. 2007). Furthermore, fisheries agreements were not formally included as a standard institutional tool under the new fishery policy from 2009, in spite of being broadly used for inland fishery management in the Amazon basin.

Under the Technical Commission on Shared Fisheries Management (MMA/MPA), technical working groups and management committees were created, composed of representatives of government and civil society. These committees and working groups propose to the Technical Commission management plans for the sustainable use of the fisheries specific for a species (e.g., lobster, mullet, sardine), gear (gillnet), stakeholder group (artisanal fishers), and fish group (demersal) (Vieira et al. 2015).

Other arrangements that are not regulated or led by government have also promoted fisheries co-management in Brazil. These include multi-stakeholder bodies and knowledge exchange networks. Examples of the former include the fishing forums, which were created as a result of communities' initiatives to organize themselves and discuss their problems and seek solutions in partnership with governmental and nongovernmental organizations. Some Agenda 21 Forums have also been initiated by communities. Examples of the latter include the contribution of the scientific community to policy and management decisions and actions and the exchange of knowledge among fishing communities and nongovernmental organizations from different regions of the country. In addition to the abovementioned formal instruments and informal arrangements, the institutionalization of protected areas plays an indirect role in the governance of small-scale fisheries.

### *18.1.3 Protected Areas*

Protected areas (PA) management had a different development path in Brazil and, as such, has faced different experiences regarding collaborative management. The Brazilian Institute of Forest Development (IBDF) oversaw federal protected areas until 1989. Similar to SUDEPE, IBDF was closed, and its tasks were taken over by the Federal Environmental Agency (IBAMA). IBAMA held jurisdiction over all federal protected areas until 2007 when the Federal Protected Areas Agency (ICMBio) was created for this purpose. ICMBio holds exclusive jurisdiction to manage federal protected areas under the National System of Nature Conservation Units (SNUC) both in terms of overall direction and management tools (including management councils and management plans). Conversely, IBAMA is in charge of surveillance and enforcement. State and municipal governments, through specific agencies, manage protected areas under their jurisdiction.

Formal collaborative management of protected areas started with the implementation of the first extractive reserve in the Amazon in 1990 and in the coastal zone in 1992. Until 2000, when the National System of Nature Conservation Units (SNUC) was established under Law N. 9985/2000, collaborative management of protected areas was relatively rare. Protected areas (PAs) under the SNUC, for example, were classified into “no-take PAs” and “sustainable use PAs.”

No-take PAs do not allow a full collaborative management process as all management councils only hold a consultative status. Even though civil society organizations and resource users may be involved in planning, the government still retains final decision-making authority. Among the sustainable-use PAs, only the extractive reserves and sustainable development reserves hold deliberative management councils, which allow for full collaborative management processes. All other classes of PAs have consultative councils, on which resources users and civil society organizations can serve as members in order to express their points of view. Since ICMBio’s creation, management initiatives inside PAs have been guided by several internal resolutions that regulate how to establish and operate management councils and elaborate management plans in a collaborative and participatory fashion. In most cases, however, collaboration in PA management is at an early stage, and numerous challenges persist in terms of overcoming conflicts, particularly regarding resource use by traditional groups inside no-take protected areas (Diegues 2008; Gasalla 2011; Bockstael et al. 2016; Seixas et al. 2017). In this regard, a new instrument – the "terms of agreement" – was issued by ICMBio in 2012 in order to search for temporary solutions to conflicts concerning resource use inside no-take PAs. The effectiveness of such instruments is still to be assessed.

## 18.2 Assessing Collaborative Coastal Management (CCM) in Brazil

In order to explore lessons learned and identify opportunities to advance CCM in Brazil, a workshop was held in 2010 in Paraty, on the Southeastern coast of Brazil, which was attended by 56 participants. These participants were divided into four working groups, each representing a mix of Brazilian and international researchers, Brazilian government officials, and community members. In each group, there was a bilingual facilitator, plus one Portuguese and one English notetaker, supplemented with people who were able to perform whispering translation. The workshop discussion was structured around a set of guiding questions to address the following topics: (1) key events and issues that have shaped CCM in Brazil and elsewhere; (2) progress for the advancement of CCM in recent years; (3) current challenges to the advancement of CCM; and (4) major knowledge gaps of CCM. The lively and sometimes heated discussion around these topics guided the development of a synthesis and series of recommendations on the future of CCM.

Figure 18.1 and Table 18.3 present the variety of CCM cases most cited during the workshop. It is important to mention though that there is a bias toward the southeastern and southern regions of the Brazil, because that is where most of the workshop participants work. Some CCM cases are related to the creation and/or implementation of protected areas and other management tools, such as coastal management plans and fisheries agreements. Others examined governance arrangements, for example, through multi-stakeholder bodies such as inter-municipal consortiums, national and state councils, and management committees. Other cases are mainly research-driven or focus more on networks and science-policy interfaces or research-action interfaces.

### *18.2.1 Key Events and Issues That Have Shaped CCM*

Collaborative coastal management in Brazil is emerging in response to a number of factors, including threats and crises faced by the social-ecological systems (SES), opportunities generated from these new government policies, and initiatives led by universities and no-governmental organizations (NGOs) in support of social movements emerging from the democratization process initiated in the 1980s (Table 18.4). Most *threats*, such as port construction, oil and gas exploitation, road construction, and shrimp farming, resulted from coastal zone development activities. In response to the threats caused by shrimp farming projects during the 2000s, communities,


**Fig. 18.1** Location of the most cited cases during the workshop. The legend for case numbers, including case names, type of arrangements, and specific municipality and state is found in Table 18.3

**Table 18.3** Location by region, municipality, and state of the most cited cases where different types of management arrangements operate as cited by participants of the workshop

| No[a] | Type | Management arrangement | Municipality/region/state[b] |
|---|---|---|---|
| 1 | Cassurubá MER[c] | Protected area | Alcobaça, Caravelas, and Nova Viçosa, BA |
| 2 | Corumbau MER | Protected area | Prado, BA |
| 3 | Canavieiras MER | Protected area | Canavieiras, BA |
| 4 | Arraial do Cabo MER | Protected area | Arraial do Cabo, RJ |
| 5 | Casimiro de Abreu MER project | Protected area | Casimiro de Abreu, RJ |
| 6.a | Fisheries assessment at Ilha Grande Bay | Research | Paraty, Angra dos Reis, RJ |
| 6.b | Fisheries agreement proposal at Ilha Grande Bay | Fisheries agreement proposal | Paraty, Angra dos Reis, RJ |
| 7 | Paraty project (IDRC funded) | Research | Paraty, RJ |
| 8 | Consultative Council of the Ilha Grande State Park | Protected area | Ilha Grande, RJ |
| 9 | Lago São João watershed committee – inter-municipal consortium | Multi-stakeholder body | Araruama, Saquarema, and Rivers São João and Una, RJ |
| 10 | Mandira MER – Cooperostra | Protected area | Cananéia, SP |
| 11 | Ecological economic zoning of northern São Paulo coast | Coastal management plan | Ubatuba, Ilhabela, Caraguatatuba, São Sebastião, SP |
| 12 | Northern coast marine environmental protected area (*APA Litoral Norte*) | Protected area | Ubatuba, Ilhabela, Caraguatatuba, São Sebastião, SP |
| 13 | Southern coast marine environmental protected area (*APA Litoral Sul*) | Protected area | Iguape, Cananéia, Ilha Comprida, SP |
| 14 | Territorial Development Council of Parana coast | Multi-stakeholder body | Coast of Paraná, PR |
| 15 | Ibiraquera MER project | Protected area | Imbituba, SC |
| 16 | Pirajubaé MER | Protected area | Florianópolis, SC |
| 17 | Littoral observatory | Science-policy network | Coast of Santa Catarina, SC |
| 18 | Ibiraquera Lagoon Forum | Multi-stakeholder body | Imbituba, SC |
| 19 | Consultative council of Baleia Franca environmental protected area | Protected area | Southern coast of Santa Catarina, SC |
| 20 | Fishing rules revision at Arvoredo marine biological reserve | Protected area | Ilha do Arvoredo, SC |
| 21 | Patos Lagoon Forum | Multi-stakeholder body | Patos Lagoon, RS |
| 22 | Brazil Meros Network | Research-action network | Some nodes: Caravelas (BA), Tamandaré (PE), Iguape (SP), São Francisco do Sul (SC) |

(continued)

**Table 18.3** (continued)

| No[a] | Type | Management arrangement | Municipality/region/state[b] |
|---|---|---|---|
| 23 | Fisheries solidarity network | Research-action network | Rio de Janeiro coast (RJ), Patos Lagoon (RG), Prainha do Canto Verde (CE) + 7 inland nodes |
| 24 | Lobster Fisheries Management Committee | Multi-stakeholder body | National |
| 25 | CONAPE – Fisheries and Aquaculture National Council | Multi-stakeholder body | National |

[a]No – case number
[b]BA (Bahia), CE (Ceará), RJ (Rio de Janeiro), SP (São Paulo), PR (Paraná), SC (Santa Catarina), RG (Rio Grande do Sul), PE (Pernambuco)
[c]Marine Extractive Reserve (MER)

**Table 18.4** Examples of events and issues that have shaped collaborative coastal management in Brazil

| |
|---|
| *People's responses to threats from environmental factors and development* |
| Threats from coastal development |
| Environmental compensation measures |
| *Crises in the fisheries systems* |
| Decline in fish production and fishers' income |
| User group conflict: smaller-scale fishers vs. larger-scale fishers |
| User group conflict in small-scale fisheries: insiders vs. outsiders |
| *Development of participatory research and partnerships with universities and NGOs* |
| Action-oriented and participatory academic research |
| Environmental assessment |
| Support/partnership with universities and NGOs |
| *Policies and legislations fostering CCM opportunities and the establishment of new arrangements* |
| New arrangements and proposals for CCM |
| Policies and programs favoring CCM |
| Government openness to revise/change legislation |
| *Establishment, implementation, or re-categorization of protected areas (conservation units)* |
| Fisheries restriction inside and/or on the buffer zones of protected areas → conflict between artisanal fishers and managers |
| People exclusion from no-take protected areas |
| Establishment of sustainable use protected areas |
| Re-categorization of protected areas (from no-take to sustainable use protected areas) |
| *Communities' claims for recognition of cultural identity* |

NGOs, and university groups joined efforts to propose the establishment of two extractive reserves in Ibiraquera, Santa Catarina State (Case 15, Fabiano 2004), and Cassurubá, Bahia State (Case 1, Dias and Soares 2007).

The *environmental compensation measures* for such coastal development sometimes also have led to the establishment or implementation of protected areas in the coastal zone. According to Brazilian environmental policies, any company developing a project with an anticipated environmental impact must pay compensation measures to the government, which in turn is to allocate the amount received to protect areas with equivalent ecosystem characteristics. For example, environmental compensatory measures for oil and gas exploration in Rio de Janeiro state (SE coast) have been used to establish a new protected area (Case 5). In Santa Catarina, compensatory measures for building a road over a mangrove inside a protected area contributed to the establishment of a management council at the Pirajubaé Marine Extractive Reserve (Case 16).

*Crises in fisheries systems*, such as fish stock declines, fishers' income declines, and user group conflicts, have resulted in the mobilization and organization of resource users and other relevant stakeholders to deal with these social-ecological problems with an increasing variety of other innovative mechanisms. Examples include the collapse of fish stocks at Patos Lagoon (Case 21) and Ibiraquera Lagoon (Case 18), which led to the establishment of multi-stakeholder bodies (forums) (Kalikoski et al. 2002; Adriano 2011). Another example focused on the decline in fisheries catch and user group conflict in Ilha Grande Bay, which led to the proposal for a fisheries agreement (Case 6b) (Araujo 2014).

*User group conflict* between smaller-scale fishers and middle-scale fishers triggered the establishment of marine extractive reserves in Arraial do Cabo (Case 4, Pinto da Silva 2004; Seixas 2008) and Corumbau (Case 2, Moura et al. 2009) and the mobilization of fishers in Santa Catarina (Case 18, Adriano 2011) and Patos Lagoon (Case 21, Kalikoski et al. 2002). Disputes over marine space have also triggered various conflicts. For instance, the top-down creation and later implementation and surveillance of a no-take protected marine reserve in an area traditionally used by small-scale fishers, which was established without even holding public hearings, led to conflicts between fishers and protected area managers (e.g., Tamoios Reserve at Ilha Grande Bay – Case 6a – and Arvoredo Reserve – Case 20) (Medeiros 2009; Begossi et al. 2010).

*Participatory research* by academics and *environmental assessments* by environmental firms, universities, and NGOs have triggered and supported new arrangements and partnerships that promote CCM. Examples in Table 18.3 include the littoral observatory in Santa Catarina State (Case 17), in which a pool of universities worked together with the public prosecutor's office in providing technical advice to reduce environmental degradation in the coastal zone. Another example is the local ecosystem assessment project that led to the establishment of the Agenda 21 Forum of the Ibiraquera Lagoon (Case 18). Research projects with strong outreach components, which built capacity for local stakeholders to engage in CCM or provided technical support to coastal communities, took place in several areas (e.g., Cases 4, 7, 15). It is worth mentioning that various partnerships and support from foreign universities and international NGOs also contributed to the important development of social capital as part of these local initiatives, such as in Hastings (2011). In fact, the social capital that has been built within the various projects, as well as between them, has been and is still today a critical resource in advancing CCM in Brazil.

In the last two decades, a diversity of *laws and policies fostering environmental protection and local development have created new opportunities for CCM*. A special category of protected areas that includes local residents (e.g., marine extractive reserves – several cases) and the legal recognition of local practices (e.g., fishing agreements) are examples of new CCM arrangements that emerged from the 1990s (Castro 2002; Glaser and Oliveira 2004). Some policies and programs are presented in the introduction section of this summary. Of particular interest is the National System of Nature Conservation Units (SNUC), which opened opportunities for collaborative management in several protected areas as discussed below. The government's openness to revise fisheries legislation based on fishers' demands has also built opportunities for CCM, such as in the cases of revising dates for the seasonal closure of shrimp fishing. It is worth noting that a National Policy for the Territorial Development of Aquaculture and Fisheries was issued in 2008, which created potential opportunities for CCM, although currently no legal instruments are in place for its implementation.

*The creation*, *implementation*, *or re-categorization of protected areas* (*PAs*), mainly after the creation of the SNUC in 2000, have made possible a variety of new CCM processes. These collaborative processes originated either in the stakeholders possibility to participate in decision-making within the management councils of some PAs or in the mobilization of resource users in the face of use and access restrictions imposed by protected areas' rules, such as those at Tamoios Ecological Station and Serra da Bocaina National Park in Paraty (both Cases 6 and 7) and at the Arvoredo Biological Reserve (Case 20). In many cases, use and access restrictions in PAs have led to conflict between fishers and PA managers. The top-down establishment of marine environmental protected areas (APAs), along the coast of São Paulo state in 2008 (Cases 12 and 13), triggered a sequence of mobilizing events among fishers that forced the government to open new spaces for dialogue and negotiation.

Finally, *the quest for recognition of cultural identity has led to community mobilization*. Cases that exemplify this process are Trindade, a *caiçara* community (Case 7, Araujo 2014), Maroons (Quilombolas) community at Mandira Marine Extractive Reserve (Case 10), and communities located in the south-central coast of Santa Catarina (Case 15). In all cases, cultural identity concerns were primary triggers of these local developments.

#### 18.2.1.1 Advancements for CCM in Recent Years

Overall, there has been a significant series of advancements related to CCM in recent years in Brazil (Table 18.5). The re-democratization processes that has taken place in Brazil since the 1980s, the recognition of fishing agreements in 2002, the

**Table 18.5** Examples of advancements in CCM in Brazil

| |
|---|
| *Legislation and public policies fostering user participation in resource management and CCM* |
| Designing the ecological-economic zoning for São Paulo coast (communities were consulted and their concerns/suggestions were taken into account in the design) (Case 11) |
| *Creation or improved performance of arenas for CCM* |
| Institutionalization of protected areas' management councils (e.g., Case 4 in 2010, case 19 in 2005) |
| *Empowerment of community-based organizations* |
| Building capacity among rural youth (program of the rural development ministry (MDA) – e.g., course on agroecology and fisheries coop in Imbituba and Garopaba, SC (Case 18 and 19);, participatory fisheries monitoring at Corumbau MER (Case 2)) |
| *Trust building and partnerships among stakeholders* |
| Increase and improvement of relations among different sectors (examples from RJ,,PR, and SC states; Cases 6–7, 15, 19) |
| Establishment of partnership with the public prosecutor office (Case 17) |
| *Recognition of traditional/local ecological knowledge (TEK/LEK) and its use in management* |
| Incorporation of TEK/LEK in official management initiatives (e.g., Cases 4 and 10) |
| *Networks for knowledge exchange and building: users network, research network, technical assistance network* |
| Research-action networks (cases 22 and 23) and science-policy network (Case 17) |
| *Universities' roles in (a) building capacity, (b) research on CCM, and (c) support/partnership with community-based organizations and government* |
| Strengthened university links with fishers (e.g., Case 7) |
| *Funding agencies support for research, capacity building, and technical assistance in CCM* |
| Funding agency support to research and outreach programs on CCM (e.g., Case 7) |
| *Increased number of government staff trained for CCM* |
| Commitment of government managers to new management directions (Case 19) |
| *Government actions to support development of fisheries and fishing communities* |
| Fisheries legislation revision (Case 2, 13, 20, 21) |
| Improvement of fisheries monitoring (Case 2 and 13) |

creation of the National Council for Fisheries and Aquaculture (CONAPE) in 2004, and the design of the ecological-economic zoning for the São Paulo coast (Case 11) in 2008 are some examples of *public policies and legislation that foster the participation of resource users in CCM processes*.

Examples of *new*, *and improvement of existing*, *arenas for CCM* include the institutionalization of protected areas management councils (Cases 4 and 19), the establishment of watershed management councils (case 9), the establishment of fishing forums (Cases 18 and 21), the implementation of processes for creating new marine extractive reserves (MER) (Case 15), and the development of new or revised management plans (e.g., Cases 6.a, 20, and 21).

*Empowerment of community-based organizations* has also contributed to CCM. The strengthening of democracy in Brazil allowed for the development of new community organizations, including new fisher organizations. Some capacity-building programs were also put in place as part of these efforts (e.g., Cases 2, 6b, 7, 18, and 19). There has been an increase in human and social capital, which in turn led to empowerment, self-identity, and increased visibility of many previously marginalized groups within society. New community voices are now being heard by government, and more are participating in decision-making related to sustainable resource use.

*Building trust and partnerships among a diversity of stakeholders* has been key to this advancement of CCM processes, and such changes deserve more recognition. Examples include increasing trust among partners and resource users (e.g., Cases 7, 10, 15, 19, and 21), increasing solidarity awareness among users with common interests (Case 23), improving trust relations with fisher representatives (e.g., Cases 15 and 16), and increasing fishers' willingness to participate in CCM (e.g., Case 11).

The *recognition of traditional and local ecological knowledge by the state and its use in management initiatives* provides incentives for CCM. The recognition of traditional peoples and groups and the pool of knowledge they hold, as well as the exchange of local and scientific knowledge in some decision-making arenas, has contributed to CCM (e.g., Cases 4 and 10). *Networks for knowledge building and exchange*, such as research-action networks (Cases 22 and 23) and science-policy networking (Case 17), as well as new spaces for dialogue, knowledge exchange, and development of policy agendas, such as the National Fisheries Conferences, also have advanced collaboration among stakeholders.

The *contribution of universities to advancing CCM* includes (a) the establishment of training programs for building new capacities for communities, within universities and in the government; (b) research projects on CCM; and (c) in supporting and partnering with often critically important relationships with grassroots organizations and government initiatives, a trend that was observed in several cases. *Support by funding agencies for research*, *capacity building*, *and technical assistance in CCM* has also been crucial (e.g., Cases 7 and 21). Over the years, there has been an i*ncreased number of government staff trained for CCM*, including those involved in enforcing legislation. Some government managers have also been more strongly committed to such new management directions (e.g., Case 19), thus increasing both the quality and number of government responses and initiatives toward CCM (Mendonça et al. 2014).

A series of *government actions to support the development of fisheries and fishing communities* has also promoted CCM. These include (i) the implementation of biodiversity conservation actions to improve fisheries in the longer term without affecting fisher well-being (e.g., Case 4); (ii) creation of protected areas for sustaining fishing communities (Cases 1, 2, 3, 4, and 10); (iii) issuing legislation favoring microcredit for fishers (national level), aquaculture licensing (Cases 4 and 8), and unemployment benefits (national level); (iv) revising fisheries legislation (e.g., Cases 2, 3, 20, and 21); (v) improving participatory fishing monitoring, for example, by scaling up small-scale fisheries in decision-making arenas as well as engaging fishers and providing learning opportunities for CCM (e.g., Cases 2 and 13); and (vi) discussing the re-categorization of some protected areas from no-take to sustainable use areas (e.g., Case 7 and 20).

### 18.2.2 *Current Challenges to the Advancement of CCM in Brazil*

Despite a significant number of recent achievements in CCM, there remains a multitude of challenges that hinder the needed advancement of CCM in Brazil (Table 18.6). A major challenge regards the *low mobilization and participation of fishers in CCM processes*, including the underrepresentation of the fisheries sector, the low legitimacy of fishers' representatives, the high dependency of fishers on one organization or person, and the lack of autonomy of fishers. There is a need to legitimize other fishers' organizations beyond fishers' unions ("*Colônias*") which typically remain poorly structured and organized. The legitimization of decision-making arenas at the local level is crucial to enhance management performance and stakeholder engagement in CCM (Fletcher 2007). It is also worth mentioning that the lack of short-term results has often led to user disinterest, which represents a major hindrance to CCM processes. Different views on stakeholders' interests and outcomes affect their representations and, ultimately, CCM performance (Fletcher 2007).

Another challenge is the *low capacity of users and government managers to engage in CCM*. There remain serious deficiencies in areas around appropriate training and strategic planning for CCM. Wever et al. (2012) pointed out that government staff are given responsibilities without training in integrated, decentralized CCM. Technical support and facilitation skills are key to overcome this challenge (Lawless 2015). Fishers often lack information on fishing rules and legislation. Thus, there is a need for increased environmental awareness among all stakeholders and capacity building among local users in order to increase their ability to engage in CCM. The professionalization of the public administration in Brazil, including building the government's capacity to assist local organizations, is also required.

**Table 18.6** Summary of challenges for collaborative coastal management (CCM) in Brazil

| |
|---|
| Low mobilization/participation of fishers; low-level representativeness in management processes; lack of empowerment and legitimacy of leaders |
| Low-level capacity of users and government managers for CCM |
| Conflicting or overlapping government agencies' agendas |
| Lack of effective participation of stakeholders in decision-making |
| Weak communication and lack of trust among stakeholders |
| Low dissemination and use of research results in management and policies |
| Discontinuity of management processes and policies |
| Few, or lack of, cross-scale dialogue and interactions |
| Lack of *de facto* implementation of CCM processes |
| Lack of flexibility and adequacy of government institutions |
| Strict focus on fisheries development only – instead of considering it within the context of sustainable territorial development |
| Discontinuity of funding support and better resource administration for CCM processes |

*Conflicting or overlapping government agencies' agendas* are also major issues. Often, governments present a fragmentation of programs and policy ambiguities, such as observed by Wever et al. (2012) when comparing the implementation of decentralized coastal management in Brazil and Indonesia. Coastal management, fisheries management, protected areas management, and watershed management are not integrated into the same processes. As a result, there are overlapping actions and a lack of articulation among technical-scientific organizations, as well as institutional incongruence (Case 7, Araujo 2014). Conflicting agendas have often led to power imbalances regarding privatization and urbanization versus fishing communities' permanence in their territories (e.g., Case 3). Overlapping agendas and management scales require a shifting perspective on governance. Multi-scale, adaptive governance is a well-recognized alternative approach for governing complex systems (Folke et al. 2005; Mahon et al. 2008; Bruckmeir 2014).

*Lack of effective user participation in decision-making* also hinders CCM. In some cases, CCM lacks the grounds for the participation and contribution of all stakeholders. For instance, the lack of consultation of some key sectors for the establishment of the marine environmental protected areas of São Paulo coast was a major shortcoming of this project (Cases 12 and 13). In other cases, participation is not legitimized, particularly in the case of the historical marginalization of the fisheries sector in decision-making. The uneven distribution of responsibility between government and fishers in decision-making remains an ongoing issue.

*Weak communication and lack of trust among stakeholders* remain key challenges for CCM. Communication may be deficient and hindered by social-political divergence among stakeholders, including government and user communities. The absence of political will by governments and lack of dialogue between government agencies (from different sectors and levels) and users were often mentioned as key challenges. The fisheries sector is not always recognized by local authorities, and hence, fishers argue that there is insufficient commitment by the local government for fisheries management.

Also related to communication, the *low dissemination and use of research findings in management and policies* are other issues to be addressed. Research results are seldom used as a basis for government regulations and are rarely disseminated to local communities and organizations. One possible way to minimize this problem is engaging stakeholders in research through participatory approaches. In fact, Trimble and Berkes (2013) demonstrated that such an approach can be a key stimulus toward CCM in their case study in Uruguay.

Often there is *discontinuity of management processes and policies*, which often results from frequent changes of government staff such as protected area managers. The lack of cross-scale dialogues and interactions is another challenge. In several cases, reconciling local and national interests is required for integrating local concerns with macro-project decision-making, building learning networks at different levels (local, regional, and federal), and using scientific knowledge and local knowledge concurrently.

A *de facto implementation of CCM processes* is still required in many cases. CCM processes are complex and full of conflicts that hinder their implementation (e.g., Cases 15 and 6b). Additionally, implementation of government committees and projects related to CCM has been slow and needs improvement in order to be effective.

The *lack of flexibility and adequacy of government institutions* is reflected in factors such as (i) the prevalence of institutional rigidity; (ii) the pervasiveness of intricate bureaucracy; (iii) unrealistic regulations; (iv) limited change in institutional ethos despite improvements in the legal institutional setting; and (v) limited alternatives for the legal recognition of CCM processes. Hence, there is a strong need for the development of new approaches.

The *strict focus on fisheries development* of some initiatives, instead of considering it within the context of sustainable territorial development, has been a challenge for CCM (e.g., Cases 4 and 21). This is noted through challenges including (i) the lack of a territorial view of fisheries by fishers; (ii) conflict between small-scale fisheries and development processes; (iii) conflict between endogenous development and the government approach to oil exploitation; and (iv) the need for increasing community well-being with no increase on resource exploitation pressure.

A final but crucial challenge relates to the *discontinuity of funding support and adequate resourcing for administration of CCM processes*. Often there exist serious discontinuities of funding with a prevalence of short-term projects. This situation, when combined with a lack of financial control of initiatives, a rigid fiscal structure, and a lack of tax incentives, also creates severe barriers of fund-raising. Finally, the existence of conflicts between different interests may also restrict funds and human resources for implementing CCM initiatives. In fact, CCM takes place in a highly politicized environment, given that changes in government due to partisan dynamics often lead to changes in government-appointed positions ("*cargo de confiança*"), institutional arrangements, and political priorities.

### *18.2.3 Future Perspectives for CCM in Brazil*

The analysis of the expanding pool of experiences related to CCM in Brazil reveals that the specific cases range from initial stages of CCM implementation (such as the case of the fisheries agreement in the Ilha Grande Bay – Case 6b) to more advanced processes (such as the implementation of a management council and the development of a management plan for the marine extractive reserve in Corumbau, Bahia, Case 2). Hence, what may be a challenge at one site may have been overcome at another site. This is certainly observed in Table 18.7 when comparing the list of achievements of, and challenges to, CCM in Brazil from Tables 18.5 and 18.6. In fact, the limited action and opportunities to encourage more knowledge sharing across and between such groups and processes may be one of major challenges to advancing CCM in Brazil.

In light of the findings from these cases, the following question has emerged: how best can more and deeper probing be encourage into a better understanding of

**Table 18.7** Challenges and achievements of CCM

| Key elements | Challenges[a] | Achievements |
|---|---|---|
| **Communication** and **trust** among stakeholders | **Weak communication** and lack of trust among stakeholders | Networks for knowledge exchange: users network, research network, technical assistance network |
| | Few, or lack of, cross-scale dialogues and interactions | Trust building and partnerships among stakeholders |
| | **Low dissemination and use of research results in management and policies** | Recognition of traditional/local ecological knowledge (TEK/LEK) and its use in management |
| Effective **participation** of users in CCM | Low mobilization/participation of fishers; **low-level representativeness** in management processes; lack of empowerment and **legitimacy of leaders** | Legislations and public policies fostering user participation in resource management and CCM |
| | Lack of effective participation of stakeholders in decision-making | Empowerment of community-based organizations |
| **Capacity building** for CCM | Low-level capacity of users and government managers for CCM | Universities' roles in (a) building capacity, (b) research on CCM, and (c) support/partnership with community-based organizations and government |
| | Discontinuity of funding support and better resource administration for CCM processes | Funding agencies support for research, capacity building, and technical assistance in CCM |
| | | Increased number of government staff trained for CCM |
| The role of **government** in CCM | Strict focus on fisheries development only – instead of considering it within the context of sustainable territorial development | New or improved arenas for CCM |
| | *De facto* implementation of CCM processes | Government actions to support development of fisheries and fishing communities |
| | Conflicting or overlapping government agencies' agendas | |
| | Lack of flexibility and adequacy of government institutions | |
| | Discontinuity of management processes and policies | |

[a]In **bold** are the challenges that have yet to be overcome in most if not in all case studies

these real challenges? To answer this question, we grouped the findings from Tables 18.5 and 18.6 into what we call key elements for CCM: (i) communication, trust building, and partnerships; (ii) effective user participation; (iii) capacity building; and (iv) government role. These key elements are presented in Table 18.7.

The comparison between challenges and achievements summarized in Table 18.7 reveals three bundles of underlying factors limiting the advances of CCM in Brazil: (1) the misrepresentation and legitimacy of user organizations; (2) political culture and government praxis; and (3) knowledge gaps.

*Political misrepresentation* stems from a long-lasting history of a nationwide network of fishers' unions (*Colônias de Pescadores*) established in 1912. These organizations were under government control and focused on the national security of the riparian and coastal territory (Breton et al. 1996). The fishers' unions were established through a top-down process in which the union head was selected by local elites and registration was compulsory. This resulted in the fishers' unions acting as a depoliticizing machine in that they suppressed dissent through their control of fishers by local political and economic elites. From the 1940s, when compulsory registration was abolished, the fishers' unions were consolidated as an organization of large-scale, industrial fishers. Only after the democratization process was initiated in the 1980s have the fishers' unions gradually become more representative of small-scale fishers in some parts of the country.

As of 1994, fishers affiliated to the fishers' union became eligible for unemployment payments during seasonal fishery closures. As a result, the fast increase in membership has been driven more by economic motivations than political empowerment. Such motivations have limited the representativeness of the unions in the decision-making process. In the past decades, fishers showed many achievements. In particular, representation of a diversity of fishers has been achieved by organizations other than *Colônias*. Despite the few cases in which the *Colônias* are seen as the legitimate representatives of fishers' interests (at least by the government), organizational capacity remains weak, and institutional restructuring is vital to improve the transparency, accountability, and legitimacy by all, including a large range of fishers.

The second bundle of underlying factors limiting CCM is related to the political culture and government praxis in Brazil. The conservation agenda of the Ministry of Environment (MMA) and the development agenda of the Ministry of Fisheries and Aquaculture (MPA) are often contradictory and lead to conflicts, environmental degradation, and social inequalities. The Environment Ministry undertakes coastal management programs (GERCO), protected areas management, and watershed management, often without adequate communication with other related agencies. The institutional innovations surrounding interministerial fisheries governance between the Ministry of Fisheries and Aquaculture and the Ministry of Environment opened new opportunities to overcoming this structural problem. However, limited institutional capacity, combined with the political instability of governmental agencies, restrains the continuity and consistency of long-term management processes and policies – a common problem in Latin America (Salas et al. 2007). The lack of flexibility and adequacy of government institutions creates additional barriers to the development of adaptive management processes. Adaptive management typically requires periodic adjustments guided by improved knowledge, assessment of outcomes, and new realities.

Both bundles of underlying factors are related to the perceptions of users and governmental agencies toward one another. On one side, the institutional ethos of governmental agencies maintains a "clientelistic relation" with local users; on the other side, local users perceive the state either as an oppressor or the benefit provider, often exacerbating deeply rooted dependent relationship. Unless this patron-client relationship is transformed into true partnerships, participatory progress will be limited (Castro 2012).

The third bundle of underlying factors posing significant challenges for conducting CCM in Brazil is related to knowledge gaps and lack of communication. There is an urgent need to improve communication and dialogue between different actors – between government and civil society, government and researchers, researchers and civil society, and within each group. Often there is information and knowledge about various aspects related to CCM that is not used (or misused) due to, for example, (i) asymmetry of access to information by different actors and (ii) ambiguous technical language used by different actors that results in different interpretations of information and often prevents the effective communication of specific messages. In addition, there is a lack of comprehensive knowledge among stakeholders about relevant legislation and the main concepts and tools that help to implement CCM processes and an absence of efficient mechanisms to put recommendations proposed by the research community into practice.

The lack of a careful evaluation of the lessons learned from experiences in CCM (what has worked, what has not, and why), including an assessment of the effects of CCM on the overall socio-ecological system, was also reported as an important gap by several participants at the workshop. Three other points raised include the need to (i) evaluate the transaction costs of collaborative management, including evaluation of appropriate communication strategies for CCM; (ii) investigate challenges about emergent problems, such as the impact of climate change on coastal areas; and (iii) explore the potentialities of institutional innovations related to CCM.

It was also noted that a number of challenges remain that would benefit from further research. These areas included (i) the sociopolitical conditions necessary to successful implementation of CCM; (ii) the dynamics of resource users, including their customs and practices; (iii) the role of gender in CCM; (iv) the threats associated with the erosion of coastal communities' livelihoods; (v) the role of education in environmental management; (vi) the impacts associated with the land use and sea use and their effects on the coastal zone; and (vii) the key factors and interactions that contribute to (un)sustainability. Finally, from a theoretical and methodological perspective, the following challenges were highlighted: (i) the need to use a clear and common language, both in use of key terms and concepts, and (ii) the importance of establishing a stronger link between the theory of the commons and the global environmental crisis.

## 18.3 Conclusions

A review of collaborative coastal management cases within a national context was performed with a focus on Brazil. In bringing together people with direct experience of CCM cases, it was possible to create a summary of what has been learned during the last 30 years and identify key areas for future research. Brazil provides an interesting national context due to the transition to democracy and the increase in civil society participation in many sectors of the economy. Perhaps what became most apparent in this review is that CCM was not a rational, steady process of national implementation but a lurching and often challenging forward and backward process in which communities and other civil society actors pushed for increased participation within specific contexts. This reflects the complexity of the Brazilian context and the influence that specific contexts have on shaping the experience of CCM. Complexity also emerged across the cases due to the great diversity of coastal ecosystems, economic activities, and social interactions. It also became evident that different cases reveal different degrees of asymmetric access across regions, and among actors, to resources (e.g., knowledge, power, finances, markets, technology, and fishing grounds). One thing that was shared by most cases was the broader national context prevalent during this period that was often characterized by rapid change within political, social, economic, and cultural systems.

The degree of ecological complexity and uncertainty, along with existing knowledge gaps, suggests that CCM will continue to benefit from an approach of sharing experiences among cases as well as an approach of ongoing learning. The identification of the challenges highlighted in this chapter should not lead to inaction but rather a continuous process of social interaction with a shared goal of improving efficiency, equity, and legitimacy as part of the implementation of CCM. The Brazilian cases reveal that CCM has the potential to move away from the lexicon of management panacea, often consisting of simple prescribed solutions for complex challenges, to an arena for knowledge building, sharing, and more balanced power relations in decision-making processes. However, this approach will require continued attention to structural problems that limit effective participation, representativeness, and communication among stakeholders in new and future CCM initiatives.

## References

Abdallaha PR, Sumaila UR (2007) An historical account of Brazilian public policy on fisheries subsidies. Mar Policy 31:444–450

Adriano J (2011) Rumo ao ecodesenvolvimento na zona costeira catarinse – estudo de caso sobre a experiência do Forum da Agenda 21 local da Lagoa de Ibiraquera, no período de 2001 a 2010. Doctoral dissertation, Universidade Federal de Santa Catarina

Aquino AZ, Bocarde F, Lima NAS, Ruffino ML (2007) Gestão participativa no manejo de recursos pesqueiros na Amazônia. In: Prates AP, Blanc D (eds) Áreas aquáticas protegidas como instrumentos de gestão pesqueira, Série Áreas Naturais Protegidas 4. MMA/SBF, Brasília, pp 227–246

Araujo LG (2014) A pesca costeira artesanal de Paraty, R.J.: Uma análise multiescalar sob o enfoque da cogestão de recursos comuns (tese de doutorado). Universidade Estadual de Campinas, Campinas, Brasil

Avritzer L (2007) Sociedade civil, instituições participativas e representação: Da autorização à legitimidade da ação. Dados 50(3):443–464

Begossi A, Lopes PF, Oliveira LEC, Nakano H (2010) Ecologia de pescadores artesanais da Baía de Ilha Grande. Rima, São Carlos

Bockstael E, Bahia NCF, Seixas CS, Berkes F (2016) Participation in protected area management planning in coastal Brazil. Environ Sci Pol 60:1–10

Borba J, Sell CE (2007) Movimentos sociais, participação e democracia: contexto e perspectivas de debate no Brasil. Política e Sociedade 11:7–18

Breton Y, Benazera C, Plante S, Cavanagh J (1996) Fisheries management and the Colonias in Brazil: a case study of a top-down producers' organization. Soc Nat Resour 9(3):307–315

Bruckmeier K (2014) Problems of cross-scale coastal management in Scandinavia. Reg Environ 14(6):2151–2160

Castro E (2000) Território, biodiversidade e saberes de populações tradicionais. In: Diegues ACS (ed) Etnoconservação: novos rumos para a conservação da natureza. HUCITEC/NUPAUB-USP, São Paulo, pp 165–182

Castro F (2002) From myths to rules: the evolution of local management in the Amazonian floodplain. Environ Hist 8(2):197–216

Castro F (2012) Between cooperation and conflict: the implementation of agro-extractive settlements in the lower Amazon floodplain. In: Brondizio E, Moran E (eds) Human-environment interactions: current and future directions. Springer, Dordrecht, pp 213–234

Christie P, White AT (1997) Trends in development of coastal area management in tropical countries: from central to community orientation. Coast Manag 25(2):155–181

Dias HM, Soares MLG (2007) Conflitos políticos, sociais e ambientais: O exemplo da carcinicultura no município de Caravelas, BA. In: Branquinho F, Felzenszwalb I (eds) Meio ambiente: experiências em pesquisa multidisciplinar e formação de pesquisadores. FAPERJ & Mauad X, Rio de Janeiro, pp 77–92

Dias-Neto J (2003) Gestão do uso dos recursos pesqueiros marinhos no Brasil. IBAMA, Brasília

Diegues ACS (1983) Pescadores, camponeses e trabalhadores do mar. Ática, São Paulo

Diegues ACS (2008) Marine protected areas and artisanal fisheries in Brazil. Samudra Monograph, International Collective in Support for Fishworkers, Chennai

Fabiano RB (2004).Conflitos socioambientais e gestão integrada e sustentável de recursos pesqueiros – estudo de caso sobre a atividade de carcinicultura na área da Lagoa de Ibiraquera (municípios de Imbituba e Garopaba, S.C). Doctoral dissertation, Universidade Federal de Santa Catarina.

Fletcher S (2007) Representing stakeholder interests in partnership approaches to coastal management: experiences from the United Kingdom. Ocean Coast Manag 50(8):606–622

Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Resour 30(1):441–473

Gasalla MA (2011) Do all answers lie within (the community)? Fishing rights and marine conservation. In: Chuenpagdee R (ed) World small-scale fisheries: contemporary visions. Eburon Academic Publishers, Delft, pp 185–204

Glaser M, Oliveira R (2004) Prospects for the co-management of mangrove ecosystems on the north Brazilian coast: whose rights, whose duties and whose priorities? Nat Res Forum 28:224–233

Hastings JG (2011) International environmental NGOs and conservation science and policy: a case from Brazil. Coast Manag 39(3):317–335

Hochstetler K, Keck ME (2007) Greening Brazil: environmental activism in state and society. Duke University Press, Durham

Holling CS, Meffe GK (1996) Command and control and the pathology of natural resource management. Conserv Biol 10(2):328–337

Jentoft S (2003) Co-management–the way forward. In: Wilson DC, Nielsen JR, Degnbol P (eds) The fisheries co-management experience: accomplishments, challenges and prospects, Fish and Fisheries Series, Number 26. Kluwer Academic Publishers, Dordrecht, pp 1–14
Jorge MA (1997) Developing capacity for coastal management in the absence of the government: a case study in the Dominican Republic. Ocean Coast Manag 36(1–3):47–72
Kalikoski DC, Vasconcellos M, Lavkulich L (2002) Fitting institutions to ecosystems: the case of artisanal fisheries management in the estuary of the Patos Lagoon. Mar Policy 26(3):179–196
Kalikoski D, Seixas CS, Almudi T (2009) Gestão compartilhada e comunitária da pesca no Brasil: Avanços e desafios. Ambiente Sociedade 12(1):151–172
Lawless P (2015) Application of sociometric methods to collaborative coastal management. J Coast Conserv 19(5):653–665
Mahon R, McConney PA, Roy RN (2008) Governing fisheries as complex adaptive systems. Mar Policy 32(1):104–112
McGrath DG, Almeida OT, Merry FD (2007) The influence of community management agreements on household economic strategies: cattle grazing and fishing agreements on the lower Amazon floodplain. Int J Commons 1(1):67–87
Medeiros RP (2009) Possibilidades e obstáculos à cogestão adaptativa de sistemas pesqueiros artesanais: estudo de caso na área da Baía de Tijucas, litoral centro-norte do Estado de Santa Catarina, no período de 2004 a 2008. Doctoral thesis, Universidade Federal de Santa Catarina
Mendonça FC, Talbot V, Macedo HS (2014) Reflexões sobre a participação social em unidades de conservação e a contribuição do Instituto Chico Mendes de Conservação da Biodiversidade. In: Bensusan N, Prates AP (eds) A diversidade cabe na unidade? Áreas protegidas no Brasil. IEB, Brasília, pp 269–307
Moura RL, Minte-Vera CV, Curado IB, Bastos Francini-Filho R, Lima Rodrigues HC, Fraga Dutra G, Corrêa Alves D, Bezerra Souto J (2009) Challenges and prospects of fisheries co-management under a marine extractive reserve framework in Northeastern Brazil. Coast Manag 37(6):617–632
Pinto da Silva P (2004) From common property to co-management: lessons from Brazil's first maritime extractive reserve. Mar Policy 28:419–428
Plummer R, FitzGibbon J (2004) Some observations on the terminology in co-operative environmental management. J Environ Manag 70:63–72
Pomeroy RS, Berkes F (1997) Two to tango: the role of government in fisheries co-management. Mar Policy 21(5):465–480
Pomeroy RS, Carlos MB (1997) Community-based coastal resource management in the Philippines: a review and evaluation of programs and projects, 1984–1994. Mar Policy 21(5):445–464
Salas S, Chuenpagdee R, Seijo JC, Charles AT (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Mar Policy 87(1):5–16
Scherer M, Sanches M, Negreiros DH (2009) Gestão das zonas costeiras e as políticas públicas no Brasil: um diagnóstico. Red Iberoamericana de Manejo Costero/Brasil, Agência Brasileira de Gerenciamento Costeiro.
Scherer-Warren I, Luchmann LHH (2004) Situando o debate sobre movimentos sociais e sociedade civil no Brasil – Introdução. Política Sociedade 5:13–35
Seixas CS (2008) Co-managing a complex commons: The case of a marine protected area established along a coastal urban setting in Brazil. Paper presented at the 12th biennial conference of the international association for the study of commons, University of Gloucestershire, Cheltenham, UK, 14–18 July 2008 (Digital library of the commons: http://hdl.handle.net/10535/1587)
Seixas CS, Kalikoski D (2009) Gestão participativa da pesca no Brasil: levantamento das iniciativas e documentação dos processos. Desenvolvimento e Meio Ambiente 20:119–139
Seixas CS, Dias ACE, De Freitas RR (2017) Navigating from government-centralized management to adaptive co-management in a marine protected area, Paraty, Brazil: turbulence, winds of opportunity, and progress towards transformation. In: Armitage D, Berkes F, Charles A (eds) Governing the coastal commons. Routledge, New York, pp 157–180

Silva CNS, Broadhurst MK, Pereira Medeiros R, Guanais JHDG (2013) Resolving environmental issues in the southern Brazilian artisanal Penaeid-trawl fishery through adaptive co-management. Mar Policy 42(November):133–141
Trimble M, Berkes F (2013) Participatory research towards co-management: lessons from artisanal fisheries in coastal Uruguay. J Environ Manag 128:768–778
Vasconcellos M, Diegues AC, Sales RR (2007) Limites e possibilidades na gestão da pesca artesanal costeira. In: Costa AL (ed) Nas redes da pesca artesanal. IBAMA/PNUD, Brasília, pp 15–83
Vasconcellos M, Diegues AC, Kalikoski D (2011) Coastal fisheries of Brazil. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean. FAO fisheries and aquaculture technical paper no. 544, FAO, Rome, pp 73–116
Verheij E, Makoloweka S, Kalombo H (2004) Collaborative coastal management improves coral reefs and fisheries in Tanga, Tanzania. Ocean Coast Manag 47(7–8):309–320
Viana JP, Castello L, Damasceno JMB, Amaral ESR, Estupiñán GMB, Arantes C, Batista GS, Garcez DS, Barbosa S (2007) Manejo comunitário do Pirarucu *Arapaima gigas* na reserva de desenvolvimento sustentável Mamirauá – Amazonas, Brasil. In: Prates AP, Blanc D (eds) Áreas aquáticas protegidas como instrumentos de gestão pesqueira, Série Áreas Naturais Protegidas 4. MMA/SBF, Brasília, pp 249–271
Vieira MARM, Santos CR, Seixas CS (2015) Oportunidades na legislação brasileira para sistemas de gestão compartilhada da pesca costeira. Bol Inst Pesca 41:995–1012
Wever L, Glaser M, Gorris P, Ferrol-Schulte D (2012) Decentralization and participation in integrated coastal management: policy lessons from Brazil and Indonesia. Ocean Coast Manag 66:63–72

**Cristiana Simão Seixas** holds a PhD in Environmental and Natural Resource Management and an MSc in Ecology. She is based at the Environmental Studies and Research Centre (NEPAM) at the University at Campinas (UNICAMP), Brazil, where she coordinates the Commons Conservation and Management Research Group (CGCommons). Her research interests include commons theory, community-based conservation and development, traditional ecological knowledge, environmental governance, social-ecological resilience, human ecology, and fisheries. Currently (2015–2018), she is co-chairing the Regional Assessment for the Americas of the Intergovernmental Platform for Biodiversity and Ecosystems Services (IPBES).

**Iain Davidson-Hunt** is professor at the Natural Resources Institute of the University of Manitoba, a member of the Canadian Institute of Planners, and Deputy Chair of the People in Nature Knowledge Basket of the International Union for the Conservation of Nature. He has worked with indigenous peoples and local communities on territorial land-use planning, ethnoecology, food systems, and biodiversity-based enterprise development.

**Daniela C. Kalikoski** is a natural resources manager by background and works at the interface of natural and social sciences. She joined the Food and Agriculture Organization of the United Nations (FAO) in 2012 as staff member. She has devoted most of her professional life on rural development and action research on the interface between society and natural resources management, with a specific focus on collective action, community-based, and co-management interventions. She works on theoretical and practical aspects of implementing participatory approaches to sustainable natural resources, including empowerment to fight poverty and hunger, vulnerability to climate change, conflicts between fisheries and conservation, the use of traditional fishing practices, and territoriality for responsible fisheries management.

**Brian Davy** received his PhD in Biology from Texas A&M, focusing on fisheries biology and natural resource management. He has worked as a postdoctoral fellow at Cornell University and as a visiting scientist at the Tokyo University of Fisheries. He has worked with the International Development Research Centre (IDRC) for over 35 years, based in Canada as well as in Singapore. He currently serves as senior research associate at the World Fisheries Trust (www.worldfish.org) and Canadian Fisheries, Oceans, and Aquaculture Management (CFOAM, www.C-FOAM.management.uottawa.ca). His interests lie in natural resource management with a focus on aquatic resources, especially regarding aquaculture within these management systems.

**Fikret Berkes** is a distinguished professor emeritus at the University of Manitoba. He has devoted most of his professional life to investigating the relations between societies and their resources and to examining the conditions under which the "tragedy of the commons" may be avoided. He works on theoretical and practical aspects of community-based management, co-management, and traditional knowledge. His publications include the books *Coast for people* (2015), *Sacred ecology* (Routledge, 2008), *Breaking ice* (University of Calgary Press, 2005), *Navigating social-ecological systems* (Cambridge University Press, 2003), and *Managing small-scale fisheries* (IDRC, 2001).

**Fabio de Castro** is assistant professor in political ecology at the Centre for Latin American Research and Documentation (CEDLA) at the University of Amsterdam. Fabio is interested in processes influencing the governance of natural resources in Latin America. His research focuses on small-scale fishing, forestry, and farming systems in the Amazon and Atlantic Forest and, more recently, on environmental politics in Brazil and Latin America. He is the author of several articles and book chapters and co-editor of four volumes, including the special issue "Enhancing Stewardship in Latin America and Caribbean Small-Scale Fisheries" by the *Maritime Studies Journal*.

**Rodrigo Pereira Medeiros** is an adjunct professor in the Center for Marine Studies (CEM) at the Federal University of Parana in the city of Pontal do Parana, State of Parana, Brazil. His research interests include participatory monitoring, small-scale fisheries, socioeconomics, and ecosystem approaches to fisheries and marine protected areas management in South Brazil.

**Carolina V. Minte-Vera** is currently a senior scientist in the stock assessment program at the Inter-American Tropical Tuna Commission, where she is mainly responsible for the stock assessment of yellowfin tuna in the eastern Pacific Ocean. She has a PhD in Aquatic and Fisheries Sciences, an MSc and a bachelor's degree in Ecology, and a specialization in Applied Statistics. Formerly she was a faculty member at the State University of Maringá, Brazil, where she taught quantitative ecology and developed research and advised students in projects related to artisanal fisheries, mainly in the Abrolhos region and the Parana River, Brazil. Her current research focus is on fisheries stock assessment.

**Luciana G. Araujo** is a researcher at the Commons Conservation and Management Research Group (CGCommons), at the University of Campinas (UNICAMP), Brazil. She has a background in Ecology (BSc, MSc) and holds a PhD in Environment and Society from UNICAMP (2014). Over the past years, she has studied small-scale coastal fisheries in Paraty on the southeastern coast of Brazil. Her research interests include the conservation and governance of the commons, policy and institutional analysis, public participation, community-based conservation and development, and social-ecological resilience. She also works as a group facilitator in participatory methodologies related to community-based conservation and local development initiatives.

# Chapter 19
# Where Small-Scale Fisheries Meet Conservation Boundaries: MPA Governance Challenges in Southern Brazil

**Mirella de Oliveira Leis, Ratana Chuenpagdee, and Rodrigo Pereira Medeiros**

**Abstract** Marine ecosystem health is threatened globally by overfishing and habitat damages, among other things, creating major challenges for the sustainability and governance of aquatic environments. With a push toward increasing coastal and ocean protection through spatial management measures, an overlap between these marine protected areas (MPAs) and small-scale fishing grounds is expected to occur. Since MPAs are never established in a vacuum, there is a need to account for the ecological, social, and governance contexts into which they are being inserted. However, such considerations are not common, and the lack of integration of these essential elements in the design and the implementation of MPAs has often resulted in lowering their governability. We illustrate this tendency using a case study of the Marine National Park of Currais Islands in Southern Brazil, which was established without any consultation with small-scale fishers whose livelihoods and well-being depend on the use of the area in question. Using a governability assessment framework, we examine the diversity, complexity, dynamics, and scale issues associated with the natural, social, and governing systems. In addition to revealing that governance of this MPA is a "wicked problem," the study shows that the MPA adds more complexity to a system where issues such as lack of trust and low governing capacity exist.

**Keywords** Marine protected areas · Small-scale fisheries · Governance · Marine National Park of Currais Islands · Brazil · Governability assessment framework

M. de Oliveira Leis (✉) · R. Chuenpagdee
Too Big To Ignore Global Partnership for Small-Scale Fisheries Research, Memorial University of Newfoundland, St. John's, NF, Canada
e-mail: mirella.deoliveiraleis@mun.ca; ratanac@mun.ca

R. P. Medeiros
Centro de Estudos do Mar, Universidade Federal do Paraná, Paraná, Brazil
e-mail: rodrigo.medeiros@ufpr.br



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_19

## 19.1 Introduction

Marine protected areas (MPAs) have been increasingly endorsed worldwide (Pauly et al. 2002; Rice et al. 2012) to address concerns with ecosystem health due to overexploitation of fish stocks and biodiversity loss (Pauly et al. 1998, 2005; Worm et al. 2006). The benefits of MPAs as a conservation measure include the increase in biodiversity and biomass inside boundaries (Halpern and Warner 2002; Lester et al. 2009) and export of fishing resources to adjacent areas (Halpern et al. 2009). For these reasons, MPAs are also seen as a tool for fisheries management. A global target has been set to protect at least 10% of world's coasts and oceans by 2020, according to the Aichi Biodiversity Target 11 of the Convention on Biological Diversity (CBD 2010).

MPAs can represent a range of objectives, from preservation or restoration of biodiversity to improving socioeconomic conditions through conservation (Pomeroy et al. 2005; Dudley 2008). This variety implies different levels of restrictions to resource uses, thus resulting in distinctive types of MPAs ranging from no-take zones to multiple-use areas (Pomeroy et al. 2005; Dudley 2008). The designation of an MPA can involve a top-down (state-driven) or bottom-up (community-driven) initiative. The mode of governance can also vary from hierarchical to co-governance and self-governance (Jentoft et al. 2007).

Despite the acknowledged benefits and various goals that MPAs can serve, their implementation still faces several challenges in terms of legitimacy and social acceptance, resulting in difficulties in meeting conservation goals on the ground. MPAs are interactive systems which are affected by the ecological and socioeconomic conditions of their surroundings, as well as by existing rules and regulations that govern a given area (Jentoft et al. 2007). Further, MPAs are never established in a vacuum, and the context in which they are implemented needs to be considered in order for these instruments to be integrated effectively into a larger set of management rules (Jentoft et al. 2007). Thus, MPAs may result in social impacts such as threats to small-scale fishers' livelihoods and the intensification of conflicts from the displacement of fishing communities from MPAs (Mascia and Claus 2009; Mascia et al. 2010). There have been many cases when the spatial boundaries of MPAs do not take fishing livelihoods into consideration (Diegues 2008), resulting in opposition from small-scale fishers of MPA design and objectives (Charles and Wilson 2009; Jentoft et al. 2012). In most cases, this oversight has resulted in a lack of compliance and increased social conflict (Diegues 2008; Mascia et al. 2010), as well as the failure to achieve environmental conservation goals. With more MPAs being designated worldwide, conflicts are likely to escalate, especially where areas that are considered ecologically important overlap with those used in fisheries (Caldeira and Pierri 2014). The notion of people as a barrier to the conservation of "wilderness" has excluded resource users from areas designated for protection, not only physically through boundary demarcation but also from participation in decision-making and in protected area management (Diegues 2008).

Conflicts between fisheries uses and the boundaries proposed for conservation are common worldwide, even after long processes of delineation and design of

MPAs (Kirkman 2013). Further impacts that MPAs can pose to livelihoods have been highlighted, with some consideration of what uses should be allowed (Mascia et al. 2010). Studies show that there is lack of guidance on how to define MPA boundaries in a way that encompasses both conservation goals and stakeholder needs (Jentoft et al. 2007; Stortini et al. 2015). This new approach to determining MPA boundaries is expected to add more complexity to natural and social systems, posing further challenges to governing systems (Jentoft and Chuenpagdee 2009; Chuenpagdee 2011). The design of MPA spatial boundaries requires an integrative approach to achieve a broad set of ecological and socioeconomic objectives (Kirkman 2013). When these objectives are not achieved, conflicts and less robust governance are expected (Chuenpagdee and Jentoft 2013).

This study focuses on the need to understand the context in which an MPA is designated, encompassing both the natural and the social systems affected. This chapter aims to identify existing boundaries to small-scale fisheries and explore the challenges that a new MPA poses to overall governability and small-scale fisheries livelihoods. By applying the governability assessment framework (Jentoft and Chuenpagdee 2009), the study argues that MPA governance can be improved to avoid conflict with local resource users by aligning conservation rules and regulations with the characteristics of the resource user system that it aims to govern. The study was conducted in Pontal do Paraná, Southern Brazil, where the Marine National Park of Currais Islands (MNPCI) has recently been designated as a no-take MPA. Like many other MPAs in Brazil, the MNPCI was established without any consultation with, or involvement by, local resource users, who in this case are small-scale fishers whose livelihoods depend on the use of the closed area.

In the following sections, the governability assessment framework is presented, followed by a description of the case study. The results section begins with detailed descriptions of the natural, social, and governing systems associated with the MPA. Next, the match between the properties of the natural and social systems that are being governed and the current governing system is analyzed and discussed. The final section offers recommendations about opportunities toward better governance.

## 19.2 Governability Assessment Framework and the Case Study

Governability is an analytical concept derived from interactive governance theory, which recognizes that not all environmental or resource systems are governable and what makes them more or less governable depend on several factors, some of which are inherent within the system-to-be-governed (Chuenpagdee and Jentoft 2013). Governance efforts and interventions aiming at improving governability can thus take up various types and forms. Interactive governance is defined by Kooiman et al. as “the whole of interactions taken to solve societal problems and to create societal opportunities; including the formulation and application of principles guiding those interactions and care for institutions that enable and control them" (2005, p. 17). This conceptual framework is holistic and interdisciplinary and focuses on interactions between and within a system to be governed, comprising natural and social systems and a governing system (Kooiman et al. 2005). Interactive governance has been applied to several contexts, including marine conservation (Chuenpagdee 2011), fisheries and aquaculture (Chuenpagdee et al. 2008), and MPAs (Jentoft et al. 2007, 2011, 2012; Chuenpagdee et al. 2013; Voyer et al. 2015).

Interactive governance theory generally argues that the more diverse, complex, and dynamic the system-to-be-governed is, the more difficult it is to govern, unless the governing system is highly capable of the governing tasks (Jentoft and Chuenpagdee 2013). Scale issues, especially in terms of boundary and jurisdictional overlap, also create low governability. Finally, the types and quality of interactions between the governing system and the natural and social systems it tries to govern determine the level of governability. In the context of MPAs, the better the interactions throughout the process of MPA planning and establishment, the more likely that it will be effectively implemented and succeed in achieving its goals.

The MNPCI is a no-take MPA (IUCN IIa), located six nautical miles off the coast of Pontal do Paraná municipality, Paraná State, Southern Brazil, covering an area of 13.5 $km^2$ (Fig. 19.1). The objective of the MNPCI is to protect three uninhabited oceanic islands for their importance as a seabird breeding colony (Martins and Dias 2003; Krul 2004; Carniel and Krul 2010). The MPA also encompasses four sets of artificial reefs, installed in 1997 by a local NGO at an 18-m depth on sandy substrate (Bumbeer et al. 2016). Currently, there is no management plan in place, and Brazilian legislation dictates that one be finished by 2018, which is the 5-year anniversary of its creation.

Using the MNPCI as an illustration, this chapter employs a governability assessment to examine the challenges that MPA implementation may face given the context in which it is inserted. This analysis is based on an evaluation of the aspects of the natural, social, and governing systems associated with the MPA that may enhance or impede its governability. The systems are evaluated according to their diversity, complexity, dynamics, and scale, as well as the governing system's capacity to address the challenges imposed by these features, which determines the overall governability. As suggested by the literature on MPA governability, the issues of institutional mismatches, overlapping boundaries, and the lack of consideration of small-scale fisheries livelihoods and values are emphasized and discussed in terms of how they may contribute to decreasing the governability of the MNPCI.

The analysis was performed through an examination of secondary data related to the Currais Islands and adjacent coastal zones, as well as the fishing communities from Pontal do Paraná municipality and their small-scale fishing activities. The materials examined included published peer-reviewed papers and unpublished documents in both Portuguese and English, such as theses, technical reports, government reports, and digital media. Additionally, field observations and key informant interviews were conducted to validate the information and fill any data gaps (Leis 2016).


**Fig. 19.1** Location of the MNPCI and nearby small-scale fishing communities along the coast of Pontal do Paraná municipality

## 19.3 Assessing the Governability of the MNPCI

### *19.3.1 The Rich and Diverse Natural System*

Brazil is considered a megadiverse country, given that it constitutes one of the world's 16 highest biodiversity areas. Brazilian coasts can be divided into five large ecosystems according to oceanographic conditions – North, Northeast, East, Southeast, and South – each of which has unique factors that determine the types of fishing operations that are possible (Vasconcellos et al. 2011). The Paraná coast extends for about 100 km along the South large ecosystem region and is intersected by two main water bodies, the Guaratuba Bay at the southernmost part and the Estuarine Complex of Paranaguá at the northern part. The MNPCI is located in between these large estuarine systems. The continental shelf of Paraná receives a high supply of sediment and freshwater from rivers and estuaries, as well as seasonal influence of the Brazil-Malvinas confluence, which brings nutrient-rich, cold sub-tropical water and results in high biological productivity (Vasconcellos et al. 2011). The Paraná coastal area encompasses one of the last remnants of Atlantic Forest in the country and is part of a UNESCO World Heritage Site (UNESCO 2017).

The region also comprises a variety of coastal ecosystems such as seagrass meadows, mangroves, sandy beaches, rocky islands, and tidal flats (Lana et al. 2001). The region also boasts a high biodiversity: the Estuarine Complex of

Paranaguá alone is home to 213 species of fish, a higher number than other estuarine systems in Brazil and worldwide (Passos et al. 2012). There are also more than 300 bird species, over half of which are resident (Lana et al. 2001). The estuarine system is also important as a nursery ground for fish species (Barletta et al. 2010), as well as a foraging and resting area for Guiana dolphins (*Sotalia guianensis*) (Santos et al. 2010) and green sea turtles (*Chelonia mydas*) (Guebert-Bartholo et al. 2011; Gama et al. 2016). The region's rocky islands make a particularly rare natural environment in the Paraná continental shelf, where the inner continental shelf is otherwise dominated by sand-muddy sediment (Veiga et al. 2004).

Currais Islands, where the MNPCI has been designated, is an archipelago encompassing three rocky islands, with surrounding depths ranging from 1.5 to 16 m and elevation of up to 10 m above sea level, with an inclination between 45 and 60 degrees (Daros et al. 2012). Currais Islands are known for hosting a diversity of benthic macrofauna (Borzone et al. 1994). There is a total of 176 taxa comprising the phyla Porifera, Cnidaria, Bryozoa, Mollusca, Annelida (class Polychaeta), Arthropoda (class Maxillopoda, order Sessilia), Echinodermata, and Chordata (class Ascidiacea), including 13 classes, 40 orders, and 75 families (Bumbeer et al. 2016). More than 100 algal species have been documented in the Currais Islands (Pellizzari et al. 2014), as well as 20 species of ascidians (Rocha and Faria 2005). It also functions as habitat for 48 reef fish species in 30 families, 11% of which are endemic to the Brazilian coast (Daros et al. 2012).

Further, the area is home to the Atlantic goliath grouper (*Epinephelus itajara*) and the sea star *Coscinasterias tenuispina* (Bumbeer et al. 2016), both of which are critically endangered species (Hackradt et al. 2011; IUCN 2017). The archipelago is important as a breeding ground for the seabirds known as brown booby (*Sula leucogaster*), kelp gull (*Larus dominicanus*), and magnificent frigatebirds (*Fregata magnificens*) throughout the year (Martins and Dias 2003; Krul 2004; Carniel and Krul 2010). These seabird species mainly feed on the discards from small-scale fisheries activity (Carniel and Krul 2012) and are classified as "least concern" in relation to their conservation status (IUCN 2017). The most common cause of seabird mortality in the region is oil contamination, followed by human disturbances, with only 6% related to fishing activities (Pelanda 2007).

### *19.3.2 Small-Scale Fisheries as Key Elements of the Social System*

In Brazil, small-scale fisheries are responsible for about 54% of total marine ladings (Vasconcellos et al. 2011). This figure is much smaller in Southern Brazil, where only 8% of landings come from small-scale fisheries due to a focus on industrial fisheries in the region (Vasconcellos et al. 2011), with Santa Catarina State being the largest producer nationally. Despite this overall regional tendency, Paraná State has only small-scale fleets, and small-scale fishing activities are highly important for the state's communities (Andriguetto-Filho et al. 2006; Caldeira and Pierri 2014).

Small-scale fisheries have taken place in the region for over 100 years and today represent the main source of income for more than 4,500 people directly and 11,000 people indirectly, particularly for family members who rely on fishing for maintaining their livelihoods (Andriguetto-Filho et al. 2006). Other economic activities in coastal Paraná include port development, tourism, and intermittent activity related to the oil industry (Pierri et al. 2006).

The fishing practices and gears used in coastal Paraná, as well as the targeted species, vary between communities according to resource availability (Andriguetto-Filho et al. 2006). Most boats are between 6 and 12 m in length, many of which are canoes with 11–24 HP engines, and can be adapted for either gillnet or bottom trawl fisheries (Andriguetto-Filho et al. 2009; Caldeira and Pierri 2014). Small-scale double-rigged trawling in the region consists of one or two cone-shaped nets that are kept open by otter boards and towed on the bottom by a single motorized canoe (Malheiros 2008). Target species include seabob shrimp (*Xiphopenaeus kroyeri*) and white shrimp (*Litopenaeus schmitti*), which represent the most economically important species (Andriguetto-Filho 2002). These species are caught throughout the year, except during the seasonal closure from March to May (Caldeira and Pierri 2014).

About 60% of Paraná fisheries use gillnets, which employ a high diversity of techniques, including set (*fundeio*) and drift (*caceio*) gillnets that can be positioned either at the bottom or at the surface of the water column, as well as encircling gillnets (*caracol*), in which the gillnets are towed concentrically, and beach seine (Caldeira and Pierri 2014). Net dimensions and mesh size vary according to targeted species, but fish accounts for 26% of total landings (Natividade et al. 2006). The main species targeted by gillnets include flounder (*Paralichthys* spp.) during autumn, mullets (*Mugil liza* and *M. platanus*) and mackerel (*Scomberomorus brasiliensis*) in winter, and croaker (*Micropogonias furnieri*) during spring. From spring to summer, castin leatherjacket (*Oligoplites saliens*), common snook (*Centropomus undecimalis*), and other species of hake (*Cynoscion leiarchus*, *C. microlepidotus*, and *C. acoupa*) constitute the main target species, with one hake species (*Macrodon ancylodon*) targeted throughout the year.

Currais Islands have been recognized for their importance to small-scale fishing livelihoods in the region (Medeiros and Azevedo 2013; Costa and Murata 2015). The area constitutes an important fishing ground in the winter, when small-scale fishers mainly from Pontal do Paraná and Matinhos municipality head to the rocky islands in search for mullet and mackerel (Medeiros and Azevedo 2013).

### *19.3.3 The Governing System Comprising State and Non-state Actors*

Fisheries, along with the environment, are managed in Brazil through a top-down, hierarchical governing system. Fisheries governance faces high institutional instability, with changes in fisheries authorities at the federal level preventing long-term objectives from being achieved (Silva et al. 2013). The Ministry of Fisheries in Brazil was extinct in 2015, passing on the responsibility of fisheries management to the Ministry of Agriculture, Livestock, and Food Supply until recently. Since March 2017, the Ministry of Industry, Foreign Trade, and Services, together with the Ministry of Environment, share authority in fisheries governance and promoting the protection and sustainable use of natural resources. Two agencies under the Ministry of Environment, ICMBio (Chico Mendes Institute for Biodiversity Conservation) and IBAMA (Brazilian Institute for Environment and Renewable Resources), have specific mandates related to environmental conservation. ICMBio deals with federal protected area designation, implementation, management, enforcement, and monitoring and is therefore in charge of the MNPCI. IBAMA is a national-level agency responsible for the management and enforcement of natural resources. At the state level, the environmental police is responsible for enforcement of environmental legislation. Environmental legislation at the state and federal levels has restricted fishing activities through seasonal and area closures, gear and vessel restrictions and licenses, as well as other conservation initiatives such as the installation of artificial reefs by a local nongovernmental organization called Mar Brasil (Brandini 2014).

Governments are not the only actors in the governing system. Fishing communities have their own *colônia*, or fishing guild, which is a formal organization of fishers that started in Brazil in the nineteenth century. The main objective of the *colônia* today is to defend fishers' rights and interests. The *colônia* of Pontal do Paraná municipality is in the Shangri-lá community and was established in 2004, while the State Federation of Fishers is based in Paranaguá and represents all *colônias* of Paraná State (Cattani 2006). Further, in Brazil, the Catholic Church through the "Fisheries Pastoral" and the National Movement of Fishers created in 1989 have a great influence in small-scale fisheries particularly at the local scale (Vasconcellos et al. 2011). The "Movement of Artisanal Fishers of Paraná State" is a fishers' organization connected with the National Movement of Fishers, which was created in response to conflicts with a protected area – Superagüi National Park – which is situated on the Northern Paraná coast. This organization enables small-scale fishers to fight for their rights and for the recognition of their traditional livelihoods, as well as connecting fishers with one another at regional and national scales and with governmental institutions.

### *19.3.4 Protected Areas as Part of the Governing System*

The current model for protected areas in Brazil is applicable to both terrestrial and marine areas and covers a wide range of protection types, as specified by the National System on Protected Areas or *Sistema Nacional de Unidades de Conservação* (SNUC) (Table 19.1). The SNUC provides criteria and regulates the designation, implementation, and management of Brazilian protected areas (MMA 2011). Notably, it includes a relatively new model of protected areas called extractive

**Table 19.1** Brazilian national system on protected area categories and their corresponding IUCN category

| Brazilian protected area system category | | IUCN category |
|---|---|---|
| No-take protected areas | Biological reserve | IA |
| | Ecological station | IA |
| | National/state/municipal park | II |
| | Natural monument | III |
| | Wildlife refuge | III |
| Sustainable use | Natural heritage private reserve | IV |
| | Area of relevant ecological interest | IV |
| | Environmental protection area | V |
| | National forest | VI |
| | Extractive reserve | VI |
| | Fauna reserve | VI |
| | Sustainable development reserve | VI |

reserves, which were established in the 1990s as a result of the rubber tappers' movement for maintaining the forest they relied on for their livelihoods in the Amazon in opposition to the threats posed by cattle raising and agriculture. Another important category is the system of sustainable development reserves which, although not created from a bottom-up movement like the extractive reserves, are an attempt to align conservation with social inclusion objectives (Medeiros 2006). These protected area categories recognize the role of local resource users in protecting biodiversity and enshrine sustainable livelihood as their main goal.

The National Strategic Plan for Protected Areas (PNAP) and its National Commission were created as a response to Brazil's international commitment to comply with CBD targets, as well as the objective of setting principles and guidelines for conservation with a specific focus on effectively implementing the SNUC (MMA 2011). The PNAP states that coastal and marine protected areas should be designated and managed for both biodiversity conservation and fisheries resource recovery (Prates 2007). Its principles and guidelines, recognized by Decree (D5758, 14/04/2006), stress the need to align conservation with socioeconomic development through no-take and sustainable use protected areas. However, the establishment of protected areas in the marine environment has been more recent compared to terrestrial protected areas and has mostly aimed at protecting biodiversity rather than being conceived as a fisheries management strategy (Prates et al. 2007).

According to Prates et al. (2007), 26 federal marine protected areas in Brazil are no-take zones, while 20 are sustainable use protected areas. The latter cover a larger area, representing about 1.6 million ha compared to 1.2 million ha dedicated to no-take zones. That study also indicated that if protected areas established at the state and local level are included, the number of sustainable use protected areas increases to 95, totaling 17.2 million ha (Prates et al. 2007). Today, some sustainable use protected areas have been recognized as successful experiences, such as the Costa dos Corais Environmental Protected Area and the Extractive Reserve of Arraial do Cabo (Prates et al. 2007).

In coastal Paraná, interest in designating protected areas began in the late 1970s and early 1980s, during a time when there was growing worldwide concern over conservation. For instance, the Ilha do Mel Ecological Station and the Guaraqueçaba Environmental Protection Area were implemented during this period, in 1983 and 1985, respectively. There are currently 21 no-take and 18 sustainable use protected areas in the state, including terrestrial and marine reserves, accounting for close to 200,000 and 500,000 ha, respectively. As a result of these management areas, about 80% of coastal Paraná is covered by this spatial management measure (Pierri et al. 2006).

Most protected areas in coastal Paraná do not have a management plan in place. The lack of management plans to guide action and determine how implementation should proceed poses serious problems, especially since the no-take protected areas are sizable. Also, similar to the majority of no-take areas in Brazil that have people living inside them (Diegues 2008), many traditional communities still live in no-take areas in coastal Paraná. Lack of compliance and enforcement is commonplace in this situation due to a shortage of technical and financial resources (Faraco et al. 2016). However, there are some positive examples with "livelihood-sensitive conservation" initiatives in marine extractive reserves, which allow for the sustainable use of resources (Diegues 2008).

## 19.4 The MNPCI and Spatial-Based Management in Coastal Paraná

As with other protected areas in the region (Faraco et al. 2016), the MNPCI boundaries were defined without any input from small-scale fishers living in the area. The federal government initiated the protected area using a top-down process, based solely on scientific evidence of the ecological importance of the islands for seabirds and reef fish species (IUCN 2017). The MPA was designated despite recommendations from ICMBio of the need to understand the context and take into consideration the uses of the area by small-scale fishers to avoid potential conflicts.

Fishing activities in Paraná coast have been spatially restricted by protected areas and fisheries regulations that have been put in place by different levels of government (i.e., federal and state), as well as different types of governing institutions (e.g., fisheries management and environmental management agencies). These regulations are applicable to both small-scale bottom trawl and gillnet fisheries. The existing fishery regulations include access controls (e.g., licenses), gear and spatial restrictions, seasonal closures, restrictions on the size of fish that can be caught, and catch and fishing effort limits.

Spatial restrictions to fisheries in Paraná apply to estuary inlets, coastal areas, and oceanic islands (Fig. 19.2), but aim at specific gears. For instance, gillnets are prohibited in the estuary inlets. Additional restrictions are defined at gradual distances from shore, such as beach seines, which are prohibited at 0.5 nm from shore. At 1 nm from shore, the use of gillnets by motorized boats and otter trawls is

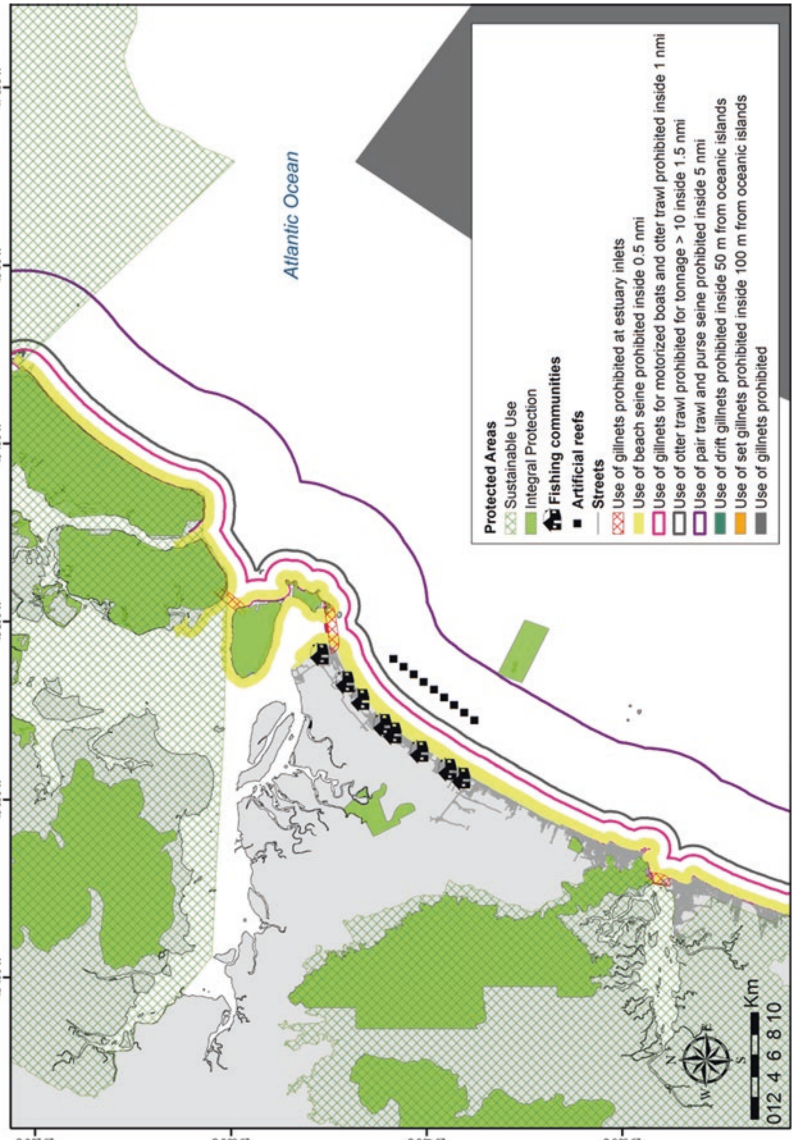



**Fig. 19.2** Protected areas and fishery regulations on coastal Paraná State, Southern Brazil

not allowed, and at 1.5 nm the use of otter trawls larger than ten tonnage is prohibited. Further offshore at 5 nm and around certain oceanic areas, pair trawls and purse seines are banned. Around coastal islands, drift gillnets are not allowed within 50 m, and the use of set gillnets is prohibited within 100 m from the rocky shores. Rocky islands located along the inner continental shelf of Paraná State also have specific spatial restrictions that apply to the surrounding marine area. At an area surrounding Itacolomis, Currais, Galheta, Palmas, and Figueira Islands (see Fig. 19.1), the use of drift gillnets is not allowed within 50 m, and the use of set gillnets is prohibited within 100 m from the rocky shores. This variety of spatial restrictions operating at different government levels adds complexity to the governing system, especially in a context of low enforcement and lack of compliance.

## 19.5 Discussion

Through the analysis of the natural and social systems encompassing coastal Paraná, it was possible to identify characteristics that add complexity and challenges to governance, making the MPA less governable and demanding higher capacity of the governing system in order to achieve sustainable outcomes. Some of these issues emerge from any governing system that lacks structure and capacity but aims to manage a very diverse natural system and complex social system. The fact that many of the protected areas in the region do not have a management plan in place often results in a free access regime (Faraco et al. 2016). Some of the boundaries created by fisheries or environmental management legislation are not respected by local users. Also, because rules operate at different levels, without participation from stakeholders in decision-making, governability challenges are heightened. Some of these challenges are discussed below.

*Lack of Compliance with Rules and Regulations* In a top-down governance mode with many rules and regulations in place overseen by a variety of government levels and institutions, it is difficult for small-scale fishers to comply with restrictions while maintaining their livelihoods. One example is the beach seine fishery, which constitutes a traditional small-scale fishing practice in the region that targets mullets, especially in the winter (Pinheiro et al. 2010). Beach seining is prohibited inside of 0.5 nm from the shore, which is the only place where it can operate. Additionally, although small-scale double-rigged trawling represents the most widespread fishing technique in coastal Paraná in terms of landings (Natividade et al. 2006), fishers are prohibited from fishing within 1 nm from shore, where most of their targeted fishing resource, the seabob shrimp, is concentrated. Despite this prohibition, some fishers do not comply, especially in the winter when, according to small-scale fishers, enforcement is weak due to reduced surveillance. Some fishers make long journeys to the Northern Paraná coast, where catches are presumably higher. This creates a situation that resembles an open access regime (Faraco et al. 2016), in which fisheries resources are not being managed. In turn, this dynamic also reduces fishers' trust in governmental capacity to address fisheries issues.

*Overlapping Boundaries* Small-scale fishers have their own boundaries in the marine space, with different fishing grounds having certain levels of economic importance to different fishing communities. Boundaries between small-scale fishers and industrial fishers also exist, with many reports from fishers describing conflicts when one crosses into the other's fishing territory. This situation is enhanced when there is a perception of unbalanced restrictions between small-scale and large-scale fishing fleets (Martins et al. 2014). Overlapping fishing grounds and shared fish stocks are understood as a problem and a source of conflict between small-scale and large-scale fisheries. Small-scale fishers reported that they have come together to fight against the invasion of their fishing grounds by large-scale fishing fleets from neighboring states (i.e., São Paulo and Santa Catarina), which also operate along the Paraná coast (UNIVALI 2013). Some of the spatial restrictions on the coast are only applicable to large-scale fleets, including industrial trawlers and purse seiners, and have prevented industrial fishers from other states from exploiting the area traditionally used by small-scale fishers from Paraná. According to small-scale fishers, these restrictions have brought benefits in terms of increases in catches, which they attributed to a regulation from 2004 that prohibited purse seines within 5 nm from shore as well as a system of artificial reefs that were installed to exclude trawlers from the area.

According to Haimovici et al. (2006), most of the 60 fish and shellfish species targeted along the Paraná coast are considered overexploited (Corrêa 1987; Natividade et al. 2006). A substantial increase in fishing effort has been reported (Felizola and Pauly 2015), coupled with a decreasing trend in fish stocks for tropical and subtropical coastal areas (Cheung et al. 2010), in addition to a perception of decline in catches which fishers share throughout the region (Faraco et al. 2016). These impacts are mainly caused by industrial fisheries, but also by destructive fishing gears used by some small-scale fishers as well as tourism and spearfishing on Currais Islands (Borzone et al. 1994). With an increasing number of restrictions to small-scale fishing activities, along with a continued decrease in catches, problems associated with overlapping boundaries and competition for resource uses are expected to be more prominent.

*Sense of Resentment* Historically, there is a notion that Paraná has been protected and prevented from development. Pierri (2003) explains that the Paraná coast, which was once part of São Paulo State, has experienced a slower rate of development than in neighboring states. With growing concern about environmental degradation in recent decades, it was possible for nature conservation initiatives to gain space while there was still a lot of relatively untouched ecosystems left to be preserved. A relatively recent influx of a large number of migrants, contrasted with few job opportunities for local people, has resulted in low-income levels and an increase in unplanned settlements (Pierri 2003). Income generation opportunities come either from foreign companies that operate intermittently in the region or from tourism, which only takes place during the austral summer. Thus, many small-scale fishers feel resentment related to their perceived exclusion from one of the few income opportunities in the region, as well as in reaction to what is perceived as overly protective state environmental legislation.

*The MPA as a New Source of Conflicts and Increased Small-Scale Fishers' Vulnerability* Conflicts related to MPA designation are not recent in the Paraná coast (Costa and Murata 2015; Faraco et al. 2016). As a result, small-scale fishers are aware of the potential impacts of the MNPCI. The designation of the MNPCI adds another constraint to fishing which, when combined with pre-existing fishing restrictions, narrows their fishing grounds substantially. Considering that coastal fisheries are usually highly mobile, being able to switch gears and fishing grounds throughout the year to follow available targeted species, such restrictions reduce adaptability and diversification in fishing practices. In the context of overfishing and stock fluctuations (Salas et al. 2011), the dependency on fishing resources is expected to increase the vulnerability of small-scale fishers and negatively impact fishers' livelihoods. The disruption of fishing livelihoods has been identified as one of the main sources of local decline in the number of small-scale fishers and the abandonment of small-scale fishing practices in the region (Pinheiro et al. 2010). Stressors such as pressure from real estate and second home tourism, as well as environmental degradation, have also been acknowledged as larger-scale issues in Brazil (Vasconcellos et al. 2011).

## 19.6 Conclusion

The governability assessment conducted in this chapter reveals that the MNPCI, as a new no-take MPA, contributes to enhancing complexity and adding new issues to a system that is already diverse and socially and legally complex. Specifically, small-scale fishers already face many regulations with which they needed to comply while attempting to continue their fishing activities prior to the establishment of the MPA. These overlapping regulations and restrictions add complexity to the governing system and reduce the governability of the natural and social systems. Rather than improving fisheries sustainability, the MNPCI exacerbates violations of existing regulations in the marine space, leading to its further characterization as a free access regime (Faraco et al. 2016). This impact deepens fishers' lack of trust in conservation efforts. The resentment and distrust of top-down government actions have already reduced compliance with spatial restrictions that were previously in place. This trend is expected to continue as the MNPCI is implemented, with small-scale fishers identifying initial challenges such as poor enforcement and lack of buy-in to the MPA.

This MPA further reduces the area available for fishing activities, which may disrupt fishing livelihoods and cause the decline or abandonment of small-scale fisheries practices. This risk is especially high with MNPCI because Currais Islands constitute an important area to small-scale fishers both socioculturally and economically. Thus, pre-existing conflicts between community user groups could be exacerbated by the recently designated MPA. Areas that are shared for different activities will be decreased, which is expected to result in greater competition for fishing resources.

In the case of the MNPCI, this governability assessment indicates that excluding all resource users from using the area negatively impacts the livelihoods of small-scale fisheries stakeholders. In this case, the benefits for conservation are also doubtful, given the insufficient capacity of the governing system to enforce rules and regulations. In this circumstance, other categories of protected areas (e.g., IUCN's category VI, Brazilian marine extractive reserves) that allow sustainable uses may be more appropriate for fisheries contexts where ongoing resource use is crucial for maintaining livelihoods and making conservation feasible (Prates et al. 2007; Ferse et al. 2010). By excluding local resource users from the area that they have traditionally used, as well as eliminating their income source and livelihoods, the MNPCI is very likely to lead to resource use conflicts. The higher the dependence of the social system on the resource system, the more consideration is required when introducing management tools like MPAs. However, the case of the MNPCI illustrates a failure to consider the socioeconomic context surrounding MPA planning and implementation.

Through the governability assessment framework, this study shows that it is important to acknowledge the socially constructed boundaries considered by small-scale fishers so that they do not undermine conservation efforts. In other words, an MPA can become a "wicked problem" if there is no consideration of the existing context in which it is being designated. Such a situation will directly influence its governing capacity. As highlighted in this study, the spatial boundaries of a no-take MPA have not been effective in prohibiting small-scale fishing activities in coastal Paraná, Brazil. Challenges are posed to the governance of the MPA since imposing a new boundary (i.e., MPA) potentially generates more conflicts among stakeholders. Chief among these conflicts is the undermining of small-scale fishers' livelihood activities, which adds to fishers' sense of resentment and distrust of top-down actions by government and scientists. This study supports the increasing recognition that MPAs are not a "quick fix" tool for conservation and, when used without proper consideration, they can worsen the wicked problem of governance and decrease the overall governability of fisheries systems.

**Acknowledgments** The research was funded by the Canadian Social Sciences and Humanities Research Council (SSHRC)-funded "Too Big To Ignore: Global Partnership for Small-Scale Fisheries Research" Partnership Grant (Grant number 895-2011-1011) and Memorial University of Newfoundland. The authors want to thank Drs. Sérgio Macedo Gomes de Mattos and Evan Edinger for their critical review of the earlier drafts. The authors are also grateful to the small-scale fishers from Pontal do Paraná municipality for sharing their time, knowledge, and experience.

## References

Andriguetto-Filho JM (2002) Sistemas técnicos de pesca no litoral do Paraná: Caracterização e tipificação. In: Raynaut C, Zanoni M, Lana PC, Floriani D, Ferreira ADD, Andriguetto-Filho JM (eds) Desenvolvimento e meio ambiente: Em busca da interdisciplinaridade. Editora UFPR, Curitiba, pp 213–233

Andriguetto-Filho JM, Chaves PTC, Santos C, Liberati SA (2006) Diagnóstico da pesca no litoral do estado do Paraná. In: Isaac V, Martins AS, Haimovici M, Andriguetto-Filho JM (eds) A pesca marinha e estuarina do Brasil no início do século XXI: Recursos, tecnologias, aspectos socioeconômicos e institucionais. Editora Universitária, Belém, pp 117–140

Andriguetto-Filho JM, Krul R, Feitosa S (2009) Analysis of natural and social dynamics of fishery production systems in Paraná, Brazil: implications for management and sustainability. J Appl Icthyol 25:277–286

Barletta M, Jaureguizar AJ, Baigun C, Fontoura NF, Agostinho AA, Almeida-Val VMF, Val AL, Torres RA, Jimenes-Segura LF, Giarrizzo T, Fabré NN, Batista VS, Lasso C, Taphorn DC, Costa MF, Chaves PT, Vieira JP, Corrêa MFM (2010) Fish and aquatic habitat conservation in South America: a continental overview with emphasis on neotropical systems. J Fish Biol 76:2118–2176

Borzone CA, Soares CR, Angulo RJ, Marone E, Camargo R, Prata Junior VP, Klingenfuss MS, Groffl JL, Ferencz F, Krul R, Moraes VS, Scherer Neto P, Lana PC, Maia MFC, Barros Junior FCR, Tavares YAG, Farias JMS, Matarezi J (1994) Proposta para a categoria e o plano de manejo das ilhas oceânicas do litoral do Paraná, Technical report. Universidade Federal do Paraná, Pontal do Paraná, Pontal do Paraná

Brandini F (2014) Marine biodiversity and sustainability of fishing resources in Brazil, a case study of the coast of Paraná state. Reg Environ Chang 14(6):2127–2137

BRASIL. Ministério do Meio Ambiente (2011) SNUC – Sistema Nacional de Unidades de Conservação da Natureza: Lei n° 9.985, de 18 de julho de 2000; Decreto n° 4.340, de 22 de agosto de 2002; Decreto n° 5.746, de 5 de abril de 2006. Plano Estratégico Nacional de Áreas Protegidas: Decreto n° 5.758, de 13 de abril de 2006. MMA, Brasília

Bumbeer J, Cattani AP, Chierigatti NB, Rocha RM (2016) Biodiversity of benthic macroinvertebrates on hard substrates in the Currais Marine Protected Area, in Southern Brazil. Biota Neotropica 16(4):e20160246

Caldeira GA, Pierri N (2014) Economic relations and the co-management of common resources: the case of marine fisheries in Pontal do Paraná, Southern Brazil. Desenvolvimento e Meio Ambiente 32:119–137

Carniel VL, Krul R (2010) Numbers, timing of breeding, and eggs of Kelp Gulls *Larus dominicanus* (Charadriiformes: Laridae) on Currais Islands in southern Brazil. Revista Brasileira de Ornitologia 18(3):146–151

Carniel VL, Krul R (2012) Use of artisanal fishery discards by seabirds on the Paraná coast in Brazil. Mar Ornithol 40:57–62

Cattani AP (2006) Estratégias coletivas adotadas pelos pescadores artesanais paranaenses na defesa de seus interesses, com destaque aos pescadores do município de Pontal do Paraná. (Bachelors thesis). Universidade Federal do Paraná, Pontal do Paraná

CBD (Convention on Biological Diversity) (2010) The strategic plan for biodiversity 2011–2020 and the Aichi biodiversity targets. CBD COP Decision X/2 annex of the conference of the parties. http://www.cbd.int/decisions/cop/?m=cop-10. Accessed 22 May 2017

Charles AT, Wilson L (2009) Human dimensions of marine protected areas. ICES J Mar Sci 66(1):6–15

Cheung WWL, Lam VWY, Sarmiento JL, Kearney K, Watson R, Zeller D, Pauly D (2010) Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Glob Chang Biol 16:24–35

Chuenpagdee R (2011) Interactive governance for marine conservation: an illustration. Bull Mar Sci 87(2):197–211

Chuenpagdee R, Jentoft S (2013) Assessing governability – What's next? In: Bavinck M, Chuenpagdee R, Jentoft S, Kooiman J (eds) Governability of fisheries and aquaculture: theory and applications. Springer, Dordrecht, pp 335–349

Chuenpagdee R, Kooiman J, Pullin R (2008) Assessing governability in capture fisheries, aquaculture and coastal zones. J Transboundary Environ Stud 7(1):14–33

Chuenpagdee R, Pascual-Fernández JJ, Szeliánszky E, Alegret JL, Fraga J, Jentoft S (2013) Marine protected areas: re-thinking their inception. Mar Policy 39:234–240

Corrêa MFM (1987) Ictiofauna da Baía de Paranaguá e Adjacências (Litoral do Estado do Paraná – Brasil): Levantamento e Produtividade (Master's thesis). Universidade Federal do Paraná, Curitiba.
Costa ACG, Murata AT (2015) Conflitos socioambientais na criação de Unidades de Conservação: o caso do Parque Nacional Marinho das Ilhas dos Currais. Revista Hipótese 1(3):48–63
Daros FA, Bueno LS, Vilar CC, Passos AC, Spach HL (2012) Checklist of rocky reef fishes from the Currais Archipelago and Itacolomis Island, Paraná State, Brazil. Checklist 8(3):349–354
Diegues AC (2008) Marine protected areas and artisanal fisheries in Brazil, SAMUDRA Monograph. International Collective in Support of Fishworkers (ICSF), Chennai
Dudley N (ed) (2008) Guidelines for applying protected areas management categories. IUCN, Gland
Faraco LFD, Andriguetto-Filho JM, Daw T, Lana PC, Teixeira CF (2016) Vulnerability among fishers in southern Brazil and its relation to marine protected areas in a scenario of declining fisheries. Desenvolvimento e Meio Ambiente 38:51–76
Felizola KM, Pauly D (2015) Fisheries catch reconstructions for Brazil's mainland and oceanic islands. Fish Centre Res Rep 23:1–56
Ferse SCA, Costa MM, Máñez KS, Adhuri DS, Glaser M (2010) Allies, not aliens: increasing the role of local communities in marine protected area implementation. Environ Conserv 37(1):23–34
Gama LR, Domit C, Broadhurst MK, Fuentes MMPB, Millar RB (2016) Green turtle *Chelonia mydas* foraging ecology at 25°S in the western Atlantic: evidence to support a feeding model driven by intrinsic and extrinsic variability. Mar Ecol Prog Ser 542:209–219
Guebert-Bartholo FM, Barletta M, Costa MF, Monteiro-Filho ELA (2011) Using gut contents to assess foraging patterns of juvenile green turtles *Chelonia mydas* in the Paranaguá Estuary, Brazil. Endanger Species Res 13:131–143
Hackradt CW, Félix-Hackradt FC, García-Charton JA (2011) Influence of habitat structure on fish assemblage of an artificial reef in southern Brazil. Mar Environ Res 72(5):235–447
Haimovici M, Rossi-Wongtschowski CLDB, Cergole MC, Madureira LS, Bernardes RA, Ávila-da-Silva AO (2006) Recursos pesqueiros da região Sudeste-Sul. In: Programa REVIZEE: avaliação do potencial sustentável de recursos vivos da Zona Econômica Exclusiva. Relatório Executivo, Ministério do Meio Ambiente, Brasília, pp 207–242
Halpern BS, Warner RR (2002) Marine reserves have rapid and lasting effects. Ecol Lett 5(3):361–366
Halpern BS, Lester SE, Kellner JB (2009) Spillover from marine reserves and the replenishment of fished stocks. Environ Conserv 36(4):268–276
Jentoft S, Chuenpagdee R (2009) Fisheries and coastal governance as a wicked problem. Mar Policy 33(4):553–560
Jentoft S, Chuenpagdee R (2013) Concerns and problems in fisheries and aquaculture: exploring governability. In: Bavinck M, Chuenpagdee R, Jentoft S, Kooiman J (eds) Governability of fisheries and aquaculture: theory and applications. Springer, Dordrecht, pp 33–44
Jentoft S, van Son T, Bjørkan M (2007) Marine protected areas: a governance system analysis. Hum Ecol 35(5):611–622
Jentoft S, Chuenpagdee R, Pascual-Fernandez JJ (2011) What are MPAs for: on goal formation and displacement. Ocean Coast Manag 54(1):75–83
Jentoft S, Pascual-Fernández JJ, Modino RC, Gonzalez-Ramallal M, Chuenpagdee R (2012) What stakeholders think about marine protected areas: case studies from Spain. Hum Ecol 40:185–197
Kirkman H (2013) Choosing boundaries to marine protected areas and zoning the MPAs for restricted use and management. Ocean Coast Manag 81:38–48
Kooiman J, Bavinck M, Jentoft S, Pullin R (eds) (2005) Fish for life: iteractive governance for fisheries. University of Amsterdam Press, Amsterdam
Krul R (2004) Aves marinhas costeiras do Paraná. In: Branco JO (ed) Aves marinhas e Insulares Brasileiras: bioecologia e conservação. Editora da Univali, Itajaí, pp 37–56

Lana PC, Marone E, Lopes RM, Machado EC (2001) The subtropical estuarine complex of Paranaguá Bay, Brazil. In: Seeliger U, Kjerfve B (eds) Coastal marine ecosystems of Latin America. Springer, Berlin, pp 131–145

Leis MO (2016) Implementation of Marine protected areas as a governability challenge in Southern Brazil. (Master's thesis). Memorial University of Newfoundland, St. John's

Lester SE, Halpern BS, Grorud-Colvert K, Lubchenco J, Ruttenberg BI, Gaines SD, Araimé S, Warner RR (2009) Biological effects within no-take marine reserves: a global synthesis. Mar Ecol Prog Ser 384:33–46

Malheiros HZ (2008) Avaliação da pesca de arrasto do camarão-sete-barbas (Xiphopenaeus kroyeri) em comunidades do entorno do Parque Nacional do Superagui – Paraná (Master's thesis). Centro de Estudos do Mar, Universidade Federal do Paraná, Pontal do Paraná, Paraná

Martins FC, Dias MM (2003) Cuidado parental de *Sula leucogaster* (Boddaert) (Aves, Pelecaniformes, Sulidae) nas Ilhas dos Currais, Paraná, Brasil. Revista Brasileira de Zoologia 20(4):583–589

Martins IM, Medeiros RP, Hanazaki N (2014) From fish to ecosystems: the perceptions of fishermen neighboring a southern Brazilian marine protected area. Ocean Coast Manag 91:50–57

Mascia MB, Claus A (2009) A property rights approach to understanding human displacement from protected areas: the case of Marine protected areas. Conserv Biol 23(1):16–23

Mascia MB, Claus A, Naidoo R (2010) Impacts of marine protected areas on fishing communities. Conserv Biol 24(5):1424–1429

Medeiros R (2006) Evolução das tipologias e categorias de áreas protegidas no Brasil. Ambiente & Sociedade 9(1):41–64

Medeiros RP, Azevedo NT (2013) Nota técnica preliminar: impacto da criação do Parque Nacional de Currais à pesca artesanal do litoral do Estado do Paraná, Technical report. Universidade Federal do Paraná, Pontal do Paraná, Pontal do Paraná

Natividade CD, Pereira MJCF, Andriguetto-Filho JM (2006) Small-scale fishing landings on the coast of the state of Paraná, Brazil, from 1975 to 2000, with emphasis on shrimp data. J Coast Res 39(3):1273–1276

Passos AC, Contente RF, Vilar CC, Daros FA, Spach HL, Abilhôa V, Fávaro LF (2012) Fishes of Paranaguá estuarine complex, southwest Atlantic. Biota Neotropica 12(3). http://www.biota-neotropica.org.br/v12n3/en/abstract?inventory+bn01312032012

Pauly D, Christensen V, Dalsgaard J, Froese R, Torres F Jr (1998) Fishing down marine food webs. Science 279(5352):860–863

Pauly D, Christensen V, Guénette S, Pitcher TJ, Sumaila UR, Walters CJ, Watson R, Zeller D (2002) Towards sustainability in world fisheries. Nature 418:689–695

Pauly D, Watson R, Alder J (2005) Global trends in world fisheries: impacts on marine ecosystems and food security. Philos Trans R Soc B 360(1453):5–12

Pelanda AA (2007) Impactos humanos sobre aves associadas a ecossistemas marinhos na costa paranaense. (Bachelors thesis). Universidade Federal do Paraná, Pontal do Paraná.

Pellizzari F, Bernardi J, Silva EM, Silva MC, Yokoya NS (2014) Benthic marine algae from the insular areas of Paraná, Brazil: new database to support the conservation of marine ecosystems. Biota Neotropica 14(2):e20130011

Pierri N (2003) O litoral do Paraná: Entre a riqueza natural e a pobreza social. Desenvolvimento e Meio Ambiente 8:25–41

Pierri N, Angulo RJ, Souza MC, Kim MK (2006) A ocupação e o uso do solo no litoral paranaense: Condicionantes, conflitos e tendências. Desenvolvimento e Meio Ambiente 13:137–167

Pinheiro L, Lana PC, Andriguetto-Filho JM, Hanazaki N (2010) Pesca de pequena-escala e a gestão patrimonial: O caso da pesca da tainha no litoral paranaense. Desenvolvimento e Meio Ambiente 21:143–155

Pomeroy RS, Watson LM, Parks JE, Cid GA (2005) How is your MPA doing? A methodology for evaluating the management effectiveness of marine protected areas. Ocean Coast Manag 48(7–8):485–502

Prates APL (2007) O Plano Nacional de Áreas Protegidas: O contexto das áreas costeiras e marinhas. In: Prates AP, Blanc D (eds) Áreas aquáticas protegidas como instrumento de gestão pesqueira, Série Áreas Protegidas do Brasil 4. MMA/SBF, Brasília, pp 19–25

Prates APL, Cordeiro AZ, Ferreira BP, Maida M (2007) Unidades de conservação costeiras e marinhas de uso sustentável como instrumento para a gestão pesqueira. In: Prates AP, Blanc D (eds) *Áreas aquáticas protegidas como instrumento de gestão pesqueira*, Série Áreas Protegidas do Brasil 4. MMA/SBF, Brasília, pp 27–39

Rice J, Moksness E, Attwood C, Brown SK, Dahle G, Gjerde KM, Grefsrud ES, Kenchington R, Kleiven AR, McConney P (2012) The role of MPAs in reconciling fisheries management with conservation of biological diversity. Ocean Coast Manag 69:217–230

Rocha RM, Faria SB (2005) Ascidians at Currais Islands, Paraná, Brazil: taxonomy and distribution. Biota Neotropica 5(2):1–20

Salas S, Chuenpagdee R, Charles A, Seijo JC (2011) Coastal fisheries of Latin America and the Caribbean region: issues and trends. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and Aquaculture Technical Paper 544. FAO, Rome, pp 1–12

Santos MCO, Oshima JEF, Pacífico ES, Silva E (2010) Guiana dolphins, *Sotalia guianensis* (Cetacea: Delphinidae), in the Paranaguá estuarine complex: insights on the use of area based on the photo-identification technique. Zoologia 27(3):324–330

Silva CNS, Broadhurst MK, Medeiros RP, Dias JH (2013) Resolving environmental issues in the southern Brazilian artisanal penaeid-trawl fishery through adaptive co-management. Mar Policy 42:133–141

Stortini CH, Shackell NL, O'Dor RK (2015) A decision-support tool to facilitate discussion of no-take boundaries for marine protected areas during stakeholder consultation processes. J Nat Conserv 23:45–52

The IUCN Red List of Threatened Species Version 2017.1 (2017) www.iucnredlist.org. Accessed 22 May 2017

UNESCO World Heritage List. Atlantic Forest South-East Reserves (2017) http://whc.unesco.org/en/list/893/. Accessed 22 May 2017

UNIVALI/CTTMar (2013) Boletim estatístico da pesca industrial de Santa Catarina – Ano 2012. 13(1), Itajaí: Universidade do Vale do Itajaí, Centro de Ciências Tecnológicas e do Mar

Vasconcellos M, Diegues AC, Kalikoski DC (2011) Coastal fisheries of Brazil. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and Aquaculture Technical Paper 544. FAO, Rome, pp 1–12

Veiga FA, Angulo RJ, Marone E, Brandini FP (2004) Características sedimentológicas da plataforma continental interna rasa na porção central do litoral paranaense. Boletim Paranaense de Geociências 55:67–75

Voyer M, Gollan N, Barclay K, Gladstone W (2015) 'It's part of me'; understanding the values, images and principles of coastal users and their influence on the social acceptability of MPAs. Mar Policy 52:93–102

Worm B, Barbier EB, Beaumont N, Duffy JE, Folke C, Halpern BS, Jackson JBC (2006) Impacts of biodiversity loss on ocean ecosystem services. Science 314(5800):787–790

**Mirella de Oliveira Leis** is a Research Fellow with Too Big To Ignore Global Partnership for Small-Scale Fisheries Research, based at Memorial University, St. John's, Newfoundland, Canada. Ms. Leis holds a BSc degree in Oceanography from the Federal University of Paraná in Brazil (2008–2012) and an MSc degree in Geography from Memorial University, Canada (2013–2016). She has been awarded the distinction of Fellow of the School of Graduate Studies as a recognition of outstanding achievement in a graduate program in 2016. Her research focuses on small-scale fisheries, marine conservation, and marine protected area governance.

**Ratana Chuenpagdee** is a Professor at the Department of Geography, Memorial University of Newfoundland, St. John's, Canada. She held the position of Canada Research Chair in Natural Resource Sustainability and Community Development at Memorial University from 2006 to 2016. Her research emphasizes interdisciplinary approaches to coastal, fisheries, and ocean governance, focusing particularly on small-scale fisheries, marine protected areas, community-based management, and food security. She has worked in several countries including Cambodia, Malawi, Mexico, Spain, Thailand, and Canada. Dr. Chuenpagdee is a Director of the Too Big To Ignore (TBTI) Global Partnership for Small-Scale Fisheries Research and co-edited the book *Interactive Governance for Small-Scale Fisheries: Global Reflections* (2015), with Professor Svein Jentoft.

**Rodrigo Pereira Medeiros** is an Adjunct Professor in the Center for Marine Studies (CEM) at the Federal University of Parana in the municipality of Pontal do Paraná, State of Paraná, Brazil. His research interests include participatory monitoring, small-scale fisheries, socioeconomics, and ecosystem approaches to fisheries and marine protected area management in Southern Brazil.

# Chapter 20
# Supporting Enhancement of Stewardship in Small-Scale Fisheries: Perceptions of Governance Among Caribbean Coral Reef Fishers

**Rachel A. Turner, David A. Gill, Clare Fitzsimmons, Johanna Forster, Robin Mahon, Angelie Peterson, and Selina Stead**

**Abstract** Small-scale fishing livelihoods dependent on Caribbean coral reefs face an uncertain future with global climate change and mounting anthropogenic pressures threatening ecosystem integrity and resilience. In the context of future threats to coral reefs, improved governance is critical to enhance the efficacy of coral reef management. Recent research places increasing emphasis on identifying gover-

R. A. Turner (✉)
Environment and Sustainability Institute, University of Exeter, Cornwall, UK

Centre for Resource Management and Environmental Studies (CERMES),
University of the West Indies, Cave Hill Campus, Barbados
e-mail: r.turner@exeter.ac.uk

D. A. Gill
National Socio-Environmental Synthesis Center, University of Maryland,
Annapolis, MD, USA

Moore Center for Science/Conservation International, Arlington, VA, USA

Department of Environmental Science and Policy, George Mason University,
VA, USA

Centre for Resource Management and Environmental Studies (CERMES),
University of the West Indies, Cave Hill Campus, Wanstead, Barbados

C. Fitzsimmons · S. Stead
School of Marine Science and Technology, Newcastle University, Newcastle upon Tyne, UK

J. Forster
Tyndall Centre for Climate Change Research, School of Environmental Sciences,
University of East Anglia, Norwich, UK

School of Marine Science and Technology, Newcastle University, Newcastle upon Tyne, UK

R. Mahon · A. Peterson
Centre for Resource Management and Environmental Studies (CERMES),
University of the West Indies, Cave Hill Campus, Barbados



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_20

nance arrangements that enable participation and engagement, with the improved 'social fit' of institutions expected to engender stewardship among fishers. However, few studies have examined the perspectives of resource users in relation to a wide range of articulated principles for good governance processes. This study contributes to an improved understanding of how fisher perceptions relate to diverse governance arrangements in the Wider Caribbean Region. We quantify perceptions among 498 reef-dependent fishers in relation to principles of 'good governance' in 12 communities across four Caribbean countries: Barbados, Belize, Honduras, and St. Kitts and Nevis. We describe perceptions relating to two underlying governance themes – institutional acceptance (reflecting principles of legitimacy, transparency, fairness, and connectivity) and engagement in reef governance (reflecting principles of accountability and inclusiveness). In addition, we identify socio-demographic factors associated with each set of perceptions and explore the implications for future governance of small-scale Caribbean reef fisheries. The findings suggest that an understanding of heterogeneous perceptions within small-scale fisheries can inform more targeted interventions to improve the fit of governance arrangements for different groups. Governance may be more effective if perceptions are used to identify areas in which to pursue greater engagement of resource users in stewardship.

**Keywords** Stewardship · Governance · Institutional acceptance · Engagement · Coral reef fisheries

## 20.1 Introduction

Fisheries in the Caribbean are predominantly small-scale, with artisanal fishing fleets accounting for an estimated 87% of fishing effort (Dunn et al. 2010; Fanning et al. 2013) and almost 80% of fish landed in the region (Pauly and Zeller 2015). This small-scale fishing activity is essential for employment and food security in Caribbean communities. The support of these fisheries is one of many important ecosystem services that coral reefs provide to coastal communities in the Wider Caribbean. In the Atlantic region, including the Caribbean, an estimated 43 million people live within 30 km of a reef (Burke et al. 2011). However, fishing livelihoods dependent on Caribbean coral reefs face an uncertain future with global climate change and mounting anthropogenic pressures threatening ecosystem integrity and resilience (Mora 2008; Stallings 2009; Eakin et al. 2010; Jackson et al. 2014). In the context of future threats to coral reefs, improved governance is critical to enhance the efficacy of coral reef management (Mumby and Steneck 2008; Heileman 2011; Mahon et al. 2014).

Governance can be defined as the structures and processes that determine how decisions are made, power is exercised, and responsibilities are allocated (Graham et al. 2003). Effective systems are frequently associated with the improved stewardship of ecosystems (Österblom and Folke 2013), but measuring their efficacy and quality is challenging. A range of principles of 'good' governance, such as legitimacy, transparency, and accountability (see Table 20.3), have been articulated (Kooiman et al. 2005; Lockwood 2010). These principles are expected to improve the quality of decision-making processes and interactions among the multiple actors involved but have mainly been described at the organizational scale (Ostrom 1990; Kooiman et al. 2005; Biermann 2007; Lockwood 2010). Few studies address issues of governance quality at the scale of individual resource users. Yet, in light of trends towards increasing participation and more collaborative governance of fisheries (Folke et al. 2005; Armitage et al. 2007; McConney and Baldeo 2007), it is important to understand the perceptions and experiences of fishers themselves with respect to governance. Here we focus on measuring these perceptions and exploring how governance improvements can be targeted to reflect differences within small-scale fisheries.

Theory suggests that resource management is most likely to be successful when resource users support governance arrangements and perceive themselves to be adequately engaged (Jentoft et al. 1998; Mascia 2003; Pomeroy et al. 2006; Pollnac et al. 2010). Therefore, governance arrangements that enable engagement and garner institutional acceptance are expected to confer support for management and engender stewardship among fishers and other resource users. Stewardship is defined here as 'the responsible use (including conservation) of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species, as well as of private needs, and accepts significant answerability to society' (Worrell and Appleby 2000). Stewardship is expected to be enhanced by the improved 'social fit' of governance arrangements, which is ultimately thought to lead to greater success in achieving governance objectives. Social fit refers to the extent to which institutions in place match the expectations and behaviour of those governed (DeCaro and Stokes 2013).

Information on fishers' perceptions can inform an understanding of social fit and acceptance of institutions among resource users. Perceptions of governance and management arrangements can directly influence fishers' decision-making and resource use behaviour (Gelcich et al. 2008, 2005; McClanahan et al. 2005b; Warner and Pomeroy 2012). Several studies of individual governance principles, such as inclusiveness and legitimacy, have found that positive perceptions were associated with greater support for management (Pita et al. 2010; Hoelting et al. 2013; Velez et al. 2014). Perceptions also have potential implications for the willingness of actors to engage in decision-making and the extent of voluntary compliance with regulations (Nielsen and Mathiesen 2003; Mora 2009). The latter is particularly important in the Caribbean context, where geographically dispersed and poorly documented fishing fleets are difficult to monitor and enforce with the limited resources of governments (Salas et al. 2007).

Fishers' views are often explored in contrast to those of other resource user groups or stakeholders (Jones 2008; Mangi and Austen 2008; McClanahan et al. 2009, 2005a). However, even within a narrow geographical setting, fishers may be very disparate and heterogeneous. Multiple studies in a diversity of contexts have identified differing views, perceptions, priorities, and behaviours among fishers. For example, socio-economic differences in variables such as education, wealth, occupational diversity, household size, age, and social group have been found to influence livelihood choices (Slater et al. 2013), perceptions of environmental threats (Korda et al. 2008), views on management options (McClanahan et al. 2012), and decisions about resource use (Daw et al. 2012). Fishers employing different gear types or fishing practices may have different social networks and environmental knowledge (Crona and Bodin 2006), express different perceptions of management measures and likely responses to change (Cinner et al. 2011; Barley Kincaid et al. 2014), and may be differentially impacted by conservation measures (Gurney et al. 2015). Variable perceptions of resource availability or environmental change can also influence fishers' decision-making and behaviour (Teh et al. 2011).

To date, there has been little empirical exploration of what drives heterogeneity in fishers' perceptions of governance. In this study of Caribbean coral reef governance, we describe perceptions among coral reef-dependent fishers in relation to principles of 'good governance' in 12 communities across 4 Caribbean countries and explore the factors characterizing differences in these perceptions. This study contributes to an improved understanding of how fishers' perceptions relate to diverse governance arrangements in the Wider Caribbean Region. Understanding how perceptions differ across multiple contexts can help develop appropriate and targeted interventions for improvements to fisheries governance and identify areas in which to pursue greater engagement of resource users in marine stewardship.

## 20.2 Methodological Approach

### *20.2.1 Study Sites*

Four countries – Barbados, St. Kitts and Nevis, Belize, and Honduras – were selected to represent diverse social and economic conditions, marine resource dependency, and natural resource governance arrangements across the Wider Caribbean region. Estimated annual fisheries production for the study countries in 2013 was 2997 t (Barbados), 31,002 t (St Kitts and Nevis), 155,682 t (Belize), and 46,122 t (Honduras) (FAO 2014). Three study sites were chosen per country for research at the community level. The selection of these sites aimed to capture the differences in reef resource use; given that reef use in one site was predominantly based in reef fisheries, one was dominated by reef-related tourism, and one was characterized by high dependence on both activities (Fig. 20.1). Fishing activities within the small-scale fisheries sector of the Caribbean are diverse, comprising multiple vessel and gear types and differing levels of commercialization and subsistence, which influence dependence on fishing (Fig. 20.2). A brief overview of the characteristics of this sector in each study country is outlined in the following sections.

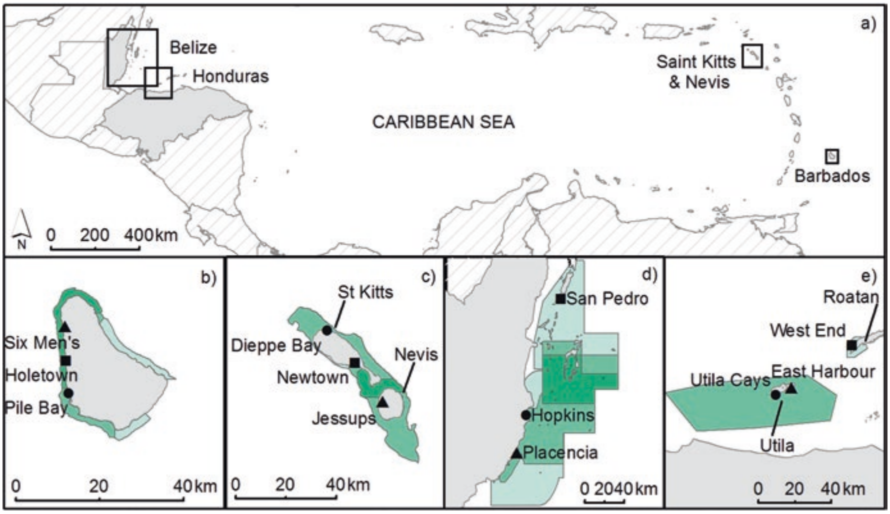



**Fig. 20.1** Locations of surveyed (**a**) countries and (**b**–**e**) communities within Barbados, St. Kitts and Nevis, Belize, and Honduras, respectively. Symbols represent reef use characteristics: ○ predominantly fishing, Δ mixed fishing and tourism, and □ predominantly tourism. Shading represents community use areas; depth of shading indicates number of study communities using area

**Fig. 20.2** Photographs illustrating the diversity of fishers and gears used at the study sites. Top row (L–R): trap fishers in Dieppe Bay and St. Kitts and Nevis; crab fisher with gear in Hopkins, Belize; and trolling and handline fisher departing from shore in East Harbour, Honduras. Bottom row (L–R): recreational and subsistence shore fishers targeting small demersal reef fish at the entrance to a lagoon in East Harbour, Honduras; spear fisher targeting demersal reef fish near Holetown, Barbados; and sports fisher returning with line fishing catch in West End, Honduras

### *20.2.2 Barbados*

The fishing industry of Barbados employs approximately 6000 individuals and directly contributes $14.6 million USD (<1% of GDP) annually to the national economy (Fisheries Division 2004), based on 2002 values. The relative contribution of the reef fishery to this total remains largely unknown but is presumed to be small, given the focus on offshore pelagic fishing in the national fishery. Vessel landings in the reef fishery are typically significantly smaller than those of the offshore pelagic fishery, and many reef fish landings remain unrecorded. Of the 1062 fishing vessels registered in 2010 in the country, 55% were open canopy vessels propelled by oars or outboard engines and were used primarily in the reef and nearshore fisheries (Research and Planning Unit 2012). Traps, nets, spears, and lines are used to target reef-associated species. The sheltered west and south coasts, where these species are primarily caught, are likely to be overfished (McConney and Mahon 1998; Fisheries Division 2004; Vallès and Oxenford 2012). The island's fisheries are open access and considered by many to be an employment safety net (McConney et al. 2003). Targeted species include reef-related fish and, to a much lesser extent, lobster (*Panulirus argus*), octopus (e.g. *Octopus vulgaris*), white sea urchin (*Tripneustes ventricosus*), and conch *(Strombus gigas)*.

### *20.2.3 St. Kitts and Nevis*

The St. Kitts and Nevis fishing industry is primarily artisanal (CRFM 2012), with the majority of fishers targeting multiple species and operating from small, open canopy pirogues with outboard engines. The largest fisheries in St. Kitts and Nevis are the shallow reef and deep-slope fisheries, accounting for over 75% of registered fishers, 80% of vessels, and 41% of estimated landings (FAO 2006). Multiple species are harvested opportunistically using fish traps, handlines, nets, and spear guns, with parrotfish (Scaridae) being the most common finfish family taken in the spear fishery (CRFM 2010). The coastal pelagic fishery involves only a small portion of the fishing fleet but includes targeting of demersal reef fish species. Conch (*Strombus gigas*) is the major fishery export of the country, followed by lobster (mainly *Panulirus argus*); both are exported to neighbouring islands. Recent catch rate declines indicate that some reef fisheries could be overexploited (Agostini et al. 2010).

### *20.2.4 Belize*

Belize's fishing industry is important for both local consumption and exports, the latter of which contributes an estimated 75% of all fish sales (Cooper et al. 2009). Reef-related fisheries have been valued at $13–$14 million USD, and marine products, such as lobster and conch, are one of the top-valued exports in the country (Cooper et al. 2009). In 2011, there were 2582 registered fishers and 752 licenced fishing boats (CRFM 2012). The industry is primarily made up of small-scale artisanal fishers who fish inside the shallow protected waters of the barrier reef and the atolls. Fishing generally takes place from fibreglass skiffs, sailing dories, or motorized dories 3.5 to 9 m in length. Fishers target a range of species according to seasonality and the geographical composition of stocks. A wide range of gears are used, including gill nets, beach seine, cast nets, hook and line, rod and reel, lobster, and fish traps.

### *20.2.5 Bay Islands, Honduras*

Many Bay Island communities depend heavily on reef resources for their livelihoods (Box and Canty 2010), with fishers on average earning higher income than those in rural mainland Honduran communities (Box 2011). Almost all of the vessels used in reef-associated fisheries are dories, which are narrow ‘canoe-like’ vessels with inboard diesel engines. Yellowtail snapper (*Ocyurus chrysurus*), along with other shallow demersal reef species caught in the fishery, account for 48% of landings (Box 2011). Grouper (e.g. *Epinephelus guttatus*), barracuda (*Sphyraena barracuda*), spiny lobster (*Panulirus argus*), and conch (*Strombus gigas*) are also commercially important species (Berthou et al. 2000). Most artisanal fishers practise line fishing, and although this is one of the least destructive fishing gears, many inshore stocks have declined (Gobert et al. 2005; Harborne et al. 2001). Molluscs and shellfish are also considered to be fully exploited in nearshore areas (Harborne et al. 2001). Though the majority of fishers at the three study sites are considered artisanal (Chollett et al. 2014), Bay Island fishers play an important role in the industrial fishery, in which shallow reef and deep water snapper and grouper are the primary marine finfish species (Turriago 2011).

## 20.3 Governance Arrangements

As one of the most geopolitically diverse regions in the world, the Wider Caribbean is home to a multiplicity of marine resource governance arrangements (McConney et al. 2007; Fanning et al. 2009). In the island nations of Barbados and St. Kitts and Nevis, national government departments are predominantly responsible for coral reef and fisheries management, with local communities consulted on particular issues. In contrast, the western Caribbean nations of Belize and Honduras have a wider diversity of actors engaged in reef management, including many non-governmental organizations (NGOs) and resource user groups, which are comparatively more organized than in the island nations studied (Table 20.1).

**Table 20.1** Characteristics of coral reef governance arrangements in study countries

| Country | Location | Geography | Main state actors in coral reef governance | Civil society involvement in coral reef governance |
|---|---|---|---|---|
| Barbados | Eastern Caribbean | Island | National government | Few local level groups or resource user organizations |
| St Kitts and Nevis | Eastern Caribbean | Two-island federation | National government and island-level administration | Few local level groups or resource user organizations |
| Belize | Western Caribbean | Continental | National government, town and village councils | Strong involvement of NGOs and resource user organizations (e.g. cooperatives, tour guide associations) |
| Honduras | Western Caribbean | Continental | National and municipal government, town and village councils | Strong involvement of NGOs and some resource user organizations |

## 20.4 Data Collection

### *20.4.1 Fisher Characteristics*

Semi-structured interviews were undertaken in 12 communities between February 2011 and August 2012 to characterize small-scale fishers and elicit their perceptions of governance. Fishers were targeted primarily through snowball sampling (Bunce et al. 2000). Through an initial scoping exercise, community members were asked for names of active reef fishers (individuals engaged in fishing within the last 12 months) that used local landing sites or adjacent fishing grounds and in what type of fishing they engaged. A list of names was compiled until no new names were encountered. The list of fishers was categorized by gear type, and we then attempted to administer interviews to over 50% of the fishers in each group. A total of 498 fishers were interviewed across the 12 communities. These interviews formed part of a larger study that also included a randomly sampled household survey and also targeted tourism-related reef resource users.

We examined 18 characteristics of fishers, their households, and fishing practices that we identified from previous literature as potential influences on fishers' perceptions of management and governance (Table 20.2). Fishers were asked a series of questions related to their fishing practices and dependence on fishing as a source of household income. Four variables were included related to the demographics of each fisher and their household. In addition, we asked four questions about fishers' perceptions of the health of the coral reef and its associated fishery resources and two questions about aspects of reef management.

**Table 20.2** Data collected on fisher characteristics through semi-structured interviews with reef-related fishers ($n$ = 498) in 12 study communities

| Covariate | Description | Data type |
|---|---|---|
| *Demographics* | | |
| Age | Age of respondent | Interval (years) |
| Education | Level of education | Categorical (primary, secondary, higher/professional) |
| Household size | Size of respondent's household, including dependents | Interval (number of people) |
| Wealth | Measured using a material style of life (MSL) index [a] | Continuous (range − 6.5–1.7) |
| *Dependency and fishing practices* | | |
| Fishing experience | Number of years reef-related fishing experience | Interval (years) |
| Commercial | Whether whole/part of catch is sold, or none is sold | Categorical (commercial/recreational) |
| Gear type | Use of scuba or freediving, handline, pots, seine, spear, or trolling [b] | Binary (yes/no for each gear type) |
| Boat ownership | Fisher's role as boat owner, crew member, or fishing from shore | Categorical (vessel owner/crew member/shore fisher) |
| Fishing importance | Perceived importance of fisheries to household income | Categorical (primary/secondary/lower importance) |
| Occupations | Number of different occupations respondent was engaged in to derive income or food, including fishing | Interval (number of occupations) |
| Reef use | Involvement in reef-related fishing and tourism activities | Binary (fishing and tourism/fishing only) |
| Tradition | Whether tradition was a motivating factor for engagement in fishing | Binary (yes/no) |
| *Concern about environment* | | |
| Decline in coral reef | Perceived decline in coral reef health over the past 10 years | Binary (yes/no) |
| Decline in reef fish | Perceived decline in reef fish resources over the past 10 years | Binary (yes/no) |
| Current reef health | Perception of current state of reef health | Categorical (healthy/neutral/unhealthy) |
| Current reef fish health | Perception of current state of reef fish resources | Categorical (many/neutral/few) |
| *Management* | | |
| Awareness of rules | Aware of rules relating to use of local reefs | Binary (yes/no) |
| Participation in reef group | Involvement in reef user group | Binary (yes/no) |

[a]The MSL index was derived from principal component analysis of 14 household assets and attributes following (Cinner et al. 2009)

[b]Trolling refers to fishing with a line towed behind a moving vessel where the line remains close to the surface and targets epipelagic reef-associated species

**Table 20.3** Governance principles and performance outcomes measured, based on Lockwood (2010), and interview questions relating to each governance principle

| Governance principle | Performance outcome measured | Interview question |
|---|---|---|
| Legitimacy | Governors act with integrity and commitment | Do you think the people that look after coral reefs in this area do a good job? |
| Transparency | The reasoning behind decisions is evident | When they make decisions, is information provided to you and the rest of the community? |
| Accountability | The governing body is answerable to its constituency | Are there ways you can challenge the rules made about reefs? |
| Inclusiveness | All stakeholders have appropriate opportunities to participate in the governing body's processes and actions | Do you have an opportunity to participate in decisions made about reefs? |
| Fairness | Decisions are made consistently and without bias | When people enforce the rules, is everybody treated fairly? |
| Connectivity | The governing body is effectively connected with governing bodies operating at the same governance level | Do different groups that have an interest in coral reefs work well together? |
| Resilience | The governing body has procedures to identify, assess, and manage risk | Do the people in charge of reefs have plans in place to respond to emergencies or future changes? |

Source: Turner et al. (2014)

### *20.4.2 Perceptions of Governance*

Initial questions established respondents' perceptions of who was responsible for coral reef governance in their community; these were followed by a series of questions reflecting established principles of good governance for natural resources (Table 20.3). Specifically, respondents' perceptions were measured using seven questions characterizing local coral reef governance corresponding to legitimacy, transparency, accountability, inclusiveness, fairness, connectivity, and resilience (Lockwood 2010). Binary responses were recorded and explanatory comments noted. Of the 498 fishers interviewed, 402 responded to questions about perceptions of governance and were included in the analysis.

## 20.5 Data Analysis

Following the analysis of a broader household data set comprising both community members and resource users (Turner et al. 2014), multiple correspondence analysis (MCA) was used to model a multivariate data set of categorical variables to reveal underlying patterns in responses among fishers. Missing values were imputed using an iterative algorithm (Josse et al. 2012). MCA identifies dimensions of variation in the data comprising subsets of variables that are correlated with one another but relatively independent of other variables. These dimensions can be interpreted as representing underlying factors that lead to patterns in responses, thus reducing complex sets of variables to fewer composite indicators. Each dimension identified was interpreted and labelled. Quantitative composite scores were calculated for each fisher on each dimension. Statistical analyses were undertaken in R using the FactoMineR and missMDA packages (Husson et al. 2007; Lê et al. 2008; Maechler et al. 2013; R Core Team 2013).

Two underlying themes were identified and interpreted from the MCA analysis: institutional acceptance and engagement. To explore the basis of differences in perceptions, fishers were classified into four similar groups based on their scores on the two governance themes. Higher scores on each dimension were interpreted as indicating more positive perceptions. The four groups captured (1) positive perceptions on both themes, (2) positive perceptions of institutional acceptance and negative perceptions of engagement, (3) negative perceptions of institutional acceptance and positive perceptions of engagement, and (4) negative perceptions of both themes. The attributes of fishers associated with different perceptions were assessed by comparing fisher characteristics (Table 20.2) among the four groups.

## 20.6 Results

### *20.6.1 Fisher Characteristics*

Fishers interviewed were on average 43 (SD = 13.84) years of age and had 25 (SD = 15.4) years fishing experience. They employed a variety of gear types. Line fishing, which requires low capital investment, was the most commonly used fishing method across all study sites, with a total of 80% of fishers using this fishing method. Fishers in St. Kitts and Nevis were most diverse in their choices of fishing gears. Differences in fishing gear used among countries were related to factors such as the availability of high-value commercial species (e.g. lobster and conch diving in St. Kitts and Nevis), and, in the case of the Bay Islands, management regulations prohibiting the use of some fishing methods. A description of the characteristics of fishers included in the analysis is provided for context on the sample (Table 20.4).

## 20.7 Perceptions of Governance

Perceptions of governance varied among fishers. Overall, 52–66% of fishers agreed with the individual statements relating to good governance principles (Table 20.5). The lowest overall agreement was for the statement relating to fairness and the highest for the statement relating to resilience.

**Table 20.4** Characteristics of fishers included in analysis ($n = 402$) among the four study countries

| Fisher characteristics | Country | | | |
|---|---|---|---|---|
| | Barbados | Belize | Honduras | St. Kitts and Nevis |
| *Demographics* | | | | |
| Number of fishers interviewed | 38 | 158 | 101 | 105 |
| Age (years; mean, SD) | 49.4 (14.4) | 38.7 (12.8) | 46.9 (14.7) | 42.3 (12.4) |
| Education (1 = primary, 2 = secondary, 3 = higher/professional; mean score, SD) | 2.0 (0.7) | 1.9 (0.7) | 1.7 (0.8) | 2.0 (0.6) |
| Household size (number of people; mean, SD) | 3.5 (2.0) | 3.8 (3.8) | 3.8 (2.1) | 3.2 (2.3) |
| MSL (higher scores reflect greater household assets; mean, SD) | 0.3 (0.6) | 0.1 (1.6) | −0.5 (1.6) | 0.3 (0.5) |
| *Fishing practices/dependence* | | | | |
| Fishing experience (years; mean, SD) | 25.7 (14.7) | 24.2 (14.5) | 27.3 (17.7) | 23.3 (14.6) |
| Fishing frequency (trips per week; mean, SD) | 2.5 (1.5) | 1.6 (1.5) | 2.1 (1.7) | 3.0 (1.6) |
| Commercial fishers (%) | 55 | 41 | 67 | 73 |
| Seine fishers (%) | 5 | 6 | 4 | 15 |
| Handline fishers (%) | 37 | 93 | 89 | 66 |
| Pot fishers (%) | 37 | 8 | 4 | 31 |
| Grain/spear fishers (%) | 11 | 53 | 12 | 26 |
| Scuba fishers (%) | 5 | 0 | 4 | 29 |
| Trolling fishers (%) | 3 | 16 | 14 | 5 |
| Boat owner (%) | 55 | 43 | 68 | 32 |
| Crew member (%) | 41 | 43 | 28 | 51 |
| Shore fisher (%) | 5 | 14 | 4 | 18 |
| Fishing importance (1 = primary 2 = secondary, 3 = lower; mean score, SD) | 1.4 (0.6) | 1.9 (0.8) | 1.6 (0.6) | 1.6 (1.0) |
| Occupations per fisher (mean, SD) | 2.1 (1.2) | 2.3 (1.0) | 2.1 (1.0) | 2.0 (1.0) |
| Additional household occupations (mean, SD) | 1.3 (1.5) | 1.0 (1.0) | 0.8 (0.9) | 1.2 (1.5) |
| Fishers involved in tourism (%) | 18 | 52 | 34 | 14 |
| Fishers motivated by tradition (%) | 53 | 54 | 22 | 46 |
| *Perceptions of environment* | | | | |
| Perceived decline in reef health (%) | 55 | 67 | 55 | 44 |
| Perceived decline in reef fish (%) | 85 | 71 | 71 | 68 |
| Reef health (score 1–3 1 = unhealthy, 3 = healthy; mean score, SD) | 2.0 (1.0) | 2.5 (0.8) | 2.4 (0.8) | 2.3 (0.9) |
| Reef fish health (score 1–3 1 = few, 3 = many; mean score, SD) | 2.0 (1.0) | 2.1 (09) | 1.9 (1.0) | 2.1 (1.0) |
| *Management* | | | | |
| Aware of reef use rules (%) | 63 | 86 | 90 | 41 |
| Member of reef-related group (%) | 40 | 63 | 4 | 43 |

**Table 20.5** Summary of fisher perceptions of governance principles and results of MCA analysis reflecting underlying themes. Percentages and numbers of fishers reported reflect those agreeing with the statements relating to individual governance principles. MCA results report the squared correlation ratio between categorical variable and dimension ($R^2$; values <0.25 are not reported; $p < 0.001$ for all variables). All $R^2$ represent positive relationships with MCA dimensions, i.e. higher values on MCA dimensions reflect more positive perceptions of governance

| Governance principle | Fisher responses | | $R^2$ for MCA dimensions | |
|---|---|---|---|---|
| | % | n | Dim. 1 | Dim. 2 |
| Legitimacy | 63 | 222 | 0.48 | – |
| Transparency | 65 | 219 | 0.42 | – |
| Accountability | 54 | 191 | – | 0.49 |
| Inclusiveness | 55 | 202 | – | 0.49 |
| Fairness | 52 | 177 | 0.37 | – |
| Connectivity | 60 | 211 | 0.44 | – |
| Resilience | 66 | 181 | 0.35 | – |

Multiple correspondence analysis identified two underlying dimensions that together explained 60.3% of the variation in responses. The first dimension, accounting for 39.7% of the variance, represented respondents' general perceptions of whether good governance principles were operational in current reef management arrangements. This first dimension was most highly correlated with perceptions of legitimacy, followed by connectivity, transparency, fairness, and resilience. The principles of accountability and inclusiveness were most weakly correlated with the first dimension, with loadings below 0.20 (Table 20.5). The second dimension, accounting for 20.5% of the variance, represented respondents' perceptions of their own engagement in reef management. This dimension was correlated equally strongly with accountability and inclusiveness (Table 20.5). Accountability reflects respondents' ability to challenge rules or decisions and hold managers accountable for reef management actions. Inclusiveness reflects respondents' perceived ability to participate in decisions made about coral reef management.

These two dimensions reflect the same broad underlying themes that were identified in previous analysis of a broader household survey sample comprising community members and direct reef resource users, including tourism operators and fishers (Turner et al. 2014). Here we apply the same interpretations to these themes. The first dimension represents 'institutional acceptance' (DeCaro and Stokes 2013), which measures the degree to which community members endorse current reef governance processes. The second dimension reflects 'engagement' (Jentoft et al. 1998; Pomeroy and Douvere 2008; Ritchie and Ellis 2010).

## 20.8 Factors Influencing Perceptions

The inclusion in the MCA analysis of supplementary variables describing fishers' demographics, fishing practices, and perceptions illustrated the characteristics of fishers that were associated with different views on coral reef governance.

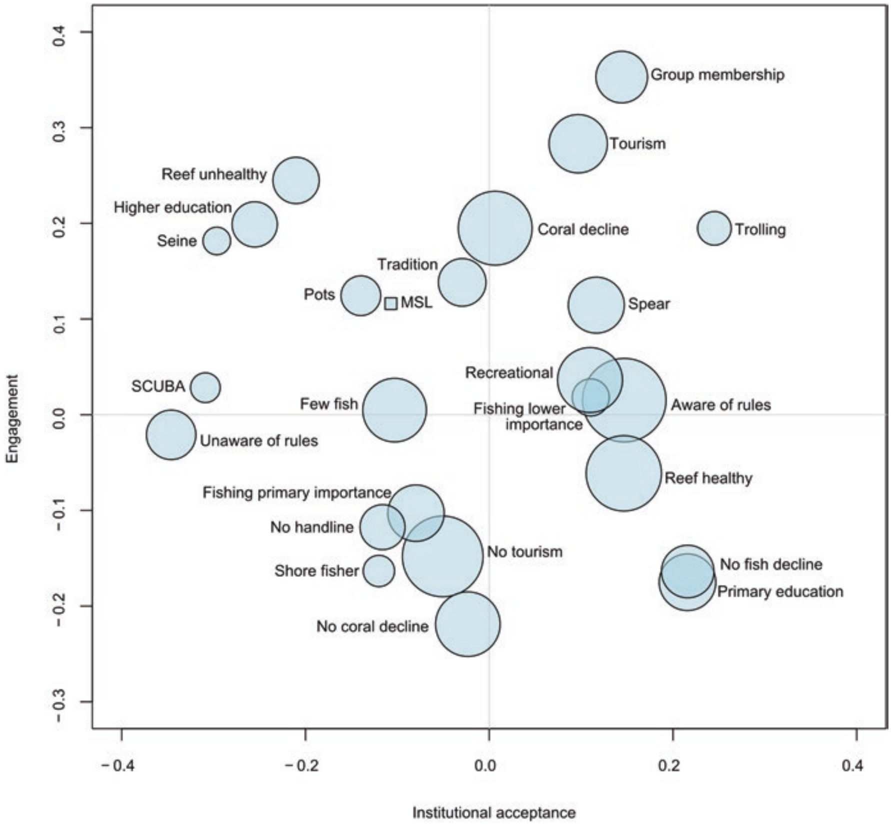



**Fig. 20.3** MCA results showing supplementary qualitative and quantitative variables describing characteristics of fishers and their association with underlying themes in perceptions of governance. Categories or variables with scores >0.1 or <−0.1 on one or both dimensions are shown. Circle radius represents number of fishers in the category. The continuous variable material style of life (MSL) is denoted using a square, and its placement reflects higher MSL values

Figure 20.3 illustrates the characteristics associated with positive and negative perceptions of institutional acceptance and engagement.

Fishers with positive perceptions of both institutional acceptance and engagement constituted the largest group ($n$ = 117). These positive perceptions were most strongly associated with membership of a reef-related group (such as a local fishers' association or cooperative), involvement in reef-related tourism as well as fishing, and involvement in trolling or spear fishing. Positive perceptions of engagement were also associated with a perception of reef decline over the past 10 years. Positive perceptions of institutional acceptance were associated with awareness of rules about reef use and a low dependence on fishing income, indicated by fishing for recreation only or by the expression that fishing was neither the primary nor secondary source of household income.

Fishers with high institutional acceptance but more negative perceptions of engagement (*n* = 102) were those with only primary education who perceived that the reef was currently healthy and had not perceived any decline in reef-associated fish populations. These fishers were less likely to belong to a reef-related group. In contrast, those with positive perceptions of engagement but low institutional acceptance (*n* = 89) generally perceived reefs to be unhealthy. These fishers tended to be wealthier and have higher levels of education and were more commonly engaged in seine, scuba, and pot fishing and saw fishing as part of their tradition or family history. Finally, fishers with negative perceptions of both governance themes (*n* = 94) tended to cite fishing as being of primary importance for their household income, were not involved in tourism activities, and typically fished from shore. These fishers were less aware of rules about reef use and tended not to have observed declines in coral reef health.

## 20.9 Discussion and Conclusions

Resource user perceptions were conceptualized using two underlying dimensions: (1) institutional acceptance, reflecting perceptions of the governance system extrinsic to themselves, and (2) engagement, reflecting fishers' perceptions of their own relationship with the governance system. These underlying themes were strongly consistent with a larger analysis, which included community members and tourism operators as well as fishers (Turner et al. 2014). Questions measured general perceptions of coral reef governance and were not specific to institutions dealing with fisheries; therefore, the perceptions measured here may not directly correspond to views on fisheries governance. Nevertheless, since all interviewees were engaged in reef-related fishing, governance interactions were relevant to their targeted resource. Further research could explore specific interactions and decision-making processes relating to fisheries.

The results of this study support the contention that improvements to coral reef governance require the consideration of interactions between governing institutions and the resource users being governed. Findings demonstrate the diversity of perceptions of governance within the small-scale fisheries sector in the Caribbean. Each of the four broad sets of perceptions identified was associated with socio-economic characteristics, broadly corresponding to different profiles or 'types' of small-scale fishers. At one extreme, these included individuals engaged in fishing primarily for tourism or recreation, who were not financially dependent on income from fishing but were involved in reef-related groups and aware of environmental change. At the other extreme were fishers heavily dependent on fishing income but with low capital investment and limited awareness of management measures. Findings are consistent with previous studies that found distinctions in resource users' knowledge, behaviour, attitudes, and perceptions within relatively small sectors. Cinner et al. (2011) analysed fishers' anticipated responses to change in resource availability and found that particular responses were associated with different socio-demographic profiles. For example, seine net fishers with high catch levels and mobility but low capital investment mobility were likely to exhibit behavioural responses that amplified resource degradation (Cinner et al. 2011). Similar approaches have identified typologies of resource users in other industries. For instance, cattle producers in Northern Australia were grouped into four 'types' based on their vulnerability to change, with the most vulnerable sharing socio-demographic characteristics such as higher mean age, low skill and interest levels, and small business sizes (Marshall et al. 2014).

In this study, the four broad sets of perceptions identified require different tactics for engendering involvement in resource stewardship. Fishers with positive perceptions of both institutional acceptance and engagement constituted the largest group (29%). These perceptions are more likely to support an intrinsic motivation for resource use behaviours that are compatible with coral reef governance objectives. The association of these perceptions with recreational fishers, who were commonly involved in tourism and did not depend on fishing for income, may explain this positivity towards reef governance. Involvement in tourism may facilitate engagement with management efforts due to the greater accessibility of tourism operators in coastal communities, in comparison to fishers who typically have more unpredictable work patterns and disparate fishing locations (Salas et al. 2007). Furthermore, those involved in recreational or tourism-related activities may have goals that are more closely aligned with those of conservation agencies involved in coral reef governance (Hoelting et al. 2013). The low dependence on fishing for income means such fishers are also less likely to be negatively impacted by fisheries management or conservation measures that restrict extractive uses of coral reef resources (McClanahan et al. 2005a). This group of fishers' intrinsic motivations are likely to be aligned with governance objectives, suggesting that current institutional arrangements may represent a relatively good social fit for these individuals (DeCaro and Stokes 2013). Greater social fit could help motivate autonomous stewardship and support for management measures, rather than motivation derived from pressure or coercion (Decaro and Stokes 2008). This is particularly critical to management success in contexts where enforcement capacity is limited (McClanahan et al. 2012).

Significantly however 23% of fishers here displayed both low institutional acceptance and negative perceptions of engagement with coral reef governance. This is a cause for concern, as such perceptions are unlikely to support the development of intrinsic motivation to behave in pro-environmental ways. Since not all fishers are intrinsically motivated to voluntarily engage in stewardship (DeCaro and Stokes 2013), understanding the characteristics of those less likely to do so may allow more specific targeting of limited resources for enforcement and engagement strategies. Findings suggest that monitoring governance perceptions may help direct where governors should target their efforts. In particular, alternative means of encouraging compliance, or new deterrents, may need to be targeted towards fishers who are highly dependent on fishing for income and also do not perceive environmental change or have awareness of management measures. Fishers who depend exclusively on fishing for income may be more vulnerable to the impacts of regulatory changes and are likely to resist changes that they perceive will limit their access to the resource. Governors should also pay attention to the many unregistered shore-based fishers who often evade fisheries managers and enforcement agencies (which typically monitor registered fishing vessels at designated landing sites or at sea). Despite low capital investment and landings, these fishers commonly perceive fishing as important to their livelihood for subsistence or as a safety net when other livelihood options are limited. In the Bay Islands of Honduras, many shore-based fishers were temporary or long-term economic migrants from mainland Honduras, representing an important demographic distinction from the 'islanders' who tend to be more socio-economically prosperous (Korda et al. 2008; Hogg et al. 2012). Migrants may lack local environmental knowledge and do not have a shared understanding of local rules and norms relating to resource use. A previous study in Utila Island (Honduras) found that this group displayed less pro-environmental behaviour than long-term residents (Hogg et al. 2012).

Our findings have important implications for consideration if the goal of improving the governance of Caribbean coral reefs and dependant small-scale fisheries is to be met. This research makes an original contribution through measuring fishers' perceptions, allowing detailed exploration of the relationships between governance and stewardship. Assessing the social fit of current institutional arrangements and providing an opportunity to incorporate fishers' views in future governance could contribute to enhanced participation and greater stewardship of coral reef resources. For respondents with less positive views of either of the governance themes, future governance developments could be tailored to encourage more positive interactions between resource users and governing institutions. This may be achieved through targeted engagement efforts towards these groups, to improve the social fit of governance arrangements for a wider range of fishers. For example, including individuals with high dependency on fishing in the design and implementation of fisheries regulations may improve the perceived legitimacy of management decisions and lead to increased cooperation and support. Greater efforts are needed to identify and engage more marginalized groups of fishers that may depend heavily on fishing but tend to operate outside the radar of typical fisheries management mechanisms. The findings of this study can be used to inform efforts to increase fishers' engagement in stewardship and focus enforcement efforts in areas where intrinsic motivation for compliance is less likely.

This study contributes to an improved understanding of how fisher perceptions relate to diverse governance arrangements in the Wider Caribbean Region. Resource user perceptions of governance quality can have important implications for institutional fit, as well as support for and compliance with management measures. Understanding how fishers' perceptions of governance arrangements differ across multiple contexts can help identify appropriate and targeted interventions for improvements. Small-scale fisheries governance may be more informed and effective if perceptions are used to identify areas in which to pursue greater engagement of resource users in stewardship.

## References

Agostini VN, Margles SW, Schill SR, Knowles JE, Blyther RJ (2010) Marine zoning in Saint Kitts and Nevis: a path towards sustainable management of marine resources. The Nature Conservancy

Armitage D, Berkes F, Doubleday N (2007) Adaptive co-management: collaboration, learning, and multi-level governance. UBC Press, Vancouver

Barley Kincaid K, Rose G, Mahudi H (2014) Fishers' perception of a multiple-use marine protected area: why communities and gear users differ at Mafia Island, Tanzania. Mar Policy 43:226–235

Berthou P, Lespagnol P, López EA, Oquelí MD, Andreakis V, Portillo PP, Rodríguez MC (2000) The census of artisanal fishermen and fishing boats of the Bay Islands vol 1. Environmental management project of the Bay Islands, Technical report PES 06 195. Bay Islands, Honduras

Biermann F (2007) "Earth system governance" as a crosscutting theme of global change research. Glob Environ Chang 17(3–4):326–337

Box S (2011) An evaluation of the socioeconomics of yellowtail snapper in the small-scale and industrial fisheries of the Honduran Caribbean. Future of reefs in a changing environment project. European Union 7th framework programme, Deliverable no. 8.5. Centro de Estudios Marinos, Honduras

Box S, Canty S (2010) The long and short term economic drivers of overexploitation in Honduran coral reef fisheries. In: Proceedings of the 63rd Gulf and Caribbean Fisheries Institute. November 1–5 2010, vol 63, San Juan, Puerto Rico, pp 1–9

Bunce L, Townsley P, Pomeroy RS, Pollnac RB (2000) Socioeconomic manual for coral reef management. GCRMN/IUCN/AIMS/NOAA, AIMS, Townsville

Burke L, Reytar K, Spalding M, Perry AL (2011) Reefs at risk revisited. World Resources Institute, Washington, DC

Chollett I, Canty SWJ, Box SJ, Mumby PJ (2014) Adapting to the impacts of global change on an artisanal coral reef fishery. Ecol Econ 102:118–125

Cinner JE, Daw TM, McClanahan TR (2009) Socioeconomic factors that affect artisanal fishers' readiness to exit a declining fishery. Conserv Biol 23(1):124–130

Cinner JE, Folke C, Daw TM, Hicks CC (2011) Responding to change: using scenarios to understand how socioeconomic factors may influence amplifying or dampening exploitation feedbacks among Tanzanian fishers. Glob Environ Chang 21(1):7–12

Cooper E, Burke L, Bood N (2009) Coastal capital: Belize, The economic contribution of Belize's coral reefs and mangroves. World Resources Institute, Washington, DC

CRFM (Caribbean Regional Fisheries Mechanism) (2010) Report of sixth annual scientific meeting – Kingstown, St. Vincent & the Grenadines, 07–16 June 2010. Supplement 1, CRFM Fishery report: National reports, vol 1. CRFM, Belize

CRFM (2012) Diagnostic study to determine poverty levels in CARICOM fisheries communities: Technical document. CRFM technical & advisory document, number. 2012/3, vol 1. CRFM, Belize

Crona BI, Bodin Ö (2006) What you know is who you know? Communication patterns among resource users as a prerequisite for co-management. Ecol Soc 11(2):7

Daw TM, Cinner JE, McClanahan TR, Brown K, Stead SM, Graham NAJ, Maina J (2012) To fish or not to fish: factors at multiple scales affecting artisanal fishers' readiness to exit a declining fishery. PLoS One 7(2):e31460

DeCaro D, Stokes M (2008) Social-psychological principles of community-based conservation and conservancy motivation: attaining goals within an autonomy-supportive environment. Conserv Biol J Soc Converv Biol 22(6):1443–1451

DeCaro D, Stokes M (2013) Public participation and institutional fit: a social–psychological perspective. Ecol Soc 18(4):40

Dunn DC, Stewart K, Bjorkland RH, Haughton M, Singh-Renton S, Lewison R, Thorne L, Halpin PN (2010) A regional analysis of coastal and domestic fishing effort in the wider Caribbean. Fish Res 102(1–2):60–68

Eakin CM, Morgan JA, Heron SF, Smith TB, Liu G, Alvarez-Filip L, Baca B, Bartels E, Bastidas C, Bouchon C, Brandt M, Bruckner AW, Bunkley-Williams L, Cameron A, Causey BD, Chiappone M, Christensen TRL, Crabbe MGC, Day O, de la Guardia E, Díaz-Pulido G, DiResta D, Gil-Agudelo DL, Gilliam DS, Ginsburg RN, Gore S, Guzmán HM, Hendee JC, Hernández-Delgado EA, Husain E, Jeffrey CFG, Jones RJ, Jordán-Dahlgren E, Kaufman LS, Kline DI, Kramer PA, Lang JC, Lirman D, Mallela J, Manfrino C, Maréchal JP, Marks K, Mihaly J, Miller WJ, Mueller EM, Muller EM, Orozco Toro CA, Oxenford HA, Ponce-Taylor D, Quinn N, Ritchie KB, Rodríguez S, Rodríguez Ramírez A, Romano S, Samhouri JF, Sánchez JA, Schmahl JG, Shank BV, Skirving WJ, Steiner SCC, Villamizar E, Walsh SM, Walter C, Weil E, Williams EH, Roberson KW, Yusuf Y (2010) Caribbean corals in crisis: record thermal stress, bleaching, and mortality in 2005. PLoS One 5(11):e13969

Fanning L, Mahon R, McConney P (2009) Focusing on living marine resource governance: the Caribbean large marine ecosystem and adjacent areas project. Coast Manag 37:219–234

Fanning L, Mahon R, McConney P (2013) Applying the large marine ecosystem (LME) governance framework in the Wider Caribbean Region. Mar Policy 42:99–110

FAO (Food and Agricultural Organization of the United Nations) (2006) Fishery and aquaculture country profiles: Saint Kitts and Nevis. FAO Fisheries and Aquaculture Department, Rome. http://www.fao.org/countryprofiles/index/en/?iso3=KNA. Accessed 20 June 2009

FAO (2014) FAO yearbook 2014: fishery and aquaculture statistics. FAO, Rome

Fisheries Division (2004) Barbados fisheries management plan 2004–2006: schemes for the management of fisheries in the waters of Barbados. Fisheries Division, Ministry of Agriculture and Rural Development, Bridgetown

Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Resour 30(1):441–473

Gelcich S, Edwards-Jones G, Kaiser MJ (2005) Importance of attitudinal differences among artisanal fishers toward co-management and conservation of marine resources. Conserv Biol 19(3):865–875

Gelcich S, Kaiser MJ, Castilla JC, Edwards-Jones G (2008) Engagement in co-management of marine benthic resources influences environmental perceptions of artisanal fishers. Environ Conserv 35(01):36–45

Gobert B, Berthou P, Lopez E, Lespagnol P, Turcios MDO, Macabiau C, Portillo P (2005) Early stages of snapper–grouper exploitation in the Caribbean (Bay Islands, Honduras). Fish Res 73(1–2):159–169

Graham J, Amos B, Plumptre T (2003) Governance principles for protected areas in the 21st century. Institute on Governance, Ottawa

Gurney GG, Pressey RL, Ban NC, Álvarez-Romero JG, Jupiter S, Adams VM (2015) Efficient and equitable design of marine protected areas in Fiji through inclusion of stakeholder-specific objectives in conservation planning. Conserv Biol J Soc Converv Biol 29(5):1378–1389

Harborne AR, Afzal DC, Andrews MJ (2001) Honduras: Caribbean coast. Mar Pollut Bull 42(12):1221–1235

Heileman S (2011) CLME Project: reef and pelagic ecosystems transboundary diagnostic analysis (TDA). Cartagena, Colombia: Caribbean Large Marine Ecosystem and Adjacent Areas (CLME) Project

Hoelting KR, Hard CH, Christie P, Pollnac RB (2013) Factors affecting support for Puget sound marine protected areas. Fish Res 144:48–59

Hogg K, Gray T, Bown N (2012) Crisis within social capital? The negative impact on natural resources of tension between household and community social capital in a migrant Ladino enclave on Utila. Soc Nat Resour 25(5):440–452

Husson F Josse J, Le S, Mazet J (2007) FactoMineR: factor analysis and data mining with R. R package version 1.04

Jackson JBC, Donovan MK, Cramer KL, Lam W (2014) Status and trends of Caribbean coral reefs: 1970–2012. Global Coral Reef Monitoring Network, IUCN, Gland

Jentoft S, McCay BJ, Wilson DC (1998) Social theory and fisheries co-management. Mar Policy 22(4–5):423–436

Jones PJS (2008) Fishing industry and related perspectives on the issues raised by no-take marine protected area proposals. Mar Policy 32(4):749–758

Josse J, Chavent M, Liquet B, Husson F (2012) Handling missing values with regularized iterative multiple correspondence analysis. J Classif 29:91–116

Kooiman J, Bavinck M, Jentoft S, Pullin R (2005) Fish for life: interactive governance for fisheries. Amsterdam University Press, Amsterdam

Korda RC, Hills JM, Gray TS (2008) Fishery decline in Utila: disentangling the web of governance. Mar Policy 32(6):968–979

Lê S, Josse J, Husson F (2008) FactoMineR: an R package for multivariate analysis. J Stat Softw 25:1–18

Lockwood M (2010) Good governance for terrestrial protected areas: a framework, principles and performance outcomes. J Environ Manag 91(3):754–766

Maechler M, Rousseeuw P, Struyf A, Hubert M, Hornik K (2013) Cluster: cluster analysis basics and extensions. R package version 1.14.4

Mahon R, Fanning L, McConney P (2014) Assessing and facilitating emerging regional ocean governance arrangements in the wider Caribbean region. Ocean Yearb 28:631–671

Mangi SC, Austen MC (2008) Perceptions of stakeholders towards objectives and zoning of marine-protected areas in southern Europe. J Nat Conserv 16(4):271–280

Marshall NA, Stokes CJ, Webb NP, Marshall PA, Lankester AJ (2014) Social vulnerability to climate change in primary producers: a typology approach. Agric Ecosyst Environ 186:86–93

Mascia MB (2003) The human dimension of coral reef marine protected areas: recent social science research and its policy implications. Conserv Biol 17(2):630–632

McClanahan TR, Davies J, Maina J (2005a) Factors influencing resource users and managers' perceptions towards marine protected area management in Kenya. Environ Conserv 32(1):42–49

McClanahan TR, Maina J, Davies J (2005b) Perceptions of resource users and managers towards fisheries management options in Kenyan coral reefs. Fish Manag Ecol 12(2):105–112

McClanahan TR, Cinner JE, Kamukuru AT, Abunge CA, Ndagala J (2009) Management preferences, perceived benefits and conflicts among resource users and managers in the Mafia Island Marine Park, Tanzania. Environ Conserv 35(04):340

McClanahan TR, Abunge CA, Cinner JE (2012) Heterogeneity in fishers' and managers' preferences towards management restrictions and benefits in Kenya. Environ Conserv 39(4):357–369

McConney P, Baldeo R (2007) Lessons in co-management from beach seine and lobster fisheries in Grenada. Fish Res 87(1):77–85

McConney P, Mahon R (1998) Introducing fishery management planning to Barbados. Ocean Coast Manag 39(3):189–195

McConney P, Mahon R, Oxenford HA (2003) Barbados case study: the fisheries advisory committee. Caribbean Coastal Co-management Guidelines Project. Caribbean Conservation Association, Barbados

McConney P, Mahon R, Pomeroy R (2007) Challenges facing coastal resource co- management in the Caribbean. In: Armitage DR, Berkes F, Doubleday NC (eds) Adaptive co-management: collaboration, learning and multi-level governance. UBC Press, Vancouver, pp 105–124

Mora C (2008) A clear human footprint in the coral reefs of the Caribbean. Proc R Soc B Biol Sci 275(1636):767–773

Mora C (2009) Degradation of Caribbean coral reefs: focusing on proximal rather than ultimate drivers. Reply to Rogers. Proc R Soc B Biol Sci 276(1655):199–200

Mumby PJ, Steneck RS (2008) Coral reef management and conservation in light of rapidly evolving ecological paradigms. Trends Ecol Evol 23(10):555–563

Nielsen JR, Mathiesen C (2003) Important factors influencing rule compliance in fisheries lessons from Denmark. Mar Policy 27(5):409–416

Österblom H, Folke C (2013) Emergence of global adaptive governance for stewardship of regional marine resources. Ecol Soc 18(2):4

Ostrom E (1990) Governing the commons: the evolution of institutions for collective action. Cambridge University Press, Cambridge

Pauly D, Zeller D (eds) (2015) Sea around us concepts, design and data. www.seaaroundus.org. Accessed 08 Sept 2016

Pita C, Pierce GJ, Theodossiou I (2010) Stakeholders' participation in the fisheries management decision-making process: fishers' perceptions of participation. Mar Policy 34(5):1093–1102

Pollnac R, Christie P, Cinner JE, Dalton T, Daw TM, Forrester GE, Graham NAJ, McClanahan TR (2010) Marine reserves as linked social-ecological systems. Proc Natl Acad Sci U S A 107(43):18262–18265

Pomeroy RS, Douvere F (2008) The engagement of stakeholders in the marine spatial planning process. Mar Policy 32(5):816–822

Pomeroy RS, Mascia MB, Pollnac RB (2006) Marine protected areas: the social dimension. UN FAO expert workshop on marine protected areas and fisheries management: review of issues and considerations (12–14 June 2006). FAO, Rome

R Core Team (2013) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna

Research and Planning Unit (2012) Barbados economic and social report 2011. Ministry of Finance and Economic Affairs, Government of Barbados

Ritchie H, Ellis G (2010) "A system that works for the sea"? Exploring stakeholder engagement in marine spatial planning. J Environ Plan Manag 53(6):701–723

Salas S, Chuenpagdee R, Seijo J, Charles A (2007) Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fish Res 87(1):5–16

Slater MJ, Napigkit FA, Stead SM (2013) Resource perception, livelihood choices and fishery exit in a coastal resource management area. Ocean Coastal Mana 71:326–333

Stallings CD (2009) Fishery-independent data reveal negative effect of human population density on Caribbean predatory fish communities. PLoS One 4(5):e5333

Teh LSL, Teh LCL, Sumaila UR (2011) Low discounting behavior among small-scale fishers in Fiji and Sabah, Malaysia. Sustainability 3(6):897–913

Turner RA, Fitzsimmons C, Forster J, Peterson AM, Mahon R, Stead SM (2014) Measuring good governance for complex ecosystems: perceptions of coral reef-dependent communities in the Caribbean. Glob Environ Chang 29:105–117

Turriago CSB (2011, February) Value-chain analysis of international fish trade and food security in the Republic of Honduras. Fisheries and Aquaculture Department Products, Trade and Marketing, FAO, San Salvador

Vallès H, Oxenford HA (2012) Queen conch (Strombus Gigas) in Barbados: density, distribution, and habitat correlates. Bull Mar Sci 88(4):947–969

Velez M, Adlerstein S, Wondolleck J (2014) Fishers' perceptions, facilitating factors and challenges of community-based no-take zones in the Sian Ka'an Biosphere Reserve, Quintana Roo, Mexico. Marine Policy 45:171–181

Warner TE, Pomeroy RS (2012) Paths of influence: the direct and indirect determinants of marine managed area success. Coast Manag 40(3):250–267

Worrell R, Appleby MC (2000) Stewardship of natural resources: definition, ethical and practical aspects. J Agric Environ Ethics 12(3):263–277

**Rachel A. Turner** is a Lecturer in Environmental Social Science at the Environment and Sustainability Institute, University of Exeter, UK. Her research involves understanding how socioeconomic and environmental contexts influence resource use and responses to change in complex socioecological systems and has implications for management and governance systems. Her work has focused on small-scale fisheries and coastal communities in the South Pacific, UK, and Caribbean. Before joining the University of Exeter, she worked as a Research Associate at the University of the West Indies, Barbados.

**David A. Gill** is a David H. Smith Postdoctoral Fellow, jointly affiliated to George Mason University and Conservation International. David Gill's research focuses on identifying the linkages between marine management, human well-being, and ecosystem health. His research includes global assessments of marine conservation performance and impacts, economic valuation of Caribbean coral reefs, and developing cost-effective approaches for marine monitoring. Dr. Gill's work has been published in journals such as Nature, Ecological Economics, Coral Reefs, and Ocean & Coastal Management. Much of his work presented in this volume was derived from his PhD, which he received at the University of the West Indies, Barbados.

**Clare Fitzsimmons** is a Senior Lecturer at Newcastle University, UK. She has a background in environmental research coupled with private sector experience gained in the defence and marine consultancy sectors. Although her expertise has been developed across several fields, a common theme across her work is the analysis of complex systems. She applies this to marine management and governance, primarily in the investigation of human interactions with ecological systems. Interested in the ways in which human activities and their organisation impact upon the marine environment, she focuses on understanding governance systems in order to support decision-making for natural resource management and associated values and trade-offs made at multiple scales.

**Johanna Forster** is a Senior Research Associate at the Tyndall Centre for Climate Change Research at the University of East Anglia, UK. Her research involves understanding multilevel perceptions and incentives and the associated implications for environmental decision-making. Her work has focused on the governance and management of natural resources, particularly around coastal and marine zones, the vulnerability and resilience of resource-dependent communities to climate change impacts, and historical and cultural influences on contemporary environmental risk and hazards. She has worked in the Caribbean, the South Pacific, and the UK.

**Robin Mahon** is Professor Emeritus at the Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies. His research activities focus on marine resource governance, particularly on the assessment of governance arrangements for transboundary systems. This work addresses institutional and organizational aspects of governance at the regional and large marine ecosystem (LME) levels, in particular the LMEs of the Wider Caribbean Region. Before joining CERMES, he worked for the Canadian Department of Fisheries and Oceans, FAO, the CARICOM Fisheries Programme, and as a consultant.

**Angelie Peterson** is a PhD student at the Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies. Her research focuses on the governance of coral reef ecosystems, using social network analysis to explore formal and informal governance systems. She completed a BA in Geology and a minor in Marine Science at Smith College in Northampton, USA, and an MSc in Tropical Coastal Management at Newcastle University, UK. Angelie has social and ecological field experience in the Caribbean and Western Indian Ocean regions.

**Selina Stead** is Professor of Marine Governance and Environmental Science at Newcastle University, UK. She is an interdisciplinary marine scientist whose motivation stems from an interest in the sustainable management of marine resources. Her research has made contributions to diverse fields such as fisheries, aquaculture, marine protected areas, integrated coastal management, coral reef ecosystems, and marine governance. Selina has held various policy advisory roles, including Chair of the Scottish Government's Marine Science Advisory Board and President of the European Aquaculture Society. Before joining Newcastle University, she was Director for Marine Resource Management at Aberdeen University.

# Chapter 21
# Existing Institutional and Legal Framework and Its Implications for Small-Scale Fisheries Development in Brazil

**Sérgio Macedo G. de Mattos and Matias John Wojciechowski**

**Abstract** Ineffective implementation of small-scale fisheries public policy seems to be related to existing institutional and legal arrangements, which affects the social and ecological sustainability of fishing communities in developing countries such as Brazil and the Latin American and Caribbean region more broadly. This dynamic has serious economic consequences for the sector, and, as a result, this lack of sustainability and institutional weakness can obstruct the implementation of public policies to enforce management measures. This chapter introduces a method of analysis and evaluation of Brazil's institutional and legal framework for small-scale fisheries sustainability as a strategy to improve the development, control, and monitoring of fisheries rules and management measures at local, national, and regional levels. This framework is intended to facilitate the implementation of public policies for sustainable and responsible small-scale fishing. As a methodological approach, we argue that it is necessary to confront legal instruments and initiatives linked to fisheries at national and international levels, as well as the existing fisheries management system. This dynamic brings forth serious economic implications for the sector and, most significantly, may thwart the implementation of public policy intended to enforce measures needed for sustainable management. This analysis and evaluation of the Brazilian institutional and legal framework, although preliminary, is a proposition on the necessity to reach three goals for national management regimes: to stay attuned with international legal instruments, to examine existing small-scale fishing communities' expectations and outlook, and to contribute to establishing an efficient and effective institutional and legal framework.

**Keywords** Fishery · Small-scale · Legal instruments · Management system · Brazil

S. M. G. de Mattos (✉)
Ministério do Planejamento., Recife, PE, Brazil

M. J. Wojciechowski
Doctorate student in Territorial Planning and Management,
Federal University of ABC (UFABC), Santo André, Brazil



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_21

## 21.1 Introduction

The social, technological, and ecological complexities found in small-scale fishing communities in developing countries, such as those in Latin American and the Caribbean, still pose challenges to integrating knowledge about the sector and hamper the enforcement of management measures. These challenges are generally due to the lack of reliable information about these fisheries. As a result, although basic tenets of effective institutional and legal frameworks recommend avoiding uncertainties and inappropriateness, the established public policies in these countries are seldom connected with local, national, and regional realities. Additionally, the need to ensure the legitimacy and representativeness of small-scale fishworkers in this institutional and legal context further complicates the implementation of public policies and the establishment of a management system capable of encompassing the diversity of small-scale fisheries.

The fisheries sector in Brazil has been heavily researched in recent decades due to the global food crisis, the declining sustainability of fish stocks, advances in technical-productive knowledge, and broader concerns about coastal regions and their multiple economic activities (Wojciechowski 2014). Within this highly complex scenario, new theoretical formulations are required to capture the (re)organization of political arenas, institutional morphology, and the rescaling of the Brazilian state developmental model in relation to the development of the fishing sector and, consequently, to better understand the modifications and structural paradoxes experienced by the sector (Mattos 2014). With the possible exception of the Amazon region, which may be better analysed separately, a variety of situations exponentially increase the challenges faced by small-scale fisheries in Brazil for the implementation of public policies. These include the definition of small-scale fisheries; territorial rights and protected areas, such as extractive reserves[1]; women's rights; and the lack of effective knowledge-sharing dialogues (Ruffino 2012). Without a proper examination of the changes discussed above and the overarching fisheries institutions and governance systems and how they affect the existence of, and relationship between, small- and large-scale fishing sectors, the status quo may be endorsing policies that inhibit the sustainability of small-scale fisheries and limit their ability to adapt to environmental and economic changes (Chuenpagdee 2011).

Freire and García-Allut (2000) stress that the concept of artisanal, or small-scale, fisheries is by nature vague and they employed five different types of definitions to establish limits and scopes, which we adapt by arguing that the diversity of definitions is a result of interacting of three main realms: (1) political and administrative: ambiguous classification is mainly a consequence of the different powers and policies that governments apply to fisheries management; (2) economic and social: the ambiguousness in this realm stems from the incredible diversity of strategies used

[1] Extractive reserves (Reserva Extrativista – RESEX) are areas protected by law designated for the conservation and sustainable management of natural resources exploited by the traditional communities.

for the exploitation of ecosystems and fishing stocks (e.g. family structure and profit sharing among family members); and (3) technological and ecological: the use of low and medium technological equipment varies with the type of species, place ecology, and traditional knowledge. In addition, the flexible and unpredictable nature of the activity further complicates its classification.

Mattos (2011, 2014) emphasized that, contrary to what many want to advocate, public policies always existed and reproduced the existing knowledge at any time, and the challenges encompass creating proper instruments to reach the most distant fishing communities and vulnerable and marginalized groups. This fact confirms the need to understand the specific characteristics of traditional and small-scale fisheries, legal instrument adequacy, policy development and management, conflicts between management and intervention, and management processes within the government and non-government interventions.

Despite the extensive coastline, due to its oceanographic features, Brazilian fisheries account for only 0.5% of the total world fish production. In 2011, close to 500,000 tons, representing close to 50% of the total fish production of Brazil, came from marine extractive fishing, and these captures seem to be stabilized. In contrast to the meagre contribution of fish production (when compared with other productive countries), the national fishing activity carries great socio-economic importance, similarly to other parts of the world. In Brazil, most of the fleet is small-scale and accounts for up to 60% of the total catch. Currently, out of the more than 1,000,000 registered fishers in Brazil, approximately 99% are small-scale and have organized into about 760 fishers' associations/guilds, 137 trade unions (at the municipal level), and 47 fishing cooperatives (Brasil/MPA 2012, 2016).

The present analysis is guided by questions regarding the relationship among international legal instruments, the institutional and legal framework, the current management system, and small-scale fisheries characteristics. The objective of this chapter is to flesh out a method of analysis and evaluation of the Brazilian institutional and legal framework for small-scale fisheries development. We hope that this analysis may guide the implementation of future management measures at local and national scales to improve the development, control, and monitoring of sustainable and responsible small-scale fisheries. As a methodological approach, we argue for the necessity to examine legal instruments and initiatives linked to fisheries at national and international levels, as well as the existing national fisheries management, identifying the alignment (or lack thereof) with the institutional and legal framework found in Brazil. By emphasizing these two dimensions, we suggest that when talking about marine fisheries resources, national and subnational government should adopt legal instruments constructed on a global and holistic basis to allow monitoring and control of the existing management system and implement public policies and fishing regulation measures for fisheries development at all relevant scales.

Although preliminary in nature, this analysis and evaluation of the Brazilian institutional and legal framework for small-scale fisheries points to the pursuit of three strategic goals for the sector: (1) to stay attuned with international legal instruments, (2) to examine existing small-scale fishing communities' expectations and general sector forecasts and perspectives about fisheries management, and (3) to mainstream an efficient and effective institutional and legal framework for small-scale fisheries. Specific attention will be given to understanding the functioning, shared decision-making, and representativeness exhibited by the co-management processes involving stakeholders and their respective capacity building. We believe that these dimensions affect the democratic performance of co-management initiatives, understood as concrete spaces of influence, inclusion, and adaptive changes and, as such, can be understood as converging issues in understanding why public policies do not reach homogenously all fishing communities, in particular the most isolated ones and the poorest fisher categories.

## 21.2 Methodological Approach: The Legal Fishing Instruments

Brazil's fishery policy framework is fragmented, fostering unsustainable development (Dias-Neto 2010), in addition to being contradictory at various scales and producing socio-spatial inequalities (Wojciechowski 2014). Evidence shows that it is skewed in favour of large-scale harvesters to the detriment of small-scale fisheries (Azevedo 2012). In light of these challenges, we urge for a necessity to define methods of analysis of legal instruments and initiatives linked to fisheries at national and international levels, as well as the analysis of the existing fisheries management system, to better manage the activity. This analysis would support the argument for an institutional and legal framework to help in enforcing sustainable management measures for small-scale fisheries.

Based on a rapid appraisal of the most relevant international legal instruments and policies ratified by Brazil, we begin by assessing the coherence of the established institutional and legal framework for small-scale fisheries. To do so our analysis considered:

- *Global issues* reflected as international legal instruments and initiatives
- How these *global issues* influence the planning process to establish proper management systems at local and national levels

As an initial step, we assessed the United Nations Convention on the Law of the Sea (UNCLOS) as a comprehensive legal regime covering all aspects of the seas and oceans and its correlation with Brazilian legal instruments. In addition, the analysis considered instruments constructed and implemented by the Food and Agriculture Organization of the United Nations (FAO):

- *The Code of Conduct for Responsible Fisheries – The Code* (FAO 1995): principles and standards applicable to the conservation, management, and development of all fisheries
- *The International Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication – SSF Guidelines* (FAO 2015): address both inland and marine small-scale fisheries and focus on the

needs of developing countries, as a complement of The Code, and take the form of guidelines that draw on existing relevant international instruments

- *The International Labour Organization Declaration on Fundamental Principles and Rights at Work – ILO Declaration* (ILO 1999): establishes the concept of decent work to promote opportunities for women and men to obtain decent and productive work in conditions of freedom, security, and human rights
- *The Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries, and Forestry in the Context of National Food Security – Tenure Guidelines* (FAO 2012): defining food security and supporting the progressive realization of the right to contribute towards the eradication of hunger and poverty and the sustainable use of the environment, within an understanding of the need to recognize fishing territorial rights, and shall strengthen the dialogue between advocates of fishers rights and environmental issues

Taking into account technical, scientific, and traditional knowledge that is relevant for fisheries development, we understand as first steps the need to assess and analyse the existing management system and their instruments and regulations for small-scale fisheries related to the following issues:

- *Fishers behaviour*. Fishworkers' relationships, organizational systems, and culture are issues that determine fisheries governance in each country, taking into consideration the existence of a multi-stakeholder structure and other possible mechanisms.
- *Fishing resources and the environment*. The management of a fishery requires an understanding of the following: the exploited fishing resource, exploitation pattern on each stock, instruments that are applied, and fish stock assessment methods and techniques. Fish stock assessment models are some of the instruments used for the development and establishment of fisheries management, which aim to define parameters and deal with uncertainties that may broaden challenges and difficulties in implementing management measures.
- *Market system*. The market system, which influences fishing strategies for a specific target stock as well as encompassing the larger value chain, can be better understood by the economics of the fisheries. A target stock is generally chosen for the monetary value it has in a specific market in order to satisfy fishers' wants and the desire of society. Anderson (1977) argues that in an extremely capitalist context and barring market failure, the market works and produces socially efficient results. Thus, the market acts as the main instrument of interaction between agents in a capitalist society. This interaction may help to define strategic policies that will be effective in the development of a particular economic sector.
- *Fisheries governance and governability*. Political issues that may influence the implementation of public policies must take into account *plans and policies for fisheries management and regulation*. Fisheries governance must ensure that institutional and legal instruments can increase governability. This entails building on competencies (licensing, inspection, control, monitoring, surveillance, sanctions and penalties, subsidies, and others instruments) while considering the specific fishing resources, fishing grounds, users or group of users, and other factors that are relevant for fisheries co-management.

## 21.3 Analysis of Existing Institutional and Legal Framework in Brazil

Since the 1960s, institutional crisis has dominated the discussions surrounding fisheries management in Brazil. Dias-Neto and Dornelles (1996) highlighted that, under the initial precepts of inexhaustibility of fish stocks, the fishing sector encouraged intense industrialization, resulting in environmental degradation, fish species abundance decline, the breakdown of many fishing communities, and the impoverishment of traditional fishers' families. According to Mattos (2011), these negative impacts prompted an overly environmentalist stance on the part of the state, which focused on improving the management of fishing resources. However, social and economic dimensions of sustainable development were neglected due to development that favoured implementing policies aimed at increasing the competitiveness of the value chain as a benchmark principle. Also, regardless of how well the framework was conceptualized and designed, an agribusiness model prevailed, generating little, if any, opportunity for small-scale fisheries. Consequently, the resulting fisheries system featured little social inclusion, thus reproducing the long global tradition of (un)sustainable development.

In Brazil, there is a diversity of fisheries systems which represent relatively different historic periods and have linkages and interdependencies among each other. Thus, the small-scale fisheries system is a particularly dynamic context for development. This system is characterized by a multi-gear, multi-fleet, and multispecies fishery that cannot easily be analysed for the consequences and risks that apply to different management measures applied to particular stocks. Although the establishment of a management system seems straightforward, based on the most relevant traditional and scientific knowledge, uncertainties due to poor availability of information along the small-scale fisheries value chain spanning from harvest to market amplify challenges to ensuring continuous human and ecological well-being. These challenges also prevent a transition towards a mutually beneficial interdependency where "fishing stocks sustainability rely on functional and socially integrated fishing communities" and "fisher's future rely on fishing stocks sustainability" (Azevedo 2012, p. 140).

Through a press release in June 9, 2015 (Halifax – Nova Scotia – Canada), the Community Conservation Research Network (CCRN) warns that "failure to involve local and indigenous communities in natural resource decisions can produce disastrous results", once resource and economic collapses are possible when communities are left out of the decision-making. This strengthens the previous assumption when concluding that communities, when suitably supported, can play a crucial role in conserving the environment while providing sustainable jobs, once the well-being of communities is linked to healthy ecosystems and vice versa. CCRN also outlines that "a healthy environment is crucial for local communities, as well as for national economies. At the same time, keeping environment healthy means conservation efforts, and communities can play a major role in this endeavor. But, if community initiatives are not supported and/or community knowledge is not recognized, then both economy and the environment suffer" (CCRN 2015, p. 30).

*The Code* (FAO 1995) provides a framework to coordinate national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment. The language of *The Code*, as a key instrument for underlining sustainability in tenure, outlines a rational process for achieving human and ecological well-being. One of its key points is that the appropriateness of any political issue used in international instruments for sustainable fisheries development requires the integration of fishing communities into the decision-making process. This principle is essential for ensuring the sustainability of fishing resources, securing environmental preservation, and fostering the market and governance system, all of which are still far from reality in Brazil.

Notwithstanding the various ideological differences, the claim for rights of both the large- and small-scale fishing sectors, and their demand for a more robust institutional framework aiming at promoting desired levels of sustainability, both sectors behave surprisingly with similar demands. Both claim to require the deregulation of the fishing regulatory system imposed by the state, despite their agendas being substantially different if not contrary to one another (Acselrad 2004). While the large-scale fisheries sector sought the deregulation and weakening of the current institutional framework as a strategy to overcome the limits to increasing capital accumulation and profit, the small-scale fisheries sector, which was seen as being persecuted and repressed by the state, has made calls for deregulation in the name of environmental justice. These sectors also debate the implications of ecological modernization, indicating that environmental issues can be internalized by financial capital through restructuring and/or the modernization of fishing methods. Small-scale fisheries voices have also advocated for overcoming inequality, enjoying the benefits derived from environmental goods, and having increased power to decide on the use of and access to natural resources.

For these reasons, it is imperative that any future management system be based on principles of food security and poverty eradication and, as a general scope according to the *SSF Guidelines* (FAO 2015), must have the intent "to support responsible fisheries and sustainable social and economic development for the benefit of current and future generations, with an emphasis on small-scale fishers and fishworkers and related activities and including vulnerable and marginalized people promoting a human rights-based approach" (p. 9).

For Wojciechowski (2014), the intersection of the food crisis narrative with the economic and environmental unsustainability narrative of the fishing sector generates at least four key relationships that dictate the sector's ultimate developmental model. These include (1) the intrinsic relationship between the production-oriented fishing industry and the insertion of fish production into the global and/or corporate food regime, (2) the relationship between the accumulation and production models and issues of sustainability and food security, (3) the relationship between the fishing industry governance model and the organizational policy of institutional actors, and (4) the relationship between financing schemes operated in the fishing sector and the production model that is adopted to capture the desired economic surplus from the oceans.

Acknowledging any of these relationships can foster the sustainable use of the environment, including the recognition of fishing territorial rights, such as extractive reserves or marine protected areas (MPAs), known in Brazilian legislation as "conservation units", and must be considered in order to strengthen the dialogue between fishers' rights and environmental issues. A discussion on fishers' professionalization and rights and the roles of MPAs in the overall fisheries management system can lead to many social and economic consequences, since it may work in a competitive, profit-driven economy (Chuenpagdee 2011). It may also support the "re-artisanalization" of fisheries activities, as observed in Brazil, where government has supported actions through the enactment of marine extractive reserves, which allow small-scale fishers to reoccupy coastal waters (Gasalla 2011).

According to Ruffino (2012), there is general agreement that the small-scale fishing sector represents a productive economic activity with positive results in relation to costs and revenues, as opposed to industrial fisheries. The sector also produces positive outcomes with regard to employment and income generation while resulting in relatively minor environmental impacts. Furthermore, a close relationship between ecosystem conservation and the health and livelihoods of small-scale fishing communities is supported in a study by Seixas and Kalikoski (2009) on the relation between a wide array of environmental protection arrangements contemplated by the National Protected Areas System[2] and the fishing sector, including environmental protection areas, extractive reserves, sustainable development reserves, conservational forums, and community management systems, among others. In addition to representing the maturity of the institutional-legal framework and a conceptually advanced model of sustainable territorial development, these arrangements also account for a large repository of participatory experiences in the fishing sector.

Fishing territorial rights and protected areas follow a partnership model that aims to reconcile the protection and conservation of natural resources alongside their sustainable economic use for the benefit and empowerment of communities. Reserves are frequently cited as institutions that protect territorial rights; in this context, there is a need to provide better access to information on existing rights regarding protected coastal communities (Ruffino 2012). Access rights to resources and collective territories greatly depend on knowledge and the ability to use relevant legal instruments to secure those rights. The management of coastal estuaries and lagoons is central for the recognition of small-scale fisheries as a priority for the implementation of public policy. The lives and subsistence of the majority of fishers in Brazil, in particular fisherwomen, are concentrated in these spaces, which are characterized by a variety of fishing communities and small-scale fishing activities with strong ethnic and cultural characteristics.

The primary goal of the International Labour Organization – *ILO Declaration* (ILO 1999) – is to promote opportunities for women and men to obtain decent and productive work in conditions of freedom, security, and human rights. Decent work is the converging focus of the *Declaration's* four components and strategic objectives,

[2] Sistema Nacional de Unidades de Conservação – SNUC: Law # 9.985/2000.

and its key dimensions are broadly based as follows: employment (generation, opportunity, paid employment, and condition of work), social security (insurance, old age pensions, other types), workers' rights (forced labour, child labour, inequality at the workplace), and social dialogue (union density coverage, collective bargaining coverage, other types). Although the *Declaration* is an international instrument, it stresses that these dimensions must be ensured and implemented at the local level. The document also stresses that access rights to resources and collective territories towards sustainability are the most appropriate way to move forward in implementing more appropriate public policies for fishing communities. In line with the *Tenure Guidelines* (FAO 2012), it is "based on principles of sustainable development and with the recognition of the centrality of land to development by promoting secure tenure rights and equitable access to fisheries" (p.5). Efforts aiming at protecting and advancing workers' rights to *decent work* may give insight on how fishing groups are formed and how they develop their activities. It may also indicate how they can work together in managing fishing grounds with neighbouring fishing communities to improve governance.

Considering the extensive coastal waters under Brazilian jurisdiction and the multi-faceted characteristics of the small-scale fisheries sector, special attention must be given to transboundary and shared fish stocks, which are exploited by many small-scale fishing communities. Where multi-specific fisheries intersect or where transboundary stocks cross between different waters, and/or occur within common fishing grounds, fishing territorial rights and/or conservations units should be implemented to preserve the interests and access of small-scale fishing fleets. In these cases, an arrangement on transboundary stocks is necessary.

The small-scale fisheries value chain in Brazil is characterized both by complexity and a marketing arrangement in which the majority of the catch is destined for local markets. This process is highly informal and beyond the full reach of government control and developmental policies. Throughout such value chains, social and economic agents interact through common relationships and establish competitive distribution models (often through middlemen) (Croccia 2002). Although the value chains are functioning, their fragmented nature often has negative results on the sector's economic efficiency (especially for the fisher people), social and gender equity, and stock sustainability.

Existing procedures for regulating the exploitation of fisheries resources in Brazil, such as fishing ground, fishing methods, gear, and fleet, which are supported by the legal institutional arrangements and state governability, should help overcome conflicts for the use of fish stocks between fisheries, between fishers and other stakeholders, as well as between fishers and the government. If the above instruments and these procedures are not properly established within a strong governance system, the conflicts may result in the collapse of fisheries management and the regulatory framework, of the fishing stocks, and, ultimately, of the fishing community's social well-being.

## 21.4 Overcoming Challenges to the Implementation of Public Policies

Potential sources of additional obstacles to implementing more appropriate public fisheries policies must be considered, given that the links between fishing pressure, environmental changes, and fish behaviour are not sufficiently understood. The creation of the Ministry of Fisheries and Aquaculture (Law # 11958/2009), and the consequent approval of the Fisheries and Aquaculture Law (Law # 11959/2009), established the National Plan on the Sustainable Development of Fisheries and Aquaculture. This plan aimed at "ensuring sustainable use of fishing resources and optimizing the economic benefits deriving there from, in harmony with environmental protection and biodiversity" (p. 3). This instrument signified a significant step towards systematizing fishing policies introduced over the last 50 years. This new institutional and legal framework established guidelines for the planning, promotion, and supervision of fishing activity as well as the preservation, conservation, and recovery of fishing resources and aquatic ecosystems. Moreover, it sought to promote socio-economic, cultural, and professional development for fishworkers, the industry, and fishing communities (Brasil/SEAP 2008).

Although some level of democratic planning and fishing co-management can be found in the Brazilian public administration, the system itself does not guarantee that jointly defined management measures will actually be respected. In fact, it is only possible with civil society monitoring and control of public policies, through mechanisms and instruments to ensure the evaluation of the development strategies of goals and programs (Oliveira 2013). In addition to the production and social dimensions of fisheries policies, the institutional context must also be taken into consideration when rethinking the Brazilian fisheries management system. Between 1950 and 2003, this system has gone through cycles of boom and bust, from fully authoritative plans and public policies, to processes that have hollowed out institutional structures (Wojciechowski 2014).

Overfishing, combined with the lack of sanitation in large urban centres, installation of large industrial and port hubs, and disputes regarding the spatial occupation of coastal areas, among other factors, have resulted in numerous environmental conflicts on the use of and access to natural resources. Schiermeier (2002) stated that the work of fisheries scientists is cursed by uncertainties because, at best, models of fish population dynamics produce imprecise estimates of the maximum catches that can be taken without driving a stock to overfishing. Factors such as climatic variations can drastically influence fish population dynamics, obscuring the effects of fishing pressure. However, for Wojciechowski (2014) these conflicts have attracted interest from academia, non-governmental organizations, and various public and state agencies operating at multiple scales and have provided a considerable body of information on governance systems and co-management in Brazil.

Trends in fisheries sciences integrate various intrinsic relationships within and between the different fisheries' components (biological, economic, or social) (Ulrich et al. 2002). Corroborating with Mesnil and Shepherd (1990) who assessed regulatory measures for multispecies and multi-fleet fisheries through a hybrid age-structured and length-structured model, Ulrich and colleagues suggest that the interactions may be of two types: the inter- and intraspecific biological interactions, such as predator-prey and competition relationships, and technical, or technological, interactions such the use of specific gear based on interaction between scientific and traditional knowledge. Understanding these interactions, according to Willmann and García (1986), is necessary in order to provide decision-makers and administrators with a straightforward instrument that can assess the possible consequences of adopting political decisions.

Wojciechowski (2014) points to five major areas of entanglement between the past and current state developmental model that has been adopted for the fishing sector, namely: (1) the relationship between state development strategies and unsustainable fishing and catch rates, (2) the relationship between the sector's financing tactics and fishing strategies, (3) the pendulum swing between "productionist" and conservation interests in fish stocks and their representations in state organizations, (4) the relationship between state democratization and the shared management of fish stocks, and (5) the relationship between national development policies and the organization of fishing territories according to the value chain.

Furthermore, Wojciechowski (2014) believes that the democratization of the participatory governance model is a process of state rescaling towards the local and/or community level, with an ultimate aim of fostering agreement on the rights of use and access of natural resources. Consequently, the model was gradually deflated, thus creating outcomes such as an unsustainable division of powers within the developmental model itself, inconsistencies in the policy frameworks among different federative scales, and institutional overlaps and contradictions among the conservation, economic, and social fields. The author contests the supposed rupture of the current social developmental model with previous phases, instead interpreting recent changes as continuities that have been reinvented with new narratives of social inclusion and environmental preservation. In this regard, a debate has emerged on whether the current developmental model is capable of actually promoting environmental preservation of fishing resources or whether it single-handedly focuses on increased production, thus privileging the large-scale mode of production.

Based on a historical and legal perspective of two Brazilian fisheries laws – the Decree Law # 221/1967 (the Fisheries Code) and the new Fisheries Law # 11,959/2009 – Oliveira and Silva (2012) conclude that the Brazilian state intervenes in the fishing sector under the aegis of industrialist "developmentalism", resulting in the hollowing out of the small-scale fishing sector. The authors suggest several arguments based on their analysis of tax incentive policies applied to the fisheries sector. On the one hand, the 1967 Fisheries Code established privileges to fishing industries using tax exemptions. On the other hand, the Code did not include any guidance on artisanal fishing, omitting its legal definition altogether. Thus, artisanal fishing was considered to be anything that was not industrial. The 2009 Law, although it included a definition of artisanal fisheries and suggested the allocation of resource for this mode of production, generated results that were dramatically opposite to those stated in the Law. As a result, the Law supports the strengthening of industrialization, providing insufficient financial stimulus to small-scale fisheries, division of labour, and disposition of properties, among others.

Azevedo (2012), in a study of resource allocation, shows that there was actually a significant increase in the overall budget allocation to the fishing sector between 2003 and 2010. Based on the review of government websites, the author shows that the annual operating budget of the fishing industry's governing body during that time (the Ministry of Fisheries and Aquiculture) increased during this period by 1900%. In absolute terms, the budget's biggest chunk went to the small-scale subsector. However, when the per capita budget allocations are compared across industry subsectors (small-scale, industrial, and aquaculture direct investments[3]), these figures are reversed:[4] artisanal fishing received the lowest per capita allocation of R$ 269.14; industrial fishing, R$ 5,584.65; and aquaculture receiving the most at R$ 7,304.81.

In actuality, the existing management system lies beyond the domain of public policy implementation. As such, the complexities of Brazilian geopolitics and institutional and legal frameworks place emphasis on the governmental sphere. Although we recognize, along with Almeida (2013), that the analysis of participatory institutions is indispensable in understanding the new fluid interactions between society and the state, we agree with Oliveira (2013) that one must first understand the governmental management cycle located within the bureaucratic framework. This is the most relevant pillar of public administration, and, as such, its institutional and legal complexities must be unravelled. Considering Brazil's path dependency in the perpetuation of the developmental state, this task is crucial in understanding the potentialities and shortcomings of the policy instruments applied to the fishing sector.

The discussion presented in this chapter indicates that, although there is a relationship between the constructed and established public policies for small-scale fisheries and the existing institutional and legal framework, it does not suitably sustain fishing communities or provide support to government agencies responsible for the implementation of public policies because communities are left out of decision-making processes. Therefore, synergies are not generated by the existing management framework that supports the involved actors. The system does not take into account basic principles established under international instruments, thus weakening the process of implementation of management measures. As a result, the failings of the current system adversely affect the social, economic, technological, and ecological processes characteristic of small-scale fishing communities in Brazil, with implication on the sectors' sustainability.

A comparative assessment of the strategies and mechanisms that can be related for small-scale fisheries development, regarding international legal instruments and the Brazilian management system under the existing institutional and legal framework, and some related management measures, is presented in Table 21.1 below.

---

[3] Direct investments here refer to the investments made by the Ministry of Fisheries and Aquaculture in sector development (infrastructure of the value chain, markets, etc.). It excludes both financial mechanisms such as credits and market mechanisms such as diesel subsidies.

[4] This is mainly due to the large population working in the small-scale fishing sector in Brazil (more than one million) in contrast to aquaculture (14,100 workers) and the industrial sector (13,000 registered companies).

**Table 21.1** International legal instruments and their relationships with the Brazilian management system, under the existing institutional and legal framework, and some related management measures – a comparative assumption herein discussed

| *International legal instruments* | *Brazilian small-scale fisheries management system* | | | |
|---|---|---|---|---|
| | Fishers' behaviour | Fishing resources and the environment | The market system | Fisheries governance and governability |
| The Code (FAO 1995) | Human and ecological well-being | Predator-prey interactions | Decision-making processes | Decision-making processes |
| | Environmental impacts and conservation interests | Shared management of fish stocks | Integrated fishing communities | Fishery sustainability |
| | | Recovery of fishing resources and ecosystems | | Transboundary and shared fish stocks |
| SSF Guidelines (FAO 2015) | Overcome inequalities and conflicts | Environmental justice | Value chain | Poverty eradication |
| | | Fishing co-management | Food security | Monitoring and control of public policies |
| | Empowerment of fishing communities | | Optimizing economics benefits | Evaluation of goals and programs |
| | Marginalized and vulnerable groups | | | Human rights-based approach |
| ILO Declaration (ILO 1999) | Decent work | Human and ecological well-being | Corporate food regime | Poverty eradication |
| | Employment and income generations | | Food security | Social security and dialogue |
| | Freedom and humans rights | | Financial scheme and tactics | Institutional actors |
| Tenure Guidelines (FAO 2012) | Fishers' rights | Secure tenure rights and environmental issues | Economic surplus from the oceans | Fishing territorial rights |
| | Equitable access to land and fishing grounds | Managing fishing grounds | Resource allocation | Neighbouring fishing communities |

## 21.5 Concluding Remarks

A key strategy in democratizing fisheries management in Brazil is the decentralization of the state machine in pursuit of sustainability and representativeness, achieved through shared management models. Indeed, the introduction of participatory mechanisms of planning and fisheries management, either through participatory processes or protectionist approaches, represented the institution of new spaces in which the state began to articulate and define fishing policies. In summation, we argue that the geopolitical complexities facing Brazil still must be better understood in order to advance sustainability in the fishery and avoid further social, economic, and environmental inequalities. In addition, although international legal instruments are well known, they are far from being properly internalized, and there are many challenges facing national adherence to these instruments.

Ineffective public policy implementation for small-scale fisheries is closely related to the existing institutional and legal frameworks, which historically have not given due importance to this subsector. From a social standpoint in particular, fishers have been considered narrowly as a workforce and have not been integrated into broader social considerations by the state. Similarly, from an economic and productive point of view, small-scale fishers are at the margins of industrial fishing developmental policies and are thus not prioritized in development strategies. Small-scale fishing activity has never been properly recognized and has always been considered as an appendage to its large-scale counterpart, a mindset which affects the sustainability of fishing communities in multiple ways. Additionally, this context does not consider fishing communities' expectations and outlooks in constructing and implementing public policies, nor does it support a fuller understanding of fishing resources and the environment, the market system, and fishing governance and governability overall.

The current fisheries governance arrangements fall short of empowering small-scale fisheries to participate actively in co-management of fisheries resources. This process is still strongly dominated by short-sighted political issues, hampering the generation of information and knowledge through a bottom-up co-management system empowered by fishers and fishing communities and implemented by decision-makers in government agencies. This results in negative externalities, whether in terms of the public policies that are pushed through the system or in terms of the management measures which are often dissociated from the real interests and concerns of fishing communities.

Based on the existing regulation mode, we suggest a two-step approach aiming at establishing an efficient and effective institutional and legal framework. The first step should consist of a *technical-political balance*, aimed at achieving parity between government representatives and civil society organizations and leading to political decision-making based on the best existing technical and scientific knowledge. The second step is to pursue overall balance between *economic and social approaches*. These two spheres must be understood within the existing economic and social imbalance inside the fisheries sector, which is shaped by regional diversity and cultural expression. In this transition, knowledge is generated according to an *empirical-traditional dimension*, as each stakeholder involved provides information and defines and establishes understandings, as well as a *technical-scientific dimension* which establishes areas of procedures and support to decision-makers.

In essence, the ideal institutional and legal framework must encompass a multifaceted approach to fisheries management, creating and/or opening spaces for democratic co-management whether for advisory, deliberative, normative, or supervisory functions. Structured as such, the resulting framework will be able to contribute to fisheries sustainability and development by linking fishing communities and government structures to encourage environmental and human well-being.

To some extent, the identification of externalities (both positive and negative) is an important factor in determining the paths to follow in rethinking the management framework for Brazilian small-scale fisheries. In fact, these externalities, encapsulated by the three dimensions of sustainability, should provide the institutional and legal framework needed to reduce the uncertainties faced when implementing public policies. Ideally, the management measures implemented in the sector should be consistent with local and national realities. By highlighting the importance of a co-management approach, we intend to anchor our exploratory proposal within the fundamental principle of community integration and capacity building as a means of navigating and overcoming the intrinsic cultural, institutional, and political complexities implied in the fisheries socioecological system.

We advocate that policies for small-scale fisheries must be integrated in multiple scales and ensure the inclusion of various social, institutional, and economic stakeholders. This integration should remain in constant realignment with up-to-date issues discussed and built on a global scale, as well as be firmly anchored in fisheries science management methods and conceptual foundations. With this approach, we hope to contribute to the debate on how to overcome the often simplistic and precipitated binary antagonisms that permeate the sustainability narrative of the fisheries sector in Brazil and in other developing countries.

The apparent complexity of the Brazilian institutional and legal framework for small-scale fisheries is a challenge worth further exploring. Future work aimed at strengthening an effective and efficient framework must attempt to answer the following questions:

- *To what extent is the existing institutional and legal framework currently establishing fishing policies that reflect the realities and conflicts found in and between small- and large-scale fisheries*?
- *To what extent does the existing institutional and legal framework build on synergies with the established management system and the implementation of management measures for small-scale fisheries*?
- *What are the effects of the management system on the existing social, economic, technological, and ecological processes found in small-scale fishing communities in Brazil and their implications for sustainable development*?

**Acknowledgement** We would like to acknowledge all contributions from Michelly de Mattos in providing insights on the most important institutional and legal issues that must be analysed as a way of improving the implementation of public policies for small-scale fisheries in Brazil.

## References

Acselrad H (2004) As práticas espaciais e o campo dos conflitos ambientais. In: Acselrad H (ed) Conflitos ambientais no Brasil. Relume Dumará, Rio de Janeiro, pp 11–34

Almeida DR (2013) Prefácio: Dilema e virtudes da institucionalização da participação. In: Silva EM, Soares LB (eds) Experiências de Participação Institucionalizada. UFMG, Belo Horizonte, pp 11–19

Anderson LG (1977) The economics of fisheries management. The John Hopkins University Press, London

Azevedo N (2012) Política nacional para o setor pesqueiro no Brasil 2003–2011. Tese de Doutorado. Programa de Pós-graduação em Meio Ambiente e Desenvolvimento. Curitiba, UFPR. http://dspace.c3sl.ufpr.br/dspace/handle/1884/29268. Accessed 12 Sept 2014

Brasil/Ministério da Pesca e Aquicultura – MPA (2016) *Registro general da atividade pesqueira.* Ministério da Pesca e Aquicultura, Brasília. http://www.mpa.gov.br. Accessed 16 Jan 2016

Brasil/Ministério da Pesca e Aquicultura – MPA (2012) Produção pesqueira e aquícola – estatística 2008–2012. Ministério da Pesca e Aquicultura, Brasília

Brasil/Secretaria Especial de Aquicultura e Pesca – SEAP (2008) Mais pesca e aquicultura – Plano de Desenvolvimento Sustentável – Uma rede de ações para o fortalecimento do setor. Secretaria Especial de Aquicultura e Pesca da Presidência da República, Brasilia

CCRN (Community Conservation Research Network) (2015) International research coalition issues warning: Failure to involve local and indigenous communities in natural resource decisions can produce disastrous results. Press release. http://ecgg.uwaterloo.ca/files/2015/06/CCRN-media-release-June-9-2015.pdf. Accessed 3 May 2017

Chuenpagdee R (2011) A matter of scale: prospects in small-scale fisheries. In: Chuenpagdee R (ed) World small-scale fisheries: contemporary visions. Eburon Academic Publishers, Delft, pp 21–36

Croccia AG (2002) Caracterização da cadeia produtiva da pesca de linha-de-mão da frota artesanal no Município de Jaboatão dos Guararapes-PE. Monografia para obtenção do título de Engenheiro de Pesca. UFRPE, Recife

Dias-Neto J (2010) Pesca no Brasil e seus aspectos institucionais: Registro para o futuro. Revista Cepsul 1(1):66–79

Dias-Neto J, Dornelles LCC (1996) Diagnóstico da pesca marítima no Brasil. Ibama, Coleção Meio Ambiente – Série Estudos da Pesca, Brasília

FAO (Food and Agriculture Organization of the United Nations) (1995) Code of conduct for responsible fisheries. FAO, Rome

FAO (2012) Voluntary guidelines on the responsible governance of tenure of land, fisheries & forests in the context of national food security. FAO, Rome

FAO (2015) Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security & poverty eradication. FAO, Rome

Freire J, García-Allut A (2000) Socioeconomic and biological causes of management failures in European artisanal fisheries: the case of Galicia (NW Spain). Mar Policy 24:375–384

Gasalla MA (2011) Do the answers lie within (the community)? Fishing rights and marine conservation. In: Chuenpagdee R (ed) World small-scale fisheries: contemporary visions. Eburon Academic Publishers, Delft, pp 185–203

ILO (International Labour Organization) (1999) Report of the director-general: decent work. In: International labour conference, 87th session. ILO, Geneva

Mattos SMG (2011) Desafios à implementação de políticas públicas e à gestão participativa da pesca artesanal. In: Mattos SMG, Moura RT, Maia WM Jr (eds) Gestão de pescarias costeiras e da maricultura. Anais da II Oficina de Trabalho de Aquicultura e Pesca do Nordeste. Ministério da Pesca e Aquicultura, Superintendência do Desenvolvimento do Nordeste, Brasilia, pp 79–96

Mattos SMG (2014) Políticas públicas e gestão participativa da pesca artesanal: O extrativismo pesqueiro em ecossistemas estuarinos. In: Silva GHG, Carolsfeld J, Olivera Galvez A

(eds) Gente Da Maré: Aspectos ecológicos e socioeconômicos da mariscagem no Nordeste Brasileiro. EdUFERSA, Mossoró, pp 315–352
Mesnil B, Shepherd JG (1990) A hybrid age-structured and length-structured model for assessing regulatory measures in multiple-species, multiple-fleet fisheries. J Cons Int Expl Mer 47:115–132
Oliveira VR (2013) O processo de participação social nos planos plurianuais do governo federal. In: Silva EM, Soares LB (eds) Experiências de participação institucionalizada. UFMG, Belo Horizonte, pp 20–46
Oliveira O, Silva V (2012) O processo de industrialização do setor pesqueiro e a desestruturação da pesca artesanal no Brasil a partir do Código de Pesca de 1967. Sequência 65:329–357
Ruffino ML (2012) Summary of Brazil consultation workshop. In Report of the workshop on International Guidelines for Securing Sustainable Small-Scale Fisheries. FAO, Rome, pp 7–10
Schiermeier Q (2002) How many more fish in the sea? Nature 419:662–665
Seixas S, Kalikoski D (2009) Gestão participativa da pesca no Brasil: Levantamento das iniciativas e documentação dos processos. Curitiba; Editora UFPR: Desenvolvimento e Meio Ambiente, 20 pp 119–139
Ulrich C, Le Gallic B, Dunn MR, Gaxuel D (2002) A multi-species, multi-fleet bioeconomic simulation model for the English Channel artisanal fisheries. Fish Res 58:379–401
Willmann R, García SM (1986) Modelo bioeconómico para el análisis de pesquerías secuenciales artesanales e industriales de camarón tropical. FAO Documento Técnico de Pesca, 270, FAO, Rome
Wojciechowski MJ (2014) Uma leitura teórica da espacialidade, institucionalidade e escalaridade do estado desenvolvimentista Brasileiro no âmbito da pesca. Dissertação de Mestrado. Programa de Pós-Graduação em Planejamento e Gestão do Território. Universidade Federal do ABC

**Sérgio Macedo G. de Mattos** works as a public manager at the Ministry of Planning, Brazil. He graduated in Fishing Engineering from the Federal Rural University of Pernambuco and holds a PhD in Marine Sciences from the Marine Sciences Institute of Barcelona. His work focuses on the management of small-scale fisheries and fisheries resources assessment, with an emphasis on fisheries bioeconomics and issues related to public policy implementation. This approach highlights economic and biological sustainability and calls for careful management that includes participation of fishers and other stakeholders. He is also a coordinator of the TBTI "Global Synthesis" cluster and a contributor to other TBTI clusters. Curriculum Lattes available at http://lattes.cnpq.br/4839144787251285.

**Matias John Wojciechowski** received a Master of Local Economic Development from the University of Waterloo (2002) and a Master of Territorial Planning and Management from the Federal University of ABC (2014). Currently he is working on a PhD in Rural Development. His thesis is on "Territories of transition: Pathways from conventional agriculture to sustainable production systems". Since 2006, he has worked with the World Fisheries Trust with inland and coastal fishing communities focusing on value-chain development, food safety, occupational health, economic development, and solidarity economy. From 2012 to 2014, he participated in the "Pesces Para la Vida" project in Bolivia, implementing participatory value-chain assessments and economic feasibility studies.

# Chapter 22
# Exploring the Governability of Small-Scale Fisheries in Ecuador and Galapagos Islands Under the *Buen Vivir* Principle

**María José Barragán-Paladines**

**Abstract** Fisheries in Ecuador and the Galapagos Islands are a very complex, diverse, and dynamic sector. Unfortunately more often than not, policies and practices applied to govern fisheries have proven to be inappropriate. Small-scale fisheries in mainland Ecuador and the Galapagos Islands face multiple challenges mostly linked to the limited governability of the fisheries systems. By using empirical evidence based on triangulation of qualitative open-ended surveys and intensive literature review, this chapter explores the fisheries sector in Ecuador through the lenses of the *Buen Vivir* standpoint, which is the guiding principle of Ecuador's National Development Plan. Under the interactive governance approach, which is used as the primary analytical framework, this chapter examines the challenges encountered in governing small-scale fisheries in both the Ecuadorian mainland and Galapagos Islands. This chapter highlights the coincidences and mismatches between the two normative instruments simultaneously operating in these two regions. Main findings confirm the existence of incongruities between the *Buen Vivir*-inspired national development path and the policies and practices taken to address small-scale fisheries issues. Yet, common grounds between both instruments exist, and they may serve to pave the road for a comprehensive governance model for the national fisheries systems. We suggest that by implementing a comprehensive overarching national policy framework for fisheries, the *Buen Vivir* principle – ruling the national development plan – would be better illustrated. By doing such, the overall governability of fisheries in Ecuador would improve, and thus the sustainability of small-scale fisheries and the viability of fishing communities in both regions would be fostered.

**Keywords** Small-scale fisheries · Governability · Ecuador · Galapagos Islands · *Buen Vivir*

---

M. J. Barragán-Paladines (✉)
Development and Knowledge Sociology-Social Science Department, Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany
e-mail: mariaj.barraganp@leibniz-zmt.de

 
S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_22

## 22.1 Small-Scale Fisheries in Ecuador and Galapagos Islands: The *Buen Vivir* Principle

In 2008, Ecuador approved its new constitution (Ecuadorian National Constitution 2008), recognizing the rights of nature for the first time ever as a subject capable of enjoying legal rights and protections in the national courts (Berros 2015). This legal mandate was inspired by the Quechua principle of *Sumak Kawsay*, translated as "good way of living," or *Buen Vivir* in Spanish. However, although this legal instrument is recent, *Buen Vivir* is not a new notion: it has remained active, mainly, in the Ecuadorian indigenous population for centuries. The term is derived from an ancient Amerindian cosmovision of equilibrium that recognizes the harmonic coexistence between nonhuman and human actors in nature, while privileging the collective over individuality and solidarity over competition. The concept is defined by Escobar (2015a) as "good living, or collective wellbeing according to culturally-appropriate ways" (p. 25). Similarly, Radcliffe (2012) describes it as a postcolonial, post-neoliberal, and holistic view of life, classifying *Buen Vivir* as a form of life philosophy of indigenous societies that has been eroded by the dominant practices and messages of Western rationality. Since 2008, the *Buen Vivir* principle has become the foundation for the National Ecuadorian Development Plan (PNBV, by its Spanish acronym), which no longer places central focus on the economy (Escobar 2015a) but rather contests the overemphasis on economic growth in previous development model (Lind 2012). This vision, according to Lind (2012), proposes alternative paths to development – which is framed as only a means to an end, rather than an end in itself – and stresses the need for "other" form of development to encompass dimensions like quality, freedom, equal rights, and sustainability.

In the decade since the new constitution was introduced, the Ecuadorian state has been the driving force in achieving social well-being on both the mainland of Ecuador and the Galapagos Islands. The government's efforts, although not completely successful, have paid increased attention to small-scale fisheries, which have been a traditionally under-estimated and marginalized sector in Ecuadorian coastal regions. For the first time in Ecuadorian history, small-scale fisheries have been taken into account alongside other labor-related sectors at the national level in order to improve the working conditions and overall well-being of fishers.

In line with that, although the new Ecuadorian constitution is guided by a comprehensive new paradigm that recognizes the rights of fishing resources to be protected, it still fails to fully acknowledge the rights of fishing people to fish. We argue that fishing families' access to fisheries-derived livelihoods has neither been explicitly accounted for neither clearly articulated to date. Thus, by invoking the notion of *Sumak Kawsay*, we claim that the full incorporation of the idea of Mother Earth into legal instruments should also include the rights of fishing people to access to fish resources.

In recent decades, increasing attention has been paid to the role that critical global issues such as climate change, marine pollution, and more recently ocean grabbing play in the sustainability of fisheries (Bennet et al. 2015). However, despite this increased research and policy emphasis on sustainable fisheries, this goal has rarely been achieved in practice (Pauly et al. 2002). In Ecuador, the high cultural importance of fish as a food source, a ceremonial asset, and a tradable good since very early stages in Ecuadorian history has been widely demonstrated by historical and archeological evidence (Norton 1982, 1985; Schwarz 1987; McEwan and Silva 1998; Staller 2001; Stothert 2008; Rostworowski 2015). Yet, in recent decades greater emphasis has been placed on research focusing on the biology and ecology of fisheries resources, as well as appropriate managerial practices (Grupo Núcleo 1999; Murillo-Posada et al. 2013), supported by the administrative bodies that govern small-scale fisheries. We posit that ethical and moral factors are also critical considerations for ensuring that small-scale fisheries governance adequately addresses urgent challenges for the sector such as poverty, malnutrition, exclusion, and marginalization. However, the biggest pitfall in this new legal regime is that these considerations, although consistent with the concept of *Buen Vivir*, have been delayed or ignored within the policies and practices framed under the National Constitution and overseen by the PBNV. This failure to recognize the complexity, diversity, and dynamics involved in Ecuadorian small-scale fisheries was evidenced by clashes between policies and practices that were put in place by two coexisting governing systems: the top-down hierarchical approach taken in the mainland of Ecuador and the horizontal co-management model adopted in the Galapagos Islands (Barragán-Paladines 2015).

The haphazardness of the national fisheries policy gave rise to dissonant and incoherent decisions and policies and to inappropriate governing strategies at dealing with fishing resources, which have been viewed purely as fish stocks to be managed. Despite these diverse values and affective bonds existing among fishers and fishing communities, management actions carried out to address small-scale fisheries challenges tend only to consider quantitative attributes of fisheries like quotas, fish landings, and market prices for commercially demanded species. Thus, the prevailing management regime has ignored the wholeness dimension of the *Sumak Kawsay* principle, as interpreted by the PNBV (SENPLADES 2009).

Research on small-scale fisheries in Ecuador has focused on both mainland and Galapagos fisheries. Studies about mainland fisheries have addressed key aspects such as fishing communities (Pollnac et al. 1987), fleet and gears (Gaibor et al. 2001), methods of studying small-scale fishing communities (Pollnac et al. 1987), fisheries development (Allsop 1985), fisheries planning (Arriaga and Martínez 2008), ordering (Beltrán Turriago 2001), local assessment (Coello 1993), and regional assessment (Charles et al. 1994; Tassara 1994). On the other hand, research on Galapagos fisheries has mainly examined environmental issues (Banks 2002, 2007, 2009; Banks et al. 2006; Bustamante et al. 1999a, b; Edgar et al. 2004a, b, 2008; Vinueza et al. 2006); socio-political aspects of fisheries (Ospina 2001; Ospina and Falconí 2007; McDonald 1997; Kerr 2005; Epler 2007; Grenier 2007; Heylings and Bravo 2007; Viteri and Chávez 2007;Taylor et al. 2009), recreational fisheries (Schuhbauer and Koch 2013), and aspects of fisheries management (Reck 1983; Ramírez 2004; Stone et al. 2006; Jobstvogt 2010; Castrejón 2011, Castrejón and Charles 2013; Castrejón et al. 2013).

Despite the diversity of existing research on small-scale fisheries in Ecuador, no studies so far have explicitly demonstrated the connection between the notion of *Buen Vivir* – which is present in all of the objectives of the PNBV – and small-scale fisheries. We identify several potential causes for this oversight. First, the indigenous-derived epistemological dimension of *Sumak Kawsay* has traditionally and intentionally been disregarded by the positivist Western rationality that has dominated the cultural construction of natural resources and their usage since the Spanish conquest of Ecuador. Second, the technocratic species-based discourses for fisheries management put in place during the last decades have underemphasized more holistic or humanistic ways of understanding and governing the environment. Third, the use of the *Buen Vivir* principle as the dominant paradigm in the PNBV is part of a very recent (i.e., since 2008) shift in mindsets, initiated by the current government, that is only beginning to dismantle the traditional notion of development that has held a hegemony over governance in both Ecuador and across Latin America.[1]

The sustainability of small-scale fisheries and the viability of fishing communities are pivotal to securing the human rights to food and livelihoods (Allison et al. 2012). Despite being constitutionally protected, the conservation of fish stocks still is subjected to incongruous management practices that preclude the effective governance of these resources. In general, the singular focus on the nominal economic value of landed fish has largely negated the existence and importance of "other" values derived from fisheries. The result is that small-scale fishers may lose their access to traditional livelihoods and, consequently, the right to fish (Harris 2008). Ultimately, as argued by Pitcher and Lam (2010), this exclusion continues to prevent the implementation of adequate policies and practices regarding small-scale fisheries and fails to secure fishing communities' human right to food security.

This chapter examines the extent to which the existing legal frameworks in place in both mainland Ecuador and Galapagos reflect (or fail to reflect) the principles of *Buen Vivir* in relation to the small-scale fisheries sector. We assess current trends in small-scale fisheries governance, from the standpoint of both fishing resources (in terms of their right to be protected) and fishers (in terms of their right to fish). This analysis is guided by a varied set of principles derived from resource-based management practices and taken directly from the PNBV and from the normative instruments ruling human's activities in Galapagos.

The guiding research question for this study seeks to understand to what extent the PNVB (as Ecuador's primary set of guidelines for governance) and the notion of sustainable development (as the predominant principle guiding the instruments in place in Galapagos) have led to the achievement of sustainability of small-scale fisheries. The chapter's specific objectives are to (a) explore the commonalities among the normative instruments in both regions and demonstrate how they interact,

[1] At the time of reviewing this chapter, new presidential elections took place in Ecuador. The recently elected government – who belongs to the same political party of the outgoing president – is expected to maintain their vocation, by fostering this national ideal, in the long term. By doing so, the *Buen Vivir* will remain as the guiding national principle, leading the Ecuadorian's development path.

(b) illustrate the mismatching elements between the varied instruments, and (c) analyze the main implications of the commonalities and differences encountered for improved governance. Some concluding thoughts and reflections are presented at the end of the chapter.

## 22.2 Methodological Approach

Duggan et al. (2014) argue that thinking about fisheries and fishing resources with an adaptive and flexible "fish-shape mentality," by fisheries governing bodies, could enhance the likeliness of the sector to adjust to the high uncertainty of the systems that affect it. According to these authors, this approach would help lead to a better balance between the profitability and sustainability of fisheries and would strengthen the linkages between fishers, the fish they catch, and the overall marine ecosystem. This idea parallels with the crux of the interactive governance approach (Kooiman et al. 2005, Kooiman 2008; Bavinck et al. 2013), which examines fisheries governance by considering the interactions between natural and social systems to be governed and their governing systems. In order to address these multiple dimensions of small-scale fisheries governance, this chapter employs interactive governance approach (Kooiman et al. 2005, Kooiman 2008; Chuenpagdee 2011; Bavinck et al. 2013; Jentoft and Chuenpagdee 2015), with a specific focus on the governability assessment framework (Kooiman 2008; Chuenpagdee and Jentoft 2009; Kooiman and Bavinck 2013). Using these frameworks, we describe how the governance attributes, including the governing system (GS), natural and social systems to be governed (SG-N and SG-S), and their governing interactions (GI), involved in the governability of small-scale fisheries in both mainland Ecuador and the Galapagos Islands are interlinked, as well as how they draw on the current developmental discourse centered around *Buen Vivir* in both regions.

### *22.2.1 The Study Area*

The study area includes two Ecuadorian geographical regions: the coastal mainland and the Galapagos Islands (Fig. 22.1). Ecuador is located in one of ten global conservation priority regions based on the abundance, productivity, and high concentration of terrestrial and marine resources present in the country (Olson and Dinerstein 1998; Olson et al. 2002). This diversity is due in part to the presence of upwelling systems in the Pacific Ocean caused by southeasterly trade winds, which shift relatively cold and nutrient-rich waters to the euphotic zone along the coast (Charles et al. 1994; Hannah et al. 2013). The coastal region of mainland Ecuador is made up of six provinces, five of which have direct access to the ocean.

The Galapagos Archipelago is one of 24 provinces in Ecuador and is the country's only island region. The islands are of volcanic origin, located about 1000 km


**Fig. 22.1** Map of Ecuador (mainland and Galapagos Islands) (Source: Modified from ECOLAP and MAE 2007)
*EBM (ecosystem-based management) is placed as a principle acting on both the GS and the SG-N. The rationale for this is that EBM is somehow a form of governance but at the same time, explicitly concerns the SG-N in terms of ecosystems

off the Ecuadorian coast. The archipelago is home to one of the most complex, diverse, and unique ecosystems in the world and is considered a natural laboratory for studying and understanding evolutionary processes (Stone et al. 2006). The high biological diversity, ecosystem richness, and productivity found in Galapagos are due to the islands' geo-biophysical characteristics and the convergence of three major oceanic currents system in this area: the Peru Current, the Cromwell Current, and the Panama Current (Bustamante et al. 1999a, b; Danulat and Edgar 2002; Baine et al. 2007).

### 22.2.2 Research Boundaries

Understanding the interactions between small-scale fisheries systems in the Ecuador mainland and Galapagos is a daunting task. Therefore, we defined the boundaries for this study around geographic settings, variables, methods, and theory. Although fishing resources in Galapagos are currently governed by policies involving the entire archipelago and the adjacent marine territory (LOREG 2016), the current study focuses on fishing activities conducted by fishers of the community of Puerto Ayora, in the Island of Santa Cruz. Yet, the implications of findings from this case do not represent all Galapagos-based fisheries; they still provide a valuable portrayal of one fishing community on the archipelago. At the ecosystem level, only coastal marine small-scale fisheries are included; neither aquaculture nor inland small-scale fisheries were taken into account. From a theoretical perspective, the study employs a conceptual framework informed by interactive governance approach and the concept of governability. In this light, governability is understood as the overall governance quality of a system or its capacity to be governed effectively (Kooiman et al. 2005). Governability primarily depends on three factors: the characteristics of the SG, the characteristics of the GS, and the ability of the GS to govern (Song and Chuenpagdee 2010; Chuenpagdee and Jentoft 2013). Within this conceptual lens, this chapter identifies key attributes that affect the governability of both the mainland Ecuador and Galapagos small-scale fisheries systems and explores the normative instruments that govern them.

### *22.2.3 Data Collection and Survey Methods*

Several methods were used in this study, including semi-structured e-mail surveys, open-ended interviews with key informants, informal conversations with key local stakeholders – including community members and government officials – field observations, and intensive review of relevant published documents (including peer-reviewed literature, theses, and gray literature). Purposive sampling was used to identify specific users to be sampled and to select interview participants, who were recruited using e-mail-based communication (Mays and Pope 1995; Teddlie and Yu 2007). This technique enabled the inclusion of a breadth of relevant perspectives (Kerr and Swaffield 2012), allowing the study's findings to reflect the diversity of the target groups within the population in both study regions (Kuzel 1992).

## 22.3 What Has Been Found? The Evolution of Small-Scale Fisheries in Ecuador

Small-scale fisheries on the Ecuadorian mainland and the Galapagos Islands have experienced very different trajectories during the past few decades (Barragán-Paladines 2015). The former have been part of a long tradition of marine resource usage, which has been mainly subsistence-based in nature, by coastal communities since at least 5000 BCE (De Madariaga 1969; Norton 1985; Staller 2002). Commercial fishing is considered a new phenomenon on both areas, beginning with early commercial fishing activities in the 1960s in the mainland and accelerated by the boom in the sea cucumber fishery in the late 1980s in Galapagos (Barragán-Paladines 2015). In this light, the two regions have taken opposing historical paths and have had divergent experiences with researching fisheries, with differing foci on research objects, target species, and fishing techniques. All of these investigations have focused on differentiated management and/or conservation strategies applied to small-scale fisheries on both areas. However, none of the development patterns followed by fisheries governance on both areas have been identified to be linked, either directly or indirectly, to any specific overarching paradigm like *Sumak Kawsay* (in form of the PNBV) or to the UN Sustainable Development Goals (SDGs).

### *22.3.1 Ecuador and Its Fishing Resources*

Fishing resources are critical assets to human welfare, serving as major sources of animal protein, essential nutrients, and livelihoods for a large proportion of Ecuadorians (Le Sann and CISP 1997). Additional to the "materiality" of their importance as a source of economic income and nutrition, small-scale fisheries on both the mainland of Ecuador and Galapagos also carry high importance in terms of social, ethical, moral, and justice-related dimensions. When the interviewees were asked about "what does 'fishing' mean to you," one respondent said:

> *It means a lot….especially for me as a user* [fisher]*…means the love that one feels about the job*. (P04, 5 April 2012)

However, these sociocultural dimensions of fisheries have largely been neglected, despite their critical role in the governance of fish stocks threatened by overexploitation (Kahmann et al. 2015). In the case of Ecuador, unfortunately, these affective attributes are almost nonexistent in national-level policy-making and strategies. Despite the ethical and moral significance of this sector, small-scale fisheries have not fully benefitted from the *Buen Vivir* paradigm that the Ecuadorian state has followed in the last decade. As one informant stated:

> *Small-scale fishers are poor, and continue to be poor* (P21, 22 March 2012)

In fact, very little has been done at the national level to bridge, or at least reduce, the gaps that exist between the two normative instruments that oversee fisheries governance in both regions of the country. At the same time, responses to fundamental questions about the future of fisheries in both regions (e.g., "who can fish?," "why?," "how much?," and "for whom?") remain to be provided in a clear way by the governing bodies. Thus, we argue that without the consideration of these sorts of inquiries in management, it is unlikely to scope viable ways to fully define, understand, and address issues concerning small-scale fisheries in Ecuador.

### *22.3.2* **The *Buen Vivir:* Its Relation to the Fisheries Sector in Ecuador**

Poverty and small-scale fisheries are considered to be closely related (Béné 2003), often interacting with precarious living conditions among marginalized groups. The former has recently begun to decrease in Ecuador, a country traditionally labelled

"Third World" that has experienced significant economic and social development in recent years. After tumultuous periods of political negligence, governmental inertia, and corruption, the country finally reached a period of political stability in 2006. Within 10 years, the Ecuadorian state has put in place innovative strategies aimed at advancing social, economic, and political stability and enhancing overall well-being. In so doing, the country has made significant progress toward reducing poverty and decreasing the marginalization of traditionally excluded social groups (OECD 2013a, b). In fact, Ecuador is one of Latin America's fastest growing economies (approximately 6% annual GDP growth) while achieving roughly 80% of its hunger eradication target under the Millennium Development Goals (MDGs) (FAO 2015a, b). This upward trend is seen in the improvement in the quality of life of the most deprived sectors of the population which, according to Escobar (2010), demonstrates an unprecedented "biocentric turn" in the political, social, and economic fabric of Latin America.

Home to some of the most deprived segments of Ecuadorian society, the coastal region of mainland Ecuador has roughly 6.5 million inhabitants, more than 0.4% of whom are directly engaged in fishing activities, equaling an estimated 25,783 active fishers (SRP 2017a). These fishers are located in 175 *caletas pesqueras* (or small-scale fishing villages) (SRP 2017b), as well as other communities where different activities in the fish chain occur, including 2706 middlemen operating at the small-scale and 240 middlemen operating at the large scale (INEC 2010; SRP 2013). Despite their low representation in the overall mainland Ecuadorian population, fisheries are still one of the most important sectors within society in terms of food security, access to livelihoods, and providing local sources of revenue for coastal communities.

A different story takes place on the Galapagos Islands. In the eyes of outsiders, the ecosystems of the Galapagos Archipelago are in good condition, representing what is imagined by Western society as a wild and pristine paradise that is synonymous with wilderness and untouched nature (Broadus 1987; Diegues 2005; Celata and Sanna 2010; Hennesy and McCleary 2011). At the same time, economic indicators suggest that Galapagos' economy is on average twice as high as on the mainland (Jones 2013) in terms of GDP. These economic indicators speak to a high level of economic growth on the archipelago (Hoyman and McCall 2013). This trend is also seen in rising investment in infrastructure, the proliferation of the service industry, and the blossoming of certain sectors (e.g., construction and transportation) that has mainly been triggered by the annual visitation of 180,000 tourists (Denkinger et al. 2013). Tourism in Galapagos is centered around the unique natural systems of the islands.

However, these trends mask the economic difficulties that local fishers have experienced in light of tourism growth. There is no official recognition in either region of the role that small-scale fisheries and fishing people play in meeting societal needs such as poverty eradication, hunger alleviation, nutrition, food security, and food sovereignty. Additionally, there have been very few attempts to identify the problems and conceptualize the most important challenges threatening the sustainability of this sector in Ecuador (Barragán-Paladines 2015). For example, the current effects of global trends like globalization and mass tourism on this sector – both locally and nationally – are rarely assessed when management programs are designed. This oversight increases the status of invisibility (or reduced visibility) of the entire sector, as highlighted by FAO (2015b). The "low profile" under which the small-scale fisheries sector is seen largely obeys to the failure in addressing small-scale fisheries governance comprehensively (Béné 2009). This perception has deeply reduced the likelihood of fisheries authorities and practitioners to improve fisheries governability in an efficient manner. Other causes for this oversight, as described by Pauly et al. (1998) and Castrejón (2011), include the prevalence of open-access policy regimes for fisheries resources and the proliferation of subsidies that, despite being intended to improve the sector's profitability, have instead led to the overcapitalization of the small-scale fisheries sector and fleet overcapacity.

Another important factor is that science-based decision and policy-making have privileged the technical and scientific dimensions of fisheries management over sociocultural values. Consequently, the "development of fisheries" under the sustainability paradigm has dominated the managerial discourse in Galapagos (Toral Granda et al. 2011). However, limited awareness still exists about the human dimensions implicit in fisheries governance and it has resulted in the inadequate approach towards fisheries in this archipelago. One potential explanation for this failing is the lack of recognition that management and governance are not synonymous, given that the former provides the "what to do" response, whereas the latter answers the "how to" achieve the aims (Chuenpagdee 2011; Armitage et al. 2012). In contrast to a narrow consideration of these management approaches, the broader focus on improved fisheries governance signals that the management age "is over" (Ludwig 2001, p. 758). In fact, too much effort has been spent assessing the effectiveness of management (Toral Granda et al. 2011; Hockings et al. 2012), focusing on the evaluation of traditional parameters such as the allocation and renewal of fishing permits, monitoring and controlling of post-harvest activities, and dealing with other management duties (Hockings et al. 2012). Thus, we confirm the thesis of Bavinck et al. (2013), arguing that while these "first-order" governance tasks are important, they do not fully address the fundamental issues affecting the human and environmental health of small-scale fisheries systems. In fact, these operational considerations do not entirely illustrate the high potential of this sector as a key employment contributor, trade promoter, and food security enhancer (Pauly et al. 2003).

## 22.4 Exploring the Relationships Between Normative Instruments on the Ecuador Mainland and Galapagos from the Perspective of *Buen Vivir*

Prevailing narratives of Galapagos tend to imagine the region through a homogenous lens of conservation, reproducing a dominant portrayal of the islands as a pristine environment devoid of human influence. On the other hand, mainland Ecuador's communities are commonly portrayed as ignorant of the environmental threats that challenge their environment. In short, the values and principles that influence the behavior of both regions are portrayed to be different (González et al. 2008), while the dominant narratives, which can act as "enabling force[s], that can inform, empower, and, in the best of all worlds, transform human activity" (Bussey 2014, p. 96), are largely separate between the two regions.

Previous research findings have shown that neither the "conservationist narrative" nor that of "fisheries protection" effectively led to fully successful implementation of marine protection in Galapagos, which has been lauded as one of the most effective marine protected areas (MPAs) in the world (Barragán-Paladines 2015). Instead, public and private interests, ranging from geopolitical forces to tourism development, have played pivotal roles in the administration of this marine reserve.

Therefore, we argue that neither on mainland Ecuador nor Galapagos have key actors shared a unified discourse that has led to improved fisheries governance. This is reflected in part by the dissonant principles that have framed development in both regions, which have followed different orders and priorities. These principles, portrayed within the existing normative frameworks in place in both regions, are shown in relation to their corresponding governability attributes that are addressed under each of them (Table 22.1).

By applying the interactive governance approach, we found that the three attributes of the systems involved in Ecuadorian small-scale fisheries governance (i.e., GS, SG-N, SG-S, and GI) are represented by the principles espoused in the existing normative instruments on mainland Ecuador and Galapagos. However, some differences were found concerning what principles are included and how they are formulated and prioritized in each region. It is important to note that the most important legal instrument in force for Galapagos – LOREG, which was approved in 2015 and came into effect in 2016 – introduces a substantial change into the former horizontal co-management model for marine resources in the archipelago. This instrument signals a shift, in Galapagos, to a more hierarchical governance mode, personified by the Government Council, which oversees natural resources in general, and by the Galapagos National Park, which specifically manages fishing resources (LOREG 2016, Art. 4; J.C.M., Pers. comm., April 2017). Thus, it seems that LOREG – at least in theory – also integrates elements of the *Buen Vivir* principle (Art. 1, Art. 2, and Art. 33) through the principles of the Sustainable Development Plan for Galapagos concerning natural heritage conservation and *Buen Vivir* at large. Yet, the extent to which this regional development plan coincides with the national PNBV, and consequently how these two governing systems align, is still a matter of further inquiry.

Furthermore, our analysis shows that the governing principles – present in the normative instruments in place in both regions – are mainly aimed at addressing human development and usage of natural resources, by allocating equal weight and keeping the "growth" dimension implicit on it. In line with that, we see few spaces for "alternatives to development" on either area against the pleaded sustainable development, sustainable economy, and new productive matrix. Overall, these findings show that existing normative instruments are not aligned to the common intended outcome of *Buen Vivir* promoted at the national scale, thus failing to invoke this principle's departure from the dominant development narrative.

**Table 22.1** Principles contained in the different normative instruments currently in force in both areas. Dark fields show the principles involving small-scale fisheries

| | Principles guiding each region's legal frameworks | | | | |
|---|---|---|---|---|---|
| | Mainland Ecuador | Galapagos Islands | | | |
| Systems | National Ecuadorian Constitution (embodied by PNBV) | GMR Management Plan (1999) | GNP Management Plan (2006) | *Capítulo Pesca del Plan de Manejo de la Reserva Marina de Galápagos* (2009) | *Ley Orgánica de Régimen Especial de la Provincia de Galápagos* (LOREG) (2016) |
| Governing system | 1. Consolidation of the **democratic** state and the construction of the people's power | 1. "**Allocation**"[a] (top-down format to surveil and control) | 2. **Sustainable development** and control (support capacity in the ecosystems) | 1. **Sustainable** management | 1.**Precautionary principle** |
| | 11. **Sovereignty** and efficiency of strategic sectors for industrial and technological transformation | 3. **Adaptive principle** | 7. **Precautionary principle** (avoiding harm to environment and ecosystems) | 5. **Science-based** decision-making | |
| | 6. Consolidation of **justice** transformation and strengthening of the integral security, strictly addressing **human rights** | 4. **Precautionary principle** | 8. **Integrated management** | 7. Integral **co-management and adaptive management** model | |
| | | 6. Integrality | | | |

| | | | | | |
|---|---|---|---|---|---|
| System to be governed (social) | 3. **Quality of life** of the population | 10. **Human well-being** | 3b. **Sustainable economics** (special models and standards of production, education, training, and employment) | 3. **Interdisciplinary** approach | 3. **Exclusion** |
| | 4. Strengthening of **citizen capacities** and potentialities | | 5. **Quality of life** for residents of the Galapagos Province should correspond with the exceptional characteristics of the natural inheritance for humankind | 8. **Traditional ecological knowledge** | 4. **Differentiated access** |
| | 5. Creation of common spaces to strengthen **national diverse identities**, and the **plurinational and intercultural** state | | | | |
| | 8. **Sustainable** consolidation of the social and solidary **economic** system | | | | |
| | 9. Guarantee of the existence of all forms of **jobs with dignity** | | | | |
| | 10. Transformation of the **productive matrix** | | | | |
| | 12. Guarantee of **sovereignty and peace** | | | | 7. **Social and economic development** |
| System to be governed (natural) | 7. Guarantee of the **rights of nature** and the promotion of territorial and global **environmental sustainability** | — | 1. Maintenance of **ecological systems and biodiversity** (especially native and endemic) | 2. **Fisheries sustainability** | 8. **Sustainable use** of natural resources and **ecosystems** |
| | | | 4.**Reduction of risks** of introduced diseases, pests, and exotic species (plants and animals) to Galapagos | 6. **Ecosystem-based management** | |

(continued)

**Table 22.1** (continued)

| | Principles guiding each region's legal frameworks | | | | |
|---|---|---|---|---|---|
| | Mainland Ecuador | Galapagos Islands | | | |
| Governing interactions | 2. **Equality, cohesion, inclusion**, and social and territorial equity | 2. Responsibility | 3a. **Participation** of local community in development activities | 4. **Consensus-based** agreement | 2. Citizen **participation** |
| | | 5. **Sustainability** | | | 5. **Sustainability** |
| | | 7. **Participatory** | | | 6. **Equilibrium** |
| | | 8. **Agreement-based** process | | | |
| | | 9. **Consensus-based** process | 6. Examination of **existing interactions** between inhabited zones and protected terrestrial and marine zones (by integrated management) | | |

Sources: PNG (1999, 2006); CTP-JMP (2009); SENPLADES (2009); LOREG (2016)

[a]The original term used to define this principle in Spanish is *Principio de Asignación* (Art. 15 inciso 1, Ley de Régimen Especial de Galápagos) (PM-PNG 1999)

Nonetheless, we identify a handful of common ground among the normative instruments, as well as principles that only concern to one or two of the frameworks examined. Figure 22.2 portrays the dimensions of the systems, as described by the interactive governance approach, in order both to illustrate the governability aspects of the natural and social systems being governed and to systematically analyze the relationships between these legal instruments in both regions. As a general observation, we found that all of the principles present in the five instruments somehow relate to the small-scale fisheries sector (Table 22.1), with virtually none of them being disconnected from the governability of fisheries.

The divergent paths taken in each of the normative instruments examined – whether informed by images of development, conservation, or growth – seem to coincide in a handful of shared principles in both regions (Fig. 22.2). In these areas of common ground, there is some level of coherence displayed between each of the analyzed instruments (e.g., quality of life, sustainable economy). In contrast, the "fisheries" dimension was unsurprisingly only addressed in the "Fisheries Chapter" within the GNP Management Plan (2009). In fact, this document contained the only explicit reference to the sector in all of the normative instruments examined.

Additionally, we found that issues related to the governing systems in both areas are virtually disconnected mainly due to the incompatible governance formats present in both regions. In the case of Galapagos, the necessity (and desire) for fisheries to be managed differently, in acknowledgment of the unique environment in the region, greatly contradicts the intention of the National Constitution to govern the entire nation state under the same plan (PNBV). The latter is consistent with the indivisibility notion espoused by the Ecuadorian State, a principle that also affects small-scale fisheries. Consequently, the consideration in both regions of principles such as development, growth, and economic and social well-being seems rather paradoxical. These findings show that, at least in theory, the *Buen Vivir* principle is recognized by the National Constitution and by LOREG as a fundamental element to the sustainability of the overall fisheries system. In practice, however, it seems that the maintenance and promotion of so-called sustainable development in Galapagos dispels the very notion of *Buen Vivir*. Ultimately, the commonalities and differences encountered between the normative instruments analyzed, has been shown, hardly touch the small-scale fisheries which evidence that small-scale fisheries could be treated either as a factor of sustainability or as a threat to it depending on the paradigm informing each document.

### *22.4.1 How the Governability of Small-Scale Fisheries Resources Aligns with the Buen Vivir Principle*

When included as part of the PNBV, *Buen Vivir* (also translated as *Vivir Bien*) (Albó 2009) was conceived as a "collective construction of a new form of living" (Acosta 2010, p. 7). In that light, the interactions between the natural and social systems being governed are never rendered as competition, but instead as complementarities

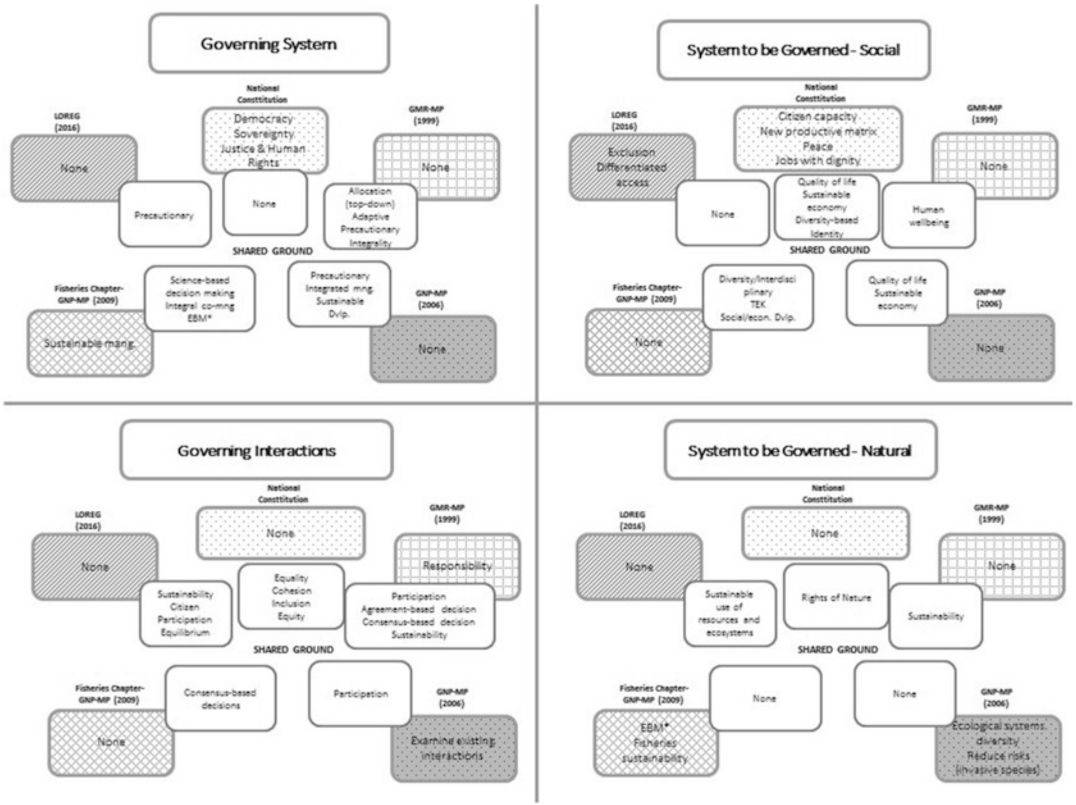



**Fig. 22.2** Common and different principles encountered in the normative instruments in place in both regions, according to the governability assessment approach. The only principle that explicitly addresses "fisheries sustainability" is underlined

(Acosta 2012), and are constructed under a communal logic (Escobar 2015b). However, the principles included in the normative frameworks analyzed in this chapter concerning small-scale fisheries governance practices do not fully illustrate that complementarity, only representing this sector in legal terms and addressing fisheries in particular.

In theory, this new model of development favors solidarity over competition and sustainability and natural and cultural wealth over economic growth (SENPLADES 2009; Lind 2012). In fact, the prevailing principle of *Sumak Kawsay* as a form of "alternatives to development" (Escobar 2012) encompasses critiques of the modern "developmentalist" model that holds a hegemony over development discourses throughout society (Gudynas and Acosta 2011; Altmann 2013). In line with this logic, the interactions between fishing people and nature in both study areas remain linked to the same traditional idea of economic growth and sustainable development driven by existing policies and practices. Moreover, the fisheries sector in both regions has not escaped this rhetoric and is still exposed to governance practices dominated by market-driven initiatives, economic interests, and traditional stock assessment guided by a technocratic rationality. Thus, the challenge remains on how to operationalize the *Buen Vivir* ideal under the two coexisting political and economic models, both of which conceptualize development within the same capitalist lens but to a differing extent.

The incongruences identified between these two governing systems and their corresponding normative instruments reveal the ineffectiveness of governance practices and the barriers to improving the governability of small-scale fisheries at the national level (Barragán-Paladines 2015). The contradiction between the "good way of living" (promoted by the *Buen Vivir* principle) and the "living better" ideal (promoted by mainstream forms of development, including sustainable development) is a core issue in the debate about what "development" is, what it should look like, and, even more importantly, for whom and by whom development should be conducted in both regions.

### *22.4.2 Implications for Small-Scale Fisheries Governability*

The governability analysis of the *Buen Vivir* principle in the context of small-scale fisheries on mainland Ecuador and Galapagos provides an in-depth understanding about the interactions of the two governing systems that, until 2015, existed in isolation from one another. For the first time, in 2014 a minister for the Galapagos Province was appointed by the president of Ecuador, thus empowering the Provincial Government Council of Galapagos (CGG) as the institution fully entitled to plan, execute, control, and monitor policies in Galapagos, including those concerning fisheries resources. This event was an historical cornerstone in the fisheries governance of the archipelago, since the CGG became the responsible governing actor for fisheries for the first time after the implementation of the co-management model in 1998. This action brought the small-scale fisheries sector in Galapagos closer to its counterpart on the mainland.

In light of this transformation of the small-scale fisheries management model, we echo the assertion of Ludwig (2001) by claiming that the notion of management "is over" (p. 758). This conclusion comes in light of the many failings of the mainstream management paradigm when confronted with complex problems, like those encountered in fisheries governance. This cognitive shift from management to governance is also alluded to by Jentoft and Chuenpagdee (2009), who posit that whereas "management constitutes a set of tools applied to solve concrete tasks with measurable outcomes, governance is an iterative, adaptive process involving interactions of stakeholders, as well as the ways in which goals are chosen and management decisions made" (p. 555). Thus, we argue that a new paradigm for fisheries, marked by a shift from management to governance, is needed at the national scale in Ecuador, including differentiated strategies aimed at governing fisheries in both areas under a unified national fisheries policy. This comprehensive instrument would represent coherent policies, practices, and desired goals for effectively governing fisheries resources in both regions, designed by involving all relevant actors in the processes.

If alternative community-based options for fisheries governance are explored in Ecuador, the *Buen Vivir* paradigm, understood as the "opportunity to imagine another world" (Acosta 2012, p. 192), may be bolstered. In other words, by revisiting the *Buen Vivir* ideal as a concept that is intrinsically linked to every stage of fisheries governance, as well as involving markets, state, and civil society, an entire set of opportunities can be found to incorporate new ethical and moral considerations in the governance of fisheries. The advancement of the *Buen Vivir* idea as both a political platform and a way of living could lead to new imaginings of "well-being" that are decoupled from the notions of growth and consumption (Escobar 2015b). Thus, this reconceptualization of the good life could represent a "new form to understand development" which, for the first time, has been incubated in the Global South in order to be exported to the Global North.[2]

### *22.4.3 Consensus-Based or Top-Down Decision-Making for Small-Scale Fisheries Governance?*

Do consensus-based processes guarantee improved small-scale fisheries governance? It can be argued that they do, at least in the case of the Galapagos Islands. Until 2015, consensus-based small-scale fisheries management on Galapagos proved to be an adequate model of fisheries governance according to a number of users within various sectors (Barragán-Paladines and Chuenpagdee 2015). At the same time, the hierarchical governance model used to manage small-scale fisheries on the mainland of Ecuador demonstrates that the top-down approach could also

[2]This idea follows the discussions and reflections during several conversations at the discussion group about the *Buen Vivir* and "Rights of Nature" concepts, hosted by the Rachel Carson Center and led by M.V. Berros and A.L. Tabios between 2015 and 2016 in Munich, Germany.

advance compliance and the organization of the sector. Evidence of these improvements can be seen along the entire fish production chain which, modestly but consistently, illustrates better social conditions and inclusion practices for fishers. Examples of these advances are further explored in the analysis made of the implementation of the *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries* (SSF Guidelines) in Ecuador (Barragan-Paladines 2017).

In Part 2 of the SSF Guidelines, Item 6 refers to "social development, employment and decent work" (FAO 2015b). In this case, the centralized Ecuadorian governance model has greatly contributed to achieving this aim by investing in human resource development and improving living conditions in small-scale fishing communities in terms of health, education, literacy, and digital inclusion. Social security and health insurance coverage for small-scale fisheries-related workers has also been implemented for the first time. This initiative has been coupled with the improvement of working conditions to provide decent work environments, which has positively impacted fishers' well-being in coastal areas. In fact, the people involved in the handling, storage, and trading of fish products have benefited from the construction of 27 new small-scale fishing harbors and related facilities along the Ecuadorian coast, made possible by the investment of roughly USD $100 million (MAGAP 2015). Finally, the Fisheries Authorities have implemented programs that promote alternative income generating activities that support and enhance access to other livelihood sources and stimulate economic diversification (Pers. comm., 8 August 2015).

However, what is still lacking is an integrated perspective for promoting a comprehensive holistic governance model for small-scale fisheries in Ecuador. Additionally, safety-at-sea issues are still aggravated by regulatory loopholes, which have begun to be partially addressed by the usage of new technologies, including an integrated system for aquaculture and fisheries that was launched by the national fishing authorities (SRP 2017c). Yet, the provision of palliative solutions, such as subsidies to fishers who have been victims of robbery at sea, do not fully alleviate deeper issues affecting small-scale fisheries.

In the case of Galapagos, even consensus-based decisions that have been made regarding fisheries-related issues have been affected by conflict and confrontation. While the provisional proposal for the Galapagos Marine Reserve zoning was approved by consensus (Castrejón 2011), there are still discrepancies and competing interests surrounding zones are used by tourism and fisheries simultaneously (Davos et al. 2007). Paradoxically, the participatory nature of the decision-making processes surrounding the reserve has presented both supports and barriers to the achievement of improved governance. As suggested by Suárez de Vivero et al. (2008), the more people that are involved in a decision, the less successful the process seems to be. Contrary to common perceptions, more people do not always imply a more successful process. Instead, according to these authors, the more people involved in MPA-related process, the less likely it is for the elements of the system to interact and for participants to have a meaningful role. The risk, according to Chevalier and Buckles (2000), is that in some contexts the equal participation of all participants is not appropriate due to cultural or environmental considerations. In short, consensus-based decisions in Galapagos risk devolving to what Thomas et al. (1996 p. 2) describe as “to equate the game field promoting an authentic and equitable dialogue in non-equitable conditions.”

### *22.4.4 Research About Small-Scale Fisheries: Differences Between Galapagos and Mainland Ecuador*

Small-scale fisheries governance is messy. Authorities and fisheries governing bodies struggle to keep up with the rapid pace of changes occurring in natural and the social systems. The PNBV, the unified management plan for Galapagos Islands (including terrestrial and marine environments) (DPNG 2014), and LOREG (2016), each of which represents a distinct normative instrument affecting small-scale fisheries, are all informed by the *Buen Vivir* principle. For the first time in history, both the mainland of Ecuador and Galapagos are considered holistically by a normative framework that apparently targets a common set of major goals under a common national vision for improved governance of natural and social systems. Yet, this approach has not fully divorced itself from the still dominant managerial doctrine at work in existing policies and practices, posing a significant challenge for the actual fulfilment of *Buen Vivir*. This goal is required for the improvement of small-scale fisheries governance and the enhancement of the governability of related systems. The extent to which the *Buen Vivir* paradigm will in fact replace the traditional notion of development, as the “alternatives to development” (Escobar 2012, p. 58), is still a matter of theoretical and empirical interest.

Future research regarding the governance of small-scale fisheries in Ecuador must also address the encroachment of sectors that are currently growing (e.g., transportation, construction, and tourism) besides fishing activities. Additional future research opportunities include the investigation of issues of high ethical importance within communities on Galapagos, such as the region’s birth rate (currently at 6% per year (INEC 2010), which is one of the highest in Ecuador), and the increase of other socially alarming trends such as criminality, teenage pregnancy, and drug abuse. Furthermore, we posit that the limited access to fish as food imposed by tourism encroachment may compromise local food security and sovereignty, requiring urgent research attention. In conclusion, regardless of the normative instruments used to address small-scale fisheries in Ecuador, neither increased governability nor improved governance will be achieved if, as Harris (2014, p. 150) posits, “we continue facing the ocean, giving our backs to the [coastal] communities.”

**Acknowledgments** The author is grateful to the TBTI project and the Social Sciences and Humanities Research Council (SSHRC) of Canada for the funding provided to conduct this research. Thanks to the three reviewers whose useful comments and feedback provided to early versions of this chapter greatly enhanced the quality of this publication. Thanks to one of them for the relevant additional literature generously provided. Thanks to the editorial team for their help in improving the writing style of the chapter.

## References

Acosta A (2010) El Buen Vivir en el camino del post-desarrollo. Una lectura desde la Constitución de Montecristi, Fundación Friedrich Eber. Quito: FES-ILDIS

Acosta A (2012) The Buen Vivir: an opportunity to imagine another world. In: Heinrich Böll Foundation (ed) Inside a champion: an analysis of the Brazilian development model. Publication Series on Democracy. Grupo Smart Printer, Berlin, pp 192–201

Albó X (2009) Suma Qamaña: El buen convivir. Revista Obets 4:25–40

Allison EH, Ratner BD, Åsgård B, Willmann R, Pomeroy R, Kurien J (2012) Rights-based fisheries governance: from fishing rights to human rights. Fish Fish 13(1):14–29

Allsopp WHL (1985) Fishery development experiences. Fishing New Books Ltd., Farnham

Altmann P (2013) Das Gute Leben als Alternative zum Wachstum?: Der Fall Ecuador. Sozialwissenschaften und Berufspraxis 36(1):101–111

Armitage D, de Loë R, Plummer R (2012) Environmental governance and its implications for conservation practice. Conserv Lett 5:245–255

Arriaga L, Martínez J (2008) Plan de Ordenamiento de la Pesca y Acuicultura del Ecuador. Informe de Consultoría. Subsecretaría de Recursos Pesqueros-Ministerio de Comercio Exterior, Industrialización, Pesca, y Competitividad. Convenio de Préstamo BIRF-No. 43-46 EC. Gobierno de Ecuador, Quito

Baine M, Howard M, Kerr S, Edgar G, Toral V (2007) Coastal and marine resource management in the Galapagos Islands and the Archipelago of San Andres: issues, problems and opportunities. Ocean Coast Manag 50:148–173

Banks S (2002) Ambiente físico. In: Danulat E, Edgar C (eds) Reserva Marina de Galápagos-Línea Base de la Biodiversidad. Parque Nacional Galápagos, Puerto Ayora, pp 22–37

Banks S (2007) Estado de especies y hábitats marinos en Galápagos. In: Danulat E, Edgar C (eds) I Reserva Marina de Galápagos- Línea Base de la Biodiversidad. Parque Nacional Galápagos, Puerto Ayora, pp 122–127

Banks S (2009) Galapagos and climate change. Final technical report from the Charles Darwin Foundation to CI and WWF Galapagos. January 1 – June 30, 2009. Charles Darwin Foundation, Puerto Ayora

Banks S, Vera M, Toscano M, Ruiz D, Tirado N (2006) Monitoreo ecológico de la zona costera para la evaluación de la zonificación provisional consensuada (ZPC). Fundación Charles Darwin, Santa Cruz, Galápagos, Ecuador

Barragán-Paladines MJ (2015) Two laws for the same fish: small-scale fisheries governance in mainland Ecuador and Galapagos Islands. In S. Jentoft & R. Chuenpagdee (eds) Interactive governance for small-scale fisheries: global reflections. MARE Publication Series 13. Springer, Heidelberg, pp 157–178

Barragán-Paladines MJ, Chuenpagdee R (2015) Governability assessment of the Galapagos Marine Reserve. Maritime Stud 14:13. https://doi.org/10.1186/s40152-015-0031-z

Bavinck M, Chuenpagdee R, Jentoft S, Kooiman J (eds) (2013) Governability of fisheries and aquaculture: theory and applications. MARE Publication Series 7. Springer, Dordrecht

Barragán-Paladines MJ (2017) The Buen Vivir and the small-scale fisheries guidelines in ecuador: A comparison. Chapter 33 In S. Jentoft et al (eds) The small-scale fisheries guidelines, MARE Publication Series 14, https://doi.org/10.1007/978-3-319-55074-9_33

Beltrán-Turriago CS (2001) Promoción de la ordenación de la pesca costera. Aspectos socio-económicos y técnicos de la pesca artesanal en El salvador, Costa Rica, Panamá, Ecuador y Colombia. FAO Circular de Pesca. No. 957/2. FAO, Rome

Béné C (2003) When fishery rhymes with poverty: a first step beyond the old paradigm on poverty in small-scale fisheries. World Dev 31(6):949–975

Béné C (2009) Are fishers poor or vulnerable? Assessing economic vulnerability in small-scale fishing communities. J Dev Stud 45(6):911–933

Bennet JB, Govan H, Satterfield T (2015) Ocean grabbing. Mar Policy 57:61–68

Berros MV (2015) The constitution of the republic of Ecuador: Pachamama has rights. Environment & Society Portal, Arcadia, Article 11 http://www.environmentandsociety.org/arcadia/constitution-republic-ecuador-pachamama-has-rights

Broadus JM (1987) The Galapagos marine resources reserve and tourism development. Oceanus 30(3):9–15

Bussey M (2014) Extending the scenario horizon: putting narratives to work: essay. J Futures Stud 18(3):95–100

Bustamante R, Collins KJ, Bensted-Smith R (1999a) Biodiversity conservation in the Galápagos Marine Reserve. Entomol Suppl 68:45–52

Bustamante R, Espinoza E, Nicolaides F, Murillo JC, Chasiluisa C, Ruttemberg B, Andrade R, Torres S, Toral MV, Barreno J, Piú M (1999b) Fishing in Galapagos: a summary of the main indicators for 1998. In: Galapagos Report 1998–1999. Fundación Natura & World Wildlife Fund, Quito, pp 35–49

Castrejón M (2011) Co-manejo pesquero en la Reserva Marina de Galápagos: Tendencias, retos y perspectivas de cambio. Tinker Foundation/ECCD/Kanankil, Mexico

Castrejón M, Charles A (2013) Improving fisheries co-management through ecosystem-based spatial management: the Galapagos Marine Reserve. Mar Policy 38:235–245

Castrejón M, Defeo O, Reck G, Charles A (2013) Fishery science in Galapagos: from a resource-focused to a social-ecological systems approach. In: Denkinger J, Vinueza L (eds) The Galapagos Marine Reserve: social and ecological interactions in the Galapagos Islands, 3rd edn. Springer, New York, pp 160–185

Celata F, Sanna VS (2010) Ambientalismo y (post-) política en un espacio de reserva: El archipiélago de las Galápagos. Scripta Nuova, 14(331), Article 62

Charles AT, Brainerd TR, Bermudez MA, Montalvo HM, Pomeroy SR (1994) Fisheries socio-economics in the developing world: regional assessments and an annotated bibliography. Ottawa, International Development Research Centre (IDRC)

Chevalier JM, Buckles D (2000) El manejo de los conflictos: Una perspectiva heterocultural. In: Buckles D (ed) Cultivar la paz: Conflicto y colaboración en el manejo de los recursos naturales. IDRC, Ottawa, pp 15–46

Chuenpagdee R (2011) Interactive governance for marine conservation: an illustration. Bull Mar Sci 87(2):197–211

Chuenpagdee R, Jentoft S (2009) Governability assessment for fisheries and coastal systems: a reality check. Hum Ecol 37:109–120

Chuenpagdee R, Jentoft S (2013) Assessing governability – what's next. In Bavinck M, Chuenpagdee R, Jentoft S, Kooiman J (eds) Governability of fisheries and aquaculture: theory and applications. MARE Publication Series 7. Springer, Dordrecht, pp 335–349

Coello S (1993) Diagnóstico de la actividad pesquera en la zona de influencia del Parque Nacional Machalilla: Estudios en áreas protegidas, vol 5. Fundación Natura, Quito

Comisión Técnica Pesquera – Junta de Manejo Participativo (CTP-JMP) (2009) Capítulo pesca del Plan de Manejo de la Reserva Marina de Galápagos. Unpublished document. CTP-JMP, Puerto Ayora

Danulat E, Edgar G (eds) (2002) Reserva Marina de Galápagos: Línea base de la biodiversidad. Fundación Charles Darwin & Servicio Parque Nacional Galápagos, Puerto Ayora

Davos CA, Siakavara K, Santorineou A, Side J, Taylor M, Barriga P (2007) Zoning of marine protected areas: conflicts and cooperation options in the Galapagos and San Andres archipelagos. Ocean Coast Manag 50:223–252

De Madariaga JJ (1969) La caza y la pesca al descubrirse América. Editorial Prensa Española, Madrid

Denkinger J, Parra M, Muñoz JP, Carrasco C, Murillo JC, Espinosa E, Rubianes F, Koch V (2013) Are boat strikes a threat to sea turtles in the Galapagos Marine Reserve? Ocean Coast Manag 80:29–35

Diegues AC (2005) El mito moderno de la naturaleza intocada (Edición revisada). Núcleo de Apoio à Pesquisa sobre Populações Humanas e Áreas Úmidas Brasileiras (NUPAUB) & Center for Research on Human Population and Wetlands in Brazil (USP)

DPNG (Dirección Parque Nacional Galápagos) (2014) Plan de Manejo de las Áreas Protegidas de Galápagos para el Buen Vivir. Gobierno de Ecuador, Puerto Ayora/Galápagos

Duggan GL, Green LJF, Jarre A (2014) 'Thinking like a fish': adaptive strategies for coping with vulnerability and variability emerging from a relational engagement with kob. Maritime Stud 13:4. https://doi.org/10.1186/2212-9790-13-4

ECOLAP & MAE (Instituto de Ecología Aplicada & Ministerio del Ambiente de Ecuador) (2007) Guía del Patrimonio de Áreas Naturales Protegidas del Ecuador. ECOFUND, Fondo Ambiental Nacional, Darwin Net, & Instituto Geográfico Militar, Quito

Ecuadorian National Constitution (2008) supra note 5, at art. 71

Edgar GJ, Banks S, Fariña JM, Calvopiña M, Martínez C (2004a) Regional biogeography of shallow reef fish and macro-invertebrate communities in the Galapagos Archipelago. J Biogeogr 31:1107–1124

Edgar GJ, Bustamante RH, Fariña JM, Calvopiña M, Toral-Granda MV (2004b) Bias in evaluating the effects of marine protected areas: the importance of baseline data for the Galapagos Marine Reserve. Environ Conserv 31(3):212–218

Edgar GJ, Banks S, Bensted-Smith R, Calvopiña M, Chiriboga A, Garske LE, Henderson S, Miller KA, Salazar S (2008) Conservation of threatened species in the Galapagos Marine Reserve through identification and protection of marine key biodiversity areas. Aquat Conserv Mar Freshwat Ecosyst 18:955–968

Epler B (2007) Tourism, the economy, population growth, and conservation in Galapagos. Fundación Charles Darwin, Puerto Ayora

Escobar A (2010) Latin America at a crossroads: alternative modernizations, post-liberalism, or post-development? Cult Stud 24(1):1–65

Escobar A (2012) Encountering development: The making and unmaking of the Third World. Princeton University Press, Princeton

Escobar A (2015a) Thinking-feeling with the earth: territorial struggles and the ontological dimension of the epistemologies of the south. Revista de Antropología Iberoamericana 11(1):11–32

Escobar A (2015b) Degrowth, postdevelopment, and transitions: a preliminary conversation [special feature – review article. Socially sustainable degrowth as a social-ecological transformation]. Sustain Sci 10:451. https://doi.org/10.1007/s11625-015-0297-5

FAO (Food and Agriculture Organization of the United Nations) (2015a) Regional overview of food insecurity – Latin America and the Caribbean: the region has reached the international hunger targets. FAO, Rome

FAO (2015b) Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. FAO, Rome

Gaibor N, Rosero J, Altamirano M (2001) El impacto de la migración humana en las artes de pesca artesanales y semi-industriales utilizadas en los Parques Nacionales Galápagos y Machalilla. Informe Técnico de consultoría para the Nature Conservancy y Fundación Natura. La Union, Guayaquil

González JA, Montes C, Rodríguez J, Tapia W (2008) Rethinking the Galápagos Islands as a complex socio-ecological system: implications for conservation and management. Ecol Soc 13(2):13

Grenier C (2007) Conservación contra natura: las Islas Galápagos. Abya Yala, Quito

Grupo Núcleo (1999, 20 Abril) Plan de Manejo de Conservación y Uso Sustentable para la Reserva Marina de Galápagos. Registro Oficial no. 173. Quito. Unpublished document

Gudynas E, Acosta A (2011) La renovación de la crítica al desarrollo y el buen vivir como alternativa: Utopía y praxis latinoamericana. Revista Internacional de Filosofía Iberoamericana y Teoría Social 16(53):71–83

Hannah L, Ikegami M, Hole DG, Seo C, Butchart SHM, Townsend Peterson A, Roehrdanz PR (2013) Global climate change adaptation priorities for biodiversity and food security. PLoS One 8(8):e72590

Harris DC (2008) The Boldt decision in Canada: aboriginal treaty rights to fish on the Pacific. In: Harmon A (ed) The power of promises: rethinking Indian treaties in the Pacific Northwest. University of Washington Press, Seattle, pp 128–153

Harris (2014, 29 August) Integrating voluntary family planning services with coastal resource management in Madagascar: Interview with Alasdair Harris. Marine Ecosystems and Management (MEAM) – News and analysis on ocean planning and ecosystem-based management, 7(6). www.MEAM.net. Accessed 29 Aug 2014

Hennessy E, McCleary AL (2011) Nature's Eden? The production and effects of 'pristine' nature in the Galápagos Islands. Island Stud J 6(2):131–156

Heylings P, Bravo M (2007) Evaluating governance: a process for understanding how co-management is functioning, and why, in the Galapagos Marine Reserve. Ocean Coast Manag 50:174–208

Hockings M, Valenzuela S, Calvopiña M, Chamorro S, León P, Bucaram S, Villalta M (2012) Galapagos Marine Reserve management effectiveness assessment. Galapagos National Park Service & World Wildlife Fund, Galapagos

Hoyman MM, McCall JR (2013) Is there trouble in paradise? The perspectives of Galapagos community leaders on managing economic development and environmental conservation through ecotourism policies and the special law of 1998. J Ecotourism 12(1):33–48

INEC (Instituto Nacional de Estadísticas y Censos) (2010) Censo Nacional de Población y Vivienda. http://www.ecuadorencifras.gob.ec/censo-de-poblacion-y-vivienda/. Accessed 10 Dec 2013

Jentoft S, Chuenpagdee R (2009) Fisheries and coastal governance as a wicked problem. Mar Policy 33:553–560

Jentoft S, Chuenpagdee R (eds) (2015) Interactive governance for small-scale fisheries: global reflections. MARE Publication Series 13. Springer, Dordrecht

Jobstvogt N (2010) Fish stock assessment of top-predator wahoo, Acanthocybium solandri, in the Galapagos Islands (Bachelor thesis). Department of Biology, Chemistry & Pharmacy. Freie Universität Berlin

Jones PJS (2013) A governance analysis of the Galapagos Marine Reserve. Mar Policy 41:65–71

Kahmann B, Stumpf KH, Baumgärtner S (2015) Notions of justice held by stakeholders of the Newfoundland fishery. Mar Policy 62(2015):37–50

Kerr S (2005) What is small island sustainable development about? Ocean Coast Manag 48:503–524

Kerr GN, Swaffield SR (2012) Identifying cultural service values of a small river in the agricultural landscape of Canterbury, New Zealand, using combined methods. Soc Nat Resour 25(12):1330–1339

Kooiman J (2008) Exploring the concept of governability. J Comp Policy Anal 10(2):171–190

Kooiman J, Bavinck M (2013) Theorizing governability: the interactive governance perspective. In: Bavinck M, Chuenpagdee R, Jentoft S, Kooiman J (eds) Governability of fisheries and aquaculture: Theory and applications. MARE Publication Series 7. Springer, Dordrecht, pp 9–30

Kooiman J, Bavinck M, Jentoft S, Pullin R (2005) Fish for life: interactive governance for fisheries. Amsterdam University Press, Amsterdam

Kuzel AJ (1992) Sampling in qualitative inquiry. In: Crabtree BF, Miller WL (eds) Doing qualitative research. Sage, London, pp 31–44

Le Sann A, Commitato Internazionale per lo Sviluppo dei Popoli (CISP) (1997) Del norte al sur: Pescar para vivir. Impreandes Presencia S.A, Bogota

Lind A (2012) Contradictions that endure: family norms, social reproduction, and Rafael Correa's citizen revolution in Ecuador. Pol Gend 8(2):254–260

LOREG (Ley Orgánica de Régimen Especial de la Provincia de Galápagos) (2016) Ley 0, Registro Oficial Suplemento 520 de 11 Junio 2015

Ludwig D (2001) The era of management is over. Ecosystems 4:758–764

MacDonald T (1997) Conflict in the Galapagos Islands: analysis and recommendations for management. In: Report for the Charles Darwin foundation (working paper). Harvard University, Cambridge, MA

MAGAP (Ministerio de Agricultura, Ganadería, Acuacultura y Pesca) (2015) Inversiones en la pesca artesanal. Gobierno del Ecuador. www.magap.gob.ec. Accessed 9 Sept 2015

Mays N, Pope C (1995) Rigour in qualitative research. Br Med J 311:109–112

Mc Ewan C, Silva MI (1998) Arqueología y comunidad en el Parque Nacional Machalilla. In: Josse C, Iturralde M (eds) Compendio de investigaciones en el Parque Nacional Machalilla. Informe de la Fundación Natura & Centro de Datos para la Conservación (CDC-Ecuador). Nuevo Arte, Quito, pp 20–30

Murillo Posada JC, Alvarez-Arce C, Oviedo-Pincay M, Delgado-Bone A, Montesdeoca, J. (2013). Evaluación de la factibilidad del co-manejo pesquero en el estuario del Río Cojimíes. Informe Final. Centro de Transferencia y Desarrollo Tecnológico, Universidad Estatal Península de Santa Elena & Vice Ministerio de Acuacultura y Pesca, Santa Elena

Norton P (1982) Preliminary observations on Loma Alta, an early Valdivia Midden in Guayas Province, Ecuador. In: Marcos JG, Norton P (eds) Primer Simposio de correlaciones antropológicas Andino – Mesoamericano. Escuela Superior Politécnica Del Litoral (ESPOL), Guayaquil, pp 101–119

Norton P (1985) Boletín de los Museos del Banco Central No.6. Simposio 45 Congreso Internacional de Americanistas. Universidad de los Andes, Bogotá

OECD (Organization for Economic Co-operation and Development) (2013a) Growth in Latin America. http://www.oecd.org/general/focus/growth-in-latin-america.htm. Accessed 7 Nov 2013

OECD (2013b) Latin America: Economic outlook 2014. Logistics and competitiveness for development. OECD Publishing. OECD, United Nations, Economic Commission for Latin America and the Caribbean, & Latin American Development Bank, Paris

Olson DM, Dinerstein E (1998) The global 200: a representation approach to conserving the earth's most biologically valuable ecoregions. Conserv Biol 12(3):502–515

Olson DM, Dinerstein ED, Wikramanayake ND, Burgess GVN, Powell EC, Underwood JA, D'Amico I, Itoua HE, Strand JC, Morrison CJ, Loucks TF, Allnutt TH (2002) The global 200: priority ecoregions for global conservation. Ann Mo Bot Gard 89:199–224

Ospina P (2001) Identidades en Galápagos: El sentimiento de una diferencia. Trama, Quito

Ospina P (2007) In: Falconí C (ed) Galápagos: migraciones, economía, cultura, conflictos, acuerdos. Universidad Andina Simón Bolívar, Sede Ecuador, Programa de Naciones Unidas para el Desarrollo, & Corporación Editora Nacional, Quito

Pauly D, Christensen V, Dalsgaard J, Froese R, Torres F Jr (1998) Fishing down marine food webs. Science 279:860. https://doi.org/10.1126/science.279.5352.860

Pauly D, Christensen V, Guénette S, Pitcher J, Sumaila UR, Walters CJ, Watson R, Zeller D (2002) Towards sustainability in world fisheries [Insight review]. Nature 418:689–695

Pauly D, Alder J, Bennett E, Christensen V, Tyedmers P, Watson R (2003) The future for fisheries. Science 302:1359. https://doi.org/10.1126/science.1088667

Pitcher TJ, Lam ME (2010) Fishful thinking: rhetoric, reality, and the sea before us. Ecol Soc., http://www.ecologyandsociety.org/vol15/iss2/art12/, 15

PNG (2006) Plan de Manejo. Quito: Ministerio del Ambiente, Parque Nacional Galápagos. Arte Digital, Puerto Ayora

PNG (Parque Nacional Galápagos) (1999) Plan de Manejo de Conservación y Uso Sustentable para la Reserva Marina de Galápagos. Unpublished, Puerto Ayora

Pollnac RB, Poggi JJ, Fierro M (1987) Enfoque teórico y metodológico para el análisis de las comunidades pesqueras. In Centro Ecuatoriano de Planificación del Estado (ed) La pesca artesanal en el Ecuador. Escuela Politécnica del Litoral, Centro Ecuatoriano de Planificación del Estado, & Instituto Latinoamericano de Investigaciones Sociales, Quito, pp 141–154

Radcliffe SA (2012) Development for a postneoliberal era? Sumak kawsay, living well and the limits to decolonisation in Ecuador. Geoforum 43:240–249

Ramírez J (2004) La pesca artesanal en la Reserva Marina de Galápagos: dinámica laboral y conflictos socio-ambientales (Disertación de Licenciatura). Pontificia Universidad Católica del Ecuador, Quito

Reck GK (1983) The coastal fisheries in the Galápagos Islands, Ecuador: description and consequences for management in the context of marine environmental protection and regional development (Doctoral Dissertation). Christian-Albrechts-Universität, Kiel

Rostworowski M (2015) Recursos naturales renovables y pesca, siglos VXI–XVII: curacas y sucesiones, costa norte (Obras completes IV). Instituto de Estudios Peruanos, Lima
Schuhbauer A, Koch V (2013) Assessment of recreational fishery in the Galapagos marine reserve: failures and opportunities. Fish Res 144:103–110
Schwarz FA (1987) Prehistoric settlement pattern in the Valdivia Valley, southwest coastal Ecuador (Unpublished M. A. Thesis). University of Calgary, Calgary
SENPLADES (Secretaría Nacional de Planificación y Desarrollo) (2009) Plan Nacional para el Buen Vivir 2009–2013: Construyendo un estado plurinacional e intercultural. República del Ecuador. Plan Nacional de Desarrollo. Versión Resumida, Quito, SENPLADES
Song AM, Chuenpagdee R (2010) Operationalizing governability: a case study of a Lake Malawi fishery. Fish Fish 11:235–249
SRP (2017a) Flota artesanal: Número de pescadores artesanales. http://www.viceministerioap.gob.ec/flota-pescadoresar-artesanales0.html. Accessed 15 May 2017
SRP (2017b) Flota artesanal: Número de caletas pesqueras. http://www.viceministerioap.gob.ec/flota-artesanal0-flota-pesquera-artesanal.html. Accessed 15 May 2017
SRP (2017c) 'Herramientas para combatir pesca ilegal en Ecuador fueron presentadas' http://wwwviceministerioapgobec/subpesca3113-herramientas-para-combatir-pesca-ilegal-en-ecuador-fueron-presentadas-a-periodistashtml. Accessed 15 May 2017
SRP (Subsecretaría de Recursos Pesqueros) (2013) Flota artesanal: comerciantes. http://www.subpesca.gob.ec/subpesca. Accessed 04 Oct 2013
Staller JE (2001) Reassessing the developmental and chronological relationships of the formative of coastal Ecuador. J World Prehist 15(2):193–256
Staller JE (2002) A multidisciplinary approach to understanding the initial introduction of maize into coastal Ecuador. J Archaeol Sci 29:33–50
Stone S, Viteri C, Conrad J, Nøstbakken L, Franklin H (2006) Fisheries management in the Galapagos Marine Reserve: a bioeconomic perspective. Region 3 Barbados, Colombia, Ecuador, Guyana, Jamaica, Peru, Suriname, The Bahamas, Trinidad & Tobago, Venezuela, Economic and Sector Study Series. Inter-American Development Bank, Washington, DC
Stothert K (2008) Valdivia y el proceso civilizador del tercer milenio A.C.Nayra Kunan Pacha-Revista de Arqueología Social, 1(1), 1–18
Suárez de Vivero JL, Rodríguez Mateos JC, Florido del Corral D (2008) The paradox of public participation in fisheries governance: the rising number of actors and the devolution process. Mar Policy 32:319–325
Tassara E (ed) (1994) Pesca artesanal, acuicultura, y ambiente: experiencia y perspectivas de desarrollo. Memorias del Seminario Internacional Las Políticas de Desarrollo de la Pesca Artesanal en América Latina y el Caribe. Ministerio del Ambiente, Comisión Europea, y la Oficina Cooperación Italiana en Colombia. EcoEdiciones, Bogotá
Taylor JE, Hardner J, Stewart M (2009) Ecotourism and economic growth in the Galapagos: an island economy-wide analysis. Environ Dev Econ 14:139–162
Teddlie C, Yu F (2007) Mixed methods sampling: a typology with examples. J Mixed Methods Res 1:77. https://doi.org/10.1177/2345678906292430
Thomas G, Anderson J, Chandrasekharan D, Kakabadse Y, Matiru V (1996) Leveling the playing field: promoting authentic and equitable dialogue under inequitable conditions. Presented at the global e-conference on addressing natural resource conflict through community forestry. Forests, trees and people Programme of the Food & Agriculture Organization of the United Nations. March-April 1996, Rome
Toral-Granda V, Hearn A, Henderson S, Jones PJS (2011) Galapagos Marine Reserve – governance analysis. In: Jones PJS, Qiu W, De Santo EM (eds) Governing marine protected areas: getting the balance right. Technical Report to Marine & Coastal Ecosystems Branch, United Nations Environment Programme Vol. 2. Publishing Services Section, UNON, Nairobi, pp 97–104
Vinueza LR, Branch GM, Branch ML, Bustamante RH (2006) Top-down herbivory and bottom-up El Niño effects on Galapagos rocky-shore communities. Ecol Monogr 76(1):111–131
Viteri C, Chávez C (2007) Legitimacy, local participation, and compliance in the Galapagos Marine Reserve. Ocean Coast Manag 50:253–274

**María José Barragán-Paladines** obtained a PhD in Geography at the Memorial University of Newfoundland in St. John's, Canada. Her undergraduate and Master's research at the Technical University of Munich (TUM) focused on marine protected areas (MPAs) and marine wildlife management. Her PhD research employed the interactive governance approach, with a specific focus on MPAs, examining the governability of the Galapagos Marine Reserve. She collaborates with TBTI and is currently a postdoctoral researcher at the "Development and Knowledge Sociology" - Social Science Department at the Leibniz Centre for Tropical Marine Research (ZMT) in Bremen, Germany. Her research interests include small-scale fisheries sustainability, fishing community viability, food security from the marine perspective, and marine resource governance.

# Part VI
# Conclusions

# Chapter 23
# Drivers and Prospects for the Sustainability and Viability of Small-Scale Fisheries in Latin America and the Caribbean

**Silvia Salas, Ratana Chuenpagdee, and María José Barragán-Paladines**

**Abstract** The global increase in demand for seafood products has accelerated the exploitation of many key fisheries resources, contributing to reduced ecosystem health and threatening fishing livelihoods. Small-scale fisheries in Latin America and the Caribbean are exposed to those global changes and other threats, which affect their viability and sustainability. In this chapter, we present a synthesis of some of the contributions of the authors to this book in order to illustrate successful and failed experiences at dealing with complex dynamic systems, such as small-scale fisheries, and discuss the necessary conditions and limitations that affect prospects for ensuring viable fisheries and sustainable livelihoods. Understanding the driving factors that threaten small-scale fisheries, as well as the contexts in which they operate, is imperative for reducing vulnerability and achieving sustainability. We synthesize experiences and lessons derived from the chapters in this book, providing examples of the types of challenges small-scale fisheries in different countries in the Latin America and the Caribbean region are facing and discussing how actors at different scales are dealing with them. Several of the authors advocate developing and promoting integrated assessment approaches, diversifying income sources, and increasing adaptive capacity in fishing communities. Tools and frameworks for assessment and management are also discussed based on the information presented and the literature

S. Salas (✉)
Marine Resources Department, CINVESTAV Mérida, Mérida, Yucatán, México
e-mail: ssalas@cinvestav.mx

R. Chuenpagdee
Department of Geography, Memorial University of Newfoundland, St. John's, NL, Canada
e-mail: ratanac@mun.ca

M. J. Barragán-Paladines
Development and Knowledge Sociology-Social Science Department, Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany
e-mail: mariaj.barraganp@leibniz-zmt.de



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0_23

review in this chapter. Finally, we offer some suggestions for improving fisheries governance to achieve sustainable and viable fisheries in the region.

**Keywords** Food supply · Small-scale fisheries · Sustainability · Viability · Governance

## 23.1 Introduction

According to the Food and Agriculture Organization (FAO) of the United Nations, by 2050, more than nine billion people will live on Earth, all of whom will need food (FAO 2016). Fish and other seafood are critical components of human diets, comprising one sixth of global animal-derived food sources (FAO 2014) and providing nearly three billion people with 20% of their dietary protein requirements and micronutrients (e.g., iodine, potassium, selenium, B vitamins, vitamin D) (Weichselbaum et al. 2013). Currently, seafood consumption is on the rise (Fabinyi et al. 2017), and fish is presently one of the most traded commodities in the world (Swartz et al. 2010). How to meet the increasing global demand for fish and seafood is an important question, especially with the advent of international standards for seafood quality, traceability, and sustainability, standards which only a limited number of fishing industries and companies can meet and thus utilize to access lucrative international markets (Pérez-Ramírez and Lluch-Cota 2010; Salazar-Araya 2013). However, the production of fish and seafood needs to satisfy not only demand but also the ethical expectations of society (Jennings et al. 2016), including protecting fishing livelihoods along the supply chain.

Given the growing demand for seafood, the development of the aquaculture industry is perceived optimistically by many, who propose it as a solution for ensuring global food security. However, improving the availability of food does not necessarily guarantee universal access to or fair distribution of resources. Heavy reliance on aquaculture is often treated as a panacea that distracts the attention of policy makers from seeking innovative alternative mechanisms, as well as strategies to avoid the decline of fisheries catches (Reid et al. 2005; World Bank 2013; FAO 2016). An overemphasis on aquaculture can also downplay the importance of recovery plans, which are often necessary tools when resources have been impacted (Hilborn et al. 2004; Colloca et al. 2013). This concern is of higher priority, especially in less wealthy countries where fisheries, particularly small-scale fisheries, are crucial to ensuring food security, employment, incomes, and economic development opportunities (Salas et al. 2007; Pollnac and Poggie 2008; Orensanz et al. 2005; Andrew et al. 2007; Salas et al. 2011a; Defeo et al. 2014). According to some estimates, around 53 million people worldwide are involved in marine fisheries work either on a full-time or part-time basis (Andrew et al. 2007; Teh and Sumaila 2013; FAO 2016). Additionally, between 660 and 820 million people (fishers, fish farmers, fish traders, fish processing workers, and their families) depend on fish-related activities as a source of income (Allison et al. 2011).

The region of Latin America and the Caribbean is one of the most influential in terms of the fish and seafood trade (Aguilar Ibarra et al. 2000; Pérez-Ramírez and Lluch-Cota 2010; Monnereau and McConney 2015; FAO 2016). For example, Chile, Ecuador, Mexico, and Peru are listed among the top 25 producer countries in the world for marine fisheries, while Brazil is one of the most important producers of inland fisheries products (Reid et al. 2005; Salas et al. 2007; FAO 2016). Given the importance of Latin America and the Caribbean in fish production and the supply chain, sustaining the region's fisheries and enhancing the viability of small-scale fisheries communities are a top priority for the region.

There are several challenges associated with the governance of small-scale fisheries in the region. For instance, the diversity of fisheries-based communities in Latin America and the Caribbean is high, such as indigenous peoples like the Miskito people in coastal waters of Nicaragua (González Chap. 17), the people from the Amazonian region in Brazil (Lopez et al. Chap. 10), the Kalinago in Dominica (Peteru et al. 2010), and small groups of fishers operating in the intertidal or rocky areas in the Pacific coast of Colombia (Castellano-Galindo and Zapata Chap. 4). Furthermore, among the services provided by small-scale fisheries in the region, the cultural significance of the sector is high, with small-scale fisheries serving to sustain community identity and providing an important foundation upon which historical and cultural diversity has been built (Pollnac and Poggie 2008; Alcalá-Moya 2011).

Additional sources of complexity in understanding and dealing with small-scale fisheries include global anthropogenic phenomena like climate change and globalization, which add complexity to locally derived inefficiencies (e.g., weak institutional arrangements, lack of legitimacy and/or power in fishers' organizations, inadequate governance systems). These conditions increase threats to the health of fish resources and, thus, the vulnerability of fishing communities that depend on them (Brooks et al. 2005; Andrew et al. 2007; Salas et al. 2011b; Defeo et al. 2013; Maldonado and Moreno-Sánchez 2014; Weeratunge et al. 2014; MacConney et al. 2015; Crona et al. 2015; Santelices Spikin and Rojas-Hernández 2016).

Equally important within the Latin America and the Caribbean region is the political dynamics that occur in some countries. For instance, the guerrilla conflicts in Colombia and El Salvador and drug trafficking in several countries along their Caribbean coasts also shape the social structure and dynamics of coastal communities and of the economic activities taking place locally (Saavedra-Díaz et al. 2016; Castellanos-Galindo and Zapata Chap. 4).

Despite the key roles small-scale fisheries play worldwide, as demonstrated by a broad body of evidence, this sector still is ignored, marginalized, and undervalued, especially when compared to the large-scale industrial sector (Defeo and Castilla 2005; Salas et al. 2011a; Chuenpagdee and Jentoft 2015). In this context, the limited attention paid to small-scale fisheries has severe consequences for the assessment and management of these fisheries and, therefore, for their sustainability. Ignoring small-scale fisheries also means dismissing their contribution to human livelihoods, especially for highly vulnerable populations, which has implications for future generations (Alcalá-Moya 2011; Weeratunge et al. 2014).

In this book, the socioeconomic, historical, and environmental contexts where small-scale fisheries take place within Latin America and the Caribbean depict the complexity of this sector and the wicked nature of the problems associated with it. As stated by Ratner and Allison (2012), the diversity of social, ecological, and economic characteristics of small-scale fisheries in developing countries calls for context-specific assessment, to understand its complexity and address the shortcomings in their governance.

In this chapter, we pose several questions associated with the sustainability and viability of small-scale fisheries, including the following: What are the socioeconomic dynamics of small-scale fisheries? What are some of the challenges faced by small-scale fisheries? What strategies do fisherfolk develop when facing vulnerable conditions, and what conditions are necessary to build adaptive capacity? What kind of management strategies has been developed in different countries to support viable fisheries? We aim to illustrate a variety of context in which small-scale fisheries operate, highlighting the challenges they face as well as the diversity of approaches and strategies developed in various countries for dealing with drivers that threaten the sustainability and viability of small-scale fisheries. We also discuss alternative assessment methods, management practices, and governance formats within different contexts that portray the options that have been implemented in the region, with an emphasis on innovative new approaches. Finally, we discuss some of the gaps that need to be covered to improve small-scale fisheries governance and better address fisheries' dynamics and their trends.

## 23.2 Challenges to the Sustainability of Small-Scale Fisheries

Globally, fisheries have gone through changes of paramount importance, such as the increase in fishing effort and the decrease in catches (FAO 2016), shifts in the marine wild fish species targeted and the size of organisms captured (Saldaña et al. 2017), rent dissipation, and the displacement of people (Aranda 2009; Gill et al. Chap. 13). All these issues compromise the sustainability of large- and small-scale fisheries alike; at the same time, increasing global seafood demand triggers an increase in fish and seafood production. Additionally, the viability and sustainability of the fishing industry are also highly dependent on what happens during post-harvest phases of the value chain (e.g., processing, marketing, and trade). In other words, food production and consumption are not the only factors to consider but also the distribution of food, to ensure that all dimensions of food security are secured, including food availability, access, affordability, and permanence (Timmer 2010). However, some interventions that aim to promote fisheries sustainability and the value chain may strengthen food security. This is the argument made regarding some market-based ecolabeling certification schemes, which may contribute to fisheries revenues and sustainability of the fisheries but can also tend to disadvantage small-scale fisheries from participating due mostly to the high cost of certification (Jacquet et al. 2010; Pérez-Ramírez and Lluch-Cota 2010). Given the challenges faced by small-scale fisheries, achieving sustainability is a daunting task. According to Krawczyk and Pharo (2013), problems mostly arise when the changing conditions of dynamic systems (like fisheries) drive shattering outcomes (e.g., decreases in catch, rent dissipation, etc.). In such cases, regulatory schemes must search for compatible measures that address the changes imposed on the one hand upon these dynamic systems and on the other hand upon the expected outcomes. The latter would ideally need to be legitimate, acceptable, and guaranteed in the long term.

Krawczyk and Pharo (2013) offer an approach based on "viability theory," which has been applied to assess the sustainability of dynamic systems including fisheries. Important questions for small-scale fisheries like how to deal with ecological and economic sustainability when aiming stock sustainability could be informed by such an approach, given that it provides insights about the compatibility between the system in question and its sustainability constrains. Within that perspective, the policies that would be created and implemented should be directed not to finding an optimal solution to the problem but instead searching for a "satisfying" one. In such circumstances, the achievement of the sustainability of small-scale fisheries may first require a close look at the viability of a given fishery, as well as the availability of resources, assets for fishers, and equitable access to resources of fishers, with an emphasis on the livelihood dimension. In short, the complexities, diversities, and dynamics implicit in fisheries systems need to be recognized early enough in order to anticipate what the outcomes may be for the different actors involved, as well as to identify constraints and potential destabilizing factors that may affect system balance.

The speed at which changes are affecting fisheries has outpaced the response capacity of institutional bodies to deal with them efficiently and generate appropriate solutions that further the sustainability and viability of small-scale fisheries in Latin America and the Caribbean. As Jennings et al. (2016) indicate, the food supply system needs to be "sufficient" and "safe" but also "shockproof" and "sound" in order to be considered "sustainable." Under these conditions, there must be an understanding of trends along the entire food supply chain from both marine and freshwater origins, which should be gained from formal and comprehensive analysis informed by the unique context of small-scale fisheries.

## 23.3 Dealing with the Dynamics of Small-Scale Fisheries Systems

Ratner and Allison (2012) state that the diversity of social, ecological, and economic characteristics of small-scale fisheries in developing countries calls for a context-specific assessment to understand the complexity of these systems and address shortcomings in their governance. In fact, in the face of increasing pressure on fisheries globally (Delgado et al. 2003), some of the challenges that threaten the sustainability and viability of these fisheries have also grown. These complexities can be illustrated and better understood by discussing successful and failed experiences at addressing some of these complex dynamic systems like some of the small-scale fisheries in Latin America and the Caribbean. These lessons learned can help to identify the most relevant issues that need to be addressed to face the challenges threatening the viability of small-scale fisheries in the region.

### *23.3.1 Socioeconomic Contexts in Which Small-Scale Fisherfolks Operate*

An important dimension of small-scale fisheries in the Latin America and the Caribbean region, as illustrated by Villanueva-Benítez and Flores-Nava (Chap. 14), is related to food consumption. The authors analyzed the contribution of small-scale fisheries to food security and household income by comparing 21 fishing communities in 3 South American countries (Chile, Colombia, and Peru). Their study illustrates how fish consumption in coastal areas is higher than the regional average. With respect to income, they find that incomes derived from fishing vary within countries, with the higher values in Chile. About 23% of artisanal fishers in the communities of this country are women (intertidal collectors), with some of them acting as divers. Further analysis by Villanueva-Benítez and Flores-Nava reveals that the lower the cash income of fishing-dependent families, the higher the participation of women as income providers. Women work directly in fishing activities in Peru and Chile, or indirectly (e.g., at processing activities in all countries), or in alternative livelihoods. In Colombia, women participate in marine and freshwater fisheries, while in the Caribbean area and Mexico, in contrast, women mainly participate in postharvest activities and gear repair (Alcalá-Moya 2011; Valle et al. 2011). Thousands of women in the Pacific coast of the Latin America and the Caribbean region participate in clam gathering. Despite the large involvement of women in the small-scale fisheries sector, their role has largely been masked in assessments of small-scale fisheries performance. Nevertheless, awareness has been increasing over time of the need to explicitly acknowledge the important role played by women in fisheries (Cortínez 2016).

Undoubtedly, markets play a key role in small-scale fisheries performance, and the sector has been forced to devise coping mechanisms to deal with changes in access to resources, fisheries dynamics, and fluctuations in market demands (Defeo et al. 2013; Salas et al. Chap. 5). Diminishing catches, as observed in many fisheries around the globe (FAO 2014) and in the Latin America and the Caribbean region (Salas et al. 2011a; FAO 2014), suggest that there are difficulties in meeting increasing demand for fish and other seafood products. Under these conditions, small-scale fisheries must rely on their own assessment of fishing resources and of their assets prior to building up a network and establishing commercial relationships among fishers, fishers' cooperatives, and different buyers. This understanding is especially important given that the fishing industry organizes multiple sources of products to secure fish supply, especially when there is a shortage of local fish availability.

Illustrating the strategic operations of fishers in the region in the face of market challenges, Pedroza (Chap. 15) analyzes the structure of the value chain in the Yucatan fisheries in Mexico. This chapter highlights the importance of the relationships and interorganizational strategies in the seafood trade and how these strategies serve to empower small-scale producers. Despite their limited participation in the market and the fact that the market is highly controlled by large businesses traders and industrial producers (who own more assets), small-scale fishers are important suppliers of products to large processing plants and, hence, help supply markets operating at different scales. The author suggests that market diversification might provide new opportunities for targeting species that currently are unexploited, which could consequently reduce pressure from overexploited resources.

With respect to markets and market diversification, Gill et al. (Chap. 13) further illustrate the complexity of the Latin America and the Caribbean region by assessing nine communities in three countries (Barbados, Honduras, and Kitts & Nevis). The study reveals that fluctuations in market values of fishing resources can have impacts on fishers' incomes, necessitating the exploration of potentially viable alternative livelihoods for members of fishing communities. Similarly, Edwards et al. (Chap. 12) state that alternative livelihood options in the area are required to release pressure from fishing resources. However, such alternatives must be economically feasible for those moving away – either totally or partially – from fisheries-based livelihoods. The participation of stakeholders in the development of management schemes, including the selection of income alternatives, is a sine qua non condition for successful policies and fisheries resources governance.

### *23.3.2 Factors Threatening Small-Scale Fisheries and Adaptive Strategies*

Recent literature has called for increased attention to the assessment of the vulnerability of small-scale fisheries, highlighting different drivers in order to learn about how these pressures shape fishers' behavior and how fishers cope and adapt to these situations (Brooks et al. 2005; Salas et al. 2011b; Defeo et al. 2013; Crona et al. 2015; Jennings et al. 2016). According to Marin (Chap. 3), little is known about the adaptive strategies that have been developed by small-scale fishers within the Latin America and the Caribbean region. Using a case study in the central-southern part of Chile, where coastal communities faced a massive earthquake and tsunami in 2010, Marin reiterates the importance of social capital and networking, as well as local ecological knowledge and livelihood flexibility, as key factors that determine success in adaptation processes.

Salas et al. (Chap. 5) assess some of the factors underlying people's behavior when dealing with uncertainty, changing environment conditions, and market dynamics in the Yucatan coast of Mexico. They present some of the coping strategies developed by fishers to handle such conditions. Like Marin, Salas et al. reiterate the importance of social capital within the context of fishing communities by indicating that the level of organization of fishing groups can shape the kind of response people exhibit to different types of threats. The authors suggest that cooperation and strong leadership among different stakeholders could enhance their adaptive capacity and thus would help improve fisheries governance. Their findings align with other studies that recognize cooperation as an important capacity-building driver in fishing communities that also enhances fisheries management and governance (Defeo and Castilla 2005; Salas et al. 2011b; Defeo et al. 2014; Villasante and Osterblow 2015).

Tolentino et al. (Chap. 6) analyze the ecological, social, economic, and political contexts where small-scale fisheries take place in the southern side of the Gulf of Mexico (Tabasco). They evaluate the factors affecting the adaptation of small-scale fisheries to environmental changes and the societal challenges faced by communities due to social exclusion driven by the expansion of oil extraction in the area. The authors examine the experiences of three communities that have each had different responses in the form of historical and social agreements, positing that this kind of analysis is fundamental to accounting for the responses taking place at different spatial and temporal scales. They also claim that it is necessary to recognize the context within which communities develop, since the capacity and requirements from fishers can differ greatly, thus also affecting how they respond to different threats.

Going beyond the context of communities, Naranjo and Bystrom (Chap. 16) stress the need to understand fishers' behavior and the dynamics of human dimensions when assessing small-scale fisheries. The authors contend that, by doing so, the challenges implicit in managing and governing fisheries practices can be addressed. Through a case study of a fishing community in the Pacific coast of Costa Rica, they reveal that economic incentives are not necessarily the main drivers of behavior. Rather, environmental, social, and cultural factors are dominant forces that also determine behaviors and decisions in small-scale fisheries in developing countries, like those within the Latin America and the Caribbean region.

Two commonly reported threats to small-scale fisheries are overfishing and illegal fishing problems (Salas et al. 2011a). In this volume, these issues are exposed in several chapters, like the case study of freshwater fisheries of the Amazonian Brazilian river basin (Lopes et al., Chap. 10). In this type of fishery, an additional threat involves the risk imposed by land-based activities, especially large-scale infrastructure development such as dams and ecosystem changes brought about by deforestation activities, with consequent impacts on resources and freshwater fisheries. Lessons from different community-based management schemes in this region are illustrated and proposed to protect fishing rights in areas where coastal and fishing communities rely on these rights for their livelihoods.

### 23.3.3 Assessment and Management Approaches

One of the most productive ecosystems worldwide is coral reef areas and associated habitats. Given that the Caribbean region has the second largest barrier reef in the world (Arrivillaga 2007), anthropogenic impacts on reefs areas must be well understood. The implementation of conservation programs for reef areas is imperative to reducing their vulnerability and supporting viable fisheries and coastal communities that depend on these resources. However, Gill et al. (Chap. 13) show that there is a high diversity of contextual complexity in the Caribbean countries that depend on reef fisheries. Likewise, the systems are highly complex with respect to GDP, size, legislation, demographic trends, and dependence on tourism. The authors indicate that the type of fish species captured, boat type, profitability of fishing activity, associated travel costs, and access to regional markets require the development of fisheries policies and management practices guided by site-specific information, rather than generalized approaches.

Gill et al. further indicate that the reef fisheries in the Caribbean region are important social safety nets across many communities, providing employment, revenues, and a vital protein source to many low-income people. In their view, fisheries have accommodated people who have moved from a more labor-intensive activity to fisheries (e.g., elders) or from activities that have been terminated. They observe that, in two sites where revenues from reef fishing by boat owners were the lowest, the primary purpose of fishing seems to be the provision of food for subsistence. The authors also refer to how the policies and activities in one country can affect others where regulations are less stringent; for example, seafood demand in one country can be an incentive for export from another country. Another example of market incentives interfering with conservation objectives is illustrated by the parrotfish (coral reef grazers) fishery closure in one country being undermined by the continued operation of that fishery in a nearby country.

While the majority of small-scale fisheries in the Latin America and the Caribbean region rely on diverse species, some are highly dependent on a few target species, limited spatial distribution of species, and specific market strategies. Chile is a good example of this kind of fishery, where income derived from fishing activities is above the national minimum wage (Reid et al. 2005). Given this complexity, different approaches are required for assessing, monitoring, and managing the fisheries systems in the Latin America and the Caribbean region.

Socioeconomic assessment like the one undertook by Edwards (Chap. 12) and participatory monitoring initiatives integrating local ecological knowledge of fishers, as reported by Fulton et al. (Chap. 7), have been shown to enhance stewardship and represent a useful and innovative strategy for building capacity in monitoring and assessing fisheries, especially in the context of limited technical and economic resources (Orensanz et al. 2005; Reid et al. 2005; Chuenpagdee et al. 2011). Further, Fulton et al. (Chap. 7) discuss the importance of citizen participation in science, in which local residents get trained and engage in research and monitoring programs. According to these authors, the participation of volunteers in collecting scientific data in coastal zones has become very popular around the world. For example, the authors illustrate how trained divers participate in monitoring programs in some communities trained by members of an NGO in Mexico – community and diversity (Spanish acronym COBI). The effect of this approach has proven positive and could be expanded to the wider Latin America and the Caribbean region, especially when financial and technical resources are scarce, but also as a way to engage resource users in the assessment and management of their resources.

Edwards et al. (Chap. 12) provide examples of participatory monitoring schemes and fisheries assessments implemented for expanding information on socioeconomic issues. This strategy is argued to increase knowledge about fisheries systems, as well as help to close existing knowledge gaps. In all the case studies, the authors report the high dependency of people on fishing activities (75%) and the heavy reliance on sea products as a source of food (47%), which both impose high pressure on fishing resources. These conditions vary within the region, thus leading to diverse household characteristics, fleet sizes, and fish chain dynamics. These diverse characteristics can define the potential adoption of management strategies and governance practices in different sites around the region. The situation becomes more challenging when resources are shared among Island States, like in the Wider Caribbean Region.

### *23.3.4 Participatory Process in Small-Scale Fisheries Governance*

Many case studies in this volume demonstrated that a wide mosaic of challenges for small-scale fisheries exists, necessitating that the lenses through which we look at the complexities associated with them need to be widened. Naranjo and Bystrom (Chap. 16) contend that it is necessary to use the emerging systemic thinking (socio-ecological system) approach when dealing with small-scale fisheries. They discuss how the resource-focused approach has shown to be ineffective for the assessment and management of small-scale fisheries, which aligns with claims made by several authors who have called for an integrated approach to assessing small-scale fisheries performance to appropriately deal with such complexity (Salas et al. 2007; Weeratunge et al. 2014; Jentoft and Chuenpagdee 2015). Several chapters in this book tackle the issues of management, governability, and governance, which are relevant to the discussion about sustainability and viability.

Fujita et al. (Chap. 8) illustrate the transition in management approaches from an open-access regime to a managed access system through a participatory and learning process of stakeholders in Belize. The successes at implementing the planned managed areas at the pilot sites included in this study provide incentives for scaling up of the program to other areas. This case study also helps to define conditions that could eliminate potential barriers for the full implementation of these programs and to make them viable in the long run. Examples from this chapter show that adaptation of management models is required during the transition process and that more effort is needed to build capacity for system scaling and maintenance. The authors state that improving compliance and enforcement is a necessary condition for maintaining credibility and trust from community members during the implementation of a program. In fact, some argue that new technological tools (such as vessel monitoring systems) and training for better enforcement (formal and traditional) could certainly increase the potential of success. However, the authors recognize the threat that illegal fishing implies when looking at transboundary dimensions at a regional scale.

Turner et al. (Chap. 20) examine fishers' perceptions in the Wider Caribbean Region, looking at how they relate to diverse governance arrangements. The study looks at institutional acceptance, reflecting on principles of legitimacy, transparency, fairness, and connectivity, as well as examining stakeholder engagement in reef governance. The chapter focuses mainly on the principles of accountability and inclusiveness. The chapter includes arguments about fishers' perceptions and their usefulness to identifying areas of action where direct users can be better engaged at practice. Stewardship is also acknowledged as a way to improve overall governance schemes.

Leis et al. (Chap. 19) analyze fishers' perceptions of governance in the context of a marine protected area (MPA) established in Southern Brazil which was established without any consultation or participation of local fishing communities. The authors contend that, under these conditions, the benefits and effectiveness of MPAs are compromised due to the contestable procedures followed during its implementation. This chapter includes an analysis of the factors and conditions needed for successful implementation of MPAs by using the governability assessment framework. Similarly, Barragan-Paladines (Chap. 22) also applies the governability assessment framework to examine challenges to the governance formats for small-scale fisheries in mainland Ecuador (hierarchical) and in the Galapagos Islands (co-management). This chapter refers to the *Buen Vivir* (good way of living) principle that was integrated in the 2008 Constitution of Ecuador, which recognizes the rights of nature as a subject of legal status and juridical protection.

Mattos and Wojciechowski (Chap. 21) look at small-scale fisheries governance in Brazil from institutional to legal standpoints. The authors analyze the frameworks applied to govern the sector by improving the existing arrangements and better aligning the expectations of fishers with those of governing bodies. Galindo et al. (Chap. 11) examine the regulatory schemes for small-scale finfish fisheries within the institutional and legal frameworks in the Gulf of Mexico and the Caribbean Sea in Mexico. The authors recognize that the current management approaches of fisheries are still greatly dominated by stock assessments focused on the main fishing resources. They stress the importance of moving toward a more "integrated approach" of small-scale fisheries assessment that incorporates biological and socioeconomic aspects of fisheries. In turn, this type of assessment also requires an integrated management approach to defining public policies and their implementation, which thus enhances stakeholder engagement.

Several authors (Espinoza-Tenorio et al. 2011; Cortínez 2016; Pedroza Chap. 15; Fulton et al. Chap. 7; Villanueva-Benítez and Flores-Nava Chap. 14; Tolentino et al. Chap. 6; Marin Chap. 4) argue that it is necessary for small-scale fisheries to provide both social and ecological benefits to fishing communities and ecosystems. These authors posit that these holistic benefits are necessary to further the sustainability and viability of small-scale fisheries. The authors claim that, by using the traditional knowledge of local fishing communities; building local capacity at different levels (e.g., through technical training, improving information via data collection, integrated assessment of fisheries, etc.); empowering community members, including women; and integrating harvesters in fisheries monitoring and assessment, great advances will be achieved. These authors also highlight the greater role that markets are currently playing in these processes. In light of this concern, some chapters highlight that markets should be emphasized more directly for their potential to provide solutions to sustainability issues.

## 23.4 Prospects for Sustainability and Small-Scale Fisheries Governance

In this closing chapter, much like throughout this book, we have emphasized the need to search for strategies and tools to achieve small-scale fisheries viability and sustainability. However, when discussing the sustainability of fisheries, one must wonder whether the tipping points of small-scale fisheries in the region (i.e., point of no return) have already been reached, especially in terms of bioecological, socioeconomic, and institutional dimensions (Westley et al. 2011; Ortega et al. 2012). If that is the case, critical questions arise concerning what tools we have at hand to face situations in which critical thresholds have already been exceeded. Such questions include what can be done to achieve a balance between the desired and actual conditions and what needs to be done to maintain viable small-scale fisheries under sustainable conditions (Crona et al. 2015; MacConney et al. 2015).

We have seen many diverse examples of small-scale fisheries governance models. Some of these models show that small-scale fisheries in Latin America and the Caribbean are still governed using conservative management approaches that privilege the biological and ecological dimensions of fisheries over social and cultural considerations (Salas et al. 2007; Chuenpagdee et al. 2011). This orthodox approach can be explained first and foremost by the type, availability, and quality of data generated by current management regimes; second, by the limited expertise and qualifications of the fisheries management bodies; and third, by the more common uni-disciplinary approach applied to govern small-scale fisheries regionally, which has mainly focused on fishing resources using a single-species approach (Aguero 1991; Salas et al. 2007, 2011a; Defeo et al. 2014; FAO 2014).

Despite the slow pace of change in the approaches used to assess and manage small-scale fisheries in the Latin America and the Caribbean region, shifts from these conventional governance formats have occurred. These shifts are characterized by a holistic perspective in light of the understanding that the overall complexity of small-scale fisheries systems cannot be addressed through a uni-disciplinary lens. In many international fora, a growing number of researchers, governmental bodies, and practitioners are invoking more holistic approaches for assessing, managing, and governing small-scale fisheries. Such a holistic perspective is also called for in the SSF Guidelines.

Many countries within the Latin America and the Caribbean region recognize the urgency of the need to improve the governance of their marine resources. In fact, there has been broad scholarly debate (MacConney et al. 2015) recognizing that what is needed is not only larger and more frequent stock assessments of fisheries resources, but instead there must be profound institutional reforms to improve small-scale fisheries governance and reduce the waste of financial and human resources on ineffective management tools. Such a transition requires that the complexity, diversity, dynamics, and scale at which small-scale fisheries occur start to be examined and understood through a transdisciplinary approach that accounts for the historical, social, economic, political, and bioecological contexts of fisheries (Ratner and Allison 2012; Weeratunge et al. 2014; Chuenpagdee and Jentoft 2015; Crona et al. 2015).

One particularly important aspect that has been identified within this comprehensive approach at governing small-scale fisheries is the multilevel governance model. This governance format acknowledges the need for integration and cooperation between national and regional governing bodies, as well as the necessity to establish multiple collaborative agendas among fishers' organizations, civil society organizations, academic institutions, and market actors (Chuenpagdee and Jentoft 2015; Jentoft and Chuenpagdee 2015; Villasante and Osterblow 2015; Fujita Chap. 8; Leis et al. Chap. 19; Fulton et al. Chap. 7; Seixas et al. Chap. 18; Turner et al. Chap. 20).

As noted in Jentoft and Chuenpagdee (2015), the many forms of knowledge and the lessons from local contexts are the most valuable inputs in moving toward the improvement of small-scale fisheries governance. This aspect becomes particularly relevant for reducing the vulnerability of small-scale fisheries and supporting their sustainability by looking at how promising global initiatives like the SSF Guidelines have been put forward to achieve common aims.

The chapters that compose this volume, which this chapter has summarized, illustrate diverse and dynamic schemes and strategies for fisheries governance and can help to address the questions presented earlier. They have been presented to demonstrate that, by improving the conditions of the small-scale fisheries sector and of the people who depend on them, a great step would be taken toward the viability and sustainability of fisheries in Latin America and the Caribbean. These steps include the implementation of protected areas, fishing refugees, co-management schemes, coastal and marine spatial planning, institutional reforms, and allocation of fishing rights to small-scale fishers in order to reduce conflicts with large-scale fishing fleets. Successful cases presented in this volume show that setting proper conditions and defining rules in a transparent and participatory manner among stakeholders have been key elements for success. Various challenges, as well as different ways to face them, have also been described. Among these, necessary conditions have been identified such as social capital and leadership, which have been identified as factors that contribute to building local capacity among groups and empowering communities. These processes can, in turn, facilitate the improvement of mechanisms that can lead to better governance of small-scale fisheries. Of equal importance is the need to move from old paradigms for assessing and monitoring small-scale fisheries in order to embody more holistic and transdisciplinary approaches.

Finally, we contend that healthy communities can match conservation objectives, so that regardless of the instruments or frameworks used to govern small-scale fisheries in the Latin America and the Caribbean region, no real improvement in governance in small-scale fisheries governability will be achieved if, as per Harris et al. (2012), we do not understand the synergistic benefits from improving social and economic development in coastal communities; hence "we should not turn the back to the communities while facing the ocean."[1]

**Acknowledgments** Silvia Salas wishes to acknowledge the financial support from FOMIX (2014-C17-247043) that facilitated her travel to Canada while she was working on the book.

## References

Aguero M (1991) Small-scale fisheries research in Pacific South America. In: Durand J-R, Lemoalle J, Weber J (ed) La Recherche Faceà la Pêche Artisanale Symp. Int. ORSTOM-IFREMER, Montpellier France.3-7, juillet l989, Paris, ORSTOM, 1991, t. I, pp 223–241

Aguilar Ibarra A, Reid C, Thorpe A (2000) The political economy of marine fisheries development in Peru, Chile and Mexico. J Lat Am Stud 32:503–527

Alcalá-Moya G (ed) (2011) Pescadores en América Latina y el Caribe: espacio, población, producción y política, volúmenes I y II. Yucatán, México: Universidad Nacional Autónoma de México, Facultad de Ciencias-Unidad Multidisciplinaria de Docencia e Investigación-SISAL

Allison EH, Béné C, Andrew NL (2011) Poverty reduction as a means to enhance resilience in small-scale fisheries. In: Pomeroy RS, Andrew NL (eds) Small-scale fisheries management – frameworks and approaches for the developing world. Wallingford, ABI, pp 216–238

Andrew NL, Béné C, Hall SJ, Allison EH, Heck S, Ratner BD (2007) Diagnosis and management of small-scale fisheries in developing countries. Fish Fish 8:227–240

Aranda M (2009) Evolution and state of the art of fishing capacity management in Peru: the case of the anchoveta fishery. Pan-Am J Aquatic Sci 4(2):146–153

Arrivillaga A (2007) The Mesoamerican reef ecoregional assessment: setting priorities for marine conservation. In: Proceedings of the 60th Gulf and Caribbean Fisheries Institute November 5–9, 2007 Punta Cana, Dominican Republic

Brooks N, Adger WN, Kelly PM (2005) The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Glob Environ Chang 15(2):151–163

Chuenpagdee R, Jentoft S (2015) Exploring challenges in small-scale fisheries governance. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries: global reflections, MARE Publication Series, vol 13. Springer, Dordrecht, pp 3–16

[1] https://meam.openchannels.org/news/meam/improving-ocean-management-addressing-population-and-human-health-concerns-insights

Chuenpagdee R, Salas S, Charles A, Seijo JC (2011) Assessing and managing coastal fisheries of Latin America and the Caribbean: underlying patterns and trends. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and Aquaculture Technical Paper No. 544. Rome, FAO, pp 385–402

Colloca F, Cardinale M, Maynou F, Giannoulaki M, Scarcella G, Jenko K, Bellido JM, Fiorentino F (2013) Rebuilding Mediterranean fisheries: a new paradigm for ecological sustainability. Fish Fish 14(1):89–109

Cortínez VO (2016) Igualdad de género para el desarrollo territorial: experiencias y desafíos para América Latina. Serie documentos de trabajo N° 180. Grupo de Trabajo Inclusión Social y Desarrollo, Rimisp, Santiago

Crona BI, Van Holta T, Petersson M, Daw TM, Buchary E (2015) Using social–ecological syndromes to understand impacts of international seafood trade on small-scale fisheries. Glob Environ Chang 35:162–175

Defeo O, Castilla JC (2005) More than one bag for the world fishery crisis and keys for co-management successes in selected artisanal Latin American shellfisheries. Fish Biol Fish 15:265–283

Defeo O, Castrejón M, Ortega L, Kuhn AM, Gutiérrez NL, Castilla JC (2013) Impacts of climate variability on Latin American small-scale fisheries. Ecology and Society 18(4):30. https://doi.org/10.5751/ES-05971-180430

Defeo O, Castrejón M, Pérez-Castañeda R, Castilla JC, Gutiérrez JC, Essington TE, Folke C (2014) Co-management in Latin American small-scale shellfisheries: assessment from long-term case studies. Fish Fish:1–17. https://doi.org/10.1111/faf.12101

Delgado CL, Wada N, Rosegrant MW (2003) Fish to 2020. Supply and demand in changing global markets. International Food Policy Research Institute, Washington, DC

Espinoza-Tenorio A, Espejel I, Wolffa M (2011) Capacity building to achieve sustainable fisheries management in Mexico. Ocean Coast Manag 54(10):731–741

Fabinyi M, Dressler WH, Pido MD (2017) Fish, trade and food security: moving beyond 'availability' discourse in marine conservation. Hum Ecol 45:177–188

FAO (2016) The state of the world fisheries and aquaculture: contributing to food security and nutrition for all. FAO, Rome

FAO (Food and Agriculture Organization of the United Nations) (2014) Contribución de la pesca y la acuicultura a la seguridad alimentaria y el ingreso familiar en Centro América. FAO, Panamá

Harris A, Mohan V, Flanagan M, Hill R (2012) Integrating family planning service provision into community-based marine conservation. Oryx 46(2):179–186

Hilborn R, Punet A, Orensanz J (2004) Beyond band-aids in fisheries management: fixing world fisheries. Bull Mar Sci 74(3):493–507

Jacquet J, Pauly D, Ainley D, Holt S, Dayton P, Jackson J (2010) Seafood stewardship in crisis. Nat Opin 467:28–29

Jennings S, Stentiford GD, Leocadio AM, Jeffery KR, Metcalfe JD, Katsiadaki I, Auchterlonie NA, Mangi SC, Pinnegar JK, Ellis T, Peeler EJ, Luisetti T, Baker-Austin C, Brown M, Catchpole TL, Clyne FJ, Dye SR, Edmonds NJ, Hyder K, Lee J, Lees DN, Morgan OC, O'Brien CM, Oidtmann B, Posen PE, Santos AR, Taylor NGH, Turner AD, Townhill BL, Verner-Jeffreys DW (2016) Aquatic food security: insights into challenges and solutions from an analysis of interactions between fisheries, aquaculture, food safety, human health, fish and human welfare, economy and environment. Fish Fish 17:893–938

Jentoft S, Chuenpagdee R (2015) Enhancing the governability of small-scale fisheries through interactive governance. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries: global reflections, MARE Publication Series, vol 13. Springer, Dordrecht, pp 727–748

Krawczyk JB, Pharo A (2013) Viability theory: an applied mathematics tool for achieving dynamic systems sustainability. Mathematica Applicanda 41(1):97–126

MacConney P, Charlery JD, Pena M, Phillips T, Van Anrooy R, Poulaln F, Bahrl T (2015) Disaster risk management and climate change adaptation in the CARICOM and wider Caribbean region; formulating a strategy, action plan and programme for fisheries and aquaculture. FAO, Rome

Maldonado J, Moreno-Sánchez RP (2014) Estimating the adaptive capacity of local communities at marine protected areas in Latin America: a practical approach. Ecol Soc 19(1):16. https://doi.org/10.5751/ES-05962-190116

Monnereau I, McConney P (2015) Governability of small-scale lobster fisheries in the wider Caribbean. In: Jentoft S, Chuenpagdee R (eds) Interactive governance for small-scale fisheries: global reflections, MARE Publication Series, vol 13. Springer, Dordrecht, pp 223–244

Orensanz JM, Parma AM, Jerez G, Barahona N, Montecinos M, Elías I (2005) What are the key elements for the sustainability of ‘small-scale fisheries’? Insights from South America. Bull Mar Sci 76:527–556

Ortega L, Castilla JC, Espino M, Yamashiro C, Defeo O (2012) Effects of fishing, market price, and climate on two South American clam species. Mar Ecol Prog Ser 469:71–85

Pérez-Ramírez M, Lluch-Cota S (2010) Fisheries certification in Latin America, recent issues and perspectives. Interciencia 35(11):855–861

Peteru S, Regan S, Klak T (2010) Local vibrancy in a globalizing world: evidence from Dominica, Eastern Caribbean. Focus Geogr 53:125–133

Pollnac RB, Poggie JJ (2008) Happiness, well-being and psycho-cultural adaptation to the stresses associated with marine fishing. Special section on vulnerability and resilience in fisheries. Hum Ecol Rev 15(2):194–200

Ratner BD, Allison EH (2012) Wealth, rights, and resilience: an agenda for governance reform in small-scale fisheries. Dev Policy Rev 30(4):371–398

Reid C, Thorpe T, van Anrooy R, Brugere C (2005) Mainstreaming fisheries into Latin American development strategies. IDPR 27(4):403–426

Saavedra-Díaz L, Pomeroy R, Rosenberg AA (2016) Managing small-scale fisheries in Colombia. Maritime Stud 15(6). https://doi.org/10.1186/s40152-016-0047-z

Salas S, Chuenpagdee R, Seijo JC, Charles A (2007) Evaluation and management of coastal fisheries in Latin America and the Caribbean. Fish Res 87(1):5–16

Salas S, Chuenpagdee R, Charles A, Seijo JC (2011a) Coastal fisheries of Latin America and the Caribbean: issues and trends. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean, FAO Fisheries and Aquaculture Technical Paper No. 544. FAO, Rome, pp 1–12

Salas S, Bjørkan M, Bobadilla F, Cabrera M-A (2011b) Addressing vulnerability: coping strategies of fishing communities in Yucatan, Mexico. In: Jentoft S, Eide A (eds) Poverty mosaics: realities and prospects in small-scale fisheries. Springer, New York, pp 195–220. https://doi.org/10.1007/978-94-007-1582-0_10

Salazar-Araya S (2013) Situación actual de la pesca artesanal en Costa Rica. Anuario de Estudios Centroamericanos, Universidad de Costa Rica 39:311–342. ISSN: 0377-7316

Saldaña A, Salas S, Arce-Ibarra AM, Torres-Irineo E (2017) Fishing operations and adaptive strategies of small-scale fishers: insights for fisheries management in data-poor situations. Fish Manag Ecol 24:19. https://doi.org/10.1111/fme.12199

Santelices Spikin A, Rojas-Hernández J (2016) Climate change in Latin America. Lat Am Fish Perspect 43(4):4–11

Swartz W, Sumaila UR, Watson R, Pauly D (2010) Sourcing seafood for the three major markets: the EU, Japan and the USA. Mar Policy 34:1366–1373

Teh CL, Sumaila UR (2013) Contribution of marine fisheries to worldwide employment. Fish Fish 14(1):77–88

Timmer CP (2010) Reflections on food crises past. Food Policy 35:1–11

Valle S, Sosa M, Puga R, Font L, Duthi R (2011) Coastal fisheries of Cuba. In: Salas S, Chuenpagdee R, Charles A, Seijo JC (eds) Coastal fisheries of Latin America and the Caribbean. FAO Fisheries and Aquaculture Technical Paper No. 544. FAO, Rome, pp 155–174

Villasante S, Osterblow H (2015) The role of cooperation for improved stewardship of marine social-ecological systems in Latin America. Ecol Soc 20(1):8. https://doi.org/10.5751/ES-05949-200108

Weeratunge N, Béné C, Siriwardane R, Charles A, Johnson D, Allison E, Nayak P, Badjeck C (2014) Small-scale fisheries through the wellbeing lens. Fish Fish 15(2):255–279

Weichselbaum E, Coe S, Buttriss J, Stanner S (2013) Fish in the diet: a review. Nutr Bull 38(2):128–177

Westley F, Olsson P, Folke C, Homer-Dixon T, Vredenburg H, Loorbach D, Thompson J, Nilsson M, Lambin E, Sendzimir J, Banerjee B, Galaz V, van der Leeuw S (2011) Tipping toward sustainability: emerging pathways of transformation. Ambio 40(7):762–780

World Bank (2013) FISH TO 2030. Prospects for fisheries and aquaculture. World Bank Report Number 83177-GLB. Agriculture and environmental services discussion paper 03. World Bank, Washington, DC

**Silvia Salas** is a professor at the Marine Resources Department at Cinvestav Unidad Merida, Mexico. Her background is in Marine Science (Cinvestav, MSc) and Resource Management and Environmental Studies (University of British Columbia, Canada, PhD). She has competence in fisheries bio-economics and management, fleet dynamics and fishing strategies, vulnerability, and risk perception with an emphasis on small-scale fisheries. She has participated as a consultant in several FAO workshops and has collaborated as a member of the advisory committee of the WECAF region (FAO). Currently she is the representative of Latin America in the IIFET Board Committee and represents Mexico in NAAFE Board Committee. She collaborates in the TBTI partnership.

**Ratana Chuenpagdee** is a professor at the Department of Geography, Memorial University of Newfoundland, St. John's, Canada. She held the position of Canada Research Chair in Natural Resource Sustainability and Community Development at Memorial University from 2006 to 2016. Her research emphasizes interdisciplinary approaches to coastal, fisheries, and ocean governance, focusing particularly on small-scale fisheries, marine protected areas, community-based management, and food security. She has worked in several countries including Cambodia, Malawi, Mexico, Spain, Thailand, and Canada. Dr. Chuenpagdee is a project director of the Too Big To Ignore (TBTI) Global Partnership for Small-Scale Fisheries Research and coedited the book *Interactive Governance for Small-Scale Fisheries: Global Reflections* (2015), with Professor Svein Jentoft.

**María José Barragán-Paladines** obtained a PhD in Geography at Memorial University of Newfoundland in St. John's, Canada. Her undergraduate and master's research at the Technical University of Munich (TUM) focused on marine protected areas (MPAs) and marine wildlife management. Her PhD research employed the interactive governance approach, with a specific focus on MPAs, examining the governability of the Galapagos Marine Reserve. She collaborates with TBTI and is currently a postdoctoral researcher in the "Development and Knowledge Sociology" Working Group at the Leibniz Centre for Tropical Marine Research in Bremen, Germany. Her research interests include small-scale fisheries sustainability, fishing community viability, food security from the marine perspective, and marine resource governance.

# List of Reviewers

Alfonso Aguilar-Perera
Minerva Alonso
Francisco Araos
Francisco Arreguín-Sánchez
Claudia S. Beltrán
Maiken Bjorkan
Fernando Carvajal-Vallejos
Gustavo Castellanos Galindo
Mónica Costa
Raquel De la Cruz Modino
Peter Edwards
Alejandro Espinoza
Lawrence Epstein
Mónica Ferreira da Costa
Johanna Forster
Stuart Fulton
Gustavo Hallwas
Oswaldo Huchim
Priscila López
Andrés Marín
Patrick McConney
Alison Macnaughton
Robin Mahon
Sergio Mattos
Nina Mendez
Beatriz Mesquita



S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0

Cristian Mullon
Juan Carlos Murillo
Helven Naranjo
Carmen Pedroza
Maria Pena
Manuel Pérez Moreno
Germán Ponce
Nadia Rubio
Peter W. Schumann
Cristiana Simão-Seixas
Edgar Torres
Ricardo Torres
Rachel Turner
Iván Velásquez Abudaner

# Index





S. Salas et al. (eds.), *Viability and Sustainability of Small-Scale Fisheries in Latin America and The Caribbean*, MARE Publication Series 19,
https://doi.org/10.1007/978-3-319-76078-0

**G**