The economic viability of small-scale fisheries

by

Anna Christina Schuhbauer

M.Sc., The University of Bremen, 2006

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY
in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES
(Resource Management and Environmental Studies)

THE UNIVERSITY OF BRITISH COLUMBIA
(Vancouver)

February 2017

Abstract

Small-scale fisheries (SSF) provide food and jobs for millions of people worldwide and therefore contribute to the wellbeing of many coastal communities. However, there is concern that the benefits they generate may dwindle to nothing because they are currently threatened by overfishing, climate change, industrialization and global market shifts. SSF are politically and economically marginalized as well as understudied. I argue that understanding the economic viability of SSF will help address these challenges.

Currently, the definition of economic viability is incoherent and often equated with financial viability, where profitability is the sole goal. However, SSF are complex dynamic systems whose goal is not always only profit but also social wellbeing and the maintenance of livelihoods play essential roles. Therefore, I define economic viability as the achievement of non-negative net benefits to society over time.

Here I determine the difference between financial and economic viability as the distortion created by the provision of fisheries subsidies. Therefore, I carried out a first global bottom-up assessment that splits subsidy amounts into those received by small- and large-scale fisheries. My analysis suggests that only 16% of global subsidies reach SSF despite their global importance. This disproportionate division of subsidies impairs the economic viability of already vulnerable SSF.

Next I compute what I denote as basic economic viability of SSF using Mexican fisheries as an example. Results suggest that decreasing fishing effort, reducing capacity-enhancing subsidies and improving monitoring and management can lead to increased economic viability of SSF. To understand the underlying dynamics of economic viability, I extended the economic viability approach and included assessments of economic impacts, employment and food security aspects into the study. Taking these attributes into account, results indicate that SSF are more important to society and have a more positive prognosis for economic viability than their large-scale counterparts.

These findings are relevant, not only for Mexican SSF but for SSF worldwide. The results help bridge the current knowledge gap in SSF research essential to policy making and management that would not only improve economic viability but also the sustainability of the fish stocks upon which they rely.

Preface

I wrote this entire thesis with my supervisor U.R. Sumaila providing guidance. I am the senior author on all chapters, and led the design and implementation of the analyses. A version of Chapter 2 has been published as: Schuhbauer A, Sumaila UR (2016). Economic viability and small-scale fisheries — A review. Ecological Economics. 124:69–75. The complete manuscript was researched and written by me with support from U.R. Sumaila and some guidance from R. Chuenpagdee.

A version of Chapter 3 is in the process of being submitted to a peer-reviewed journal with co-authors R. Chuenpagdee, W. Cheung, K. Greer and U.R. Sumaila. I gathered necessary data and developed the methodology and model with the help of U.R. Sumaila. K. Greer provided important data used for estimating fisheries fuel consumption. I wrote the manuscript, U.R. Sumaila contributed with guidance and revisions throughout and all co-authors provided comments for improvement of the final version.

Chapter 4 has been prepared for submission to a peer-review journal. I developed the methods, collected the necessary data and wrote the manuscript with help from A. Cisneros-Montemayor and support from U.R. Sumaila who both are co-authors of the paper based on this chapter.

Chapter 5 is also being prepared for publication with co-authors A. Cisneros-Montemayor, M. Moreno-Baez and U.R. Sumaila. I wrote the core of the manuscript, collected the data and developed the methods with help from U.R. Sumaila. A. Cisneros-Montemayor and M. Moreno-Baez helped provide key data and helped with parts of the analysis.

Ethics approval for this research was granted by the Faculty of Science of the UBC Behavioral Research Ethics Board (ID: H12-02720).

Table of contents

List of tables

List of figures

List of abbreviations

APEC – Asia Pacific Economic Cooperation

BEV – Basic Economic Viability

CONAPESCA - National commission of Aquaculture and Fisheries (Mexico)

EEV – Extended Economic Viability

FAO – Food and Agriculture Organization

FERU – Fisheries Economic Research Unit

INEGI - National Institute of Statistics and Geography (Mexico)

LSF – Large-scale fisheries

OECD – Organization for Economic Cooperation and Development

SSF – Small-scale fisheries

UNCTAD – United Nations Conference on Trade and Development

UNEP – United Nations Environment Programme

Acknowledgements

First and foremost, I thank my supervisor Dr. Ussif Rashid Sumaila for his support, trust, patience and constant encouragement. Thanks to my committee members Dr. Ratana Chuenpagdee for your vision, encouragement and critical revisions and Dr. William Cheung for your invaluable advice and your help.

Many thanks to Dr. Andres Cisneros-Montemayor for sharing his knowledge and guidance throughout this PhD. Thanks to Dr. Vicky Lam, especially, for her patience and help with conquering the global fisheries economic data sets. Thank you, Dr. Dana Miller, for your constant encouragement, revising my work and always being there, and many thanks to Dr. Wilf Swartz for sharing your knowledge and ideas.

I likewise thank the many students, staff and faculty of the UBC Fisheries Centre, now Institute for the Oceans and Fisheries, as well as our FIMAR group for their support throughout these years. Also, I thank the various students, staff and scientists who I've met through the *Too Big To Ignore* Partnership for inspiration, ideas and knowledge (especially, Dr. Paul Onyango and Dr. Moenieba Isaac). Thanks to the Centre for Ocean Solutions for a huge learning experience about ocean policy.

A huge thanks to my parents, my sisters and especially to my husband, Sam Clarke, for believing in me, for your invaluable support and for reviewing, reading, and helping me with concepts, ideas and designs. Thanks to Martha McGrath for reading and reviewing and thank you to all my friends who have helped me keep my sanity and keep both feet on the ground.

Special thanks go to the *Too Big To Ignore* Global Partnership for small-scale fisheries research funded by the Social Sciences and Humanities Research Council of Canada (SSHRC 895-2011-1011) for financial support. I also thank the Canadian Fisheries Research Network (NETGP 389436-09) and *OceanCanada* for support (SSHRC 895-2013-1009).

Thank you Dr. Sean Pascoe, Dr. Harry Nelson, Dr. Philippe Le Billion and Dr. Sergei Severinov for your time, proposed revisions and comments.

Dedication

An meine Familie.

Chapter 1: Introduction

Millions of people depend on fisheries resources for food and livelihoods (Pauly et al. 2005; Béné 2006; FAO 2016a). Marine fisheries are estimated to contribute about 240 billion USD to the world economy, based on direct, indirect and induced impacts (Dyck and Sumaila 2010).The global oceans, however, are threatened by climate change, overfishing and pollution, which jeopardizes biodiversity, food security and the well-being of coastal communities across the world (Cheung et al. 2009; Srinivasan et al. 2010; Rice and Garcia 2011; Sumaila et al. 2011; McClanahan et al. 2013). Climate change projections show an especially worrisome prospect for already impoverished coastal communities as commercial fish biomass is redistributing and declining with changing climate (Cheung et al. 2010; Sumaila et al. 2011; Lam et al. 2012). Overfishing, a threat faced across the global ocean, has been tackled only in a handful of places, most of which are in the developed world (Mora et al. 2009; Worm et al. 2009). However, fishing in most areas in the world is still poorly or not at all regulated and in urgent need for rebuilding (e.g., Pauly et al. 2003; Mora et al. 2009; Sumaila et al. 2012). With the global human population increasing towards 9 billion people and growth in purchasing power, demand for seafood has been growing and solutions need to be found urgently to deal with the fisheries crisis (Godfray et al. 2010; FAO 2016a).

According to the FAO, over 90% of the 4.36 million vessels active in the world can be classified as small-scale fisheries (SSF). Teh and Sumaila (2013) also estimated that SSF support up to 22 million fishers, who make up about 44% of all fishers in the primary production sector. Furthermore, Béné et al. (2007) report that an additional 100 million people are involved in the post-harvest sector of SSF. Despite their large numbers and importance globally, small-scale fisheries, in comparison to their large-scale fisheries (LSF) counterpart, are generally hit hardest by the above mentioned threats (Berkes et al. 2001; Chuenpagdee 2011). Most of them are located in the developing world and coastal communities especially depend more on marine resources for food and livelihoods (Béné et al. 2007; Chuenpagdee 2011). Small-scale fisheries are often found to be marginalized, here I define marginalization in the context of geographic, socio-economic and political remoteness from decision making processes and economic activity. Additionally SSF are often understudied, worldwide, and in need of further attention and solution-focused research needs to be urgently carried out (Pauly 1998; Chuenpagdee et al. 2006; Béné and Friend 2011).

This thesis will address these challenges by contributing scientific information that would help reduce SSF marginalization and bring them to the attention of fisheries policy makers. I argue that promoting the economic viability of SSF is fundamental to help prepare them to withstand the barrage of threats they face. The following section and chapters of this thesis will demonstrate what economic viability means, how it can be assessed, and how this is likely to bring attention and understanding to the existing problems encountered by these fisheries.

1.1 Objective and research questions

The general research objective of this study is to assess the economic viability of small- in comparison to large-scale fisheries by computing net benefits to society and considering a broader set of attributes. More specific research objectives include:

1. Understand and define economic viability of SSF;
2. Evaluate the role of fisheries subsidies in the economic viability of small-scale compared to large-scale fisheries;
3. Assess basic economic viability (based on fisheries total revenue, total costs and subsidies) and analyze what it means for small- compared to large-scale fisheries;
4. Broaden the basic economic viability assessment by determining and measuring additional key attributes of SSF;
5. Identify and discuss policy recommendations towards improving the economic viability of small-scale fisheries.

1.2 What are small-scale fisheries

Small-scale fisheries are defined in many different ways using a variety of criteria. Characteristics used to split a country's or a region's fishery into large- and small-scale are often relative, i.e., small-scale in one region might be considered large-scale in another. Hence, there is no single universally agreed definition of small-scale fisheries (see e.g., Sumaila et al. 2001;

Guyader et al. 2013; Natale et al. 2015 for an attempt). Despite SSF being such a contextual term, there is also some common ground found in these fisheries, which I describe below.

SSF are often perceived to be fisheries that use low technologically advanced gears, and whose products are usually for the fisher's own household consumption and/or sold locally (FAO et al. 2008; Pomeroy and Andrew 2011). Often, small-scale fisheries tend to be tied to their local communities, reflecting their traditional and cultural values (FAO et al. 2008; Pomeroy and Andrew 2011). Small-scale fisheries around the world are facing similar problems and threats; some of which are: low economic performance, inability for small-scale fishing communities to retain most of the benefits from their fisheries; relatively high incidence of poverty and undernourishment in certain SSF communities and pressure from globalization and industrialization as well as climate change. In addition to these challenges, ineffective management and the under-representation of local stakeholders in decision making processes have contributed to the marginalization of SSF (Béné 2003; Béné et al. 2010b; Chuenpagdee 2011; Allison et al. 2012; Sumaila 2012; Lam et al. 2012). The often unorganized nature of small-scale fisheries makes them difficult to monitor and consequently they are frequently undervalued. Besides most SSF exist in data-poor conditions (Pauly 1997; Zeller et al. 2006; Andrew et al. 2007).

For the purposes of this study, I use each country's own definition of SSF. For example, in Tanzania small-scale fisheries are defined as follows (FAO 2007): "All artisanal fisheries in marine waters that take place within the territorial waters (12 nautical miles stretch). The catch consists mostly of fin fish, and to a small extent, shrimps. It is dominated by the artisanal fishers using poor crafts and fishing methods." Another example of the definition of SSF from Ukraine: "The Ukrainian coastal fisheries consist of two main commercial sectors: artisanal (small-scale) and industrial (large-scale). The artisanal sector is characterized by small boats averaging 4-5 m in length, which use passive fishing gear such as set traps ('stavniki') and fixed nets." (Ulman et al. 2015).

In cases where no national definitions were found for the small-scale or artisanal fishing sector, I adopt the definition proposed by the *Sea Around Us*: SSF operate in domestic waters, within their country's Exclusive Economic Zone (EEZ), maximum 50 km off the coast or 200 m depth (whichever comes first) and include both commercial and non-commercial fisheries (Pauly and Zeller 2015, 2016). Furthermore, I use the following points as guidelines to describe SSF: a) their catch is primarily geared towards household consumption; b) they use low technologically advanced gears; c) they are minimally managed; and d) operate at a low level of economic activity (Chuenpagdee et al. 2006; Teh and Sumaila 2013)

1.2.1 Too Big To Ignore – small-scale fisheries research

This PhD project, is part of a larger initiative supported by SSHRC, known as *Too Big To Ignore* (TBTI), a global research and knowledge mobilization partnership established to elevate the profile of SSF, to argue against their marginalization in national and international policies, and to develop research and governance capacity to address global fisheries challenges (http://toobigtoignore.net/). While maintaining a comprehensive view and acknowledging ecosystem, social, institutional and economic dimensions of fisheries, this thesis focuses on assessing the key components affecting economic viability. At the same time other partners and contributors of the TBTI network of SSF research will address and focus their work on governance, livelihoods, rights, stewardship and ecosystem aspects of small-scale fisheries, which in the broader sense can also affect the economic viability of a fishery.

1.3 Economic viability

Any economic system has to adapt to scarcity constraints and be balanced between supply and demand for the system to function viably (Aubin 2011). The goal of most economic entities is profitability; the higher the profit, the better is the entity's status. A private entity is therefore considered 'financially viable' when its profit is positive. However, when considering economic viability, I refer not only to the sole profit of a private individual (or private entity) but also to the whole society or the public sector, such that economic viability is accomplished when net benefit of an activity to society is non-negative.

Often, measures such as the return on investment (net cashflow/investment) are used as an indicator to judge a system's economic performance. Profit is necessary for a system to be economically viable, but it is not necessarily the sole measure, particularly since a profitable system today may not necessarily be so tomorrow (Tisdell 1996; Baumgärtner and Quaas 2009). Additionally, SSF are often embedded in their community’s culture and traditional values where the goal for the participants is not always only profit (Kronen 2004; Pollnac and Poggie 2008; Hospital and Beavers 2012; Berkes et al. 2012). The term viability describes the long-term survival of a system, and especially for SSF, measuring the pure financial performance of the fishery does not provide enough information to determine whether the fishery can be considered economically viable or not. Measuring economic viability of SSF is therefore quite challenging as it goes beyond assessing only the financial situation and other economic aspects need to be taken into account, such as the amount of fisheries subsidies received by this sector. This thesis, therefore, distinguishes between financial viability, basic economic viability and extended economic viability. Financial viability, is defined as net benefits to a private entity (profit), which includes the subsidies it receives from the government. Basic economic viability is defined as net benefit to society that is based on the real undistorted cost of inputs and value of outputs. The extended economic viability broadens this basic approach by further including key attributes into the assessment. In the next section, I will present a few more details on how this is carried out.

1.4 Attribute based method

Using attributes to measure the state of a fishery is a common technique applied in order to achieve a variety of goals, including assessing the sustainability of a fishery. For example, attributes were identified and used to describe and understand different SSF in Europe (Guyader et al. 2013). In Brazil, an analysis was performed using socio-economic indicators to assess and compare the performance of different fishing fleets under ecosystem-based management (Gasalla et al. 2010). In the context of marine protected areas, Edgar et al. (2014) identified five key attributes that need to be considered in order to optimize conservation outcomes. Finally, a study by Fulton et al. (2005) shows how ecological attributes can detect the effects of fishing on marine ecosystems. Based on these experiences and other examples, I use a variety of attributes from different dimensions as the foundation of my approach to assess economic viability of SSF more broadly.

1.4.1 Basic economic viability

Key elements of basic economic viability are i) total revenue generated from fishing; ii) total cost of fishing; and iii) fisheries subsidies. Total revenue (landed value) is the product of ex-vessel prices and tonnes of landed catch. Ex-vessel prices are defined as the price that a fisher receives at the dock per unit weight of fish sold (Sumaila et al. 2007). Total costs of fishing include fixed and variable costs of fishing. It is important to note that economic costs, in contrast to accounting costs, are captured by the opportunity costs of input to fishing. Fisheries subsidies are defined as financial transfers, which can be direct or indirect, from public entities to the fishing sector (Sumaila et al. 2010a). Subsidies, therefore, help the fishing sector to make more profit than it would otherwise.

1.4.2 Extended economic viability

Extended economic viability builds on the concept of basic economic viability by broadening the perspective and including additional aspects into the assessment of economic viability. According to Cunningham et al. (2009), studying economics of fisheries is important in order to understand how to best maximize the potential of a fish stock and in turn generate wealth and contribute to social welfare. However, to achieve not only profitable fisheries but also social equity, which is an important aspect of sustainable fisheries, it is essential to look beyond profit maximization. To better validate how economic and socio-economic drivers of small-scale fisheries contribute to their economic viability, the following attributes are integrated into this study: proportion of SSF landed value to total landed value, cost structure, economic impact of fishing (multiplier), employment, fisheries discards and the use of fisheries products.

1.5 Thesis overview and scope of the study

This thesis contains four main research chapters, preceded by Chapter 1: the introduction and bookended by Chapter 6: the conclusion, which together address the objectives of my dissertation.

In Chapter 2, I conduct a critical literature review about economic viability. I explore how economic viability is currently defined and assessed in relation to SSF in the literature. Additionally, I provide suggestions on how to make economic viability assessments more coherent and useful to policy makers.

I turn my attention to fisheries subsidies in Chapter 3, where I estimate how much of the subsidies provided by a country go to small- compared to large-scale fisheries. This analysis is carried out for all maritime countries of the world and I discuss what the results mean for the economic viability of SSF.

In Chapters 4 and 5, I use Mexico as an example. I compute basic economic viability in Chapter 4, where I also compare economic viability to financial viability for both small- and large-scale fisheries over time.

In Chapter 5, I study the role of some socio-economic attributes on economic viability and extend the economic viability assessment by measuring the wider impacts of fishing on the economy, employment and food security, to name just a few.

Finally, results reported in earlier chapters are discussed and conclusions drawn in Chapter 6. Furthermore, recommendations are made on how economic viability of SSF can be improved. Management and policy recommendations are aimed at contributing to the resilience of small-scale fisheries to large-scale processes of change by increasing their economic viability.

The scope of this study is limited to commercial and subsistence marine fisheries. However, the methods, approaches and frameworks developed are general and comprehensive enough to be applicable to freshwater and recreational fisheries too. Furthermore, while Chapters 2 and 3 have a global focus, Chapters 4 and 5 are geographically located in Mexico, using timelines from the years 2000-2012 for Chapter 4 and a static view for Chapter 5. Methods as explained in Chapter 1 include attribute based approaches using quantitative and qualitative information as well as a mathematical model to estimate missing data.

Chapter 2: Economic viability and small-scale fisheries – a review [1]

2.1 Introduction

Marine fisheries play a crucial economic, social and cultural role globally; they support human well-being through employment in fishing, processing, and retail services (Pontecorvo et al. 1980; Dyck and Sumaila 2010; FAO 2014a) as well as food security (Srinivasan et al. 2010). However, global fisheries are known to be underperforming, mainly due to overfishing, harmful subsidies and over capacity (e.g., Milazzo 1998; Pauly et al. 2002; Sumaila et al. 2010a). Small-scale fisheries (SSF) constitute a substantial component of global fisheries, however, they are found to be understudied as well as politically and economically marginalized (Pauly 1997; Allison and Ellis 2001; Chuenpagdee 2011).

As explained in Chapter 1, I argue that understanding how to make SSF more economically viable is very relevant as it would bring attention and understanding to the existing problems encountered by these fisheries. Here, I ask the question: how can economic viability analysis of SSF facilitate a resource management approach that comprehensively takes into account the ecosystem, social, economic and institutional attributes of SSF. This Chapter, therefore, critically reviews the usefulness of current economic viability analyses of SSF. The goal is to examine how economic viability is currently defined and what approaches have been applied to analyze it

[1] A version of this chapter is published: Schuhbauer, A., and U. R. Sumaila. 2016. Economic viability and small-scale fisheries — a review. Ecological Economics 124:69–75

in relation to SSF. Further objectives for this study are to (i) identify gaps in the assessments presented herein; and (ii) present recommendations on what could be done to

possibly improve the way economic viability of SSF has been defined and applied in the past. I suggest that this can help to improve policies for managing small-scale fisheries.

Small-scale fisheries do not only make up for the vast majority of fishing vessels globally but support millions of people directly and indirectly (Béné et al. 2007; Teh and Sumaila 2013; FAO 2014b). The livelihoods of many fishers in fishing communities with few employment opportunities are supported by SSF, which therefore, perform a very important function as an employer of last resort, which if not regulated can result in fish stock depletion (Sumaila 2012).

The main reason for critically reviewing the intersection of SSF and economic viability is that SSF research clearly needs more attention, especially, in regard to the social dimension (e.g., Gutiérrez et al. 2011; Ommer et al. 2012; Pascoe et al. 2014). Analyzing economic viability by applying viability theory (a mathematical method based on viability kernel developed in Aubin, 1991) has been the dominant approach to date for the study of how economically viable small-scale fisheries are. Contributions that have applied this approach to consider social, ecosystem, economic and institutional dimensions in their study of SSF include Cissé et al. (2015) and Hardy et al. (2013).

2.2 Defining economic viability

According to the Webster 2nd edition 20th century Dictionary, viability is: "The state or quality of being viable (i.e. able to live) and the state of being able to survive under conditions of wide geographical distribution, as species of animals and plants". This definition is also used to describe the viability of artificial systems, entities and ideas, which have to maintain themselves in the long term to survive. Viability theory studies dynamical systems that capture viability and uses algorithms to describe and model them. The future of these complex and diverse systems is uncertain due to many variables and frequent changes that cannot be easily determined. It is necessary to understand how the dynamic system and the constraints it faces function to be able to restore its viability when problems arise (Aubin 2011). Viability kernel analysis (Krawczyk et al. 2013), has been adapted for use in modeling the dynamics of renewable resource systems under scenarios of uncertainty (Béné and Doyen 2000; Béné et al. 2001; Baumgärtner and Quaas 2009; Doyen et al. 2013).

Variables that describe biological and/or social systems can evolve in many different ways which can be deterministic or stochastic; they, however, have the purpose to always adapt to their environment (Aubin 2011). For example, any economic system has to adapt to scarcity constraints and it needs to find a balance between supply and demand to be able to function (Aubin 2011). According to Aubin et al. (2011), the environment is described by different types of variables and that some of those variables must obey specific constraints that can never be violated. Constraints are restrictions that are applied to a given system, they can, for example, be economical, biological or social. The strength of viability theory therefore is that it involves interdisciplinary investigations, meaning it spans across fields, which have traditionally developed in isolation (Aubin 2011).

To fully comprehend the term 'economic viability ', the economic part of it also needs to be clearly understood. The term 'economic viability' has been used in many different contexts in the literature without it being explicitly defined (Ehui and Spencer 1993; Lery et al. 1999; Barclay and Cartwright 2007; Yazdani and Gonzalez 2007; Adeogun et al. 2009). Here, I combine the concept of economics with viability and focus on how an economic entity (e.g., a small-scale fishing enterprise) can survive in the long term. To be able to understand economic viability, therefore, the system's variables and constraints need to be identified (Aubin 1991; Baumgärtner and Quaas 2009; Doyen et al. 2012). Constraints in this case is that the system's net benefits to society cannot be negative forever without consequences.

In the following paragraph, I provide a selected review of how economic viability is described in the context of natural resource exploitation and more specifically fisheries in the literature (Table 1). Lery et al. (1999) and Adeogun et al. (2009) analyzed and compared economic viability of fisheries in the sense of pure financial performance based on financial indicators, which typically include net cash flow divided by the sum of total earnings and returns on investment (net cash flow/investment). These indicators are then used to compare the economic viability of different fisheries or a threshold can be set, which has to be exceeded for the fishery to be considered economically viable (Adeogun et al., 2009; Lery et al., 1999). Economic performance, another term often used, measures how well the economic entity is doing currently, as opposed to evaluating it over time. Tisdell (1996) argues that economic viability should not only address the momentary economic performance of an economic entity but also consider its future performance. Tisdell (1996), also points out that the most important step in assessing viability is the consideration of time, as an economic entity needs to be profitable not only today but also in the future. Cost benefit analysis is often seen as a good tool to determine how economically viable an entity is as it incorporates the time aspect into the assessment of net benefits (Tisdell, 1996). When assessing natural resource exploitation, e.g., by fisheries, it is essential to also consider an intergenerational equity perspective, meaning one should account for the ability of future generations to also be able to benefit from the use of these resources in the future (Sumaila and Walters 2005; Doyen and Martinet 2012; Ekeland et al. 2015).

Baumgärtner and Quaas (2009) argue that a dynamic system, such as a fishery, is viable when its different components and functions remain stable, an indication that they will exist with sufficiently high probability into the future. The authors also specify that viability should be a normative criterion for any ecological-economic system. Furthermore, economic viability must provide the basis of strong sustainability under conditions of uncertainty, which means maintaining natural capital stocks and ecosystem services separately. In most models, a level of certainty of the system's future is assumed in order to simulate fluctuations and outcomes. However, using viability kernel analysis makes it possible to endogenously model the system's uncertainties (Béné et al. 2001; Baumgärtner and Quaas 2009; Doyen et al. 2013).

Table 1 Economic viability definitions and approaches

Main Topic	Use of economic viability	Approaches to assessing economic viability	Source publication
Financial	Equivalent to financial viability.	The study describes the important economic performance indicators for fishing operations that include investments, revenues, costs, earnings, and returns on equity ratio.	Adeogun et al. (2009).
	Equivalent to financial viability.	Viability kernel analysis.	Béné and Doyen (2000).
	Equivalent to financial viability or economic performance.	Financial and economic performance measures such as cash flow and revenue over investment ratio are used to assess the fisheries' viability.	Tietze et al. (2005).
	Equivalent to financial viability or economic performance.	Financial performance measures such as revenue over investment.	Lery et al. (1999).
	Related to farming and defined as a static concept which refers to the efficiency with which resources are employed in the production process at a given period.	Uses interspatial total factor productivity, which measures the economic viability of one system compared to another (similar to economic performance measures).	Ehui and Spencer (1993).
	No clear definition of economic viability, focus lies on financial and economic performance.	Focusses on assessing both economic and financial performance measures using net cash flow and the ratio of net cash flow over total earnings, with a minimum threshold of 10%.	Ünal and Franquesa (2010).
	Study focus lies on pure economic aspects and discusses that socio-economic indicators should be included.	Based on economic indicators such as net present value, calculating costs and revenue, using cost benefit analysis. Split into market viability and production viability.	Kronen (2004).
	Used in the sense of long term financial stability.	No assessment approached applied or discussed.	Yazdani and Gonzalez (2007).
	Equivalent to profitability.	No approach used for assessment.	Barclay and Cartwright (2007).

Main Topic	Use of economic viability	Approaches to assessing economic viability	Source publication
Ecological-economics	It is used as ecological-economic viability, which is defined as strong sustainability under uncertainty.	Stochastic dynamic network of funds and services using ecological and economic notions of viability.	Baumgärtner and Quaas (2009).
	Bio-economic viability, similar to sustainability and ecological-economic viability, focus on management.	Uses a stochastic viability approach incorporating social, economic and ecological objectives in regulating fisheries, and uses a bio-economic multi-species and multi-fleet model.	Gourguet et al. (2013).
	Co-viability analysis considering both biological and economic constraints.	Co-viability analysis: use of the stochastic viability framework introduced in Gourguet et. al. 2013. Employs bio-economic modelling.	Maynou (2014).
	Co-viability assessment focused on biological and economic constraints.	Approach based on stochastic viability framework and applied using a bio-economic model.	Gourguet et al. (2016)
	General viability when the fishery is in a crisis situation.	Viability kernel analysis.	Béné et al. (2001).
	Viability is used more in the ecological-economic context and explores if the ecosystem itself is viable (no clear definition).	Viability kernel analysis.	Cury et al. (2005).
	Viability is considered to be similar to sustainability where all social, economic and ecological constraints need to be met for the system to be viable, focus on management.	Viability kernel analysis.	De Lara and Martinet (2009).
	Cooperative fisheries management is considered viable when it fulfills both, ecological and bio-economic constraints.	Viability Kernel Analysis.	Doyen and Péreau (2012).
	Assesses small-scale fisheries using viability theory to understand trade-offs between biodiversity conservation and food security.	Viability kernel analysis.	Hardy et al. (2013).
	Economic viability of small-scale fisheries integrating ecological, economic and social dimensions using biodiversity preservation, fleet profitability and food security as constraints in light of ecosystem based fisheries management.	Viability kernel analysis.	Cissé et al. (2015).

Main Topic	Use of economic viability	Approaches to assessing economic viability	Source publication
Others	Assumes that viability is achieved when economic, social and ecological constraints are met; It specifically assesses a fisheries quota system.	Viability kernel analysis, viable control method, bio-economic model.	Péreau et al. (2012).
	Refers to the viability of a fishery with respect to economic, social and biological constraints focussing on fishery restoration.	Viability kernel analysis.	Martinet et al. (2007).
	Assesses and and compares the viability of management frameworks in place.	Viability kernel analysis.	Eisenack (2003).
	Focuses on management, using viability in terms of management targets (i.e. the ability of the target to persist through time and remain resilient in the face of stressors.	No assessment approach applied, describes how indicators can be used to improved fisheries management that incorporates social, biological and economic aspects.	Pomeroy and Andrew (2011).
	Sees economic viability as more than just financial performance measures when analyzing the conservation of farming projects.	No assessment approach applied but suggests the use of social Cost Benefit Analysis.	Tisdell (1996).

2.3 Economic viability of fisheries

Fisheries are prone to uncertainty because environmental, institutional, economic and social changes cannot easily be foreseen or determined (Lane and Stephenson 1998; Charles 1998; De Lara and Martinet 2009; Fulton et al. 2011; Teh and Sumaila 2013). To determine whether a fishery is economically viable, uncertainties need to be dealt with in the most realistic way possible. Only by handling the uncertainties in a model appropriately, can we find out how the fishery system will perform in the future.

Béné et al. (2001), Doyen and Péreau (2012) and Gourguet et al. (2013), adjust the classical dynamic fishery model, which focusses on sustainable fisheries and rent maximization by using a viability theory framework. The goal of this approach is to assess the system's dynamics and its constraints. Controls can then be determined to ensure that the necessary constraints are not violated. Béné et al. (2001) state that economic viability is reached when the bio-economic system is found in good health. The authors attempted to find instantaneous and simultaneous criteria that would help ensure viability. The article focusses on the viability of the system in crisis situations, meaning that the higher its viability the better it can handle crises. However, while this approach is highly relevant to the concept of economic viability, it is very specifically related to a crisis situation in regard to the bio-economic system rather than to the general state of the system's economic viability. Béné and Doyen (2000) sought to improve the economic viability of the fishery by introducing fish storage capacities to the system, which protects fishers from hazards of market fluctuations. With storage facilities in place, the fishery is less vulnerable to crisis situations thereby making the fishery economically viable (Béné and Doyen 2000).

Viability theory has been applied to assess the sustainability of different fisheries management frameworks (Eisenack 2003; Gourguet et al. 2013, 2016; Maynou 2014). Eisenack (2003) defines viability criteria in terms of biological and economic thresholds. The management scheme is considered viable when the thresholds set are not exceeded. Thresholds are commonly known as limit reference points (e.g. Maximum Sustainable Yield) in fisheries management. Similarly, Gourguet et al. (2013) and Maynou (2014) applied the viability theory framework to test and compare fisheries management strategies and recommend them based on their potential usefulness to policy makers. Here, the trade-offs between conflicting objectives in mixed fisheries and the necessary constraints are based on both ecological and economic aspects.

Doyen and Péreau (2012) deals with cooperative fisheries management and how viability theory comes into play when assessing the compatibility between bio-economic constraints and an exploited common stock dynamic. This model considers present and future states of the exploited renewable resource system, and the conditions and coalitions under which it can fulfill both profitability and conservation objectives. This is an example germane to trans-boundary stocks that are managed by different legal entities, and presents an interesting and useful alternative to standard game theory models (Sumaila 1999; Bailey et al. 2010). Péreau et al. (2012) show how this approach can be used to assess the sustainability of quota systems of fisheries. The main focus, however, of the above examples is not on the overall economic viability of the fishery but instead directed more specifically at the management strategies aiming for ecological-economic or bio-economic viability.

2.4 Economic viability of small-scale fisheries

Small-scale fisheries need to be treated somewhat differently when assessing financial viability or economic performance because, as argued in many studies, the goal of small-scale fishers does not always seem to be just profit maximization but also includes the maintenance of traditional, cultural and social values (Berkes et al. 2001; Pollnac et al. 2001; Kronen 2004; Pollnac and Poggie 2008; Trimble and Johnson 2013). Often, large proportions of the catch of SSF are for home consumption (Hospital and Beavers, 2012), and fishing is considered a way of life rather than a profit-orientated business (Kronen, 2004). For example, Hospital and Beavers (2012) found that for the majority of fishers in the Hawaiian bottomfish fishery, cultural aspects outweigh any economic prospects, and although the majority of fishers can cover some of their costs, their main income comes from other activities.

Because of these additional considerations, the assessment of economic viability is more challenging as many variables that are not based on financial values need to be considered, making pure quantitative approaches insufficient to fully understand and capture the fishery's dynamics (Martinet et al. 2007; Adeogun et al. 2009; Kronen et al. 2010). Furthermore, it is important to note that using a bio-economic model to assess a fishery requires large amounts of data to be successful. It is known that efforts, especially in SSF, are often not sufficient to collect enough data to carry out an integrated bio-economic fishery assessment (Charles 1991). This disadvantage, therefore, tremendously increases the challenge of constructing comprehensive bio-economic models of these data-poor fisheries.

Kronen (2004) illustrates another challenge, i.e., the assumption that price changes are influenced by national and international market price fluctuations. This assumption is often made when assessing the economics of fisheries but does not necessarily apply to SSF. This study explains that prices stay at levels at which friends and families are able to pay. Prices can therefore be much lower or higher in local markets without taking any cues from national, regional or international markets. This is particularly the case in low income communities (Kronen, 2004). Considering that this is an observation specific to the fishing community studied in the cited paper and therefore not necessarily representative for all SSF, it is still good to identify some of many variables and drivers that should be paid attention to when studying SSF. Therefore, when assessing economic viability of a small-scale fishery, it is important to learn about the underlying social dynamics of that fishery and its community rather than focusing on a few selected variables only.

The challenge to assessing economic viability has been tackled through approaches such as the viability kernel analysis described in Sections 2.1 and 2.2, which gives a decent foundation to an analytical framework and addresses natural resource management issues that are important for a sustainable development of SSF and their viability (Béné et al. 2001). Through the viability kernel analysis, social, economic and biological constraints can be selected to illustrate possible recovery paths of a fishery (Martinet et al. 2007). The viability approach has also been implemented in regard to food security and ecological constraints of a fishery using an example from SSF in the Solomon Islands (Hardy et al. 2013). This is the first study known to the authors that brings in a wider context of development in relation to food security, poverty and their link to resource conservation using viability theory (Hardy et al. 2013).

Other authors focus primarily on multi-objective problems with respect to natural resource management and conservation (Baumgärtner and Quaas, 2009; Péreau et al., 2012). Hardy et al. (2013) chose indicators from ecological (species richness) and economic (cash vs subsistence indices) dimensions to model the trade-offs between food security and biodiversity conservation. Different scenarios were modeled to show different outcomes depending on different economic, social and ecological variables that were used. Results from this contribution demonstrates that the status quo scenario is not favorable as it will not secure enough food for the local population and the biodiversity of the fished area will continue to decline. This study's conclusions suggest that the results from the model based on viability theory can serve as a baseline for finding solutions to the problems identified. These include the proposal of management strategies that combine biodiversity preservation with social and economic needs of the local community from the system.

Additionally, Cissé et al. (2015) used the same approach as a function of eco-viability, which includes constraints such as food security, ecological indices (e.g., species richness) as well as profit viability to model different fishing scenarios as a basis to provide monitoring and management strategy recommendations using an example from SSF of French Guiana. The studies reviewed herein present some evidence of the effectiveness of using the viability theory approach to understand the complex dynamics of small-scale fisheries.

It is also important to point out the limitation of models based on viability theory, for example, Martinet et al. (2007) discuss how economic constraints are seen as more stringent in their analyses whereas social aspects are less so. Furthermore, approaches to assess the viability of a fishery based on viability kernel analysis are primarily focused on their economic and ecological aspects, whereas social aspects are often underrepresented (Adeogun et al., 2009; Eisenack et al., 2006; Kronen et al., 2010; Martinet and Blanchard, 2009). A few exceptions from the more recent studies presented above do incorporate food security, as a representation of the social dimension, into the viability theory approach. Their results demonstrate the importance of the integration of more than mere ecological and economic aspects into these fisheries assessments as management recommendations differ much depending on which constraints were applied (Hardy et al 2013 and Cisse et al 2015). However, it is critical to note that these are still only a few exceptions and that the management of renewable resources, ecosystems and biodiversity is still far from satisfying social, ecological and economic criteria (Doyen et al. 2013). Furthermore, the fact that only few constraints have been chosen to represent the social aspects of SSF can easily lead to an underrepresentation in this dimension.

Additional to social drivers, it has also been shown that the institutional structure plays a key role not only in general for any system connected to the use of renewable resources (Ostrom, 1990) but specifically to SSF (Barclay and Cartwright, 2007; Trimble and Johnson, 2013). Trimble and Johnson (2013) argue that for a fishery to be economically viable, governance needs to be integrated into the dynamics of the fishery and therefore adaptable to changes within the fishing community and the fishery itself. Barclay and Cartwright (2007) present an example of the Western and Central Pacific Ocean and discuss how governments can improve the fishery's situation by having the right mindset and minimizing corruption. The governments can, therefore, have a positive influence on the fishing community and give incentives to be economically more efficient, despite little funding opportunities.

Furthermore, it has been argued often that decentralized management through co-management is important (Sumaila and Domínguez-Torreiro, 2010), which has to be supported by participatory research that promotes integrated and participatory decision making processes (Jentoft et al., 1998; Lane and Stephenson, 1995). Fisheries management through cooperatives, as a form of self-governance, has also shown successes in different places especially coupled to user rights based on territory and culture (McCay et al. 2014; Sylvia et al. 2014). Co-management and participatory processes are especially important for improving SSF management where fishers are often isolated from and therefore frustrated with fisheries governance processes (Trimble and Berkes, 2013).

2.5 Discussion and recommendations

This review shows that for a fishery to be considered viable many criteria, variables and constraints need to be identified ideally from social, ecological, governance and economic dimensions at the same time. Small-scale fisheries are very dynamic and complex systems which makes assessing their economic viability extremely challenging, especially, when considering social factors, which are not easily captured using quantitative assessment methods. Various examples call for the inclusion of socio-economic and cultural factors into the assessment of a fishery's economic viability (Adeogun et al., 2009; Baumgärtner and Quaas, 2009; Lery et al., 1999). This, however, is based merely on suggestions since no study on economic viability was found where social or socio-economic aspects were represented comprehensively. Moreover, currently in the literature, financial viability, economic performance and ecological-economic viability are used interchangeably to depict economic viability even though these terms have different meanings.

Tisdell (1996) discusses how social cost benefit analysis is a good approach to incorporating externalities, ensuring that not only the private owner benefits from the system but the society as well. Furthermore, this article highlights that profit is necessary for a system to be viable; however, it is not the sole criteria. Tisdell (1996) argues that when dealing with natural resources, a holistic approach is needed as economic attributes depend not solely on financial factors. However, no solution has been presented on how safe minimum standards can be best determined while considering monetary and non-monetary values (Tisdell, 1996).

The viability kernel analysis is already an extensive way of modeling the constraints and dynamics of a fishery addressing, inter alia, management, restoration, crisis situations and trade-offs. However, a few gaps in this analysis still need to be considered, especially when planning on using the approach specifically to SSF, which highly depend on social and governance aspects additionally to the financial and ecological ones. The rising complexity, the missing details, paucity of data availability and the underlying uncertainties (especially when incorporating social aspects) make it extremely challenging to adequately capture the more qualitative information about the fishery, suggesting that there is still room for improvement.

For example, only few studies using the viability kernel analysis incorporate any sort of cultural and institutional aspects into their approach, which are key factors in SSF. Furthermore, despite the acknowledgement of the need to include more dimensions in the analysis of economic viability, this review demonstrates that it is still profit that is considered the main factor driving the fishery (e.g., Martinet et al., 2007). Therefore, existing approaches used to assess economic viability should be extended or reconsidered. Cissé et al. (2015) and Hardy et al., (2013) are useful examples where the challenge has been tackled and more social aspects have been integrated in relation to the livelihoods of small-scale fisheries communities and their economic viability. However, despite this step in the right direction and the success in capturing a larger part of the diverse dynamics of the SSF system, there is still more to explore and expand upon. Using food security, cash or subsistence economy and biodiversity conservation as set constraints is definitely insightful and important to the SSF system, however, other aspects such as subsidies, fair distribution of benefits or employment might be equally important drivers of the fishery's economic viability.

As explained by Berkes et al. (2001), the postharvest sector (including buyers, processors, and market linkages) is part of the fishery system, as well as its governance system. Hence, a fishery consists of biological, technological, economic, social, cultural, and political dimensions. Berkes et al. (2001) directed this statement more towards a functioning SSF management system; however, I find that similar reasoning applies when assessing the viability of SSF.

Various approaches have been developed, suggested and discussed in the literature to achieve sustainable management of SSF and find ways to secure livelihoods in small-scale fishing communities (e.g., Allison and Ellis, 2001; Cunningham et al., 2009; Béné et al., 2010a). Such frameworks include the wealth-based approach, which argues that poverty can be alleviated by introducing access rights to open access fisheries, which gives the natural resource the chance to recover and foster future rent maximization for the remaining fishers (Cunningham et al., 2009).

Another example is the sustainable livelihood approach, which incorporates more dimensions such as vulnerability and marginalization (Allison and Ellis, 2001). It focuses more on the people and on poverty alleviation as well as promotes cross-sectorial thinking, rather than using economic rent as the main goal for the fishery (Allison and Horemans, 2006). The welfare function, another approach, explains how SSF absorb unskilled surplus labor and creates a safety-net for poor households, instead of functioning as a poverty trap (Béné et al., 2010a).
All three approaches have their benefits and caveats. For example, the welfare approach has been found to lead to the unfair distribution of benefits within SSF fishing communities (e.g., Isaacs et al., 2007; Sinan and Whitmarsh, 2010). Furthermore, it is essential to understand the situation of a fishery before deciding whether (or which) of the existing approaches is adequate and realistic (Chuenpagdee and Jentoft, 2007). Hence, it could be useful to assess the economic viability of a SSF fishery to then identify the approach that is most in line with its needs to achieve sustainability, rectify marginalization and reduce its vulnerability to large scale threats. As poverty, vulnerability and marginalization are also mentioned as key aspects to be considered when planning to assess the economic viability of SSF (Béné and Friend, 2011; Allison and Horemans, 2006), it could also be useful to build upon what has already been created through existing frameworks and methodologies in order to learn from their successes, failures and their usefulness in understanding the economic viability of SSF.

This chapter reviewed the definitions and approaches with regard to SSF, concluding that the lack of coherence that currently surrounds the term 'economic viability' needs to be rectified. I therefore decided to define what economic viability should mean for an active small-scale fishery. This definition incorporates only some of the aspects discussed in this article which are: society versus the private sector, the time component, and that achieving non-negative net benefits from SSF is likely a more appropriate goal than profit maximization. With these aspects in mind, the definition I suggest is as follows: A small-scale fishery is considered economically viable when non-negative net benefits to society from fishing are maintained. One of the key factors in these definitions have been identified as subsidies, which need to be subtracted when assessing net benefits to society, as they are a cost and not a benefit to society. To address the shortcoming of better incorporating the social and/or governance values in economic viability analysis I suggest once the net benefits to society are assessed a list of attributes will need to be identified and their importance and contribution to the economic viability tested.

Chapter 3: The unequal distribution of global fisheries subsidies undermines the economic viability of small-scale fisheries

3.1 Fisheries subsidies and small-scale fisheries

The objective of this chapter is to understand the role that subsidies play in marine small-scale fisheries (SSF) globally. Therefore, I ask and address the following research questions:

1. What is the proportion of global fisheries subsidies that reach small- compared to large-scale fisheries?
2. How much of these subsidies are categorized as beneficial and capacity-enhancing for each sector?
3. What do the results from 1. and 2. mean for the economic viability of small-scale fishers?

The amount provided globally to the fisheries sector as subsidies, estimated at 35 billion USD (in 2009), is between 30 and 40% of the total gross revenue from global marine fisheries (*The Sunken Billions* 2009; Dyck and Sumaila 2010; Sumaila et al. 2016). After the 2nd World War, fisheries subsidies were provided to help lower the cost of fishing and thus enable them to catch more fish. The higher the subsidies provided, the more fish was caught. Today, however, the situation has changed; with fish stocks in decline worldwide, most subsidies provided by governments turn to stimulate exploitation of already over-depleted resources in many cases

(Pauly et al. 2002; Sumaila and Pauly 2006; Sumaila et al. 2008, 2010a). Therefore, many subsidies are considered to be harmful or capacity-enhancing rather than beneficial and have been identified as one of the main contributors to the current global fisheries crisis (e.g., (Milazzo 1998; Munro and Sumaila 2002; Clark et al. 2005; OECD 2006a; Sumaila et al. 2016).

Fisheries subsidies are defined here as financial transfers, which can be direct or indirect, from public entities to the fishing sector (Milazzo 1998; Munro and Sumaila 2002; Sumaila et al. 2010a). The support from governments to the fishing sector can take many forms, including those provided by parastatals, through direct capital infusion, financial assistance and preferential tax treatment, expenditures on market promotion, fisheries management and research, as well as negotiating access agreements for distant water fleets (NOAA 1999). It should be noted that the term subsidy is being used interchangeably with support programs, financial support, economic assistance, and government financial transfers, all of which are payments that governments provide to the fisheries sector.

Fisheries subsidies and their different impacts on fish and fisheries around the world have been studied extensively over the last two to three decades (e.g., (Milazzo 1998; Munro and Sumaila 2002; Clark et al. 2005; Sumaila and Pauly 2007; Harper et al. 2012; Sumaila et al. 2016). Notably, the World Trade Organization (WTO) has taken on the subject of fisheries subsidies and included them as one of the key issues within the Doha Trade Round of Negotiation (WTO 2001; Schorr 2005, 2007; Moltke 2012). An agreement was made in 2005 to implement rules that would regulate subsidies leading to overcapacity and overfishing, with the supporting argument that they negatively impact global trade, development and the environment (WTO

2005; Cho 2015). Unfortunately, the negotiations seem to have lost their impetus since 2011, and thus, until today no agreement within the WTO has been reached to date (Cho 2015).

Discussion within the WTO Doha Round have also included the plight of small-scale fisheries and it has been argued that SSF, especially those in developing countries, should receive special treatment when international rules regarding harmful fisheries subsidies are implemented (Grynberg 2003; Schorr 2005; Yu and Fonseca-Marti 2005; Chou and Ou 2016). However, negotiations have proven to be more prolonged and complicated than anticipated and no special rules had been defined (Schorr 2007). One of the main reasons for this, it has been argued, is that small-scale fisheries, as for all other fisheries, need to reach sustainability and are not immune to the negative impacts caused by harmful fisheries subsidies (Schorr 2007). On the contrary, some have argued that SSF need subsidies to help the fishing communities minimize the effects of poverty and enhance their food security (Yu and Fonseca-Marti 2005).

However, almost all current studies on fisheries subsidies focus on large-scale (industrial) fisheries while the impact of fisheries subsidies on small-scale fisheries (including subsistence and artisanal fisheries) is essentially unexplored (Charles 2011). Despite being understudied, the importance of small-scale fisheries in economies worldwide cannot be ignored (Chapter 1). A description and a definition of SSF for the purpose of this study is presented in Chapter 1.

Small-scale fisheries face many challenges, including: ineffective management and weak governance; poverty and undernourishment in fishing communities; pressure from industrialization and global changes such as market shifts and climate change (Béné 2003;

Jentoft et al. 2011; Lam et al. 2012). The under-representation of local stakeholders in decision making processes have, furthermore, contributed to the political marginalization of SSF as their interests are often neglected or not accounted for (Pauly 1997; Béné et al. 2010a; Chuenpagdee 2011; Allison et al. 2012). Economic viability assessments have informed management and policy decision making and presented trade-offs necessary to balance food security needs with ecosystem conservation of SSF communities (Hardy et al. 2013; Cissé et al. 2015). Understanding the economic viability of these fisheries is essential to help rectify their marginalization and bolstering them against potential crisis (Béné and Doyen 2000; Schuhbauer and Sumaila 2016). Here, I refer to the whole society, such that economic viability is accomplished when net benefits of an active fishery to society are non-negative over time (Schuhbauer and Sumaila 2016). The fact that subsidies are shouldered by taxpayers, demonstrates that subsidies are an integral part of society and therefore of economic viability.

The first task I set myself is therefore to estimate the proportion of total subsidies received by the small-scale fishing sector. With this knowledge, I suggest policy recommendations on how to address some of the challenges SSF face and thereby improve their economic viability.

3.2 Methodology

3.2.1 Subsidy data assessment

The starting point for the analysis in this chapter is the country-level fisheries subsidies database reported in Sumaila et al. (2010a, 2016). Of the 146 maritime countries that are included in the database, I analyze subsidies in 81 countries, which were selected based on data availability and the total amount of subsidies they provide globally. In all, these countries gave 98% of the estimated $35 billion annual global fisheries subsidies in 2009. To obtain a truly global sample, I also made sure that countries from each continent are included (Fig. 1).

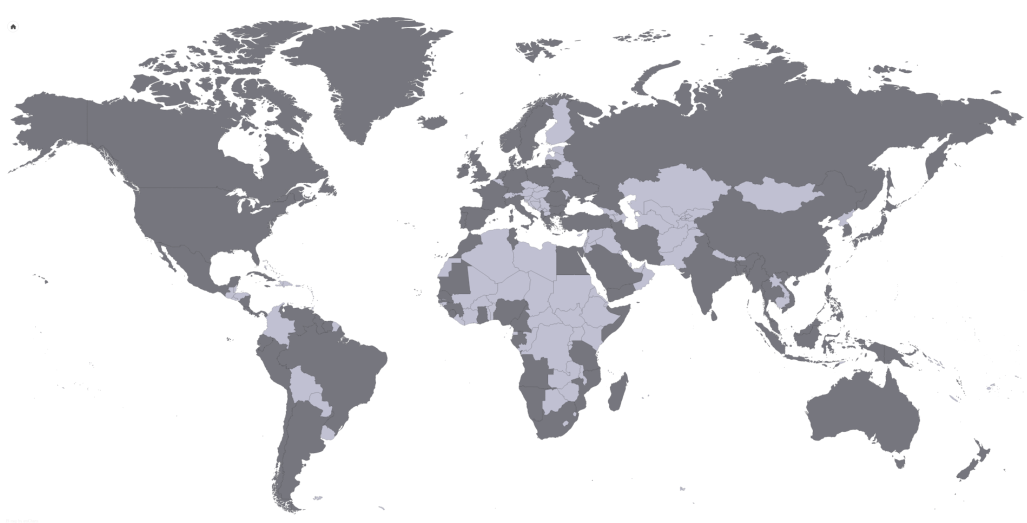

Figure 1 World map showing in dark grey the 81 countries covered in this study (www.amcharts.com last accessed November 2016).

Countries were grouped into developing and developed nations based on each country's Human Development Index (HDI) as was done in Sumaila et al. (2010a). To split country-level subsidies into SSF and LSF, I applied two approaches for: 1. non-fuel subsidies and 2. for fuel subsidies.

Sources and references used to split each country and subsidy subtype can be found in the Appendix (last page). I describe below how the subsidies are split into SSF and LSF for each country and subsidy subtype.

3.2.2 Assessing SSF non-fuel fisheries subsidies

Of the 81 countries, I had data on non-fuel subsidies for 73 countries. Subsidies can be divided into various categories. The categorization applied in this study is based on a given subsidy's possible impact on fish stocks over time, which may or may not result in investment in sustainable fish stocks. Non-fuel subsidies include the subtypes: 1. Beneficial subsidies: Fisheries management; fisheries research and development and marine protected area. 2. Capacity-enhancing subsidies: Boat construction, renewal and modernization; development programs; port development; infrastructure for market and storage; tax exemptions and fishing access agreements and 3. Ambiguous subsidies: Fisher assistance; vessel buyback and rural fisher community development programs (Khan et al. 2006; Sumaila et al. 2010a, 2016).

For each subsidy subtype the collected information that was found in the literature was grouped into three data categories as illustrated in Fig. 2 all using the baseline for the year 2009.

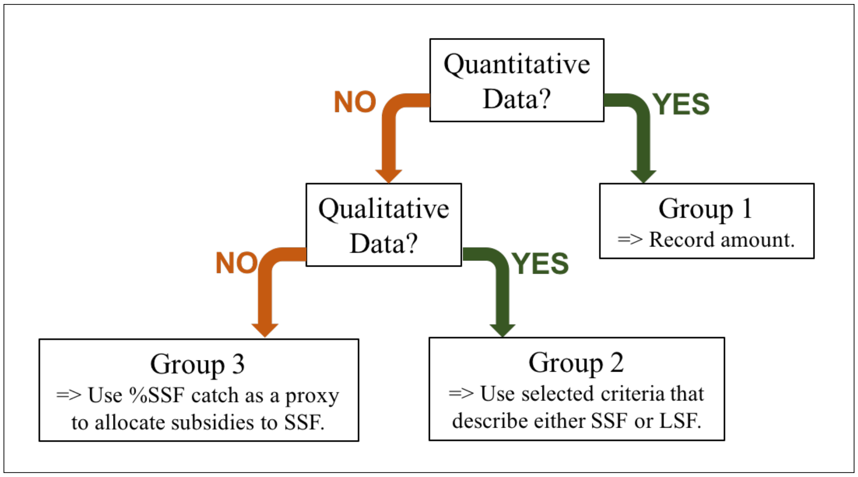

Figure 2 Illustrating the methodology used to divide 2009 subsidy amounts into small- (SSF) and large-scale fisheries (LSF).

Group 1) Is there quantitative data available? If yes, then the indicated subsidy quantity to SSF is recorded (Fig.2).

Group 2) Is qualitative data available? If yes, use the qualitative information to estimate the amount of subsidies provided to SSF (Fig. 2). Qualitative data is often found in the form of bullet points and tables which are broken down into objectives. If a subsidy amount was described by more than one objective/bullet point, I split the total subsidy equally between the stated objectives (see example in Fig 3). To be consistent the use of the following words depicts SSF: artisanal; subsistence; small-scale; non-motorized; coastal and community-based and LSF: industrial; large-scale; freezer trawlers; off-shore; over sea and deep sea.

To better illustrate the procedure of the methods (Fig. 2), I use a description of the subtype "boat construction and renovation" from Thailand presented in Fig. 3 (APEC 2000).

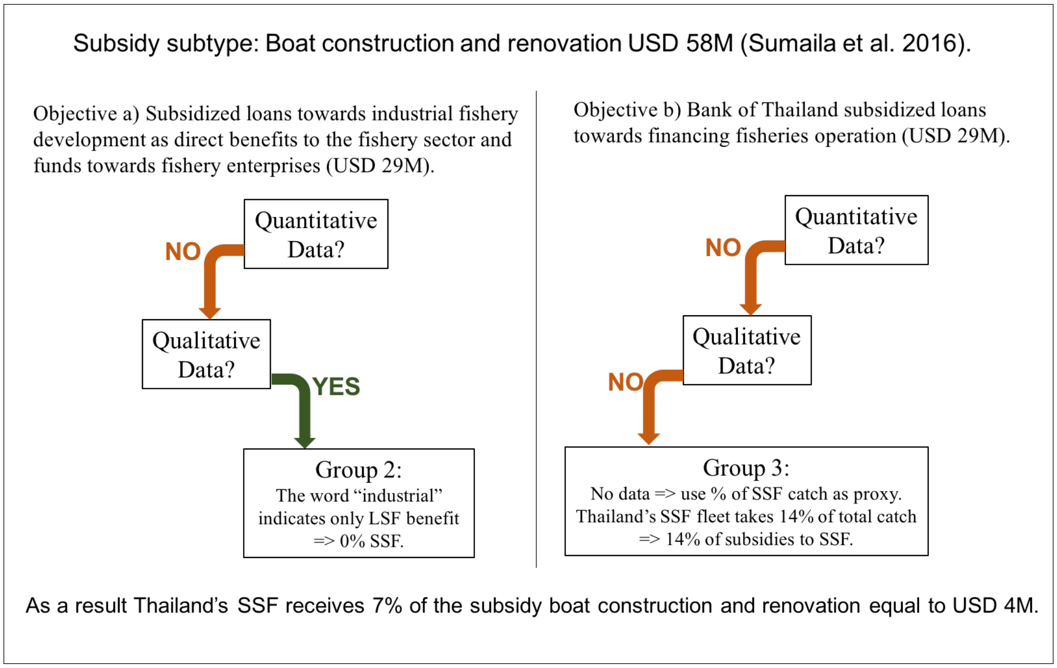

Figure 3 Diagram shows how a fishery subsidy subtype is split into small- and large-scale based on available information, illustrated using an example from Thailand.

Group 3) If no quantitative or qualitative data are available, we have a no data situation. In this case I use the percentage of SSF catch data (volume in tonnes) to total catch of the country is then used as a proxy to allocate the proportion of subsidies to SSF. Catch information is obtained from the *Sea Around Us* (www.seaaroundus.org last accessed on February 2016), which are more comprehensive than FAO catch data because they include more information specifically on SSF catches (Pauly and Zeller 2015, 2016; FAO 2016b). It is important to note that the proportion of SSF to total catch differs depending on the size of a country's distant water fishing fleet and number of foreign vessel fishing with the country's EEZ. The *Sea Around Us* catch information distinguishes between the catch that has been caught in a country's Exclusive Economic Zone (EEZ) and the amount caught by a country's fleet. This is important because beneficial subsidies (such as management) benefit the fisheries in a country's EEZ. Capacity-enhancing and ambiguous subsidies (e.g., boat construction), on the other hand, are directed at a country's fishing fleet.

It should be noted that exceptions were made if no data was available for the subtype rural fisher community development we assume that 100% of the subsidy go to the SSF. The reason is that based on the description of the subsidy subtype rural fisher community and the definition of SSF, only SSF would benefit from this subsidy. On the other hand, 0% of foreign access agreement subsidies are assumed to go to SSF as based on the definition of SSF, no SSF operate in the waters of another country. See Sumaila and Pauly (2006) for a detailed description of each subsidy subtype.

3.2.3 Assessing SSF fuel subsidies

Fuel subsidies are split into small- and large-scale depending on fuel consumption data availability using the method described in (Greer 2014). Of the total 81 countries that I analyzed, 35 countries had fuel consumption data available which I used to estimate SSF fuel subsidies. The amount of fuel consumed by a vessel depends on many factors, both operational and technological (Wilson 1999; Gulbrandsen 2012). Small-scale fisheries commonly use small, outboard engines powered by gasoline or use no engine, whereas industrial fishers tend to operate from large inboard engines powered by marine diesel (Corbett and Koehler 2003).

The Specific Fuel Consumption Rate (SFR) used for the small-scale sectors (artisanal and subsistence) was estimated to be 0.35kg/kWh and the equivalent number for the industrial sector is 0.2kg/kWh. These SFR represent the fuel consumption of engines in the mid 2000s, but engine efficiency has changed substantially over time. In order to account for this change, Greer (2014) estimated a fuel coefficient (FC) using fuel consumption data from Yanmar engines, an international builder and supplier of marine engines to adjust to the year 2009, which I applied here (http://www.yanmarmarine.eu/ last accessed February 2016). The number of hours fished (can be interpreted as the number of hours the engine is running) was determined by sector: LSF are assumed to run their engines 24 hours a day when fishing (Winther 2007) while SSF are assumed to fish 12 hours per day. Fuel consumption is calculated by multiplying the fishing effort (number of boats times hours fished) by specific fuel consumption rate and by the fuel coefficient. If no other information was available that indicates how much fuel subsidies are provided to the SSF, I calculate the proportion of SSF fuel consumption to total fuel consumption. This proportion was then applied to calculate the fraction SSF receive of the total fuel subsidy amount. In total, I assessed 520 data points from the 81 countries and 13 different subsidy subtypes, out of which 12% are in Group 1, 41% in Group 2 and the remaining in Group 3.

3.2.4 Estimating SSF subsidies of remaining countries

Here I describe how total subsidies are split into those received by SSF and LSF for the remaining countries that were not assessed individually, and which represent only 2% of the global subsidy amount. I divide the world into 21 subregions (based on the UN geoscheme http://unstats.un.org/unsd/methods/m49/m49regin.htm last accessed November 2016) and use catch data as a proxy for SSF sector size. For each subregion the SSF subsidy proportion per subsidy subtype is calculated (equation 1) using data from the countries assessed in this study.

$$propSSFsubsidy_{s,j} = \frac{\left(\sum_{i,j=1}^{I,J} SSFsubsidies_{i,j}\right)_s}{\left(\sum_{i,j=1}^{I,J} Totalsubsidies_{i,j}\right)_s} \quad (1)$$

where prop stands for the proportion of SSF to total subsidies, s = 1 to S denotes subregion; j = 1 to J represents subsidy subtype and i = 1 to I denotes country.

The next step is to calculate the proportion of SSF to total catch per country i (equation 2) and per subregion s (equation 3) using data of all maritime countries from the *Sea Around Us* database.

$$propSSFcatch_i = \frac{SSFcatch_i}{Totalcatch_i} \quad (2)$$

$$propSSFcatch_s = \frac{\left(\sum_{i=1}^{I} SSFcatch_i\right)_s}{\left(\sum_{i=1}^{I} Totalcatch_i\right)_s} \quad (3)$$

To estimate the SSF subsidy of a country i and subype j that has not been assessed, I use: 1. the result of the proportion of SSF subsidies subtype j for subregion s in which country i is located (equation 1); 2. the proportion of SSF catch for country i (equation 2) and 3. The proportion of SSF catch for the subregion s (equation 3). To be able to do this most accurately with the data available, I calculate an adjustment factor for each country (equation 4).

$$Adjustmentfactor_i = \frac{propSSFcatch_i}{propSSFcatch_s} \tag{4}$$

The adjustment factor (which is the same for all subsidy subtypes (j – J)) for country i is then multiplied with the SSF subsidy per subregion s and subsidy subtype j (equation 5).

$$propSSFsubsidyestimate_{i,j} = propSSFsubsidy_{s,j} \times Adjustmentfactor_i \tag{5}$$

The proportion of SSF subsidy estimate for each country and subtype is multiplied with the total amount of subsidy per subtype for the relevant country to obtain the SSF subsidy amount in USD (2009).

3.3 Results

3.3.1 Small-scale versus large-scale fisheries subsidies

The analysis suggest that of the estimated global fisheries subsidies of USD 35 billion in 2009 (Sumaila et al. 2016), USD 5.6 billion are provided to the small-scale fishing sector. This works out to be only 15.8% of total fisheries subsidies provided by governments worldwide (Fig 4).

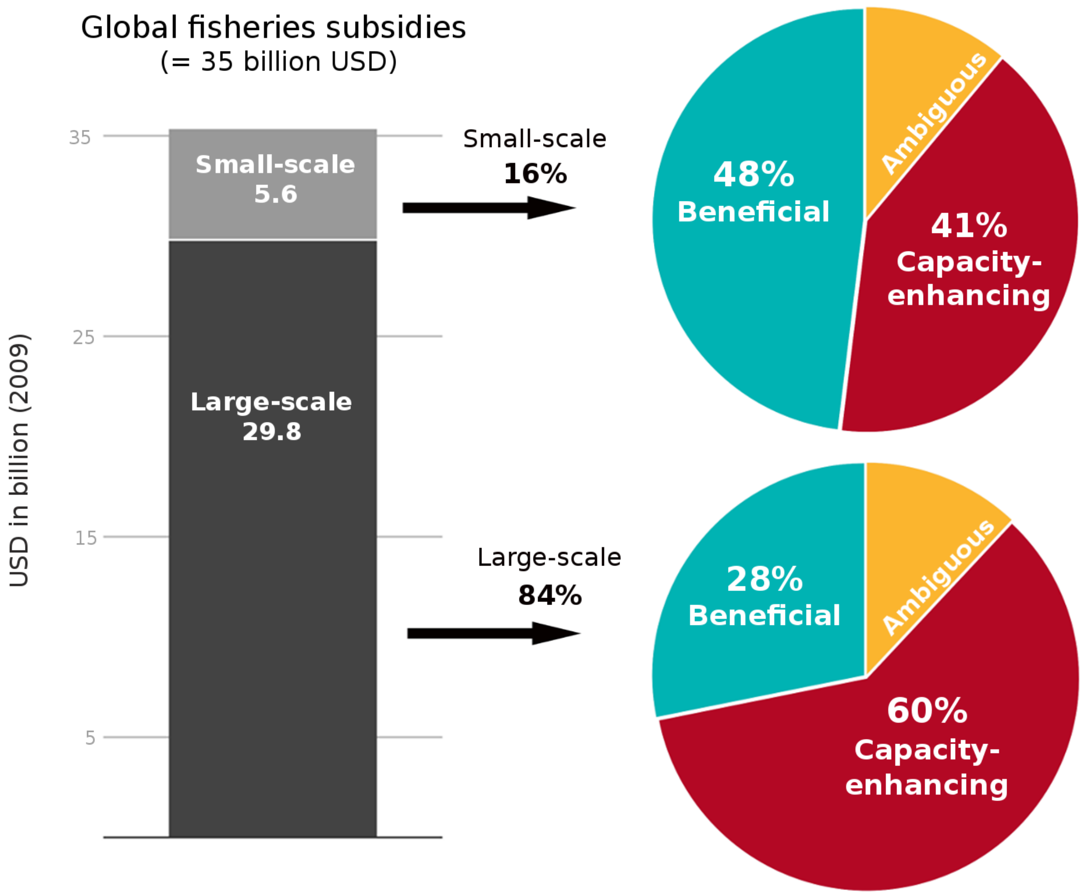

Figure 4 Global fisheries subsidies divided into large- and small-scale fisheries and split into three subsidy categories: Beneficial, capacity-enhancing and ambiguous.

The composition of the subsidy estimates by sector and subsidy category, shown in Fig. 4, reveals that small-scale fisheries received 2.7, 2.3 and 0.6 billion USD of beneficial, capacity-enhancing and ambiguous subsidies, respectively. Subsidies to LSF, on the other hand, are divided into 8.4, 17.8 and 3.6 billion USD, respectively, for the same categories. Results show that 89% of the estimated 20 billion USD capacity-enhancing subsidies go to the large-scale fishing sector.

Fuel subsidies are the highest subsidy amount provided to the total fishing sector globally (Sumaila et al. 2016), out of which, we find that the SSF sector receives only 6% (equivalent to 0.5 billion USD). Our study suggests that the highest amount in total provided to the SSF sector are subsidies for fisheries management and monitoring (beneficial subsidies) with 1.8 billion USD (representing 25.7% of the total amount provided to SSF), Table 2. The subsidy subtypes for which the SSF receive the lowest percentage are 'fishing access' and 'vessel buyback' (0 and 0.2%, respectively), Table 2. See Appendix for a detailed breakdown of the data by country and subsidy subtype.

Table 2 Global fisheries subsidies by category and subtype for small- and large-scale fisheries.

Subsidy category and subtype		USD in million (2009)		
		Small-scale	Large-scale	Total
Beneficial	Fisheries management and monitoring	1,835	5,303	7,137
	Fisheries research and development	588	2,120	2,708
	Marine Protected Areas	271	958	1,229
Capacity-enhancing	Fuel subsidies	462	7,108	7,570
	Fishing port development	722	2,738	3,460
	Boat construction and renovation	503	2,796	3,299
	Market and storage infrastructure	186	2,518	2,704
	Tax exemption	147	948	1,095
	Fisheries development projects	270	775	1,045
	Fishing access	0	937	937
Ambiguous	Vessel buyback programs	3	2,076	2,080
	Fisher assistance	480	1,463	1,942
	Rural fisher communities	138	26	164
Total		5,631	29,740	35,371

3.3.2 Fisheries subsidies by level of development

Figure 5 summarizes the results obtained in terms of large-scale and small-scale fisheries grouped into developed and developing countries and presented by subsidies category: capacity-enhancing, beneficial and ambiguous. We see from the figure that of the total subsidies provided to the SSF, 66% (2009 USD 3.4 billion) go to SSF in developed countries on the other hand 34% (2009 USD 2 billion) to SSF in developing countries (Fig. 5). These allocations are similar to the total global fisheries subsidies presented in (Sumaila et al. 2016), where 65% of total fisheries subsidies are attributed to developed countries. As shown in Fig. 5, developing countries provide the largest percentage of capacity-enhancing subsidies to their large-scale sector, whereas the larger percentage of beneficial subsidies is provided by developed countries to their small-scale fisheries.

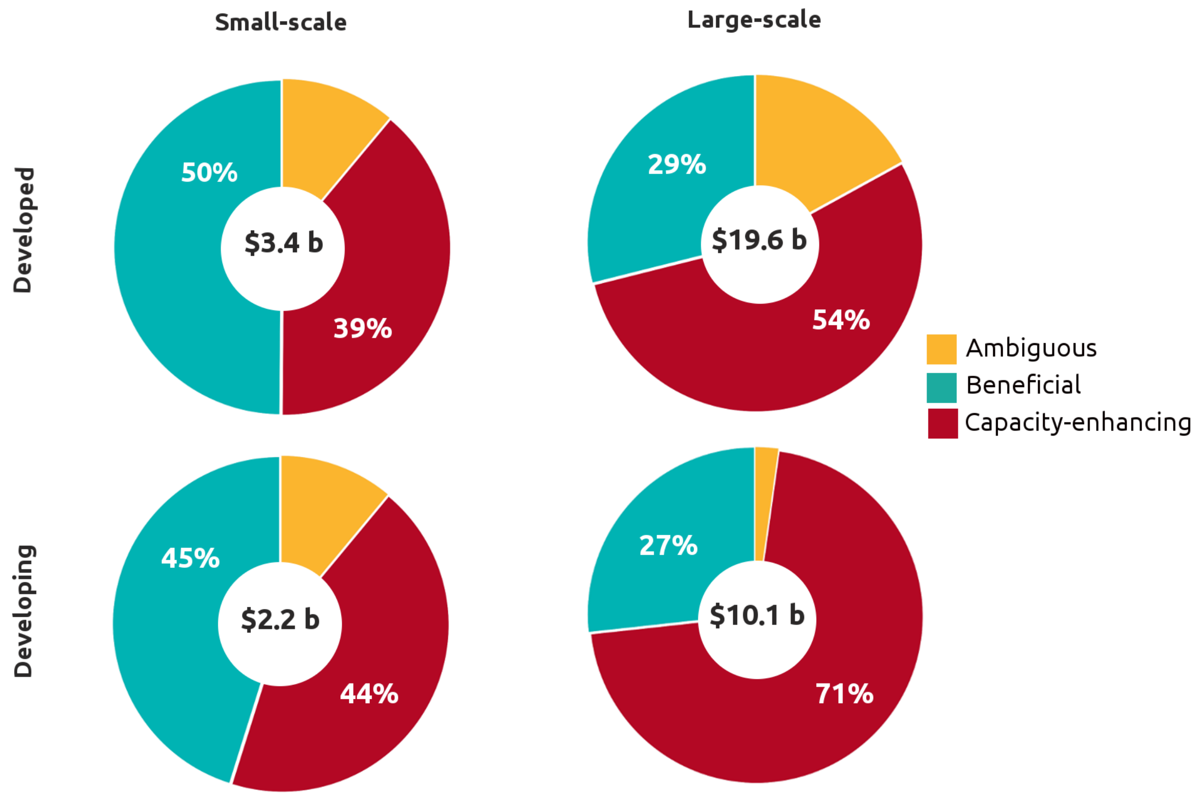

Figure 5 Global fisheries subsidies by developed and developing countries by fisheries subsidy category (capacity-enhancing, beneficial and ambiguous) for small- and large-scale fisheries.

Table 3 shows that the regions which provide the lowest amount of subsidies in total are the regions giving more to the SSF sector. For example, Africa provides 33% of their total subsidies to its SSF, which accounts for only 2.5% of global fisheries subsidies. Asia as the leading subsidizing region, which is the source for 53% of total global SSF subsidies, provides only 19% of its total to its SSF. Europe and Oceania provide the lowest percentages to the SSF (7% and 4%, respectively), whereas their total subsidies combined make up for 33% of all subsidies.

While the difference between the highest and lowest subsidizing regions is quite large (Asia and Africa respectively, see Table 3), the size of the fishing sector (SSF and LSF) per region also differs. We therefore calculated the ratio of subsidy estimates to number of fishers per regions for SSF and LSF to normalize for the differences in sector size per region and as a measure of subsidy intensity. Marine fisheries employment data were obtained from Teh and Sumaila (2013).

Table 3 Subsidies in million USD and subsidy intensity (subsidy amount / number of fishers), information on direct employment (# of fishers) taken from (Teh and Sumaila, 2013).

Region	SSF subsidies (USD x 10^6)	LSF subsidies (USD x 10^6)	SSF subsidies (percent)	SSF subsidy intensity (USD per fisher)	LSF subsidy intensity (USD per fisher)	Ratio SSF/LSF intensity
Africa	291	600	33	129	717	5.5
Asia	3,023	12,490	19	194	418	2.5
Oceania	141	3,178	4	212	68,988	*325
SC America	526	1,164	31	188	1,058	5.6
Europe	600	7,971	7	3,682	12,654	3.4
N America	1,023	4,362	19	2,279	12,219	5.4
Total	5,605	29,767	16	256	1,028	4.0

*The value for Oceania is an outlier probably due to an underestimation of large-scale fishers active in that region because of the presence of large-scale foreign pelagic vessels active in its waters.

In total, with respect to global subsidies, we estimate that LSF receive 4 times more subsidies per fisher than SSF. That is, while a typical small-scale fisher receives annually around USD 250, a large-scale fisher receives about USD 1,000 per year. Considering regional data, the calculation shows that the ratio of SSF to LSF intensity is the lowest in Asia followed by Europe, providing 2.5 and 3.4 times more subsidies per fisher employed in LSF compared to one active in a small-scale fishery, respectively.

3.4 Discussion

The results of this study show that the distribution of fisheries subsidies creates a bias against the SSF sector, which is already threatened by large industrial fisheries especially in developing countries (Kaczynski and Fluharty 2002). This bias undermines the economic viability of SSF by making LSF artificially more competitive in the market place than their SSF counterparts.

The biggest subsidy subtype is fuel subsidies, which is provided to 96% to the large-scale sector (Table 2), i.e., marine diesel subsidies, whereas most SSF vessels run on gasoline due to the high cost of purchasing and maintaining diesel motors (Wilson 1999). Fuel subsidies are recognized for their negative impacts both on the fisheries economy and marine ecosystems (Sharp and Sumaila 2009; Harper et al. 2012). They foster the use of fuel-inefficient technology and help the LSF stay in business even though operating costs outweigh total revenue gained from fishing (Sumaila et al. 2008; Harper et al. 2012). Subsidies towards port development and boat construction, renewal and modernization, of which the SSF receives only a small fraction, give the LSF sector another significant advantage over their small-scale counterparts.

Furthermore, subsidies that pay for foreign access agreements aggravate the harm that subsidies can do, especially to underdeveloped SSF in developing countries (Kaczynski and Fluharty 2002). A framework and recommendations on how to address some of these disadvantages have been proposed. For example, in Le Manach et al. (2013), it is recommended that the European Commission Fisheries Fund assistance should not be used to cover the cost of fishing access agreements. Instead, these funds, which are paid for mainly by European tax payers, should focus on improving the host countries' monitoring and enforcement capacities to foster sustainable fishing practices. This would not only benefit the local fisheries, which are mainly small-scale, but also bring higher economic rent to the foreign fleets in the long term. Only a small fraction, 0.2% of vessel buybacks, which has been shown to often affect fisheries sustainability negatively (Sutinen and Upton 2000; Clark et al. 2005), reaches SSF (Table 2). An example, reported in Béné and Doyen (2000), shows that making storage facilities available to SSF can vastly improve their fisheries economic viability, because it increases their adaptive capacity and makes them resilient in times of crisis. Subsidies for market and storage are to 97% provided to LSF, exacerbating the struggle of SSF reaching economic viability.

3.4.1 The need to take action

Results from this study clearly show that the vast majority of subsidies, especially in developing countries, is provided as capacity-enhancing subsidies to large-scale fisheries. These do not help poor coastal communities, but instead provide a direct advantage to the already overpowering LSF sector, leaving the SSF sector with hardly any chance of achieving economic viability. Clearly, food security and the maintenance of livelihoods should be in the foreground when negotiating fisheries subsidies (e.g., Béné et al. 2007; Chuenpagdee 2011; Eide et al. 2011; Rice and Garcia 2011; Hardy et al. 2013).

International NGOs (e.g. Oceana, WWF) and the International Centre for Trade and Sustainable Development (ICTSD) are playing crucial roles and continue to publish and advocate towards prohibiting capacity-enhancing fisheries subsidies, which negatively impact global fisheries sustainability. Furthermore, an important agreement has been reached in the fourteenth session of the United Nations Conference on Trade and Development (UNCTAD) in Nairobi, Kenya, in

July 2016 towards ending harmful subsidies. The mandate is that the regulation of fisheries subsidies becomes an integral part of the implementation of the 2030 sustainable development agenda. This joint statement brought forward by UNCTAD, FAO and UNEP (United Nation Environment Programme) has been currently signed by 90 countries and 11 international, regional and civil society organizations. It has reintroduced most of the discussions that were held at the WTO Doha rounds and includes: 1. to improve transparency in what subsidies countries provide; 2. prohibit harmful fisheries subsidies, not only those to overfishing and illegal fishing but also those that jeopardize nutritional security and livelihoods of coastal community; 3. introduce instruments and tools to discourage from new harmful subsidies and 4. give special attention and treatment for developing countries, focusing on least developed and Small Islands Development States, (UNCTAD-FAO-UNEP 2016).

3.5 Caveats and data quality

Currently, the most comprehensive database for small- and large-scale marine fisheries is provided by the *Sea Around Us,* without which this study would have not been possible. However, using catch data as a proxy for the size of the fishing sector comes with its own caveats. For example, either sector could be much smaller or bigger depending on fish abundance and target species. Despite that a fraction of the data points used in this analysis was estimated based on SSF catch (in volume) as a proxy for sector size, results of global SSF subsidies are much lower (16%) than the percentage of global SSF catch (24% www.seaaroundus.org last accessed Feb 2017).

This highlights the need for a detailed database of global fishing effort disaggregated by sector and collected independently from catch information.

One of the main issues that has been reported in the past when studying fisheries subsidies (Sumaila et al. 2010b, 2010a, 2016; Charles 2011), and which we experienced in this study also, is the scarcity of data and lack of transparency. Due to international pressure from different NGOs and international organizations, the European Commission, has now made information on fisheries subsidies (or fisheries funds) of their member states much more transparent and the amounts are provided online (EFF 2007). Yet, categories are still very broad, no information is published on who exactly receives these funds, nor is it clear how much each individual country provides in addition. Also, the Organization for Economic Co-operation and Development (OECD) and Asia Pacific Economic Cooperation (APEC) are making efforts to increase transparency by frequently publishing reports on the amounts of fisheries subsidies provided by their members (OECD 2006a).

These efforts are steps in the right direction, however, much more transparency is still needed to carry out more in depth research to advance effective decision making for sustainable fisheries management. Fortunately, the now signed UNCTAD-FAO-UNEP agreement, clearly calls for more detailed information on fisheries subsidies and has addressed the persistent lack of information surrounding this topic (UNCTAD-FAO-UNEP 2016). Attention needs to be paid not only to which category fisheries subsidies fall into, but also which fishing sector benefits, in order to understand all underlying dynamics of the impacts fisheries subsidies have on natural marine resources and the people who depend on them.

3.6 Recommendation and conclusions

As subsides are completely paid for by taxpayers, results of this study should be of great concern to our global working population. Currently, their money is not only being used to exacerbate the degradation of our ocean's ecosystems, but also to further the large industrialized fisheries creating a disadvantage to the small-scale fisheries which support millions of livelihoods and food security worldwide often in impoverished and threatened coastal communities.

The economic and political marginalization that SSF face (see Chapter 1) can only be tackled when data, such as information on subsidies, is available and assessments (e.g., analyzing impacts of subsidies on sustainable fisheries) can be carried out integrating all dimensions of small-scale fisheries: social, economic, ecosystem and institutional. This study's contribution will improve the chance to effectively address the concerns regarding subsidies provided to SSF and help the urgently needed recovery of our oceans. In conclusion, there is no argument left that can be made against reducing capacity-enhancing subsidies or converting them into beneficial ones. Therefore, my recommendation is not to increase subsidies to small-scale fisheries but instead to reduce those proven to be harmful to resource conservation and economic viability of fisheries in general.

Chapter 4: Determining basic economic viability of small- compared to large-scale fisheries using Mexico as an example

4.1 Introduction

Economic viability is an important cornerstone when it comes to developing management and policies towards sustainable fisheries (Eisenack et al. 2006; Baumgärtner and Quaas 2009; Cissé et al. 2015; Schuhbauer and Sumaila 2016). This is especially true for small-scale fisheries, which are often part of local culture and traditions and have been found to focus not only on profitability (Kronen 2004; Hospital and Beavers 2012). Following Schuhbauer and Sumaila (2016), an active fishery is considered to be economically viable when its net benefit to society from fishing is non-negative over time.

As already explained in detail in Chapter 1, small-scale fisheries are politically and economically marginalized worldwide (Pauly 1997; Allison and Ellis 2001; Chuenpagdee 2011), despite the fact that they make up for about 44% of all fishers in the primary production sector and provide livelihoods for millions of people (Béné et al. 2010a; Teh and Sumaila 2013). Additionally, these coastal community-based fisheries are understudied and found to be threatened by global market shifts, climate change and large-scale fisheries (Kaczynski and Fluharty 2002; Béné et al. 2010a; Sumaila et al. 2011; Lam et al. 2012). Large-scale (industrial) fisheries (LSF) are not only more technologically advanced than their small-scale counterparts, but are often given advantages at economic and political levels by governments. For example, LSF are estimated to receive 84% of global fisheries subsidies (Chapter 3), national management strategies and policies are often geared towards LSF and overlook SSF, plus most fisheries research, globally, focuses on LSF (Pauly 1997; Chuenpagdee and Bundy 2006; Chuenpagdee et al. 2006; Zeller et al. 2006; Jacquet and Pauly 2008; Chuenpagdee 2011).

This chapter aims to understand, assess and compare economic viability of small- and large-scale fisheries, and address the following research questions:

1. How much total revenue is generated from fishing?
2. What are the total economic costs of fishing?
3. How much subsidies are provided to both fishing sectors?
4. What are the net benefits to society (that is, basic economic viability) generated by small- and large-scale fisheries?
5. What implications do these results have for policy and management of small-scale fisheries?

In recent years, efforts have been made by researchers and international organizations to more thoroughly collect information on fisheries subsidies, the catch and revenues they generate and the fishing costs they incur (OECD 2006a; Lam et al. 2011; Swartz et al. 2013; Sumaila et al. 2016; Pauly and Zeller 2016). However, most of these key economic data lack detail and are still not well documented at national levels. Information on catch, landed value and subsidies has been disaggregated by fishing sector (SSF and LSF), showing, on the one hand, how important the small-scale sector is globally (based on amounts of landings and total revenue) and at the same time disadvantaged due to unfair subsidy distribution (Pauly and Zeller, 2016 and Chapter 3).

To illustrate my approaches, I couched my analysis on Mexico. This is because Mexico's fisheries are well studied, however, the emphasis has been on LSF, such as those for sardine, tuna and shrimp (e.g., (Garcia-Caudillo et al. 2000; Lluch-Cota et al. 2007; Ishimura et al. 2013; Punt et al. 2016). Although Mexico's marine small-scale fishing fleet is, among the largest small-scale fisheries globally (based on catch and employment), it is understudied and largely unregulated (Teh and Sumaila 2013; Cisneros-Montemayor et al. 2013). This sector is comprised of around 70,000 small fiberglass boats, catching around 900 thousand tonnes of fish and invertebrates per year (Cisneros-Montemayor et al. 2013). Some regional and local studies as well as efforts by national government institutions have revealed the social, economic, political and ecological importance of small-scale fisheries in Mexico (e.g., (Smith et al. 2009; Cisneros-Mata 2010; Salas et al. 2011; Espinoza-Tenorio et al. 2011b, 2011a; Conapesca 2013).

This sector is embedded in a wide cultural context providing food and employment for hundreds of thousands of people and contributing to coastal social and economic development (OECD 2006c; Lluch-Cota et al. 2007). Small-scale fisheries are complex and diverse as target species and fishing methods vary for different seasons and regions, and landing sites are spread along the coastlines (Smith et al. 2009; Finkbeiner 2015). This complexity makes monitoring and sustainable management of these fisheries challenging (Sala et al. 2004; Cudney-Bueno and Basurto 2009; Salas et al. 2011; Erisman et al. 2011).

The lack of communication between the central government and people involved in small-scale coastal fishing in Mexico has led to mismanagement in many places leading to marine ecosystem degradation (Young 2001; Sala et al. 2004; Lluch-Cota et al. 2007; Cudney-Bueno and Basurto

2009; Espinoza-Tenorio et al. 2011b). Additionally, Mexican small-scale fisheries suffer from extreme climate fluctuations and variability caused by phenomena such El Nino and are very vulnerable to climate change (Collins et al. 2002; Pérez-Brunius et al. 2006; Sumaila et al. 2014; Morzaria-Luna et al. 2014; Páez-Osuna et al. 2016). Furthermore, that large-scale fisheries receive mostly capacity-enhancing fisheries subsidies is alarming (around 45% Chapter 3) since many Mexican fisheries already suffer from overfishing and overcapacity (Sala et al. 2004; Cisneros-Montemayor et al. 2013; Barnes-Mauthe et al. 2013).

Strategies on how to better use fisheries subsidies (taxpayer's money), for both the large- and small-scale sectors have already been suggested and should be taken into account by policy makers worldwide (Sumaila et al. 2010b, 2010a, 2016; Charles 2011; Cisneros-Montemayor et al. 2016 and Chapter 3). For example, effective subsidies should address the core issues a fishing industry is facing and not just the symptoms by increasing profits artificially through the provisions of subsidies. Furthermore, policy makers should focus on establishing clear feasible long term goals (Cisneros-Montemayor et al. 2016). Another example is to bring education and skill development to coastal communities to increase employment opportunities to coastal fishers (Sumaila et al. 2016). This is especially important in a developing country such as Mexico, where coastal small-scale fisheries are essential for the well-being of hundreds of thousands of people, and over 20 million people suffer from undernourishment (Olaiz-Fernandez et al. 2006). These suggestions directed at fisheries subsidies in general, would bring more equity to the distribution of subsidies and with it improved economic viability for SSF.

Fisheries specific studies and government reports are the sources of information used to compute revenues, fishing costs and subsidies of Mexican fisheries and form an important cornerstone for economic viability assessments (OECD 2006b; Conapesca 2013; Cisneros-Montemayor et al. 2013; Ramírez-Rodríguez and Almendárez-Hernández 2013). However, not much is known on these main economic indicators (costs, revenues and subsidies) and their impact on small- compared to large-scale fisheries over time. Here, these will be provided and analyzed for the period from 2000 to 2012 and conducted at national as well as regional levels. The situation of Mexican fisheries is not an exception but rather a typical example of small-scale fisheries globally. Therefore, results and conclusions drawn from this chapter are expected to serve as helpful guidelines to fill knowledge gaps in support of policy making essential to the optimization of sustainable fisheries management in general.

4.2 Methods

4.2.1 Case study: Mexican fisheries

Based on the definition of the Mexican National Commission of Aquaculture and Fishing, the marine small-scale fishing sector includes artisanal commercial fisheries by both indigenous and non-indigenous fishers, who either sell most of their catch at local markets and often keep a portion of it for household consumption. All fishers use “pangas”, open-deck fiberglass boats around 7 m in length, usually with 50-115 hp outboard engines. The most common fishing gears used are gillnets, hook-and-line, hookas (a regulator and on-board air-compressor), traps, and a range of small bottom-trawl nets. Large-scale (or industrial) fisheries, on the other hand, include vessels with a covered deck, inboard engine (almost exclusively diesel), mechanical winches and their fishing gear, including otter trawls, purse-seiners and longlines. There is an offshore fleet targeting tunas and billfishes, and a large coastal fleet targeting shrimp and small pelagic fishes (e.g., sardines). Although recreational fisheries in Mexico are a significant industry for some regional economies and interact strongly with marine ecosystems and other fisheries (Cisneros-Montemayor et al. 2012), they are not included in the assessment carried out in this study.

Fisheries on the Atlantic and the Pacific coasts of Mexico can be quite different. Especially with regards to the large-scale sector, which mainly depends on shrimp, sardine and tuna on the Pacific coast, whereas most boats on the Atlantic target finfish and shrimp (OECD 2006b; Conapesca 2013; Cisneros-Montemayor et al. 2013). To capture these regional differences both regional (Pacific and Atlantic) and national assessments are carried out.

4.2.2 Analysis of key attributes

To compute basic economic viability (BEV), I start by defining and describing the key elements that together constitute BEV. That is total revenue generated from fishing, total cost of fishing and fisheries subsidies (Table 4). Their sources as well as the differences between BEV and financial viability will be explained in the following paragraphs.

Table 4 Elements of basic economic viability, the geographical scale and time frame of the attributes depend on the study's objectives.

Nº	Economic attributes(unit)	Definition	Sources and measures
1	Landings (t)	Amount of fish in weight landed in all ports (2000-2012).	For national numbers see FAO and SAUP (*Sea Around Us Project*, specifically catch reconstruction data) database. For case studies check literature, e.g., government reports; conduct surveys; and monitor the landing.
2	Ex-vessel price ($)	Price received by fishers at the dock per unit weight of fish sold (Sumaila et al., 2007).	For national numbers see *Fisheries Economic Research Unit* (FERU) and SAUP database (Sumaila et al. 2007; Swartz et al. 2013) For case studies check literature e.g., government reports, conduct surveys, log book, buyer record.
3	Total Cost of fishing ($)	Total cost represents the value of inputs at the next alternative best use. Cost is split up into fixed cost, which do not change with production (e.g., capital investment, sunk cost) and variable cost, which can vary based on the output (e.g., fuel, crew, maintenance). The total cost includes opportunity cost which makes it different from accounting cost, here represented as labour costs. (Lam et al., 2011).	For national numbers see FERU database (Lam et al., 2011). For case studies check literature, e.g., government reports and/or conduct surveys.
4	Subsidies ($)	Subsidies are defined here as financial transfers, direct or indirect, from public entities to the fishing sector which help the sector make more profit than it would otherwise (Sumaila et al., 2010).	For national numbers see Sumaila et al. (2010,2013 and 2016) For case studies check literature, e.g., government reports and conduct surveys and interview key informants.

Total revenue

Total Revenue (TR) is calculated as follows:

$$TR = PxTL \tag{6}$$

Where P denotes non-distorted ex-vessel prices and TL the total fisheries landings. TR is calculated for each year t =2000 to 2012:

$$TR_t = \sum_{u=1}^{U} (TRt_t)_u \tag{7}$$

Where u = unit, which represents a fishing vessel or a fishing company that owns more than one vessel and U the total number of units for each year t. Data for the calculations for ex-vessel prices are from the *Sea Around Us* and *Fisheries Economic Research Unit* databases (www.seaaroundus.org last accessed September 2016) and from the National Commission of Aquaculture and Fishing annual fisheries reports (CONAPESCA) (Conapesca 2013; Swartz et al. 2013; http://www.conapesca.sagarpa.gob.mx/wb/, last accessed September 2016). Landings data for the years 2000 to 2010 from *Sea Around Us* (Cisneros-Montemayor *et al.*, 2013) were already disaggregated into large-scale (industrial) and small-scale (artisanal and subsistence) fisheries and therefore directly multiplied with ex-vessel prices to estimate total revenue. For 2011 -2012, data from CONAPESCA reports were used, which contained total revenue data. These were divided into small- and large-scale based on each sector's fisheries landings (percentages) per species group using 2010 *Sea Around Us* data. To make up for missing information on unreported and illegal catches for the years 2011-2012, I used 2010 total revenue data from unreported and illegal landings from (Cisneros-Montemayor *et al.*, 2013) and added them to the 2011 and 2012 CONAPESCA data, which otherwise only represent the total revenue of reported fisheries landings in Mexico.

Total costs of fishing

Total Costs (TC) are calculated as follows:

$$TC = VC + FC \tag{8}$$

Where VC represent variable costs, which comprise of fuel, maintenance, labour (opportunity cost) and other running costs (e.g., docking fees), and FC denotes fixed costs which consist of depreciation and interest paid on capital cost. It is important to note that total costs were assumed to be non-distorted, i.e., they were estimated before subsidies (e.g., tax reductions) were added.

TC is calculated for each year t = 2000 to 2012:

$$TC_t = \sum_{u=1}^{U} (TC_t)_u \tag{9}$$

Where u = 1 to U denotes unit, which represents a fishing vessel or a fishing company that owns more than one vessel, with U representing the total count of all vessels for each year.

To assess the cost of fishing for Mexican small- versus large-scale fisheries, I based my method on data from the cost structure of individual fishing units. Cost structure is the ratio of the different categories of variable and fixed costs to total costs. For the large-scale fishing sector, data were mainly available for the three biggest fisheries: shrimp, sardine and tuna, which make up about 65% of the total large-scale fisheries catch of Mexico (Cisneros-Montemayor et al., 2013). I used information from Gillet (2008) and Agroprospecta (2010) for shrimp and sardine fisheries and Lam et al. (2011) for tuna fisheries and computed a weighted average based on number of boats active in each fishery. Fixed costs were on average 11% of total costs (Lasch 2005) interest rates and depreciation costs were computed based on the initial cost/investment of the fishing vessel and its age. For small-scale fisheries, I used information from (OECD 2006b; Lam et al. 2011; Ramírez-Rodríguez and Almendárez-Hernández 2013).

As I found that the cost of fuel was the largest component (around 35% on average), I used the change of fuel costs over time to estimate the total costs for each year of the study period (2000-2012). This assumes that other costs of fishing stayed constant over time. The cost of fuel was estimated for both SSF and LSF using annual fuel price (Table 5) and fuel consumption data based on fishing effort. The amount of fuel consumed by each vessel depends on operational and technological factors, I therefore used: specific fuel consumption rate (SFR), Fuel Coefficient (FC) and the number of hours fished (Wilson 1999; Gulbrandsen 2012; Greer 2014).

To scale up the data to the fishing fleet for SSF and LSF for each year, I used numbers of boats from CONAPESCA annual reports (Table 4). As data on cost of fishing is scarce, especially, for small-scale fisheries, it was important to use and compare different approaches and case-study data to make sure that the resulting numbers were realistic. This was done using raw data per fishing gear from different countries reported in Lam *et al.*, (2011) and information found in Tietze et al. (2001, 2005) and OECD (2006b). As information in government reports are disaggregated either by coastline or by federate state, this data was used to assess total cost by Atlantic and Pacific region for both SSF and LSF applying the same method described above for the national level study.

Table 5 Key data used to estimate total cost of fishing: Number of boats and fuel costs per liter in constant 2015 USD for small- (SSF) and large-scale fisheries (LSF) in Mexico.

Year	Number of boats				Cost of fuel (USD / liter)	
	Pacific		Atlantic		national	
	SSF	LSF	SSF	LSF	SSF (gasoline)	LSF (diesel)
2000	56,412	2,014	43,392	1,552	0.78	0.64
2001	56,412	2,053	43,392	1,565	0.76	0.63
2002	56,412	2,064	43,392	1,563	0.78	0.65
2003	56,412	2,075	43,392	1,559	0.71	0.59
2004	56,412	2,075	43,392	1,567	0.68	0.57
2005	56,412	1,995	43,392	1,499	0.71	0.58
2006	56,412	1,974	43,392	1,459	0.71	0.59
2007	56,412	1,945	43,392	1,453	0.72	0.61
2008	56,412	1,945	43,392	1,453	0.72	0.63
2009	56,412	1,865	43,392	1,435	0.63	0.64
2010	51,257	1,788	36,049	1,418	0.71	0.75
2011	43,206	1,775	32,117	1,406	0.79	0.82
2012	40,490	1,758	23,967	1,400	0.81	0.83

Fisheries subsidies

Fisheries subsidies are direct or indirect financial transfers from public entities (i.e., tax revenues) to private firms (here, the fishing sector) (Milazzo 1998; OECD 2006a; Sumaila et al. 2008). Subsidies have been categorized, depending on their impact on the fish stocks over time, into beneficial, capacity-enhancing and ambiguous (Chapter 3). Many different forms such as financial assistance, tax breaks, fisheries management and research as well as direct capital infusion are considered subsidies (e.g., Abdallah and Sumaila 2007). Data on fisheries subsidies were collected from different reports and publications and up-dated where possible using fisheries reports, CONAPESCA annual reports, peer-reviewed articles, OECD (Organisation for Economic Co-operation and Development) reports and gray literature (OECD 2006b; Lara and Guevara-Sangines 2012; Ramírez-Rodríguez and Almendárez-Hernández 2013; Sumaila et al. 2016).

Based on the objective stated in the literature that described what each fishery subsidy was for, it was possible to divide them into percentages directed at large- and small-scale fisheries (Chapter 3 Fig. 2). Furthermore, once I gathered information of total subsidies for each year (2000 – 2012), data from CONAPESCA annual reports were used to find percentages that would reach the small- compared to the large-scale sector, which were then applied to the total subsidy amount where no other detailed description was available (see Chapter 3 for more detailed description of the methods). Again, based mainly on CONAPESCA reports, the same approach was used to disaggregated the data by region.

The amount of total subsidies (TS) per fishing sector received from the government is calculated for each year t = 2000 to 2001:

$$TS_t = \sum_{u=1}^{U} (TS_t)_u \tag{10}$$

where TS = Total Subsidies and u = unit, which represents a fishing vessel or a fishing company that owns more than one vessel and U the total number of units for each year t. Costs and prices are assumed to be otherwise non-distorted.

4.2.3 Basic economic viability calculation

Basic economic viability (BEV) is defined here as the net benefits to society from fishing, a fishery is considered economically viable once these are non-negative. On the other hand, a fishery would be financially viable when net benefits from fishing to the private sector are non-negative (Schuhbauer and Sumaila 2016).

To estimate basic economic viability as Net Benefits (NB) from fishing, the following calculations are carried out for both small- and large-scale fisheries for the years t = 2000 to 2012. Equations 6-10 above are used to calculate net benefits to society as follows:

$$NB_t^S = TR_t^S - TC_t^S \tag{11}$$

where the superscript, S, denotes society.

Equation 12 below is used to calculate the average basic economic viability (net benefits to society: NB^S) over the years under study here (n):

$$\overline{NB^S} = \frac{1}{n}\sum_{t=2000}^{2012} NB_t^S \tag{12}$$

Financial viability, as in net benefits to the private sector, on the other hand, are calculated as expressed in equation (13). The key difference between equation (11) and (13) is that the economic viability is distorted by subsidies (equation 5),

$$NB_t^p = TR_t^p - TC_t^p + TS_t \tag{13}$$

where the superscript, p, denotes the private sector. Average net benefits to the private sector:

$$\overline{NB^p} = \frac{1}{n}\sum_{t=2000}^{2012} \left(NB_t^p\right) \tag{14}$$

For society, the amount of subsidy paid to fishers is a cost (equation 11). It should be noted that in formulating the equations above, we assume that the only distortion is the subsidy received by the fishing unit. From the point of view of the private sector, on the other hand, subsidies are added, because each fishing unit benefits from the subsidy provided to it (equation 13).

To evaluate the quality of data used in this analysis, I sought out two fisheries scientists who are deeply knowledgeable about Mexican fisheries and compared their experiences and data with my results (personal communication with Dr. Miguel Angel Cisneros-Mata and Dr. Elena Finkbeiner). To make sure that our numbers are comparable over time and comparable to studies from other countries, I expressed values in constant 2015 USD using currency conversion rates from Mexican Peso to USD (Feenstra et al. 2015) and the Consumer Price Index taken from the World Bank website to convert amounts from real to constant USD (last accessed July 2016 http://data.worldbank.org/indicator/FP.CPI.TOTL).

4.3 Results and discussion

4.3.1 Total revenue

Although small-scale fisheries have landed only about half of Mexican total fisheries landings (sum of landings 2000-2010) (Cisneros-Montemayor *et al.*, 2013), their total revenue on average (2000-2012) is over 30% higher than those of their large-scale counterpart (Fig 6). The main reason for this is that a high percentage of large-scale fisheries landings (especially on the Pacific coast) is not for direct human consumption and therefore fetches lower prices (e.g., sardine fisheries) than most other fish and seafood (Conapesca, 2013). I also find that estimated total revenue from fishing has decreased for large- and increased for small-scale fisheries over time (Fig. 6).

When looking into the regional difference of total revenue by fishing sector, trends of total revenue over time show a clear decline on the Atlantic, however, on the Pacific they have stayed more stable with a slight increase even. Looking into SSF, trends show total revenue increasing on the Pacific and slightly decreasing on the Atlantic (Fig 6). Target species vary not only between the two fishing sectors but also across the two regions. Total revenue trends can therefore be explained with both changes in prices and resource availability. For example, the decline of large-scale fisheries total revenue could be due to the drop in large-scale shrimp catches and landed value (Cisneros-Montemayor *et al.*, 2013), which makes up over 60% of the total landed value of large-scale fishing in both regions combined.
For small-scale fisheries, on the other hand, both landings and landed values increased over time on the Pacific, despite (or maybe because of) the fact that the number of vessels in the sector

decreased in the same period of time (Table 5 and Fig. 6). This indicates that prices for small-scale fisheries landings have stayed rather stable or increased, at least in the Pacific region.

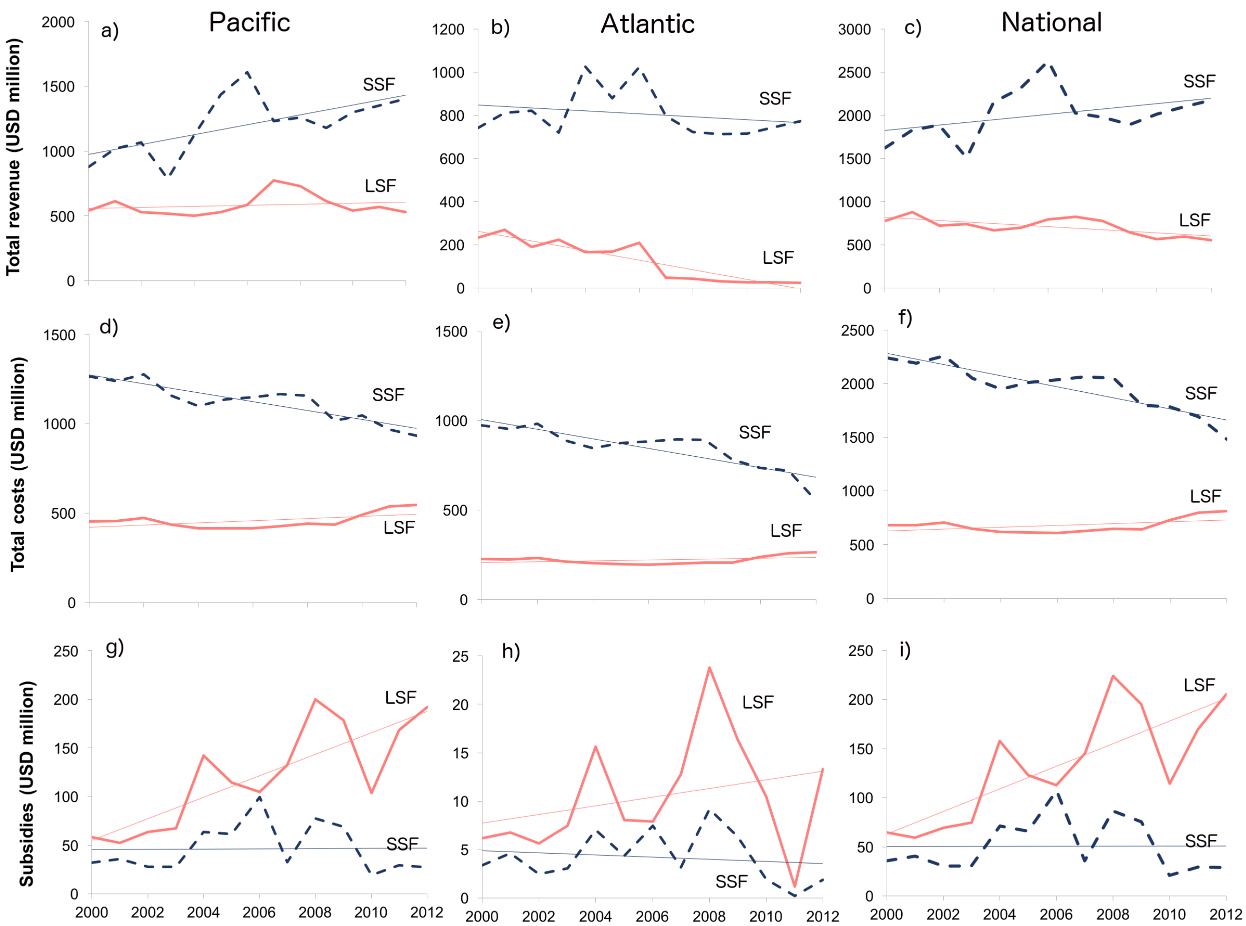

Figure 6 Total revenue from fishing (a-c); total cost of fishing (d-f) and fisheries subsidies (g-i) presented in constant 2015 USD millions of Mexican small- (SSF) and large-scale fisheries (LSF) from 2000 to 2012.

4.3.2 Total costs of fishing

There are about 20 times more small- than large-scale fishing vessels active in Mexico, because of which the results show much higher total cost for small- compared to large-scale fisheries (Fig. 6). However, results show that the annual cost for an individual large-scale fishing vessel on average is almost 10 times higher than the cost of a small-scale vessel (around USD 20,000 vs 200,000, respectively). The total costs estimated from 2000 to 2012 for the large-scale sector have increased by around 20%, whereas it decreased by over 30% for the small-scale sector in the same period (Fig 6).

Trends of the national total costs over time are very similar when broken down into regions for both SSF and LSF (Fig 6). The number of fishing vessels in SSF has dropped by around 35% whereas this only decreased by around 11% in the LSF sector. This partly explains the decrease in total costs for SSF and increase for LSF. Looking into the trends of costs per boat over time by sector and region, results indicate an increase in costs per boat for LSF both on the Atlantic and Pacific, whereas it reveals a decrease for SSF. The price of fuel and number of fishing vessels seem to be the important drivers in this assessment. Fuel makes up a large percentage of the total costs. Prices for diesel fuel have risen from 2000 to 2012 by almost 30%, which is reflected in the increase in the cost per vessel in the large-scale sector. Gasoline prices, on the other hand, have stayed more stable (Table 5), which has helped the cost of fishing per boat for SSF to stay more stable.

In addition to the number of fishing vessels active in each sector, the number of hours and days fished each year is also a key factor in the cost calculation. However, due to a lack of more detailed information, these are assumed to have stayed constant over the years. This assumption, while it simplified our analysis, creates a bias as there is the probability that fishers have changed their behaviors within the 13 years of the study period. Fishers might be traveling further and fishing for more hours to help make up for changes or declines in near-shore availability of marine resources (Sagarin et al. 2008 and pers. communication with Dr. E. Finkbeiner). Additionally, the number of boats used in this study were based on government reports, and for the small-scale sector had not changed between 2000 and 2009, neither in the Atlantic nor the Pacific region (Table 4), which might be due to the lack of effective monitoring of the number of active boats. Nonetheless, I believe despite a possible under- or overestimation of active boats due to lack of monitoring, the bias is consistent throughout the years because the data source is the same.

4.3.3 Fisheries subsidies

Capacity-enhancing fisheries subsidies can compromise the sustainable use of fish stocks and distort prices and costs of fishing. As shown in Chapter 3, the large-scale sector receives most capacity-enhancing fisheries subsidies, not only in Mexico but also globally. Fig. 6 shows annual subsidies provided from 2000 – 2012 to Mexican fisheries divided into those provided to small- and large-scale fisheries. While the amount of subsidies provided to Mexican fisheries has increased, the percentage provided to the small-scale sector decreased from almost 40% in 2000 to only 12% in 2012 (Fig 6). On average, from 2000 to 2012, this analysis suggests that large-scale fisheries have received over 70% of all fisheries subsidies.

The trend shows that SSF receive a decreasing share of total subsidies over the period of study while the amount of subsidies provided in total has been increasing (Fig 6). While SSF employ more people and also take about half of the total fisheries catches, it receives only a small fraction of total subsidies. The regional analysis reveals that the Atlantic region of the country receives much less subsidies than the Pacific region for both SSF and LSF. However, both SSF and LSF sectors are smaller in regard to catch, number of people and number of boats compared to the Pacific. Furthermore, it becomes clear that Pacific LSF not only receive the largest share overall but the subsidies they receive have increased three fold over the 13 year study period (from USD 59 to 192 million).

4.3.4 Basic economic viability

Results from calculating net benefits over the 13 year study period show, as expected, lower net benefits to society (basic economic viability) compared to the net benefits to the private sector (financial viability) for both small- and large-scale fisheries (Fig 7).

The contribution of the small-scale sector has increased, fallen and then has risen again more recently. The difference between basic economic and financial viability is much more visible in large-scale fisheries as they receive a much greater share of the subsidies compared to the small-scale sector (Fig 7). This difference, furthermore, has been increasing over time with the increase in subsidies provided to LSF, especially to Pacific LSF (Fig 6).

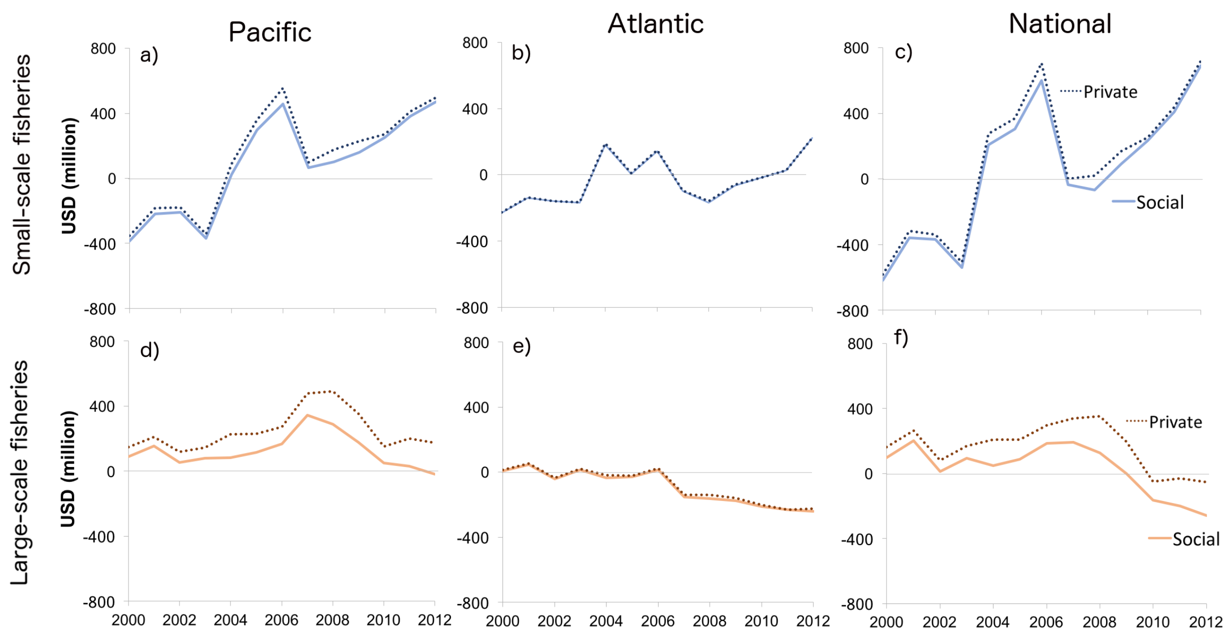

Figure 7 Net benefits (NB) presented by region and fishing sector before subsidies (society) and after subsidies (private) in constant 2015 USD million.

Results of net benefits by region show a much more detailed picture of how net benefits are distributed by sector. Based on this basic economic viability assessment, averages over the 13 year study period show, SSF and LSF on the Atlantic are not economically or financially viable, whereas both are at the Pacific (Table 6). It is interesting to see how across both regions both SSF and LSF average out to be economically viable on a national level (Table 6). The reason, I assume, is that the fishing sector on the Pacific is much larger, reflected here by its larger revenue and costs for both SSF and LSF (Table 6). Results suggest that fisheries in the Atlantic, both SSF and LSF, are not economically viable. Hence, fisheries in this region of Mexico need close attention.

Table 6 Basic economic viability (BEV) assessment of small- (SSF) and large-scale fisheries (LSF) averaged over the years 2000-2012 (constant 2015 USD million).

	Pacific		Atlantic		National	
	LSF	SSF	LSF	SSF	LSF	SSF
Total Revenue	583	1,203	128	808	711	2,011
Total Cost of fishing	458	1,124	220	845	678	1,969
BEV	**125**	**79**	**-92**	**-37**	**33**	**42**
Subsidies	122	46	10	4	132	51
Financial viability	**247**	**125**	**-82**	**-33**	**165**	**93**

Analyzing results over time show that the small-scale sector as a total group has not been economically nor financially viable between the years 2000 and 2004, as both private and societal net benefits were negative (Fig 7). Interestingly, after a period of positive economic viability (2004-2007), the net benefits to society dropped again below zero from 2007 to 2008, whereas financial viability maintained itself just above zero. This analysis suggests that the economic viability of small-scale fisheries has increased over time. Split into regions, trends for both Atlantic and Pacific SSF are generally increasing (Fig 7). However, net benefits on the Atlantic are much lower than on the Pacific and have after a stretch of economic viability between 2005 and 2007 fallen below zero from 2007-2010. Fortunately, Atlantic SSF have been rising since 2010 and returned to economic viability (Fig 7).

It is important to note that the rather stable price of fuel and the decrease in number of vessels in the small-scale sector are most likely the underlying factors that explain these trends (Table 5). These results are a good sign as, purely based on this study's basic economic viability analysis, the small-sale sector seems to be better prepared now than a few years ago, to possibly tackle some of their struggles, such as their vulnerability to a changing ecosystem. However, as many coastal communities depend on currently declining living marine resources (Sala et al. 2004; Lluch-Cota et al. 2007; Finkbeiner 2015) and this study only reflects a national and broader regional picture of the sector, an important next step is to further look at local levels as there might be large differences and inequities within the small-scale sector (Cinti 2010; Cinti et al. 2010; Basurto et al. 2012).

The large-scale sector has until recently maintained positive net benefits, and only in 2009 started to generate negative net benefits, both private and societal (Fig 7). The decrease in total revenue plus the increase in diesel costs over time has contributed to the increase in costs of the large-scale sector leading to the decline of economic and financial viability. Despite the fact that 83% of fuel subsidies are channeled to the large-scale sector (Lara and Guevara-Sangines 2012) paid by the taxpayers, the net benefits at the national level have not made it back above zero (Fig 7). However, when looking into the regions separately, results show how Pacific net benefits to the private sector for LSF have been increasing and have been financially viable over the 13 year study period despite a decrease from 2008 to 2010 (Fig 7). Clearly, the large proportion of subsidies provided to Pacific LSF have made this possible as their economic viability has shown a decreasing trend and fallen below zero in 2012 (Fig 7). Atlantic LSF have not been economically or financially viable in most years, and have fallen below zero with a decreasing trend since 2007 (Fig 7).

Highlighting the years 2007 and 2008, despite receiving only a small fraction of fisheries subsidies, small-scale fisheries maintained positive financial viability. The large-scale sector received increasing amounts and shares of fisheries subsidies, reaching a maximum amount in

2008 (Fig 6), their net benefits dropped below zero only 2 years later regardless (Fig 7). Results also indicate that small-scale fisheries provide much higher net benefits to society during times of positive economic viability (see 2004-2005 and 2010-2012, Fig. 7), compared to the large-scale sector, demonstrating their importance to society in Mexico. The net benefits of small-scale fisheries show much higher variance over the years compared to their large-scale counterpart, which could be due to their complexity and dynamics and possibly higher vulnerability to institutional, economic and environmental changes. LSF only depend on three main target species groups (sardine, shrimp and tuna), which makes them quite vulnerable to both market fluctuations and resource availability. This can be seen by the decline of economic viability over the last few years not only due to an increase in costs, but also a decrease in total revenue, for which the most likely reason is the decline in the price of shrimp, possibly due to its competition with aquaculture (see Section 3.1 and pers. communication E. Finkbeiner).

4.4 Policy and management implications

To better understand what the results of this study mean for small-scale fisheries, not just in Mexico, it is important to put this into the perspective of what is currently known about this sector, its challenges, vulnerabilities and also its opportunities. Small-scale fisheries have been described as opportunistic, where fishers would change their target species based on local abundance of the different commercially valued species, travel to different locations and use a variety of different fishing gear (Allison and Ellis 2001; Salas et al. 2004; Smith et al. 2009; Aburto et al. 2009; Finkbeiner 2015). These are important factors to be considered in the interpretation of the results of the basic economic viability assessment for SSF.

In the case of Mexico, net benefits have been highly fluctuating over the 13 years under study, which possibly reflects their diversity and complexity. Currently, most Mexican small-scale fisheries are de facto open access (meaning that despite needing a fishing license to fish not all active fishers have licenses and fishing effort is only controlled in some places), which has let to overcapacity, overfishing and ecosystem degradation (Cisneros-Mata 2010; Cisneros-Montemayor et al. 2013), and the implementation of regulations has been suggested on both the Pacific and the Atlantic coasts (OECD 2006b; Cisneros-Montemayor et al. 2013, 2016). Furthermore, recommendations for improved policy and management strategies, with a focus on implementing ecosystem-based as well as livelihood-based approaches have been made, not only for the small- but also the large-scale sector (Salas et al. 2007; Cisneros-Mata 2010; Cinti et al. 2010; Erisman et al. 2011).

An important example is to establish policies that give incentives toward fishing practices that are oriented towards increasing the added value and reducing impacts on the environment (Cisneros-Mata 2010). Managing fisheries based on their spatial distributions along the coastlines as well as emphasizing equitable fishing access rights and involving fishers in the decision making processes also have been recommended (Salas et al. 2007; Erisman et al. 2011). These measures are critical to the improvement of basic economic viability of SSF and the sustainability of fisheries on ecosystem, social, economic and institutional levels.

Results of this study suggest that reduced fishing effort can lead to an increase in basic economic viability of Mexican small-scale fisheries (Fig 7 years 2009-2012 and Table 5). Increased basic economic viability is linked to improving the livelihoods of people who depend on marine resources. It is not an easy step to implement regulations, such as reducing fishing effort, in a place where hundreds of thousands of people depend on SSF and many fishers are marginalized from policy-processes. A possible redistribution of fishing effort at least in some places could lead to a similar outcome and will lead to more equity, as currently only few individuals hold the majority of fishing permits (number of fishing permits does not always equal to number of fishing vessels registered) (Cinti et al. 2010; Basurto et al. 2012). There is a lack of communication with the federal fisheries agency, and often not enough funding is available from federal agencies to enable them to contribute adequately at the local scale (Cudney-Bueno and Basurto 2009). This downfall makes it challenging to see recommended regulations being adequately implemented for the maintenance of positive basic economic viability. Furthermore, inconsistent and sometimes contradictory policy directions have inhibited sustainable fisheries management, especially, for small-scale fisheries (Espinoza-Tenorio et al. 2011b).

Finkbeiner and Basurto (2015), however, suggest that Mexican fisheries should be governed for resilience suggesting a variety of feasible and realistic solutions which include the legal recognition of the small-scale fishing labor force. The authors also argued for more equitable access to fishing, which would directly lower illegal fishing and help enforce regulations. As currently a large percentage of fish catch in Mexico is unreported and illegal (Cisneros-Montemayor et al. 2013), it is difficult to obtain information reflecting the real fishing effort and with it its costs and the revenue it generates to compute economic viability. Legal recognition and equitable access to resources would, therefore, improve the economic viability of Mexican small-scale fisheries.

4.5 Caveats and data quality

Despite Mexico ranking quite high on the last OECD open government data review (OECD 2016), there is still a lack of transparency concerning fisheries related information at the economic, social and institutional levels. The scarcity of publicly available data has caused a big challenge to gather sufficient and good quality data for this study. Similar findings have been reported previously, highlighting the importance of access to data, especially, concerning information on fisheries subsidies (Cisneros-Montemayor et al. 2013, 2016). It is important that monitoring is improved to provide data with better resolution, accuracy and consistency (Erisman et al. 2011). Improving not only the access to data but also the quality, is essential to better our understanding of economic performance, viability and the well-being of coastal communities.

Finding information on costs of fishing has been very difficult. The cost data publicly available are based on a few studies, however, it was possible to come up with a realistic estimate by comparing results with either fishery specific or global level information (Lam et al. 2011; Ramírez-Rodríguez and Almendárez-Hernández 2013). Furthermore, finding enough information to make an accurate assessment over time has been challenging, e.g., government reports present the exact same number of small-scale fishing boats for each year until 2009 (Table 5), which can hardly be true. However, at least these data exist and have provided a basis for a first economic viability analysis despite some gaps (which were filled using simple statistical approaches). The results, despite some caveats, can therefore be seen as the best science available on the economic viability of Mexican small- and large-scale fisheries over time. Furthermore, methodology in this study can be used at local scales where necessary data can be directly collected. This would result in more details and possibly accuracy, however, the focus here lies on understanding major trends and differences of Mexican small- versus large-scale fisheries over time.

Mexican fisheries, as many other SSF worldwide, not only bring economic but also societal benefits to fishing communities. While acknowledging these cultural and social contributions, this economic viability assessment has not accounted for them. Therefore, it is important to, also understand other socio-economic drivers of economic viability.

4.6 Recommendations

There is no single accepted definition of SSF that applies worldwide because it is argued that SSF are too diverse and different from each other depending on the country and the oceans where they operate (Berkes et al. 2001; FAO et al. 2008; FAO 2014a). A similar argument could be made for small-scale fisheries on a national level in Mexico, as they are also very diverse and complex with each fishery having their own unique characteristics. However, at the same time, SSF encounter very similar if not the same challenges, just to name a few: lack of cross-scale communication and support between local fishers and federal fisheries agencies; volatility in market prices; limited and unfair access to fishing rights; limited or no funding for monitoring and enforcement; changing oceanic conditions; receiving a much smaller fraction of fisheries subsidies compared to LSF; and decreasing marine resources (Sala et al. 2004; Salas et al. 2007;

Cudney-Bueno and Basurto 2009; Bueno and Basurto 2009; Cisneros-Mata 2010; Cinti et al. 2010, Chapter 3 of this thesis).

It is therefore important to understand the economic viability at a national and wider regional level so these problems can be addressed by the federal fisheries agency for each fishing sector rather than for only a few individual fisheries. Integrated approaches to ecosystem-based management (human dimension included) in comparison to single species management have been promoted for many years to achieve sustainability at the ecosystem, economic and social levels (e.g, Velarde et al. 2004; Lluch-Cota et al. 2007; Arreguín-Sánchez and Arcos-Huitrón 2011; Cisneros-Montemayor et al. 2012; Fulton et al. 2014). Policies to foster ecosystem-based approaches need to focus on whole areas rather than on specific fisheries, therefore, understanding the economic viability of fisheries as a whole is much more useful rather than of an individual fishery only.

Based on this study's results, direct recommendations to improve economic viability of Mexican fisheries are the following:

1. The inequity of subsidy distribution has been increasing over time mainly benefiting the Pacific LSF, this inequity is visible not only between sectors but also between regions. As shown in many other studies at global and national levels (e.g., (Schorr 2005; Sumaila et al. 2010a; Charles 2011; Cisneros-Montemayor et al. 2016), subsidies are in need of reform and capacity-enhancing types urgently need to be reduced (to zero if possible);

2. Financial support should focus on monitoring and enforcement on a local scale where currently funds are scarce. This would not only fight illegal and unreported fishing but also improve the quality of economic viability assessments;
3. Active small-scale vessels need to be accurately monitored and it is important to assess how many people depend on fishing for their livelihoods, this is an integral part to make management suggestions that could improve economic viability, such as redistributing access rights (Saavedra-Díaz et al. 2016). With this information, ways can be found to maintain fishing effort at a sustainable level, which would not only benefit the marine ecosystem but also the economic viability of fishing communities. Improved economic viability, therefore, would help improve food security, alleviate poverty and undernourishment in coastal fishing communities.

Chapter 5: Extended economic viability of small- and large-scale fisheries; an example from Mexico

5.1 Introduction

Basic economic viability has been defined as achieving non-negative net benefits to society from fishing (Schuhbauer and Sumaila 2016) and assessed at a national and regional level using Mexican fisheries as an example in Chapter 4. Here, I extend the basic definition of economic viability and its assessment by including an additional set of attributes. First, I identify, define and measure attributes regarded important to the economic viability of fisheries. Second, I assess the results of the measured attributes and their possible impact on economic viability. Third, I analyze the implications of the results for sustainable fisheries policies and management.

Small-scale fisheries, which play an integral part in global fisheries and support millions of livelihoods, are threatened by anthropogenic changes such as overfishing and climate change (Jackson et al. 2001; Cheung et al. 2009, 2010; Srinivasan et al. 2010; Sumaila et al. 2011; Costello et al. 2016). When it comes to developing policies towards sustainable ocean and coastal management, it is essential to consider ecosystem, social, economic and institutional dimensions of small-scale fisheries (Allison and Ellis 2001; Chuenpagdee 2011; Pomeroy and Andrew 2011). Furthermore, it has been recognized that quantitative measures alone are not sufficient to understand how to achieve sustainable policies, but instead, values, agency and inequality should be core measures (Hicks et al. 2016). A variety of socio-economic indicators and frameworks to model the interactions of human activity and the marine environment have been developed over the last decades (e.g., Charles 1991; Bowen and Riley 2003; Eisenack 2003; Cheung and Sumaila 2008; Gasalla et al. 2010). These are important for addressing the need to more comprehensively understand the underlying dynamic and complexities of small-scale fisheries (e.g., Isaacs 2011; Jentoft et al. 2011). Fortunately, the importance of socio-economics of small-scale fisheries is being increasingly recognized all over the world (e.g., (McConney and Charles 2008; Ünal and Franquesa 2010; Chuenpagdee 2011; Teh et al. 2011).

It has been a challenge, with the current state of knowledge and data availability, to implement recommendations provided by socio-economic studies into fisheries policy making (Mora et al. 2009; Cudney-Bueno and Basurto 2009; Symes and Hoefnagel 2010; Usseglio et al. 2014). Methodologies such as the sustainable livelihood approach, the welfare function and the wealth-based approach have all been developed, suggested and discussed in the literature with the goal of achieving sustainable management of fisheries to secure livelihoods and achieve food security in small-scale fishing communities (Allison and Ellis 2001; Cunningham et al. 2009; Béné et al. 2010a; Schuhbauer and Sumaila 2016). Vulnerability in the sense of exposure, sensitivity and adaptive capacity, as well as food security have been identified as key to protecting threatened fisheries communities whose livelihoods depend on marine fisheries (Pauly et al. 2005; Béné et al. 2007; Srinivasan et al. 2010; McClanahan et al. 2013; Hicks et al. 2016).

For example, McClanahan et al. (2013) measures sensitivity in the context of fisheries by the degree of human dependence on marine resources for food, revenue and income. Teh and

Sumaila (2013), argue that it is essential for sustainable fisheries management to know the numbers of people involved directly and indirectly in the fishing sector. However, often, employment in the sector is not well reflected in official statistics, which is especially important to the SSF sector whose work is often not part of the formal sector and include work of women and children who are not usually counted (Teh and Sumaila 2013; Harper et al. 2013). The importance of an industry in the economy of a country is usually measured in terms of their contribution to the Gross Domestic Product (GDP), however, this raises some issues with regards to small-scale fisheries. First, percentage of GDP accounts for the added value of the fishery but not necessarily for total economic and social impacts, and second small-scale fisheries are not always represented fully as their catches are often not reported comprehensively in official catch statistics (Zeller et al. 2006; Dyck and Sumaila 2010; Teh et al. 2011). Therefore, to assess the economic contribution from fishing to society it is not sufficient to only consider the direct output from fishing expressed in gross revenue or profit. More impacts such as indirect and induced impacts, should also be considered.

Understanding the economic viability of small-scale fisheries is relevant as it will bring attention to the existing problems encountered by these fisheries (Schuhbauer and Sumaila, 2016 and Chapter 4). Various studies reported in the literature call for the inclusion of a broad range of attributes (e.g., socio-economic indicators) into the assessment of a fishery's economic viability (Lery et al. 1999; Adeogun et al. 2009; Baumgärtner and Quaas 2009; Schuhbauer and Sumaila 2016). This is challenging as many variables and attributes could be responsible to increase or decrease the economic viability of SSF.

Mexico is used as an example to illustrate how to extend the basic economic viability assessment and tackle this challenge. The reason Mexico was chosen is that it reflects a typical developing country in terms of fisheries encompassing a large small-scale fisheries sector, which employs hundreds of thousands of people spread along the coastlines (FAO 2003). Furthermore, a first basic economic viability assessment on a national level has been carried out already (Chapter 4), which is used as the starting point of the analysis in this chapter. To be able to bring economic viability into a broader perspective and extend its assessment, it is necessary to look into more than just total revenue, total costs and subsidies. Therefore, integrating an additional set of attributes into the analysis is the goal for this chapter. In the following method section, after identifying and defining key attributes, I introduce Mexico's fisheries as the case study and then describe in detail how each attribute is being assessed and analyzed and what that means for designing sustainable fisheries policies.

5.2 Methods

5.2.1 Attributes of economic viability

Frameworks that are based on defining and measuring attributes are commonly used in fisheries assessments. For example, attributes have been the basis to successfully analyze fisheries performance, marine protected areas, or the effect of fishing on marine ecosystems (Fulton et al. 2005; Gasalla et al. 2010; Edgar et al. 2014).

I carried out a thorough literature review to come up with a first list of attributes that would play a role in determining the economic viability of fisheries. The next step was the consultation of scientists whose expertise lies in the fields of economic, social, governance and ecological aspects of fisheries. Furthermore, a workshop was organized, with a whole day committed to discuss my proposed attributes individually (*Too Big To Ignore*, 2014), which provided the foundation for the attribute list presented in Table 7. The *Too Big To Ignore* (TBTI) partnership facilitated both the consultations and the workshop. See Appendix B for details on the workshop and the framework developed based on the results. The attributes shown in Table 7 have been adopted specifically for the scope of this Chapter of my thesis and can be applied at various scales: local, regional, national and global. The selection criteria for the attributes include relevance, availability, measurability, and objectivity, i.e., whether the same result is obtained when the attributes are measured by different scientists at different times (Boyd and Charles 2006).

Table 7 List of attributes included in the extended economic viability assessment of small- and large-scale fisheries, their definitions, sources and measures.

Nº	Attributes	Definition	Sources and measures
A1	Proportion of SSF to total landed value (%)	The ratio of SSF revenue to total revenue of the whole fishery.	For national numbers see data from *Sea Around Us* and FERU. For case studies check literature, e.g., government reports and/or conduct surveys.
A2	Cost structure (ratio)	Cost structure is the ratio of fixed costs (e.g., capital investment) to variable costs (e.g., fuel, labor).	For national numbers see Lam et al., (2011). For case studies check literature, e.g., government reports and/or conduct surveys.
A3	Cost per tonne of catch ($)	Cost divided per tonne of catch, useful when comparing different fisheries and countries.	For national numbers see Lam et al., (2011). For case studies check literature, e.g., government reports and/or conduct surveys.
A4	Multiplier (factor)	Describes indirect income (income multiplier) and induced effects on society (economic multiplier) through fisheries. A multiplier is a factor by which we can multiply the value of final demand for an economic activity's output to obtain its total contribution to economic output including activities directly and indirectly dependent on it.	For national numbers see Dyck and Sumaila (2010) For cae studies adjust the national multipliers (both income and economic multipliers) either using reports and/or surveys.
A5	Employment (#)	Number jobs highlights the contribution of fisheries employment including both commercial and subsistence marine SSF. Employment type describes how a worker is employed. For example, the International Labor Organization (ILO) classifications are: employees, employers, own-account workers, members or producer cooperatives, contributing family workers, workers not classifiable by status. These can be adjusted to fisheries (e.g., boat owner, paid by catch share, employed by a company/cooperative).	For national numbers see (Teh and Sumaila, 2013), ILO and FAO. For case studies review FAO, government reports and carry out surveys (government agencies, NGOs and/or fishers).
A6	Subsidy intensity (ratio)	A measure of equity among different groups in society or a community in regard to the distribution of subsidies.	Compute ratio of total subsidies per fishing sector to either number of fishers, landed value or fisheries landings. For national numbers see Chapter 3 of this thesis, Teh and Sumaila, 2013 and *Sea Around Us* data. For case studies review FAO, government reports and carry out surveys (government agencies, NGOs and/or fishers).
A7	Fisheries discards (%)	How much of total catch is being discarded at sea compared to landed at the ports.	For national numbers see FAO and Sea Around Us database. For case studies check literature, e.g., government reports; conduct surveys; and monitor the catch.
A8	Catch not used for direct human consumption (%)	The amount of landings that are used directly for human consumption compared to indirect human consumption (e.g., fodder for livestock) and industrial use (e.g, beauty products).	For both national numbers and case-studies see FAO and literature, e.g., government reports and carry out surveys (government agencies, NGOs and/or fishers).

The selected attributes A1 – A8 presented and defined in Table 7 highlight the point that there is more than just the economic dimension to economic viability. The proportion of landed value, which also forms part of the fisheries catch and price estimates from Chapter 4, was chosen as it gives us another perspective highlighting differences between the fisheries sectors. Attributes A2-3 are part of the total cost of fishing, also serving to better compare sectors and regions. Attribute A4, as part of the economic dimension also has a social component, as it captures the fact that the higher the economic impact of the fishery the more output and opportunities for employment exist for society.

Employment (Attribute 5) is considered part of the socio-economic dimension, showing how many people directly depend on fisheries for their work and livelihoods. I consider subsidy-intensity (Attribute A6) also as part of socio-economics, as it can highlight inequities in subsidy distribution among sectors, regions and countries. Attribute A7 is important to the ecosystem component, as wasted fish through discards directly harms the environment and exacerbates overfishing, at the same time it impacts food security and costs of fishing as valuable resources are wasted. The end destination for fisheries landings (Attribute A8) is a key aspect that impacts ex-vessel prices and food security, and therefore it represents economic and social components of fisheries. In the following sections, I show how these attributes are measured using Mexico as an example.

5.2.2 Case study: Mexican fisheries

Small-scale fisheries are distributed widely along Mexico's coastlines and target different fish and invertebrate species. Some fishing communities are well organized such as the lobster and abalone fisheries in the North Pacific area, whereas others are found isolated from markets and marginalized from policy processes (Cinti et al. 2010; Salas et al. 2011; Cota-Nieto et al. 2015). Declining resources, vulnerability to climate change, high dependency of fishing for livelihoods, poverty and inequities regarding access rights, however, are very common threats faced by most Mexican SSF (e.g., Dickinson et al. 2006; Salas et al. 2007; Morzaria-Luna et al. 2014; Finkbeiner 2015). For the definition of Mexican small-scale fisheries (SSF) see Chapter 4 of this thesis. Large-scale fisheries (LSF), which are assessed here to compare to SSF, mainly target shrimp, tuna and sardine on the Pacific. On the Atlantic side the fisheries focus mainly on finfish and shrimp (Fernández et al. 2011; Conapesca 2013).

5.2.3 Analyzing attributes

The attributes presented in Table 7 have been selected to describe the extended economic viability assessment which broadens the basic economic viability assessment presented in Chapter 4. Here, I analyze these attributes (A1-8 in Table 7), at a national and regional level; regions are the Pacific and the Atlantic coasts of Mexico. I use annual data and also calculate averages for the years 2000 to 2012 where available. Where no complete data sets were available, information is taken from the most neighboring years with data. All amounts are converted into constant 2015 USD. See following sections for a detailed description of each attribute and its data sources.

Proportion of SSF revenue to total revenue

I used total revenue data from Chapter 4, mainly obtained from Cisneros-Montemayor et al., (2013), FAO statistics and CONAPESCA annual reports for 2000-2010 to calculate the proportions of total revenue to the revenue generated by SSF for each region.

Cost structure: ratio of fuel to labor costs

The total cost of fishing and the cost structure may vary depending on the fishing gear and vessel type. The reader is referred to Chapter 4 for a detailed description of the cost and cost structure estimates for Mexican small- and large-scale fisheries. In summary, data for variable costs (fuel, labor and running costs) and fixed costs (depreciation and interest) were calculated using various data of either a single fishery and/or individual fishing units. The results were then scaled up to regional and national levels using fishing effort data (number of boats and fishers) per fishing sector and/or fishery for Atlantic and Pacific coasts (Agroprospecta, 2010; Conapesca, 2013; Greer, 2014; Ramírez-Rodríguez and Almendárez-Hernández, 2013). To simplify the cost structure, I calculate the ratio of fuel to labor costs, using fuel as an indicator for efficiency and labor as a social indicator. As SSF are often owner-operated and fishing crew gets paid with a share of the catch rather than a wage, I include opportunity cost. I argue the lower that the ratio of fuel to labour cost, the better its impact on basic economic viability.

Cost per tonne of catch

To be able to compare costs of fishing across the sectors and regions, I calculated the cost of fishing per tonne of catch over the years 2000 to 2010. Here, I used calculated cost data from

Chapter 4 of both SSF and LSF from the Atlantic and the Pacific and divided them by tonnes of catch using data from Cisneros-Montemayor et al. (2013).

Economic impact

To measure the total economic impact of Mexican small- and large-scale fisheries, it is important to look beyond the landed value that each fishery produces and estimate the direct and indirect impact from fishing on the economy. Direct impact is considered all money spent by fishers to carry out fishing (e.g., boats, motors, paint, fuel, etc.). Indirect impact refers to the impact arising from purchased inputs, spent by the sellers of goods to fishers (e.g., equipment needs to be bought to sell fuel, produce nets, catch bait, etc.). When these impacts are added together it reflects the total impact of fishing on a country's economy. To quantify these impacts an input-output model is usually used. Although national numbers for the economic impact of fishing in Mexico exist (Dyck and Sumaila, 2010), not enough information is available to split economic impact results into regions and the different fishing sectors. Fortunately, the National Institute of Statistics and Geography (INEGI) provided data for the year 2008, which include total revenue from fishing and the total added value, together these produce the total economic impact from fishing.

INEGI data are available by municipality, however, not by fishing sector. As Mexican large-scale fisheries focus on a few species whose landings are concentrated at a few ports (FAO 2003; Erisman et al. 2011), I decided to use the data of municipalities where the large-scale fishing ports are located to estimate the economic multiplier for large-scale fisheries. The ports include: Ensenada, Comondú, Manzanillo, Tapachula, Mazatlán, Guaymas and Progreso. Most of the processing plants of the LSF sector are located in these municipalities with about 80% of all plants of the Pacific found in the Gulf of California, where on the Atlantic side almost 50% of the processing plants are found in Progreso, Yucatan (FAO, 2003). Data from all other coastal municipalities was used to estimate the economic multiplier for small-scale fisheries as SSF are found spread along the coastlines with various landing sites. The multiplier was then used to estimate the total economic impact using total revenue (Chapter 4, based on data from Cisneros-Montemayor et al., 2013; Conapesca, 2013).

Employment

The number of people employed in fisheries and number of dependents accounted for here can be direct and indirect. Direct employment includes all people who fish, this includes men, women and children as well as encompasses all fishing activities, whether they happen from the shore e.g., collecting invertebrates, or fishing from a boat. Indirect employment includes people engaged in the post-harvest sector, any processing and selling of the catch. Data made available by INEGI 2008 shows the most complete number of people who work in the fishing sector, as done through population census, which very likely capture the informal sector also. These data also include numbers of people engaged in fishing who are employed versus self-employed and number of people who have health benefits compared to those who don't. Information from annual fisheries reports (Conapesca, 2013) show number of fisher combined in aquaculture and fisheries as a total national value and per region (Atlantic and Pacific), illegal and informal fishers are probably not captured here. To disaggregate the number by fishing sector, I used the number of active fishing vessels and average number of crew per type of fishery from official statistics to estimate the reported number of fishers active in each fishery. Then I used the fraction of unreported to reported catch data to reconstruct the number of total fishers per sector aimed to cover numbers of both licensed and unlicensed fishers.

Subsidy intensity

The term subsidy intensity is used to express the amount of subsidies by total revenue. Furthermore, I compute subsidies per fisher to better understand inequity in the subsidies distribution to the two sectors and regions. The reason I choose not only subsidies by total revenue but also by number of fisher is to attempt to better reflect the impact on actual people involved in fishing in comparison to number of firms or boats. It needs to be clarified, especially for fishers employed in the LSF, that the resulting amounts do not reflect what each fisher actually receives, but more likely instead what the company receives or saves in costs as subsidies. However, the main goal here is to show the inequity in subsidy distribution more, in general, on a socio-economic perspective as well as to have a more standardized way to compare fishing sectors and regions.

Fisheries discards

The ratio of discards to landings from small- and large-scale fisheries is an essential aspect in relation to food security and poverty. In a country such as Mexico where millions of people suffer from undernourishment (Olaiz-Fernandez et al. 2006), it is important to look closely into how much fishery products are being wasted at sea not only for economic efficiency and wasted food but also for ecosystem health aspects. This analysis was possible due to catch reconstruction data that indicate whether the catch (both reported and unreported) was landed or discarded disaggregated into fishing sector and region (Pacific and Atlantic) (Cisneros-Montemayor et al., 2013).

Fish for human consumption

The demand for fishmeal production globally is growing and with it the use of fish not for human consumption (The World Bank 2013; Cashion et al. 2017). This has become a challenge for food security, especially in regards to animal protein and micronutrients on a global level (Naylor et al. 2000; Béné et al. 2016; Majluf et al. 2017). It is interesting to see in the case of Mexico how much of the actual landings are directly used for human consumption in comparison to animal fodder (agri- and aquaculture) as well as for industrial use (e.g. beauty products). Official Mexican fisheries reports indicate what percentage of landings is used for either direct human consumption, indirect human consumption (e.g. animal fodder) and industrial use, also shown separated by sector and region (Conapesca, 2013).

5.2.4 Relating attributes to basic economic viability

Here, I attempt to bring the results from the attributes described above together to analyze SSF in light of basic economic viability results reported in Chapter 4, and compare them across regions. It is important to note, that while I use a time series (2000 – 2012) to estimate basic economic viability in Chapter 4, the lack of data only lets me analyse extended economic viability at an annual level. The question I address here is, how is each attribute likely to affect the results from the basic economic viability? To address this questions, I designed a simple point system, which scores each attribute of SSF with - or + depending on whether the attribute being analyzed is expected to impact the results of the basic economic viability analysis negatively or positively in comparison to their LSF counterpart.

It should be noted that the scores are given under the assumption that all else remains the same (ceteris paribus), we therefore assume the following:

$$\frac{\partial BEV}{\partial A_i} > 0 \; for \; i = 1,4,5,6 \tag{15}$$

where BEV = Basic Economic Viability and A_i = the result of each attribute

$$\frac{\partial BEV}{\partial A_i} < 0 \; for \; i = 2,3,7,8 \tag{16}$$

Equation 15 and 16 show how the result of each attribute impact BEV, the higher the attribute in equation 15 and the lower each attribute in equation 16 the better it will be for BEV.

The sum of the scores for all the attributes are computed and used to qualitatively explain whether the economic viability results computed for SSF can be expected to increase or decrease in comparison to LSF when these attributes are taken into account.

5.3 Results and discussion

In the following sections results of attributes will first be presented and discussed separately and, second, brought together to be discussed in light of basic and extended economic viability.

5.3.1 Proportions of landings and total revenue

Small-scale fisheries achieve higher total revenues than LSF at a national and regional level. The gap between the two sectors is the highest on the Atlantic coast where the SSF sector generates 85% of the total revenue. It is interesting to note that the total revenue of Pacific SSF is much higher than LSF (Table 8) although LSF catches more fish on average (Cisneros-Montemayor et al. 2013). The higher the percentage of total revenue to SSF the better, I assume, the impact on basic economic viability.

Table 8 Results from the extended economic viability assessment for Mexican small- (SSF) and large-scale fisheries (LSF).

Extended economic viability attributes	Pacific		Atlantic		National	
	SSF	LSF	SSF	LSF	SSF	LSF
A1. Proportion of SSF to total revenue (%)	67	33	85	15	74	26
A2. Fuel costs / costs of labor (ratio)	1.5	1.2	1.5	1.6	1.5	1.6
A3. Cost per tonne of catch (USD)	1,858	480	2,045	3,612	1,934	668
A4. Multiplier (factor)	1.53	1.50	1.58	1.32	1.54	1.49
A5. Employment (# x 1000)	202	17	106	40	308	57
A6. Subsidy intensity (subsidies per fisher USD) and by total revenue (ratio)	281 0.03	8,712 0.20	127 0.02	1,185 0.11	215 0.03	5,243 0.19
A7. Fisheries discards (%)	7	22	10	47	8	24
A8. Catch not for direct human consumption (%)	0	60	0	6	0	58

5.3.2 Costs per tonne of catch

Results at the national level show that costs are much higher for SSF compared to LSF when divided by tonne of catch (Table 8). However, Atlantic LSF have the highest cost per tonne of catch looking into results by region and sector. A likely reason for the high costs is a drastic drop in catches of the Atlantic LSF by about half between 2000 and 2010, along with only a very slight decrease in number of boats (by 10%).

5.3.3 Cost structure

Based on our estimates on cost structure it is important to note that not enough data was available to distinguish the cost structure of Atlantic and Pacific SSF, which therefore are presented at the national level only (Fig.8). The percentage of cost of fuel is much higher in SSF, almost half of the total costs of fishing (Fig. 8). Labor is the second largest.

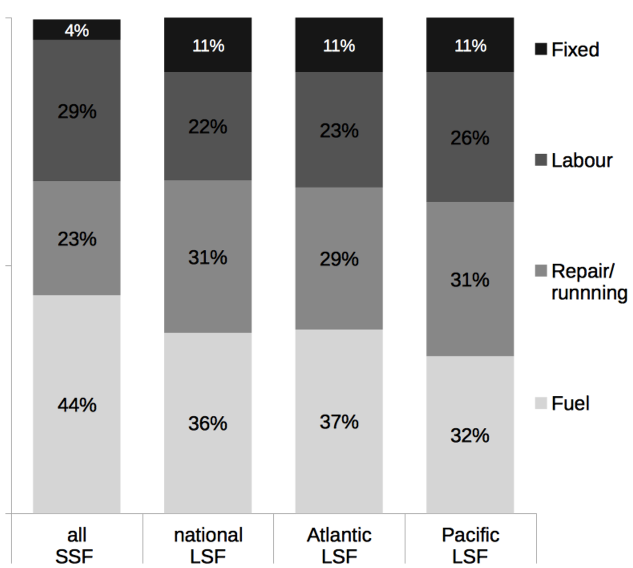

Figure 8 Total cost of fishing shown by cost structure divided into fixed and variable (labor, repair and running, fuel) costs, by small- (SSF) and large-scale fisheries (LSF) in percentages

As fuel costs constitutes a large chunk for SSF total costs, fuel efficiency is an important factor for the small-scale fisheries, which almost exclusively use outboard gasoline powered engines. Fixed costs and running costs take a larger fraction within the LSF costs compared to SSF, for both regions. The fact that fixed costs are higher in LSF compared to SSF (11 and 4%, respectively) reflects that LSF vessels have a much larger initial investment, furthermore most SSF boats and gear are much older compared to many boats in LSF (Conapesca, 2013).

Small-scale fisheries are often not as profit oriented as large-scale and their initial investment is lower, most of them are owner-operated and labor costs can easily make up for a third of total cost of fishing. Often, the fishing crew consists of family members or close friends who will get a share of the catch rather than a salary. Large-scale fisheries, on the other hand, have crews from 10 to over 100 people per vessel, which are often being paid a salary regardless of any fish being caught. The argument could be made here that LSF therefore bring more job security as long as the fishery is financially viable, however, employ a lot less people in total (Table 8 A5). The calculated ratio of fuel costs over costs of labor shows that Pacific LSF have a much lower score meaning they spend a lower proportion on fuel and a higher proportion on labor costs compared to SSF. I therefore assume, the lower the score the better it is for basic economic viability.

5.3.4 Economic impact

Data used to estimate multipliers to capture the economic impact from Mexican fisheries were taken from all coastal municipalities. Atlantic SSF are estimated to have the highest multiplier, however, at the same time not very high revenue and therefore less economic impact that Pacific SSF (Fig 9). Small-scale fisheries on the Pacific with the second largest multiplier have the largest total impact from fishing (Fig 9). The lowest multiplies is found from Atlantic LSF, which also bring the lowest total revenue, and therefore, has by far the lowest economic impact from fishing.

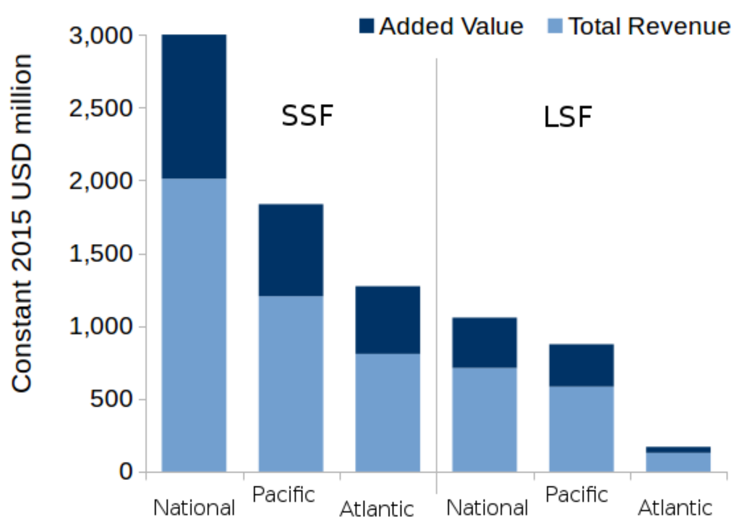

Figure 9 Total economic impact from Mexican fisheries shown by small- (SSF) and large-scale fisheries (LSF) and by region as total revenue from fishing plus added value.

The economic multiplier for small-scale fisheries was estimated at 1.5 for large-scale and 1.59 for small-scale fisheries (Table 8). The economic multiplier assessed by Dyck and Sumaila (2010) for Mexico is 1.72, the reason for this difference is very probable that induced effects are not accounted for in the available data. However, as this is the only data available that made it possible to divide the economic impact by sector and region, it is useful as a first estimate as well as to compare regions and sector. Here, the higher the score the better it is for economic viability.

5.3.5 Employment

Based on Teh and Sumaila (2013) estimates for direct and indirect employment for Mexican fisheries are around 750 thousand people. Based on 2012 reported numbers there are in total 185 thousand people active in fisheries in Mexico (Conapesca, 2013) but about 340 thousand occupied in total in the fishing sector, which to some extend includes indirect employment (INEGI 2008). However, as rightfully argued in Teh and Sumaila (2013), official statistics rarely capture people in the small-scale sector, especially, those in remote places, those in the informal sector and women. The results of my reconstructed number of fishers is therefore almost double the number of reported active fishers (339 thousand), using reported and unreported catch data from Mexican catch reconstruction (Cisneros-Montemayor et al., 2013).

To account for indirect employment also, I calculated a multiplier using reported numbers (1.8) and applied it to the reconstructed active fishers. I estimate that another 288 thousand people are occupied indirectly in fisheries for the year 2012. The total amount of people who depend on fisheries for their employment is therefore 627 thousand, which is very close to what Teh and Sumaila (2013) estimated using a global model.

Reconstructed number of fishers in Mexico by region shows the lowest number of people working in the Pacific LSF (Table 8), despite them making up for almost half of Mexican total catch. However, most amount of people working in fisheries are found within the Pacific SSF

(Table 8). The Atlantic sector is quite a bit smaller, however, the total estimate for Atlantic fishers is 146,000 (Table 8). As both SSF and LSF based on the Atlantic are, based on Chapter 4, not economically viable, it is important to understand that whichever management is being suggested to rectify this must make sure that not only livelihoods of these fishers are being considered but also those of people indirectly employed in fisheries.

5.3.6 Subsidy intensity

Computed subsidy intensity expressed in amount of subsidy per fisher shows on a national level that a large-scale fisher would receive 24 times more support than a small-scale fisher over the 13 years of the study period. Although Pacific SSF receive more subsidies than Atlantic LSF (Chapter 4 Fig 6), when looking into subsidy intensity, the Atlantic LSF receives much more subsidies per total revenue and per fisher. Furthermore, subsidy intensity (subsidy/total revenue) of Atlantic LSF has been increasing drastically (Fig 10), simultaneously with the drop in total revenue in 2006 (Chapter 4 Fig 6).

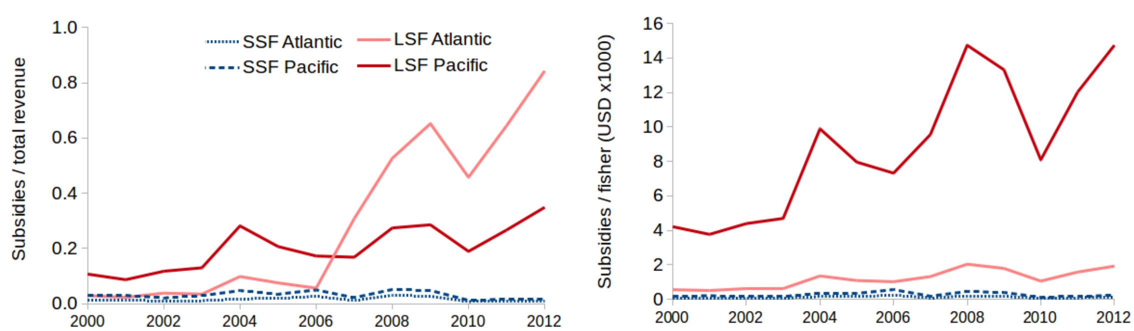

Figure 10 Subsidy intensity shown in subsidies per total revenue and subsidies per fisher from 2000-2012 for small- (SSF) and large-scale fisheries (LSF) of Mexico divided into Atlantic and Pacific regions.

Pacific LSF receiving the largest share of subsidies, shows subsidy intensity steadily increasing over the years, both per fisher and per total revenue (Fig 10). Economic viability of Pacific LSF has dropped since 2007, whereas subsidies continued to increase strongly, enough to keep financial viability positive while economic viability had already declined below zero in 2012 (Chapter 4 Fig 7). This is interesting as the question arises why the government decides to support the Pacific LSF with increasing subsidies, when the basic economic viability of SSF is increasing while the share of subsidies is decreasing.

5.3.7 Fisheries discards

Results indicate that LSF have a much higher discard rate (Fig 11), even though the small-scale sector lands most of their catch (Fig 11). However, despite that Atlantic LSF have the lowest total catch when divided by sector and region they have the highest discard rate at 47% on average over the study period. Also, SSF on the Atlantic have a slightly higher discard rate than Pacific SSF (10 and 7%, respectively).

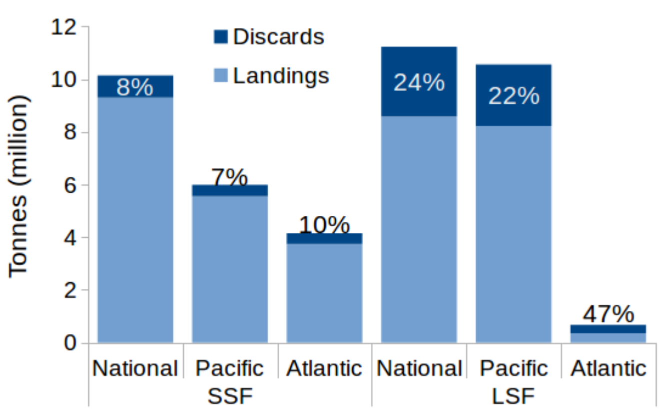

Figure 11 Total catch divided into landings and discards, sum from 2000 to 2010 for small- (SSF) and large-scale fisheries of Mexico shown by Pacific and Atlantic regions.

Possible reasons for the large discrepancies between the sectors are that SSF use their catch for home consumption, even if fish are too small to sell. Furthermore, SSF use more passive gear like traps often quite selective. LSF on the other hand work with large trawlers, and especially industrial shrimp fishery is known to be prone to large bycatch and discard rates (Kelleher 2005; Shepherd and Myers 2005).

5.3.8 Fish for human consumption

Out of the total landings from SSF and LSF combined, 56.5% is for human consumption, 43% for indirect human consumption (mainly fish meal for animal fodder) and 0.5% for industrial use (e.g., beauty products). But when split into the sectors on a national level, 42% from LSF while 100% of the SSF catch is for direct human consumption. Out of the total catch 99% from total Atlantic fisheries, and 50% from total Pacific fisheries is for direct human consumption. As 100% of total catch from SSF is exclusively used for direct human consumption, percentages per sector for each region shift, i.e., out of total Atlantic LSF 94% and 40% of Pacific LSF is aimed at direct human consumption, respectively (Table 8).

5.4 Extended economic viability

Table 9 shows extended economic viability (EEV) scores for each attribute based on results shown in Table 8 and discussed in Section 5.3. As explained in Section 5.2.4 (following equations 15 and 16) each attribute result has been assigned a plus (+) indicating that the result of the attribute for SSF has a positive impact on basic economic viability (BEV) compared to their LSF counterpart, a minus (-) denotes the contrary. For each positive point that SSF receives, the LSF counterpart receives a negative point. The higher the score of extended economic viability the more positive its prognosis for BEV.

Table 9 Scores of extended economic viability (EEV) of small-scale fisheries, positive (+) and negative (-) impact on basic economic viability (BEV), the higher the EEV score the stronger the impact on BEV.

	Pacific	Atlantic	National
A1. Proportion of SSF (%) to total revenue	+	+	+
A2. Fuel costs / costs of labor (ratio)	-	+	-
A3. Cost per tonne of catch (USD)	-	+	-
A4. Multiplier (factor)	+	+	+
A5. Employment (# x 1000)	+	+	+
A6. Subsidy intensity (ratio)	-	-	-
A7. Fisheries discards (%)	+	+	+
A8. Catch not used for human consumption (t)	+	+	+
EEV total score	**+ 5**	**+ 7**	**+ 5**
BEV from Chapter 4 (USD in million)	**79**	**-37**	**42**
Increasing or decreasing effect of extended economic viability score on BEV.	⇧	⇧	⇧

As shown in Chapter 4, using the BEV formula, both the small- and large-scale sectors can be considered economically viable, on average, over the years 2000-2012. However, showing the averages per region, SSF on the Atlantic (Table 9), are not economically viable (BEV) as net benefits to society are negative, whereas they are economically viable on the Pacific.

Based on EEV total points shown in Table 9, SSF have a positive score of 5 (out of a maximum of 8) at the national level. This means as indicated by the arrows (last row Table 9) that based on the EEV assessment, prospects for SSF are better compared to LSF.

Regionally, Pacific SSF show a positive EEV score coinciding with a positive BEV result, meaning that their economic viability prospect for the future seems stable and increasing in comparison to Pacific LSF. While BEV of The Atlantic SSF is negative their EEV score is quite high (+ 7) indicating a positive prognosis. It is important to note that due to the SSF extended economic viability score being relative to LSF, that the reason for the high Atlantic SSF score could be the grim situation of Atlantic LSF. Furthermore, it is important to keep in mind that the analysis is based on the ceteris paribus concept (where all else remains the same). I qualitatively analyze all attribute results in more depth of each fishing sector on a national and regional level in the following.

The outlook of total revenue from fishing for SSF is quite positive compared to LSF. The number of people employed directly and indirectly is quite high as well as the total economic impact measured using the multiplier. This shows the importance of SSF to society in Mexico, which indicates, with increasing economic viability over the studied years, a positive perspective into the future. Besides, SSF have quite low discard rates, which is positive for both the environment because less (often juvenile) fish get unnecessarily taken, and for economic efficiency, as discarding fish means more effort is needed to catch the same amount of fish (Crowder and Murawski 1998). Low discard rates mean either selective gear (not much by-catch) or that a large variety of sizes and species are marketable and high grading is not necessary. Furthermore, all fish is used for human consumption, which is important for food security within coastal rural communities, where people depend on seafood for protein intake. On the other hand, SSF operate at very high costs per tonne of catch and high fuel costs, which make up for almost half their expenses, showing that boats do not run very efficiently or fish are hard to catch.

In the following I highlight a few differences between the SSF on the Pacific and the Atlantic. Based on this analysis, reasons for the Atlantic being less viable than the Pacific could be that Atlantic SSF have lower fisheries landings per boat with decreasing numbers (Cisneros-Montemayor et al. 2013), higher discard rates and catches have been decreasing whereas increasing on the Pacific. This might indicate that fishing effort is too high for the amount of marine resources available for Atlantic SSF to be economically viable.

Pacific LSF operate at very low costs per tonne of catch compared to SSF, which is positive for their economic viability (Table 8). Additionally, Pacific LSF seem much more fuel efficient, as fuel take less of a proportion in their total costs than within SSF, which can be positive for the environment if operating within sustainable levels of resource exploitation. Looking into fisheries subsidies, Pacific LSF receive the largest fraction with the subsidy amounts increasing over time. However, despite subsidies largely increasing the fisheries' financial viability, they do not seem to have a long term effect on their economic viability, as both financial and economic viability have been on a decreasing trend since 2007 (Chapter 4 Fig 7). A large percentage of LSF landings, especially on the Pacific coast is destined for fish meal production. Knowing that most fish and seafood production companies are accumulated in only a few areas where LSF operate (FAO, 2003), I assumed the more post fisheries production is carried out the higher the economic impact would be. However, based on the results, the contrary is true. The higher multipliers are found in areas where mainly SSF operate and where 100% of the landed fish is used for direct human consumption and mostly sold fresh to the final consumer. Furthermore, LSF in general only employ a very small fraction of total fishers, which is highlighted by the very large subsidy intensity when analyzing subsidy per fisher. Discards in LSF are much higher than in SSF, which is of concern for their economic viability as well as for ecosystem sustainability as explained above.

Economic viability of Atlantic LSF has been very low for the entire study period and negative since 2006 (Chapter 4 Fig 7). While Pacific LSF have very low costs per tonne of catch on average, Atlantic LSF have a much larger cost. Reasons for this might be their very low catches per boat and decreasing total catches (compared to increasing catches by Pacific LSF). One huge concern here is the large amount of discards, Atlantic LSF throw almost half of their catch overboard, which creates waste, degrades the marine ecosystem, impacts food security and jeopardizes economic viability due to increase in cost of fishing. Furthermore, Atlantic LSF do not only have the lowest total revenue compared to other regions and sectors, but also the lowest economic multipliers, leading to a very small total economic impact. Atlantic LSF are in urgent need for attention from the Mexican government, as continuing at this rate, people soon will be out of their jobs. Additionally, the already threatened marine ecosystem will rapidly degrade possibly having a direct negative impact on the economic viability of Atlantic SSF.

5.5 Caveats and data quality

Data availability is the main limiting factor here. It would have been interesting to carry out a cluster analysis, principal component analysis or a general regression analysis to better understand the relationship among the different attributes as well as their relation and importance to economic viability more statistically (see Appendix B for details on how this could be carried out). This would be useful to weigh the attributes and find out if they are equally important to economic viability of not. However, as we have maximum one data point per year, sector and region and often even less, such statistical analyses cannot be applied here. Nonetheless, this chapter as the extended viability analysis has more a descriptive focus, as it is the first of its kind, trends and dynamics of these attributes clearly help us understand underlying mechanism and possible drivers of economic viability. Once more data can be gathered, possibly at a local level, statistical analysis will be much more helpful to interpret data patterns and trends. It is important to keep in mind the scope of this chapter which is to apply a newly developed methodology on a national and regional scale to identify major trends, differences and pitfalls of Mexican small- versus large-scale fisheries.

5.6 Recommendations and conclusion

Using results from this study I present a set of key recommendation to Mexican fisheries policy makers and managers both at regional and federal levels that I believe can improve economic viability of SSF. Monitoring of active boats and fishers needs to be improved and up-dated regularly, the fact that costs per tonne are extremely high and catch per vessel very low for Atlantic LSF might be due to an over-reporting of active fishing vessels. This largely influences not only the outcome of the basic but also the extended economic viability assessment. Besides, improved on board monitoring for both SSF and LSF will help improve fishing technologies to reduce discards rates. Discards often comprise of juvenile fish, their protection will improve ecosystem health in already overfished areas, this and a reduction in cost due to better and more selective fishing technology, while regulating fishing effort, will improve economic viability.

That such a large component of fisheries landings is not used for direct human consumption (60%) is of great concern on various levels. Sardines and anchovies, the main target fish used for fish meal and oil production could be marketed for human consumption instead, this would yield higher profits and help local food security (Béné et al. 2016; Cashion et al. 2017). As for example proven in the case of Peruvian anchoveta, fisheries could make more money by selling the fish as food and not for fish meal production (Christensen et al. 2014; Majluf et al. 2017). While small pelagic fish are very nutritious they are also more affordable in comparison to, for example, larger pelagic or reef fish. This has been argued in many places already, especially where undernourishment and food security are prevalent issues in coastal communities (Alder et al. 2008; Tacon and Metian 2009; Majluf et al. 2017).

Furthermore, arguments have been made that leaving more sardines in the ocean as forage fish, which play crucial roles in marine ecosystems, will lead to greater fisheries profitability in the long term (Hannesson et al. 2009). The same argument can be made here based on my results for economic viability of Mexican Pacific fisheries as with increased ecosystem health due to healthier forage stocks, all Pacific fisheries would directly benefit.

If SSF could improve their fuel efficiency they would lower their costs of fishing drastically. This would be beneficial for the environment, as modern more energy efficient equipment increases efficiency and decreases pollution. Although SSF already operate with rather low discard rates, better equipment might also help reducing by-catch rates even further. Lower costs, healthier ecosystems and higher efficiency will improve economic viability. Here, a recommendation could be to instead of supplying SSF with new outboard gasoline powered engines, which is currently part of Mexico's subsidies policy, policies should be made with long term goals in mind and help fisher access financing to be able to afford more efficient and environmentally friendly technologies. Although this might lead to an increase in fixed costs due to a higher initial investment, it would decrease fuel as well as maintenance costs, due to less problems with newer engines, which need less frequent repairs. It is important to note that this would only work if the current open access regime was regulated to avoid an increase in fishing effort motivated by increasing profits.

Again, as pointed out clearly in earlier chapters of this thesis, subsidies are a main concern, as unfairly distributed and while making Pacific LSF financially viable they definitely do not show a positive impact on the fisheries' economic viability. SSF on both coasts clearly employ many more people and contribute to a larger extend to the total economic impact from fishing than LSF, however, subsidies are continued to increase only to Pacific LSF, whose economic viability is in decline. Therefore, I argue that policies on fisheries subsidies are in urgent need of reform.

Differences not only between sectors but also between regions call not for improved policies on a federal level as well as better regionally oriented fisheries management.

Factors that influence economic viability such as discard rates and whether fish is used for direct human consumption or not, seem to be key factors when it comes to issues such as food security and ecosystem health as well. Results show that by better understanding the economic viability of fisheries we also touch on other ecosystem and social aspects which are important to understand for achieving a balanced fisheries management.

Chapter 6: Conclusions

This study is the first attempt to clearly define and assess economic viability of small-scale fisheries. The literature has shown incoherence surrounding the definition of the term economic viability, not only for fisheries specific studies but also in general. Economic viability has often been used interchangeably with economic performance and financial viability (Chapter 2). While both economic performance and financial viability are important for fisheries to be able to survive in the long term, they fail to integrate other key attributes that make a fishery economically viable such as subsidies, employment and food security.

Fisheries subsidies have been identified as the main distortion between financial and economic viability. Results from this study, especially from Chapter 3, show how subsidies undermine the economic viability of small-scale fisheries as the majority of total subsidies provided are capacity-enhancing and mainly go to large-scale fisheries. This in turn contributes to the depletion of fisheries resources that possibly both SSF and LSF depend upon.

Results of the simple calculation presented in Chapter 4 show how basic economic viability depends on total revenue and total costs and, again, subsidies. It is important to note that economic viability is often undermined because of underlying dynamics such as increasing inequity in subsidies distribution, decreasing prices and catches, increasing costs, unfair access to resources and fishing under open access regimes leading to possible overcapacity. Additionally, results highlight the importance of assessing the two fishing sectors (small- and large-scale fisheries) separately as the two are very different.

Chapter 5 presents how factors such as employment, economic impact and food security matter in economic viability assessments. These attributes, could become good indicators of a fishery's economic viability and therefore need to be explored further. Also policy makers should consider to look closer into social, economic and ecosystem components of fisheries to reveal underlying dynamics and possible drivers of the economic viability.

6.1 Policy advancements in small-scale fisheries

As discussed in Chapter 1, marine fisheries are threatened globally and small-scale fisheries are the ones that suffer the most as a result of these threats. Fortunately, the current fisheries crisis has already been recognized and solutions have been proposed. These include the reduction of harmful fisheries subsidies (Milazzo 1998; Sumaila et al. 2016), the implementation of marine protected areas (McClanahan et al. 2006; Edgar et al. 2014; Sumaila et al. 2015; Boonzaier and Pauly 2016) and management of fisheries through ecosystem-based approaches (Mora et al. 2009; Fulton et al. 2014; Edgar et al. 2014; Christensen et al. 2015). International agreements have been quite positive, especially in relation to small-scale fisheries, during the last few years. For example, the United Nations' Sustainable Development Goals include targets such as reducing illegal fishing, protecting marine biodiversity and providing small-scale fisheries access to natural resources and markets (Targets 14.4 and 14.b in United Nations 2016).

Another important step towards improving the current state of small-scale fisheries has been the development of guidelines to secure sustainable small-scale fisheries in the context of food security and poverty eradication (FAO 2015). These guidelines, while voluntary, have been developed through a human rights based approach and are a sign that the importance of SSF is increasingly being recognized across the world as they play major roles in food security and nutrition as highlighted in the case of Mexico in Chapter 5.

Furthermore, as shown in Chapter 3, the reduction of capacity-enhancing fisheries subsidies has been agreed upon at the international level (UNCTAD agreement and Sustainable Development Goals 14). This agreement, unlike many other international agreements focusses not only on large-scale fisheries, but also on nutritional security, livelihoods of coastal communities and fisheries in developing countries.

These policy advancements over the last years geared towards achieving sustainable small-scale fisheries are huge. However, considering the large knowledge gap that exists in small-scale fisheries research, in order to achieve agreed targets and effectively implement set policies, it is clear that more research needs to be carried out. It is expected I argue that the results of this study will contribute to filling some of this knowledge gap at global, national and regional levels.

6.2 Economic, ecosystem, social and institutional dimensions

As argued throughout this study, it is important that more than just a financial perspective is considered in the assessment of economic viability. It is therefore important to take institutional, economic, social and ecosystem dimensions into account. This has been a significant challenge, as the list of attributes that would comprehensively cover these dimensions is too long to be studied in one single thesis. Therefore, I narrowed the approach and identified core attributes that are key for basic and extended economic viability. Most of these key attributes that form economic viability are part of the economic dimension: Total costs, subsidies, ex-vessel prices, total economic impact and cost structure. These attributes are covered in detail throughout the thesis and discussed at global, national and regional levels in Chapters 3 to 5. However, having the financial as well as basic and extended economic viability assessments in mind, I summarize in the following what role ecosystem, social and institutional dimensions might play in economic viability.

If fish stocks and the marine ecosystem are not healthy, fisheries landings over the long term will suffer. Fisheries landings are, aside from price, the core attribute of total revenue. If we assume stable prices and fish abundance declines, total revenue will also decrease. The ecosystem dimension is therefore clearly part of the total revenue from fishing. Furthermore, if fish abundance decreases, fishers might try to compensate by, for example, fishing longer hours, further away from their home ports and by investing in advanced technologies. These factors directly impact the cost of fishing. Governments tend to provide capacity-enhancing subsidies to fisheries whose total revenue is decreasing, which often leads to increased fishing effort, exacerbating overfishing. Another important aspect is that with declining marine resources targeted in fisheries the chances are high that by-catch rates and with it discard rates will increase, which has a direct negative impact on the marine ecosystem. The ecosystem dimension is, therefore, represented here in the sense of fish abundance, if fisheries operate at an ecologically sustainable level and the marine ecosystem is found to be in a healthy state, then economic viability will be positively impacted.

Socio-economic and social attributes are shown to play important roles based on results from the extended economic viability assessment. Employment and food security are both part of the social and socio-economic dimension. For example, the use of fisheries product for fish meal production instead of direct human consumption undermines food security and economic viability (Christensen et al. 2014; Béné et al. 2016; Cashion et al. 2017). It can be concluded that with economic viability, the chances are much higher that employment and food from fishing can be secured for the long term.

Many of the defined and assessed attributes important to economic viability are influenced by institutional structures and decision making at governance and management levels. Therefore, it is of great importance to understand how institutional changes can improve the economic viability of fisheries. For example, if subsidies allocated by the government to the fisheries sector are within the beneficial category only and if they were more equally distributed to the small- and large-scale fishing sectors, both economic viability as well as sustainability of fisheries would improve. Institutional long term thinking and political will are crucial to improving the economic viability of fisheries.

6.3 Caveats and data quality

Results show how important it is to analyze small- and large-scale fisheries separately in order to properly address the needs of each fishing sector as they are very different from each other, not only at a national level but also in different regions. The lack of data in many countries is a huge challenge to this research. As mentioned, throughout Chapters 3-5, data transparency and accessibility is a key factor in need of improvement. Especially Chapter 3 possibly suffers from a lack of details for each assessed country, however, as a first global study it provides the best available data set on subsidies provided to SSF. Publishing this data will hopefully bring more attention to the issue that more detailed information is needed for improved policy making. Both Chapters 4 and 5 use the same government information as a foundation whose data quality clearly has room for improvement. I hope, the result of this study not only brings attention to the data quality problem but also helps to correct it.

It should be noted that because of the broad scale of the analysis carried out in this study, I have not emphasized on uncertainty and the calculation of confidence intervals around my estimates. The overall goal is to provide the first ballpark estimates that can be improved in subsequent studies.

An important caveat that needs to be acknowledged in this study is that the importance of cultural values of small-scale fisheries in society has been mentioned but not analyzed or discussed. This is beyond the scope of this research project; however, it would be useful for future research to incorporate cultural values into the economic viability assessment framework.

As this is the first study to analyze economic viability of small-scale fisheries at the national and regional levels, it would be interesting to repeat this assessment in other countries as well as at a global scale. This will help further bridge the current knowledge gap in small-scale fisheries research.

A valuable next step would be to analyze the global cost of fishing data (Lam et al. 2011) and split cost per country into small- and large-scale fisheries. Once this is done, the basic economic viability assessment can be carried out at a global level using global catch and landed value data from Pauly and Zeller (2016), subsidies results from Chapter 3 and the methodology developed in Chapter 4.

6.4 Recommendations to policy makers

Based on my results and knowledge from this thesis I recommend the following to policy makers:

Economic viability needs to be understood and assessed with more than just profit in mind in order to reveal the underlying dynamics of small-scale fisheries in support of informed decision making.

The reduction (if possible to zero) of capacity-enhancing fisheries subsidies is urgent and will very likely benefit the economic viability of small-scale fisheries, worldwide.

Regulating fishing effort, facilitating the improvement of fishing technologies and investing in monitoring and enforcement are only a start to improving the economic viability of SSF.

The integration of aspects such as food security, employment and ecological factors (discard rates), into policy making are essential to understanding how to best improve economic viability not only with regard to profits but also by focusing on the maintenance of livelihoods.

References

Abdallah, P. R., and U. R. Sumaila. 2007. An historical account of Brazilian public policy on fisheries subsidies. Marine Policy 31(4):444–450.

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

Adeogun, O. A., P. O. Abohweyere, H. K. Ogunbadejo, A. Tanko, L. Jim-Saiki, and others. 2009. Economic Viability of Small-scale Marine Capture Fisheries in the Bonny Area, Rivers State, Nigeria. Marine Resource Economics 24(2):195.

Agroprospecta. 2010. Unidades representativas de producción acuícola y pesquera. Panorama económico 2008–2018. Universidad Autónoma Chapingo, Chapingo, México.

Alder, J., B. Campbell, V. Karpouzi, K. Kaschner, and D. Pauly. 2008. Forage Fish: From Ecosystems to Markets. review-article.

Allison, E. H., and F. Ellis. 2001. The livelihoods approach and management of small-scale fisheries. Marine policy 25(5):377–388.

Allison, E. H., B. D. Ratner, B. Åsgård, R. Willmann, R. Pomeroy, and J. Kurien. 2012. Rights-based fisheries governance: from fishing rights to human rights. Fish and Fisheries 13(1):14–29.

Andrew, N. L., C. Béné, S. J. Hall, E. H. Allison, S. Heck, and B. D. Ratner. 2007. Diagnosis and management of small-scale fisheries in developing countries. Fish and Fisheries 8(3):227–240.

APEC. 2000. Study into the nature and extent of subsidies in the fisheries sector of APEC member economies, APEC Committee on Trade and Investment. PricewaterhouseCoopers and Asia Pacific Economic Cooperation Secreteriat, Singapore.

Arreguín-Sánchez, F., and E. Arcos-Huitrón. 2011. La pesca en México: estado de la explotación y uso de los ecosistemas. Hidrobiológica 21(3):431–462.

Aubin, J.-P. 1991. Viability Theory. Springer Verlag, Birkhaeuser.

Aubin, J.-P. 2011. Viability Theory - New Directions.

Bailey, M., U. Rashid Sumaila, and M. Lindroos. 2010. Application of game theory to fisheries over three decades. Fisheries Research 102(1–2):1–8.

Barclay, K., and I. Cartwright. 2007. Governance of tuna industries: The key to economic viability and sustainability in the Western and Central Pacific Ocean. Marine Policy 31(3):348–358.

Barnes-Mauthe, M., K. L. L. Oleson, and B. Zafindrasilivonona. 2013. The total economic value of small-scale fisheries with a characterization of post-landing trends: An application in Madagascar with global relevance. Fisheries Research 147:175–185.

Basurto, X., A. Cinti, L. Bourillón, M. Rojo, J. Torre, and A. H. Weaver. 2012. The Emergence of Access Controls in Small-Scale Fishing Commons: A Comparative Analysis of Individual Licenses and Common Property-Rights in Two Mexican Communities. Human Ecology 40(4):597–609.

Baumgärtner, S., and M. F. Quaas. 2009. Ecological-economic viability as a criterion of strong sustainability under uncertainty. Ecological Economics 68(7):2008–2020.

Béné, C. 2003. When fishery rhymes with poverty: a first step beyond the old paradigm on poverty in small-scale fisheries. World development 31(6):949–975.
Béné, C. 2006. Small-scale fisheries: assessing their contribution to rural livelihoods in developing countries. Page 46p. FAO, FAO Fisheries Circular Np. 1008, Rome.
Béné, C., R. Arthur, H. Norbury, E. H. Allison, M. Beveridge, S. Bush, L. Campling, W. Leschen, D. Little, D. Squires, S. H. Thilsted, M. Troell, and M. Williams. 2016. Contribution of Fisheries and Aquaculture to Food Security and Poverty Reduction: Assessing the Current Evidence. World Development 79:177–196.
Béné, C., and L. Doyen. 2000. Storage and viability of a fishery with resource and market dephased seasonalities. Environmental and Resource Economics 15(1):1–26.
Béné, C., L. Doyen, and D. Gabay. 2001. A viability analysis for a bio-economic model. Ecological Economics 36(3):385–396.
Béné, C., and R. M. Friend. 2011. Poverty in small-scale fisheries old issue, new analysis. Progress in Development Studies 11(2):119–144.
Béné, C., B. Hersoug, and E. H. Allison. 2010a. Not by Rent Alone: Analysing the Pro-Poor Functions of Small-Scale Fisheries in Developing Countries. Development Policy Review 28(3):325–358.
Béné, C., R. Lawton, and E. H. Allison. 2010b. “Trade Matters in the Fight Against Poverty”: Narratives, Perceptions, and (Lack of) Evidence in the Case of Fish Trade in Africa. World Development 38(7):933–954.
Béné, C., G. Macfadyen, and E. H. Allison. 2007. Increasing the contribution of small-scale fisheries to poverty alleviation and food security. Page 125p. FAO, FAO Fisheries Technical Paper No. 481.
Berkes, F., N. C. Doubleday, and G. S. Cumming. 2012. Aldo Leopold’s Land Health from a Resilience Point of View: Self-renewal Capacity of Social–Ecological Systems. EcoHealth 9(3):278–287.
Berkes, F., R. Mahon, P. McConney, R. Pollnac, and R. Pomeroy. 2001. Managing Small-scale Fisheries: Alternative Directions and Methods. Ottawa: International Development Research Centre.
Boonzaier, L., and D. Pauly. 2016. Marine protection targets: an updated assessment of global progress. Oryx 50(1):27–35.
Bowen, R. E., and C. Riley. 2003. Socio-economic indicators and integrated coastal management. Ocean & Coastal Management 46(3–4):299–312.
Boyd, H., and A. Charles. 2006. Creating community-based indicators to monitor sustainability of local fisheries. Ocean & Coastal Management 49(5–6):237–258.
Bueno, N., and X. Basurto. 2009. Resilience and collapse of artisanal fisheries: a system dynamics analysis of a shellfish fishery in the Gulf of California, Mexico. Sustainability Science 4(2):139–149.
Cashion, T., F. Le Manach, D. Zeller, and D. Pauly. 2017. Most fish destined for fishmeal production are food-grade fish. Fish and Fisheries:n/a-n/a.
Charles, A. 2011. Small-scale fisheries: on rights, trade and subsidies. Maritime Studies (MAST) 10:85–94.
Charles, A. T. 1991. Bio-socio-economic dynamics and multidisciplinary models in small-scale fisheries research. Pages 603–608 *in* J.-R. Durand, J. Lemoalle, J. Weber, and Symposium International ORSTOM-IFREMER, Montpellier (FRA), 1989/07/3-7,

editors. La recherche scientifique face à la pêche artisanale = Research and small-scale fisheries. ORSTOM, Paris.
Charles, A. T. 1998. Living with uncertainty in fisheries: analytical methods, management priorities and the Canadian groundfishery experience. Fisheries Research 37(1–3):37–50.
Cheung, W. W. L., V. W. Y. Lam, J. L. Sarmiento, K. Kearney, R. Watson, and D. Pauly. 2009. Projecting global marine biodiversity impacts under climate change scenarios. Fish and Fisheries 10(3):235–251.
Cheung, W. W. L., V. W. Y. Lam, J. L. Sarmiento, K. Kearney, R. Watson, D. Zeller, and D. Pauly. 2010. Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Global Change Biology 16(1):24–35.
Cheung, W. W. L., and U. R. Sumaila. 2008. Trade-offs between conservation and socio-economic objectives in managing a tropical marine ecosystem. Ecological Economics 66(1):193–210.
Cho, Y. 2015. Revisiting WTO Fisheries Subsidies Negotiations. Beijing Law Review 6:9–15.
Chou, Y., and C.-H. Ou. 2016. The opportunity to regulate domestic fishery subsidies through international agreements. Marine Policy 63:118–125.
Christensen, V., M. Coll, J. Buszowski, W. W. L. Cheung, T. Frölicher, J. Steenbeek, C. A. Stock, R. A. Watson, and C. J. Walters. 2015. The global ocean is an ecosystem: simulating marine life and fisheries. Global Ecology and Biogeography 24(5):507–517.
Christensen, V., S. de la Puente, J. C. Sueiro, J. Steenbeek, and P. Majluf. 2014. Valuing seafood: The Peruvian fisheries sector. Marine Policy 44:302–311.
Chuenpagdee, R. 2011. World Small-scale Fisheries: Contemporary Visions. Eburon Uitgeverij B.V.
Chuenpagdee, R., and A. Bundy. 2006. What was hot at the fourth World Fisheries Congress? Fish and Fisheries 7(2):147–150.
Chuenpagdee, R., L. Liguori, M. L. D. Palomares, and D. Pauly. 2006. Bottom-Up, Global Estimates of Small-Scale Marine Fisheries Catches. Page 110. Fisheries Centre, University of British Columbia, Canada, Research Report Volume 14 Number 8, Vancouver.
Cinti, A. 2010. Rules and Sustainable Resource Use: Case Studies of Small-Scale Fisheries in the Northern Gulf of California, Mexico.
Cinti, A., W. Shaw, R. Cudney-Bueno, and M. Rojo. 2010. The unintended consequences of formal fisheries policies: Social disparities and resource overuse in a major fishing community in the Gulf of California, Mexico. Marine Policy 34(2):328–339.
Cisneros-Mata, M. A. 2010. The importance of Fisheries in the Gulf of California and ecosystem-based sustainable co-management for conservation. Page The Gulf of California: biodiversity and conservation. Brusca, R. and Brusca, R.C., University of Arizona Press, Tucson.
Cisneros-Montemayor, A. M., V. Christensen, F. Arreguín-Sánchez, and U. R. Sumaila. 2012. Ecosystem models for management advice: An analysis of recreational and commercial fisheries policies in Baja California Sur, Mexico. Ecological Modelling 228:8–16.
Cisneros-Montemayor, A. M., M. A. Cisneros-Mata, S. Harper, and D. Pauly. 2013. Extent and implications of IUU catch in Mexico's marine fisheries. Marine Policy 39:283–288.
Cisneros-Montemayor, A. M., E. Sanjurjo, G. R. Munro, V. Hernández-Trejo, and U. R. Sumaila. 2016. Strategies and rationale for fishery subsidy reform. Marine Policy 69:229–236.

Cissé, A. A., L. Doyen, F. Blanchard, C. Béné, and J.-C. Péreau. 2015. Ecoviability for small-scale fisheries in the context of food security constraints. Ecological Economics 119:39–52.

Clark, C. W., G. R. Munro, and U. R. Sumaila. 2005. Subsidies, buybacks, and sustainable fisheries. Journal of Environmental Economics and Management 50(1):47–58.

Collins, C. A., C. G. Castro, H. Asanuma, T. A. Rago, S.-K. Han, R. Durazo, and F. P. Chavez. 2002. Changes in the hydrography of Central California waters associated with the 1997–98 El Niño. Progress in Oceanography 54(1–4):129–147.

Conapesca. 2013. Anuario Estadistico de Acuacultura y Pesca. SAGARPA. Mexico. CONAPESCA (Comisioon Nacional de Acuacultura y Pesca)., Mexico.

Corbett, J. J., and H. W. Koehler. 2003. Updated emissions from ocean shipping. Journal of Geophysical Research: Atmospheres 108(D20):4650.

Costello, C., D. Ovando, T. Clavelle, C. K. Strauss, R. Hilborn, M. C. Melnychuk, T. A. Branch, S. D. Gaines, C. S. Szuwalski, R. B. Cabral, D. N. Rader, and A. Leland. 2016. Global fishery prospects under contrasting management regimes. Proceedings of the National Academy of Sciences:201520420.

Cota-Nieto, J. J., B. E. Erisman, M. Moreno-Baez, G. Hinojosa-Arango, and O. Aburto-Oropeza. 2015. Fisheries driving development in Punta Abreojos, Mexico. DataMares.

Crowder, L. B., and S. A. Murawski. 1998. Fisheries Bycatch: Implications for Management. Fisheries 23(6):8–17.

Cudney-Bueno, R., and X. Basurto. 2009. Lack of Cross-Scale Linkages Reduces Robustness of Community-Based Fisheries Management. PLOS ONE 4(7):e6253.

Cunningham, S., A. E. Neiland, M. Arbuckle, and T. Bostock. 2009. Perspectives: Wealth-based Fisheries Management: Using Fisheries Wealth to Orchestrate Sound Fisheries Policy in Practice. Marine Resource Economics 24(3).

Cury, P. M., C. Mullon, S. M. Garcia, and L. J. Shannon. 2005. Viability theory for an ecosystem approach to fisheries. ICES Journal of Marine Science: Journal du Conseil 62(3):577–584.

De Lara, M., and V. Martinet. 2009. Multi-criteria dynamic decision under uncertainty: A stochastic viability analysis and an application to sustainable fishery management. Mathematical Biosciences 217(2):118–124.

Dickinson, F., D. Viga, I. Lizarraga, and T. Castillo. 2006. Collaboration and conflict in an applied human ecology project in coastal Yucatan, Mexico. Landscape and Urban Planning 74(3–4):204–222.

Doyen, L., A. Cissé, S. Gourguet, L. Mouysset, P.-Y. Hardy, C. Béné, F. Blanchard, F. Jiguet, J.-C. Pereau, and O. Thébaud. 2013. Ecological-economic modelling for the sustainable management of biodiversity. Computational Management Science 10(4):353–364.

Doyen, L., and V. Martinet. 2012. Maximin, viability and sustainability. Journal of Economic Dynamics and Control 36(9):1414–1430.

Doyen, L., and J.-C. Péreau. 2012. Sustainable coalitions in the commons. Mathematical Social Sciences 63(1):57–64.

Doyen, L., O. Thébaud, C. Béné, V. Martinet, S. Gourguet, M. Bertignac, S. Fifas, and F. Blanchard. 2012. A stochastic viability approach to ecosystem-based fisheries management. Ecological Economics 75:32–42.

Dyck, A. J., and U. R. Sumaila. 2010. Economic impact of ocean fish populations in the global fishery. Journal of Bioeconomics 12(3):227–243.

Edgar, G. J., R. D. Stuart-Smith, T. J. Willis, S. Kininmonth, S. C. Baker, S. Banks, N. S. Barrett, M. A. Becerro, A. T. F. Bernard, J. Berkhout, C. D. Buxton, S. J. Campbell, A. T. Cooper, M. Davey, S. C. Edgar, G. Försterra, D. E. Galván, A. J. Irigoyen, D. J. Kushner, R. Moura, P. E. Parnell, N. T. Shears, G. Soler, E. M. A. Strain, and R. J. Thomson. 2014. Global conservation outcomes depend on marine protected areas with five key features. Nature advance online publication.

EFF. 2007, 2013. The European fisheries fund (EFF) (2007-2013) - Fisheries - European Commission. http://ec.europa.eu/fisheries/cfp/eff/index_en.htm.

Ehui, S. K., and D. S. C. Spencer. 1993. Measuring the sustainability and economic viability of tropical farming systems: a model from sub-Saharan Africa. Agricultural Economics 9(4):279–296.

Eide, A., M. Bavinck, and J. Raakjær. 2011. Avoiding Poverty: Distributing Wealth in Fisheries. Pages 13–25 *in* S. Jentoft and A. Eide, editors. Poverty Mosaics: Realities and Prospects in Small-Scale Fisheries. Springer Netherlands.

Eisenack, K. 2003. Qualitative Viablility Analysis of a Bio-Socio-Economic System.

Eisenack, K., J. Scheffran, and J. P. Kropp. 2006. Viability analysis of management frameworks for fisheries. Environmental Modeling & Assessment 11(1):69–79.

Ekeland, I., L. Karp, and R. Sumaila. 2015. Equilibrium resource management with altruistic overlapping generations. Journal of Environmental Economics and Management 70:1–16.

Erisman, B. E., G. A. Paredes, T. Plomozo-Lugo, J. J. Cota-Nieto, P. A. Hastings, and O. Aburto-Oropeza. 2011. Spatial structure of commercial marine fisheries in Northwest Mexico. ICES Journal of Marine Science: Journal du Conseil 68(3):564–571.

Espinoza-Tenorio, A., I. Espejel, and M. Wolff. 2011a. Capacity building to achieve sustainable fisheries management in Mexico. Ocean & Coastal Management 54(10):731–741.

Espinoza-Tenorio, A., I. Espejel, M. Wolff, and J. Alberto Zepeda-Domínguez. 2011b. Contextual factors influencing sustainable fisheries in Mexico. Marine Policy 35(3):343–350.

FAO. 2003. Information on fisheries management in the United Mexican States. http://www.fao.org/fi/oldsite/FCP/en/mex/body.htm.

FAO. 2007. National Fishery Sector Overview: The United Republic of Tanzania. Rome.

FAO. 2014a. State of World Fisheries and Aquaculture 2014. Food & Agriculture Org.

FAO. 2014b. The State of World Fisheries and Aquaculture (SOFIA). Food and Agriculture Organization of the United Nations, Rome.

FAO. 2015. Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. Food and Agriculture Organization of the United Nations, Rome.

FAO. 2016a. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Food and Agriculture Organization of the United Nations, Rome.

FAO. 2016b. FAO's response to the Nature Communications article "Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining." Food and Agriculture Organization of the United Nations.

FAO, WorldFIsh, and World Bank. 2008. Small-scale capture fisheries - a global overview with emphasis on developing countires. 1885.

Feenstra, R. C., R. Inklaar, and M. P. Timmer. 2015. The Next Generation of the Penn World Table. American Economic Review 105(10):3150–3182.

Fernández, J. I., P. Álvarez-Torres, F. Arreguín-Sánchez, L. G. López-Lemus, G. Ponce, A. Díaz-de-León, E. Arcos-Huitrón, and P. del Monte-Luna. 2011. Coastal fisheries of Mexico. Page 231 Coastal fisheries of Latin America and the Caribbean.
Finkbeiner, E. M. 2015. The role of diversification in dynamic small-scale fisheries: Lessons from Baja California Sur, Mexico. Global Environmental Change 32:139–152.
Finkbeiner, E. M., and X. Basurto. 2015. Re-defining co-management to facilitate small-scale fisheries reform: An illustration from northwest Mexico. Marine Policy 51:433–441.
Fulton, E. A., A. D. M. Smith, and A. E. Punt. 2005. Which ecological indicators can robustly detect effects of fishing? ICES Journal of Marine Science: Journal du Conseil 62(3):540–551.
Fulton, E. A., A. D. M. Smith, D. C. Smith, and P. Johnson. 2014. An Integrated Approach Is Needed for Ecosystem Based Fisheries Management: Insights from Ecosystem-Level Management Strategy Evaluation. PLoS ONE 9(1):e84242.
Fulton, E. A., A. D. M. Smith, D. C. Smith, and I. E. van Putten. 2011. Human behaviour: the key source of uncertainty in fisheries management. Fish and Fisheries 12(1):2–17.
Garcia-Caudillo, J. M., M. A. Cisneros-Mata, and A. Balmori-Ramirez. 2000. Performance of a bycatch reduction device in the shrimp fishery of the Gulf of California, México. Biological Conservation 92(2):199–205.
Gasalla, M. A., A. R. Rodrigues, L. F. A. Duarte, and U. Rashid Sumaila. 2010. A comparative multi-fleet analysis of socio-economic indicators for fishery management in SE Brazil. Progress in Oceanography 87(1–4):304–319.
Gillet, R. 2008. Global study of shrimp fisheries. Part 2: Shrimp fishing in Mexico. Page 331p. FAO, 475, Rome.
Godfray, H. C. J., J. R. Beddington, I. R. Crute, L. Haddad, D. Lawrence, J. F. Muir, J. Pretty, S. Robinson, S. M. Thomas, and C. Toulmin. 2010. Food security: the challenge of feeding 9 billion people. Science (New York, N.Y.) 327(5967):812–818.
Gourguet, S., C. Macher, L. Doyen, O. Thébaud, M. Bertignac, and O. Guyader. 2013. Managing mixed fisheries for bio-economic viability. Fisheries Research 140:46–62.
Gourguet, S., O. Thébaud, S. Jennings, L. R. Little, C. M. Dichmont, S. Pascoe, R. A. Deng, and L. Doyen. 2016. The Cost of Co-viability in the Australian Northern Prawn Fishery. Environmental Modeling & Assessment 21(3):371–389.
Greer, K. 2014. Considering the “effort factor” in fisheries : a methodology for reconstructing global fishing effort and CO2 emissions, 1950 - 2010. Master of Science, University of British Columbia, Canada.
Grynberg, R. 2003. WTO fisheries subsidies negotiations: implications for fisheries access arrangements and sustainable management. Marine Policy 27(6):499–511.
Gulbrandsen, O. 2012. Fuel savings for small fishing vessels. FAO, 57, Rome.
Gutiérrez, N. L., R. Hilborn, and O. Defeo. 2011. Leadership, social capital and incentives promote successful fisheries. Nature 470(7334):386–389.
Guyader, O., P. Berthou, C. Koutsikopoulos, F. Alban, S. Demanèche, M. B. Gaspar, R. Eschbaum, E. Fahy, O. Tully, L. Reynal, O. Curtil, K. Frangoudes, and F. Maynou. 2013. Small scale fisheries in Europe: A comparative analysis based on a selection of case studies. Fisheries Research 140:1–13.
Hannesson, R., S. Herrick, and J. Field. 2009. Ecological and economic considerations in the conservation and management of the Pacific sardine (Sardinops sagax). Canadian Journal of Fisheries and Aquatic Sciences 66(5):859–868.

Hardy, P.-Y., C. Béné, L. Doyen, and A.-M. Schwarz. 2013. Food security versus environment conservation: A case study of Solomon Islands' small-scale fisheries. Environmental Development 8:38–56.

Harper, S., D. Bevacqua, R. Chudnow, S. Giorgi, V. Guillonneau, F. Le Manach, T. Sutor, and U. R. Sumaila. 2012. Fuelling the fisheries subsidy debate: Agreements, loopholes and implications. Fisheries Research 113(1):143–146.

Harper, S., D. Zeller, M. Hauzer, D. Pauly, and U. R. Sumaila. 2013. Women and fisheries: Contribution to food security and local economies. Marine Policy 39:56–63.

Hicks, C. C., A. Levine, A. Agrawal, X. Basurto, S. J. Breslow, C. Carothers, S. Charnley, S. Coulthard, N. Dolsak, J. Donatuto, C. Garcia-Quijano, M. B. Mascia, K. Norman, M. R. Poe, T. Satterfield, K. S. Martin, and P. S. Levin. 2016. Engage key social concepts for sustainability. Science 352(6281):38–40.

Hospital, J., and C. Beavers. 2012. Economic and Social Characteristics of Bottomfish Fishing in the Main Hawaiian Islands. Page 44 p. + Appendix. NOAA, Administrative Report H-12-01 H-12-01, Honolulu, Hawaii.

Isaacs, M. 2011. Creating Action Space: Small-Scale Fisheries Policy Reform in South Africa. Pages 359–382 *in* S. Jentoft and A. Eide, editors. Poverty Mosaics: Realities and Prospects in Small-Scale Fisheries. Springer Netherlands.

Ishimura, G., S. Herrick, and U. R. Sumaila. 2013. Stability of cooperative management of the Pacific sardine fishery under climate variability. Marine Policy 39:333–340.

Jackson, J. B., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, and J. A. Estes. 2001. Historical overfishing and the recent collapse of coastal ecosystems. science 293(5530):629–637.

Jacquet, J., and D. Pauly. 2008. Funding Priorities: Big Barriers to Small-Scale Fisheries. Conservation Biology 22(4):832–835.

Jentoft, S., A. Eide, M. Bavinck, R. Chuenpagdee, and J. Raakjær. 2011. A Better Future: Prospects for Small-Scale Fishing People. Pages 451–469 *in* S. Jentoft and A. Eide, editors. Poverty Mosaics: Realities and Prospects in Small-Scale Fisheries. Springer Netherlands.

Kaczynski, V. M., and D. L. Fluharty. 2002. European policies in West Africa: who benefits from fisheries agreements? Marine Policy 26(2):75–93.

Kelleher, K. 2005. Discards in the World's Marine Fisheries - An Update. Page 131p. FAO FISHERIES TECHNICAL PAPER 470, Rome.

Khan, A., R. U. Sumaila, R. Watson, G. Munro, and D. Pauly. 2006. The nature and magnitude of global non-fuel fisheries subsidies. Pages 5–37. The University of British Columbia, Fisheries Centre Research Reports 14(6), Vancouver.

Krawczyk, J. B., A. Pharo, O. S. Serea, and S. Sinclair. 2013. Computation of viability kernels: a case study of by-catch fisheries. Computational Management Science 10(4):365–396.

Kronen, M. 2004. Fishing for fortunes?: A socio-economic assessment of Tonga's artisanal fisheries. Fisheries Research 70(1):121–134.

Kronen, M., A. Vunisea, F. Magron, and B. McArdle. 2010. Socio-economic drivers and indicators for artisanal coastal fisheries in Pacific island countries and territories and their use for fisheries management strategies. Marine Policy 34(6):1135–1143.

Lam, V., W. Cheung, W. Swartz, and U. Sumaila. 2012. Climate Change Impacts on Fisheries in West Africa: Implications for Economic, Food and Nutritional Security. African Journal of Marine Science 34(1):103–117.

Lam, V. W. Y., U. R. Sumaila, A. Dyck, D. Pauly, and R. Watson. 2011. Construction and first applications of a global cost of fishing database. ICES Journal of Marine Science: Journal du Conseil 68(9):1996–2004.
Lane, D. E., and R. L. Stephenson. 1998. A framework for risk analysis in fisheries decision-making. ICES Journal of Marine Science: Journal du Conseil 55(1):1–13.
Lara, J., and A. Guevara-Sangines. 2012. Apoyos al sector pesqueroo en Mexico 2005-2011. Page 13. WWF, Mexico.
Lasch, R. 2005. Technical, operational and economic characteristics of selected fishing vessels by country. Economic performance and fishing efficiency of marine capture fisheries:53–76.
Le Manach, F., M. Andriamahefazafy, S. Harper, A. Harris, G. Hosch, G.-M. Lange, D. Zeller, and U. R. Sumaila. 2013. Who gets what? Developing a more equitable framework for EU fishing agreements. Marine Policy 38:257–266.
Lery, J.-M., J. Prado, and U. Tietze. 1999. Economic viability of marine capture fisheries: Findings of a global study and an interregional workshop. FAO.
Lluch-Cota, S. E., E. A. Aragón-Noriega, F. Arreguín-Sánchez, D. Aurioles-Gamboa, J. Jesús Bautista-Romero, R. C. Brusca, R. Cervantes-Duarte, R. Cortés-Altamirano, P. Del-Monte-Luna, A. Esquivel-Herrera, G. Fernández, M. E. Hendrickx, S. Hernández-Vázquez, H. Herrera-Cervantes, M. Kahru, M. Lavín, D. Lluch-Belda, D. B. Lluch-Cota, J. López-Martínez, S. G. Marinone, M. O. Nevárez-Martínez, S. Ortega-García, E. Palacios-Castro, A. Parés-Sierra, G. Ponce-Díaz, M. Ramírez-Rodríguez, C. A. Salinas-Zavala, R. A. Schwartzlose, and A. P. Sierra-Beltrán. 2007. The Gulf of California: Review of ecosystem status and sustainability challenges. Progress in Oceanography 73(1):1–26.
Majluf, P., S. De la Puente, and V. Christensen. 2017. The little fish that can feed the world. Fish and Fisheries.
Martinet, V., O. Thébaud, and L. Doyen. 2007. Defining viable recovery paths toward sustainable fisheries. Ecological Economics 64(2):411–422.
Maynou, F. 2014. Coviability analysis of Western Mediterranean fisheries under MSY scenarios for 2020. ICES Journal of Marine Science: Journal du Conseil 71(7):1563–1571.
McCay, B. J., F. Micheli, G. Ponce-Díaz, G. Murray, G. Shester, S. Ramirez-Sanchez, and W. Weisman. 2014. Cooperatives, concessions, and co-management on the Pacific coast of Mexico. Marine Policy 44:49–59.
McClanahan, T., E. Allison, and J. Cinner. 2013. Managing fisheries for human and food security. Fish Fish:n/a-n/a.
McClanahan, T. R., M. J. Marnane, J. E. Cinner, and W. E. Kiene. 2006. A Comparison of Marine Protected Areas and Alternative Approaches to Coral-Reef Management. Current Biology 16(14):1408–1413.
McConney, P., and A. Charles. 2008. Managing Small-Scale Fisheries: Moving Towards People-Centred Perspectives. Centre for Resource Management and Environmental Studies University of the West Indies, Barbados.
Milazzo, M. 1998. Subsidies in world fisheries a reexamination. World Bank, Washington, D.C.
Moltke, A. von. 2012. Fisheries Subsidies, Sustainable Development and the WTO. Routledge.
Mora, C., R. A. Myers, M. Coll, S. Libralato, T. J. Pitcher, R. U. Sumaila, D. Zeller, R. Watson, K. J. Gaston, and B. Worm. 2009. Management Effectiveness of the World’s Marine Fisheries. PLoS Biol 7(6):e1000131.

Morzaria-Luna, H. N., P. Turk-Boyer, and M. Moreno-Baez. 2014. Social indicators of vulnerability for fishing communities in the Northern Gulf of California, Mexico: Implications for climate change. Marine Policy 45:182–193.
Munro, G., and U. R. Sumaila. 2002. The impact of subsidies upon fisheries management and sustainability: the case of the North Atlantic. Fish and Fisheries 3(4):233–250.
Natale, F., N. Carvalho, and A. Paulrud. 2015. Defining small-scale fisheries in the EU on the basis of their operational range of activity The Swedish fleet as a case study. Fisheries Research 164:286–292.
Naylor, R. L., R. J. Goldburg, J. H. Primavera, N. Kautsky, M. C. M. Beveridge, J. Clay, C. Folke, J. Lubchenco, H. Mooney, and M. Troell. 2000. Effect of aquaculture on world fish supplies. Nature 405(6790):1017–1024.
NOAA. 1999. Federal fisheries investment taskforce: Report to US Congress. Part1: Background and conceptual basis. NOAA, Baltimore.
OECD. 2006a. Financial Support to Fisheries: Implications for sustainable development. Organization for Economic Co-operation and Development.
OECD. 2006b. Agriculture and Fisheries Policies in Mexico - Recent Achievements, Continuing the Reform Agenda:332.
OECD. 2006c. Agricultural and Fisheries Policies in Mexico. Organisation for Economic Co-operation and Development, Paris.
OECD. 2016. Open Government Data Review of Mexico. Organisation for Economic Co-operation and Development, Paris.
Olaiz-Fernandez, G., J. Rivera-Dommarco, T. Shamah-Levy, R. Rojas, S. Villalpando-Hernandez, and J. Sepulveda-Amor. 2006. Encuesta Nacional de Salud y Nutricion. Cuernavaca, Mexico: Instituto Nacional de Salud Publica.
Ommer, R. E., R. Ian Perry, G. Murray, and B. Neis. 2012. Social–ecological dynamism, knowledge, and sustainable coastal marine fisheries. Current Opinion in Environmental Sustainability 4(3):316–322.
Páez-Osuna, F., J. A. Sanchez-Cabeza, A. C. Ruiz-Fernández, R. Alonso-Rodríguez, A. Piñón-Gimate, J. G. Cardoso-Mohedano, F. J. Flores-Verdugo, J. L. Carballo, M. A. Cisneros-Mata, and S. Álvarez-Borrego. 2016. Environmental status of the Gulf of California: A review of responses to climate change and climate variability. Earth-Science Reviews 162:253–268.
Pascoe, S., K. Brooks, T. Cannard, C. M. Dichmont, E. Jebreen, J. Schirmer, and L. Triantafillos. 2014. Social objectives of fisheries management: What are managers' priorities? Ocean & Coastal Management 98:1–10.
Pauly, D. 1997. Small-scale fisheries in the tropics: marginality, marginalization, and some implications for fisheries management. In E.K. Pikitch, D.D. Hupert and M.P. Sissenwine (eds.):40–49.
Pauly, D. 1998. Tropical fishes: patterns and propensities*. Journal of Fish Biology 53:1–17.
Pauly, D., J. Alder, E. Bennett, V. Christensen, P. Tyedmers, and R. Watson. 2003. The Future for Fisheries. Science 302(5649):1359–1361.
Pauly, D., V. Christensen, S. Guénette, T. J. Pitcher, U. R. Sumaila, C. J. Walters, R. Watson, and D. Zeller. 2002. Towards sustainability in world fisheries. Nature 418(6898):689–695.

Pauly, D., R. Watson, and J. Alder. 2005. Global trends in world fisheries: impacts on marine ecosystems and food security. Philosophical Transactions of the Royal Society B: Biological Sciences 360(1453):5–12.

Pauly, D., and D. Zeller. 2015. Sea Around Us Concepts, Design and Data.

Pauly, D., and D. Zeller. 2016. Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. Nature Communications 7:10244.

Péreau, J.-C., L. Doyen, L. R. Little, and O. Thébaud. 2012. The triple bottom line: Meeting ecological, economic and social goals with individual transferable quotas. Journal of Environmental Economics and Management 63(3):419–434.

Pérez-Brunius, P., M. López, and J. Pineda. 2006. Hydrographic conditions near the coast of northwestern Baja California: 1997–2004. Continental Shelf Research 26(8):885–901.

Pollnac, R. B., R. S. Pomeroy, and I. H. T. Harkes. 2001. Fishery policy and job satisfaction in three southeast Asian fisheries. Ocean & Coastal Management 44(7–8):531–544.

Pollnac, R., and J. J. Poggie. 2008. Happiness, well-being, and psychocultural adaptation to the stresses associated with marine fishing. Human Ecology Review 15(2):194.

Pomeroy, R., and N. L. Andrew. 2011. Small-scale Fisheries Management Frameworks and Approaches for the Developing World. CABI.

Pontecorvo, G., M. Wilkinson, R. Anderson, and M. Holdowsky. 1980. Contribution of the ocean sector to the United States economy. Science (New York, N.Y.) 208(4447):1000–1006.

Punt, A. E., A. D. MacCall, T. E. Essington, T. B. Francis, F. Hurtado-Ferro, K. F. Johnson, I. C. Kaplan, L. E. Koehn, P. S. Levin, and W. J. Sydeman. 2016. Exploring the implications of the harvest control rule for Pacific sardine, accounting for predator dynamics: A MICE model. Ecological Modelling 337:79–95.

Ramírez-Rodríguez, M., and L. C. Almendárez-Hernández. 2013. Subsidies in the jumbo squid fishery in the Gulf of California,Mexico. Marine Policy 40:117–123.

Rice, J. C., and S. M. Garcia. 2011. Fisheries, food security, climate change, and biodiversity: characteristics of the sector and perspectives on emerging issues. ICES Journal of Marine Science: Journal du Conseil 68(6):1343–1353.

Saavedra-Díaz, L. M., R. Pomeroy, and A. A. Rosenberg. 2016. Managing small-scale fisheries in Colombia. Maritime Studies 15(1):1–21.

Sagarin, R. D., W. F. Gilly, C. H. Baxter, N. Burnett, and J. Christensen. 2008. Remembering the Gulf: Changes to the Marine Communities of the Sea of Cortez since the Steinbeck and Ricketts Expedition of 1940. Frontiers in Ecology and the Environment 6(7):372–379.

Sala, E., O. Aburto-Oropeza, M. Reza, G. Paredes, and L. G. López-Lemus. 2004. Fishing Down Coastal Food Webs in the Gulf of California. Fisheries 29(3):19–25.

Salas, S., M. Bjørkan, F. Bobadilla, and M. A. Cabrera. 2011. Addressing Vulnerability: Coping Strategies of Fishing Communities in Yucatan, Mexico. Pages 195–220 *in* S. Jentoft and A. Eide, editors. Poverty Mosaics: Realities and Prospects in Small-Scale Fisheries. Springer Netherlands.

Salas, S., R. Chuenpagdee, J. C. Seijo, and A. Charles. 2007. Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. Fisheries Research 87(1):5–16.

Salas, S., U. R. Sumaila, and T. Pitcher. 2004. Short-term decisions of small-scale fishers selecting alternative target species: a choice model. Canadian Journal of Fisheries and Aquatic Sciences 61(3):374–383.

Schorr, D. K. 2005. Artisanal Fishing: Promoting Poverty Reduction and Community Development Through New WTO Rules on Fisheries Subsidies. UNEP.
Schorr, D. K. 2007. Sustainability Criteria for Fisheries Subsidies: Options for the WTO and Beyond. UNEP/Earthprint.
Schuhbauer, A., and U. R. Sumaila. 2016. Economic viability and small-scale fisheries — A review. Ecological Economics 124:69–75.
Sharp, R., and U. R. Sumaila. 2009. Quantification of U.S. Marine Fisheries Subsidies. North American Journal of Fisheries Management 29(1):18–32.
Shepherd, T. D., and R. A. Myers. 2005. Direct and indirect fishery effects on small coastal elasmobranchs in the northern Gulf of Mexico. Ecology Letters 8(10):1095–1104.
Smith, W., J. Bizzarro, and G. Cailliet. 2009. The artisanal elasmobranch fishery on the east coast of Baja California, Mexico: Characteristics and management considerations. Ciencias Marinas 35(2):209–236.
Srinivasan, U. T., W. W. L. Cheung, R. Watson, and U. R. Sumaila. 2010. Food security implications of global marine catch losses due to overfishing. Journal of Bioeconomics 12(3):183–200.
Sumaila, R. U., and D. Pauly. 2006. Catching more bait: A bottom-up re-estimation of global fisheries subsidies. Fisheries Centre Research Reports 14(6).
Sumaila, U. R. 1999. A review of game-theoretic models of fishing. Marine Policy 23(1):1–10.
Sumaila, U. R. 2012. Seas, Oceans and Fisheries: A Challenge for Good Governance. The Round Table 101(2):157–166.
Sumaila, U. R., W. Cheung, A. Dyck, K. Gueye, L. Huang, V. Lam, D. Pauly, T. Srinivasan, W. Swartz, R. Watson, and D. Zeller. 2012. Benefits of Rebuilding Global Marine Fisheries Outweigh Costs. PLoS ONE 7(7):e40542.
Sumaila, U. R., W. Cheung, and V. Lam. 2014. Climate change effects on the economics and management of marine fisheries. Page Handbook on the Economics of Ecosystem Services and Biodiversity. Edward Elgar.
Sumaila, U. R., W. W. L. Cheung, V. W. Y. Lam, D. Pauly, and S. Herrick. 2011. Climate change impacts on the biophysics and economics of world fisheries. Nature Climate Change 1(9):449–456.
Sumaila, U. R., A. S. Khan, A. J. Dyck, R. Watson, G. Munro, P. Tydemers, and D. Pauly. 2010a. A bottom-up re-estimation of global fisheries subsidies. Journal of Bioeconomics 12(3):201–225.
Sumaila, U. R., A. Khan, L. Teh, R. Watson, P. Tyedmers, and D. Pauly. 2010b. Subsidies to high seas bottom trawl fleets and the sustainability of deep-sea demersal fish stocks. Marine Policy 34(3):495–497.
Sumaila, U. R., V. Lam, F. Le Manach, W. Swartz, and D. Pauly. 2016. Global fisheries subsidies: An updated estimate. Marine Policy.
Sumaila, U. R., V. W. Y. Lam, D. D. Miller, L. Teh, R. A. Watson, D. Zeller, W. W. L. Cheung, I. M. Côté, A. D. Rogers, C. Roberts, E. Sala, and D. Pauly. 2015. Winners and losers in a world where the high seas is closed to fishing. Scientific Reports 5:8481.
Sumaila, U. R., Y. Liu, and P. Tyedmers. 2001. Small Versus Large-Scale Fishing Operations In The North Atlantic. Pages 28–35. Fisheries Centre, Research Report Volume 9 Number 5.
Sumaila, U. R., A. D. Marsden, R. Watson, and D. Pauly. 2007. A Global Ex-vessel Fish Price Database: Construction and Applications. Journal of Bioeconomics 9(1):39–51.

Sumaila, U. R., and D. Pauly. 2007. All fishing nations must unite to cut subsidies. Nature 450(7172):945–945.
Sumaila, U. R., L. Teh, R. Watson, P. Tyedmers, and D. Pauly. 2008. Fuel price increase, subsidies, overcapacity, and resource sustainability. ICES Journal of Marine Science: Journal du Conseil 65(6):832–840.
Sumaila, U. R., and C. Walters. 2005. Intergenerational discounting: a new intuitive approach. Ecological Economics 52(2):135–142.
Sutinen, J. G., and H. F. Upton. 2000. Economic Perspectives on New England Fisheries Management. Northeastern Naturalist 7(4):361–372.
Swartz, W., R. Sumaila, and R. Watson. 2013. Global ex-vessel fish price database revisited: a new approach for estimating “missing”prices. Environmental and Resource Economics 56(4):467–480.
Sylvia, G., C. Cusack, and J. Swanson. 2014. Fishery cooperatives and the Pacific Whiting Conservation Cooperative: Lessons and application to non-industrial fisheries in the Western Pacific. Marine Policy 44:65–71.
Symes, D., and E. Hoefnagel. 2010. Fisheries policy, research and the social sciences in Europe: Challenges for the 21st century. Marine Policy 34(2):268–275.
Tacon, A. G. J., and M. Metian. 2009. Fishing for Feed or Fishing for Food: Increasing Global Competition for Small Pelagic Forage Fish. Ambio 38(6):294–302.
Teh, L. C. L., and U. R. Sumaila. 2013. Contribution of marine fisheries to worldwide employment. Fish and Fisheries 14(1):77–88.
Teh, L. S. L., L. C. L. Teh, and U. R. Sumaila. 2011. Quantifying the overlooked socio-economic contribution of small-scale fisheries in Sabah, Malaysia. Fisheries Research 110(3):450–458.
The Sunken Billions : The Economic Justification for Fisheries Reform. 2009. . The World Bank, World Bank Publications.
The World Bank. 2013. Fish to 2030 : prospects for fisheries and aquaculture. Pages 1–102. The World Bank, 83177.
Tietze, U., J. Prado, J. M. Le Ry, and R. Lasch. 2001. Techno-economic performance of marine capture fisheries. Page 80. FAO, 421, Rome.
Tietze, U., W. Thiele, R. Lasch, B. Thomsen, and D. Rihan. 2005. Economic performance and fishing efficiency of marine capture fisheries. FAO.
Tisdell, C. 1996. Economic indicators to assess the sustainability of conservation farming projects: An evaluation. Agriculture, Ecosystems & Environment 57(2–3):117–131.
Trimble, M., and D. Johnson. 2013. Artisanal fishing as an undesirable way of life? The implications for governance of fishers’ wellbeing aspirations in coastal Uruguay and southeastern Brazil. Marine Policy 37:37–44.
Ulman, A., V. Shlyakhov, S. Jatsenko, and D. Pauly. 2015. A reconstruction of the Ukraine’s marine fisheries catches, 1950-2010. Journal of Black Sea / Mediterranean Environment 21(2).
Ünal, V., and R. Franquesa. 2010. A comparative study on socio-economic indicators and viability in small-scale fisheries of six districts along the Turkish coast. Journal of Applied Ichthyology 26(1):26–34.
UNCTAD-FAO-UNEP. 2016. Regulating Fisheries Subsidies must be an integral part of the implementation of the 2030 sustainable development agenda. Nairobi, Kenya.
United Nations. 2016. Progress towards the Sustainable Development Goals.

Usseglio, P., A. Schuhbauer, and A. Friedlander. 2014. Collaborative Approach to Fisheries Management as a Way to Increase the Effectiveness of Future Regulations in the Galapagos Archipelago. Pages 187–202 *in* J. Denkinger and L. Vinueza, editors. The Galapagos Marine Reserve. Springer International Publishing.

Velarde, E., E. Ezcurra, M. A. Cisneros-Mata, and M. F. LavÍn. 2004. SEABIRD ECOLOGY, EL NIñO ANOMALIES, AND PREDICTION OF SARDINE FISHERIES IN THE GULF OF CALIFORNIA. Ecological Applications 14(2):607–615.

Wilson, H. 1999. Fuel and financial savings for operators of small fishing vessels. Page 42. FAO, Fisheries Technical Paper 383, Rome.

Winther, M. 2007. No. 650: Fuel consumption and emissions from navigation in Denmark from 1990-2005 - and projections from 2006-2030. National Environmental Research Institute, 109.

Worm, B., R. Hilborn, J. K. Baum, T. A. Branch, J. S. Collie, C. Costello, M. J. Fogarty, E. A. Fulton, J. A. Hutchings, S. Jennings, O. P. Jensen, H. K. Lotze, P. M. Mace, T. R. McClanahan, C. Minto, S. R. Palumbi, A. M. Parma, D. Ricard, A. A. Rosenberg, R. Watson, and D. Zeller. 2009. Rebuilding Global Fisheries. Science 325(5940):578–585.

WTO. 2001. Ministerial Declaration. Doha, Qatar WT/MIN(01)/DEC/1.

WTO. 2005. Doha Work Programme Ministerial Declaration. Hong Kong, People's Republic of China. WT/MIN(05)/DEC. Hong Kong.

Yazdani, S. S., and R. Gonzalez. 2007. Anaerobic fermentation of glycerol: a path to economic viability for the biofuels industry. Current Opinion in Biotechnology 18(3):213–219.

Young, E. 2001. State Intervention and Abuse of the Commons: Fisheries Development in Baja California Sur, Mexico. Annals of the Association of American Geographers 91(2):283–306.

Yu, V. P. B., and D. Fonseca-Marti. 2005. Reflecting Sustainable Development and Special and Differential Treatment for Developing Countries in the Context of new WTO Fisheries Subsidies Rules. The United Nations Environment Programme (UNEP), Geneva.

Zeller, D., S. Booth, and D. Pauly. 2006. Fisheries Contributions to the Gross Domestic Product: Understanding Small-scale Fisheries in the Pacific. Marine Resource Economics 21(4).

Appendices

Appendix A Global fisheries subsidies from 2009 in constant USD (x1000) by region, country and subtype showing results and sources of percentages provided to the small-scale sector (SSF).

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%) *	Source **
Africa	Algeria	Fisheries mangt.	73	19	this study
		Fishery R&D	1,925	9	this study
		MPAs	754	38	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	598		this study
		Fishing port develop.	863	0	this study
		Markt. & storage infrast.	1,479	2	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	391	100	this study
	Angola	Fisheries mangt.	18,410	**45**	FAO
		Fishery R&D	826	**46**	UNDP
		MPAs	1,037	**45**	(a)
		Boat constsruct. & renov.	44,924	**46**	FAO
		Fisheries dev. projects	38,848	**53**	UNDP/FAO
		Fishing port develop.	5,717	**0**	FAO
		Markt. & storage infrast.	9,795	**46**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	30,735	**52**	FAO
		Fisher assistance	826	**46**	FAO
		Vessel buyback	0		
		Rural fisher communities	2,472	**100**	FAO
	Benin	Fisheries mangt.	928	78	this study
		Fishery R&D	387	100	this study
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	6,146	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	79	100	this study
	Cameroon	Fisheries mangt.	3,153	**75**	FAO
		Fishery R&D	2,243	**75**	FAO
		MPAs	372	**75**	(a)
		Boat constsruct. & renov.	6,118	**0**	FAO
		Fisheries dev. projects	3	**67**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Cape Verde	Fisheries mangt.	118	29	this study
		Fishery R&D	1,007	43	this study
		MPAs	42	12	this study
		Boat constsruct. & renov.	2,916	45	this study
		Fisheries dev. projects	3,945	49	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	151	68	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	1,373	**36**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

* Numbers in bold indicate percentage assessed using available data.

** See list and legend of sources on the last page of Appendix, This study refers to all data estimated as explained in Chapter 3 Section 3.2.4

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Africa	Comoros	Fisheries mangt.	29	34	this study
		Fishery R&D	202	53	this study
		MPAs	89	53	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	110	74	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	114	100	this study
	Congo Dem Rep	Fisheries mangt.	418	50	this study
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	6	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Congo Rep	Fisheries mangt.	822	35	this study
		Fishery R&D	585	40	this study
		MPAs	189	31	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	4	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Cote d'Ivoire	Fisheries mangt.	2,332	24	this study
		Fishery R&D	1,659	36	this study
		MPAs	112	10	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	764	100	this study
		Fishing port develop.	744	100	this study
		Markt. & storage infrast.	0		
		Tax exemption	1,437	40	this study
		Fishing access	0		
		Fuel subsidies	3,003	100	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Djibouti	Fisheries mangt.	11	18	this study
		Fishery R&D	0		
		MPAs	13	31	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	477	78	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	6	100	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	2	100	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Africa	Egypt	Fisheries mangt.	5,320	**27**	FAO
		Fishery R&D	3,784	**11**	FAO
		MPAs	2,699	**27**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	30	**20**	OECD
		Fishing port develop.	1,697	**0**	FAO
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Eq Guinea	Fisheries mangt.	75	13	this study
		Fishery R&D	0		
		MPAs	169	12	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	12	75	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	11	100	this study
	Eritrea	Fisheries mangt.	396	29	this study
		Fishery R&D	1,160	44	this study
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	95	76	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	202	100	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	53	100	this study
	Gabon	Fisheries mangt.	2,293	**28**	FAO
		Fishery R&D	1,582	**28**	FAO
		MPAs	1,017	**28**	FAO
		Boat constsruct. & renov.	106	**63**	FAO
		Fisheries dev. projects	1,482	**100**	FAO
		Fishing port develop.	0		
		Markt. & storage infrast.	1,215	**64**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	4,130	59	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	133	**100**	FAO
	Gambia	Fisheries mangt.	120	28	this study
		Fishery R&D	676	42	this study
		MPAs	58	12	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	836	100	this study
		Fishing port develop.	303	100	this study
		Markt. & storage infrast.	519	100	this study
		Tax exemption	586	54	this study
		Fishing access	0		
		Fuel subsidies	516	100	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	137	100	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Africa	Ghana	Fisheries mangt.	10,134	**45**	FAO
		Fishery R&D	5,513	**52**	FAO
		MPAs	0		
		Boat constsruct. & renov.	1,669	**52**	FAO
		Fisheries dev. projects	2,333	**75**	FAO/OECD
		Fishing port develop.	29,600	**52**	FAO / (b)
		Markt. & storage infrast.	28	**50**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	21,063	**100**	KG
		Fisher assistance	472	**100**	(c)
		Vessel buyback	0		
		Rural fisher communities	1,121	**100**	FAO
	Guinea	Fisheries mangt.	136	**0**	FAO / (d)
		Fishery R&D	8,171	**22**	FAO / (d)
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	7,396	**21**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	6,342	**100**	(d)
		Tax exemption	7,080	**0**	(d)
		Fishing access	6,682	**0**	(d)
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	368	**100**	FAO / (d)
	GuineaBissau	Fisheries mangt.	119	11	this study
		Fishery R&D	192	17	this study
		MPAs	270	5	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,157	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	39	100	this study
	Kenya	Fisheries mangt.	326	36	this study
		Fishery R&D	232	54	this study
		MPAs	89	53	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,506	77	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	201	25	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Liberia	Fisheries mangt.	380	23	this study
		Fishery R&D	0		
		MPAs	129	10	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	84	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	234	56	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	55	100	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Africa	Libya	Fisheries mangt.	1,892	44	this study
		Fishery R&D	1,346	20	this study
		MPAs	1,462	87	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Madagascar	Fisheries mangt.	7,544	**25**	FAO
		Fishery R&D	0		
		MPAs	249	**73**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,440	**30**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,091	**100**	(e)
	Mauritania	Fisheries mangt.	120	**0**	FAO
		Fishery R&D	5,038	**0**	FAO
		MPAs	401	**4**	(a)
		Boat constsruct. & renov.	4,003	**50**	FAO
		Fisheries dev. projects	9,353	**100**	OECD
		Fishing port develop.	2,258	**50**	FAO
		Markt. & storage infrast.	3,869	**50**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,024	**100**	FAO
	Mauritius	Fisheries mangt.	246	13	this study
		Fishery R&D	0		
		MPAs	140	19	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	690	37	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Morocco	Fisheries mangt.	23,968	**2**	FAO
		Fishery R&D	17,050	**2**	FAO
		MPAs	3,844	**5**	(a)
		Boat constsruct. & renov.	140,000	**9**	FAO / (f)
		Fisheries dev. projects	11,350	**100**	FAO
		Fishing port develop.	0		
		Markt. & storage infrast.	13,095	**0**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	3,466	**100**	FAO

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Africa	Mozambique	Fisheries mangt.	1,294	**50**	FAO
		Fishery R&D	0		
		MPAs	309	**73**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	8,402	**79**	FAO/OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	418	**100**	FAO
	Namibia	Fisheries mangt.	21,648	**0**	FAO
		Fishery R&D	15,400	**0**	FAO
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,847	**0**	FAO
		Fishing port develop.	0		
		Markt. & storage infrast.	11,828	**0**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	37,688	**0**	FAO
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Nigeria	Fisheries mangt.	26,920	**25**	FAO
		Fishery R&D	17,604	**68**	FAO
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1,024	**50**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,959	**100**	FAO
	Sao Tome Prn	Fisheries mangt.	195	59	this study
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	664	94	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	28	100	this study
	Senegal	Fisheries mangt.	115	**43**	(g)
		Fishery R&D	2,952	**50**	FAO
		MPAs	114	**44**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,831	**50**	(h)
		Fishing port develop.	0		
		Markt. & storage infrast.	580	**0**	FAO / (g)
		Tax exemption	1,137	28	this study
		Fishing access	0		
		Fuel subsidies	11,453	**85**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	139	**100**	(g) / (h)

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Africa	Seychelles	Fisheries mangt.	994	**11**	FAO
		Fishery R&D	707	**11**	FAO
		MPAs	1,022	**11**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1,293	**0**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	11,041	4	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	144	**100**	FAO
	Sierra Leone	Fisheries mangt.	138	**76**	FAO
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	9,284	**33**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	5,276	**50**	FAO
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,069	**100**	FAO
	Somalia	Fisheries mangt.	3,125	**38**	FAO
		Fishery R&D	0		
		MPAs	881	**38**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	975	**0**	FAO
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	452	**100**	FAO
	South Africa	Fisheries mangt.	16,214	**8**	FAO
		Fishery R&D	11,534	**8**	FAO
		MPAs	5,053	**8**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	726	**8**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	29,744	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Sudan	Fisheries mangt.	302	27	this study
		Fishery R&D	215	13	this study
		MPAs	41	54	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	6	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	165	2	this study
		Tax exemption	186	53	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	44	100	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Africa	Tanzania	Fisheries mangt.	742	**60**	FAO
		Fishery R&D	528	**96**	FAO
		MPAs	591	**96**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,048	**96**	OECD / (i)
		Fishing port develop.	0		
		Markt. & storage infrast.	405	**94**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Togo	Fisheries mangt.	379	28	this study
		Fishery R&D	0		
		MPAs	63	13	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	234	47	this study
		Fishing access	0		
		Fuel subsidies	1,142	100	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	55	100	this study
	Tunisia	Fisheries mangt.	1,777	**26**	FAO/OECD
		Fishery R&D	0		
		MPAs	256	**26**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1,945	**26**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	971	**13**	FAO
		Tax exemption	1,095	**26**	na
		Fishing access	0		
		Fuel subsidies	6,994	**43**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
Asia	Bahrain	Fisheries mangt.	4,742	100	this study
		Fishery R&D	1,259	100	this study
		MPAs	490	65	this study
		Boat constsruct. & renov.	3,658	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	1,985	46	this study
		Markt. & storage infrast.	0		
		Tax exemption	383	100	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	1,477	62	this study
		Vessel buyback	0		
		Rural fisher communities	0		
	Bangladesh	Fisheries mangt.	32,024	86	this study
		Fishery R&D	22,182	86	this study
		MPAs	573	82	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	22,495	41	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	16,421	**79**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	4,509	100	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Asia	Brunei Darsm	Fisheries mangt.	64	75	this study
		Fishery R&D	46	72	this study
		MPAs	93	69	this study
		Boat constsruct. & renov.	125	39	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	35	20	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Cambodia	Fisheries mangt.	120	3	this study
		Fishery R&D	3,155	2	this study
		MPAs	103	2	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	33	18	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	641	51	this study
	China	Fisheries mangt.	1,369,776	**36**	APEC
		Fishery R&D	112	**23**	APEC
		MPAs	4,928	**36**	(a)
		Boat constsruct. & renov.	6,259	**0**	APEC
		Fisheries dev. projects	28,549	**23**	APEC/FAO
		Fishing port develop.	1,232	**23**	APEC
		Markt. & storage infrast.	119	**24**	APEC
		Tax exemption	166,399	**0**	APEC
		Fishing access	235,282	**0**	(j)
		Fuel subsidies	1,986,520	**0**	(z)
		Fisher assistance	7,202	**23**	na
		Vessel buyback	702,433	**0**	na
		Rural fisher communities	0		
	Cyprus	Fisheries mangt.	565	75	this study
		Fishery R&D	642	73	this study
		MPAs	530	39	this study
		Boat constsruct. & renov.	5,907	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	1,228	1	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	521	0	this study
		Fisher assistance	5	0	this study
		Vessel buyback	1,715	0	this study
		Rural fisher communities	0		
	Hong Kong	Fisheries mangt.	11,195	37	this study
		Fishery R&D	0		
		MPAs	19,694	28	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	5,434	1	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Asia	India	Fisheries mangt.	6,450	**42**	FAO / (k)
		Fishery R&D	2,179	**41**	FAO / (l)
		MPAs	1,782	**42**	(a)
		Boat constsruct. & renov.	4,035	**0**	(k)
		Fisheries dev. projects	3,751	**20**	FAO
		Fishing port develop.	4,062	**17**	FAO / (l)
		Markt. & storage infrast.	4,035	**25**	(k)
		Tax exemption	123,957	**20**	(k)
		Fishing access	0		
		Fuel subsidies	250,825	**25**	KG
		Fisher assistance	5,085	**41**	FAO
		Vessel buyback	0		
		Rural fisher communities	2,905	**100**	(k)
	Indonesia	Fisheries mangt.	51,715	**22**	APEC, (l)
		Fishery R&D	100,657	**11**	APEC
		MPAs	15,839	**22**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	34,071	**30**	APEC
		Fishing port develop.	197,417	**0**	APEC
		Markt. & storage infrast.	3,897	**16**	APEC, (l)
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	203,773	**0**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	19,146	**100**	APEC
	Iran	Fisheries mangt.	50,120	**58**	FAO
		Fishery R&D	35,653	**58**	FAO
		MPAs	1,580	**58**	(a)
		Boat constsruct. & renov.	97,269	**58**	FAO
		Fisheries dev. projects	26	**58**	FAO/OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	27,384	**50**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	7,248	**100**	FAO
	Iraq	Fisheries mangt.	0		
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Israel	Fisheries mangt.	1,040	24	this study
		Fishery R&D	380	24	this study
		MPAs	1,085	12	this study
		Boat constsruct. & renov.	642	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Asia	Japan	Fisheries mangt.	484,785	**24**	FAO/OECD
		Fishery R&D	187,663	**12**	OECD/APEC
		MPAs	42,521	**24**	(a)
		Boat constsruct. & renov.	173,250	**74**	OECD/APEC
		Fisheries dev. projects	152,197	**27**	APEC
		Fishing port develop.	2,048,629	**27**	OECD
		Markt. & storage infrast.	32,359	**16**	OECD
		Tax exemption	169,965	**27**	na
		Fishing access	257,348	**0**	na
		Fuel subsidies	180,065	**0**	KG
		Fisher assistance	767,563	**27**	OECD/(j)
		Vessel buyback	173,250	**0**	OECD
		Rural fisher communities	0		
	Jordan	Fisheries mangt.	74	96	this study
		Fishery R&D	0		
		MPAs	111	50	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	160	65	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Korea D P Rp	Fisheries mangt.	0		
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Korea Rep	Fisheries mangt.	69,200	**22**	FAO/OECD
		Fishery R&D	28,518	**16**	FAO/OECD
		MPAs	3,104	**16**	(a)
		Boat constsruct. & renov.	67,415	**12**	FAO/OECD
		Fisheries dev. projects	115	**0**	FAO/OECD
		Fishing port develop.	440,425	**17**	FAO/OECD
		Markt. & storage infrast.	70,535	**0**	FAO/OECD
		Tax exemption	10,024	**0**	FAO/OECD
		Fishing access	60,174	**0**	OECD
		Fuel subsidies	407,831	0	this study
		Fisher assistance	0		
		Vessel buyback	22,581	**0**	FAO/OECD
		Rural fisher communities	0		
	Kuwait	Fisheries mangt.	183	48	this study
		Fishery R&D	238	47	this study
		MPAs	279	25	this study
		Boat constsruct. & renov.	65	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	432	45	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Asia	Lebanon	Fisheries mangt.	779	100	this study
		Fishery R&D	0		
		MPAs	404	59	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Malaysia	Fisheries mangt.	571	**20**	APEC
		Fishery R&D	637	**22**	APEC
		MPAs	20,007	**22**	(a)
		Boat constsruct. & renov.	55,897	**26**	APEC
		Fisheries dev. projects	151	**11**	APEC
		Fishing port develop.	0		
		Markt. & storage infrast.	7,189	**22**	APEC
		Tax exemption	60,964	**0**	APEC
		Fishing access	0		
		Fuel subsidies	81,040	0	this study
		Fisher assistance	33,009	**50**	APEC
		Vessel buyback	0		
		Rural fisher communities	0		
	Maldives	Fisheries mangt.	1,860	19	this study
		Fishery R&D	186	19	this study
		MPAs	3,149	18	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	809	16	this study
		Fishing port develop.	583	11	this study
		Markt. & storage infrast.	8,650	28	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	5,836	14	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Myanmar	Fisheries mangt.	143,062	**21**	FAO
		Fishery R&D	101,769	**32**	FAO
		MPAs	4,522	**21**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	8	**38**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	78,164	**0**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	20,688	**100**	FAO
	Oman	Fisheries mangt.	21,445	93	this study
		Fishery R&D	9,850	91	this study
		MPAs	1,545	48	this study
		Boat constsruct. & renov.	41,618	0	this study
		Fisheries dev. projects	7,471	70	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	11,717	75	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	3,101	100	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Asia	Pakistan	Fisheries mangt.	933	65	this study
		Fishery R&D	20,153	65	this study
		MPAs	329	62	this study
		Boat constsruct. & renov.	2,026	67	this study
		Fisheries dev. projects	11	27	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	1,087	52	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	883	50	this study
		Vessel buyback	0		
		Rural fisher communities	1,565	100	this study
	Philippines	Fisheries mangt.	150,317	**29**	FAO/APEC
		Fishery R&D	106,930	**25**	FAO
		MPAs	14,325	**29**	(a)
		Boat constsruct. & renov.	291,724	**25**	(m)
		Fisheries dev. projects	5,987	**25**	OECD/APEC
		Fishing port develop.	0		
		Markt. & storage infrast.	2,305	**20**	APEC
		Tax exemption	92,663	**0**	(m)
		Fishing access	0		
		Fuel subsidies	186,370	0	this study
		Fisher assistance	35,605	**100**	FAO/(n)
		Vessel buyback	0		
		Rural fisher communities	21,737	**100**	(m)
	Qatar	Fisheries mangt.	2,072	100	this study
		Fishery R&D	0		
		MPAs	1,041	61	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	971	90	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	778	70	this study
		Vessel buyback	0		
		Rural fisher communities	0		
	Saudi Arabia	Fisheries mangt.	8,247	**65**	FAO
		Fishery R&D	5,867	**65**	FAO
		MPAs	1,538	**65**	(a)
		Boat constsruct. & renov.	16,006	**0**	FAO
		Fisheries dev. projects	3	**100**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,193	**100**	FAO
	Singapore	Fisheries mangt.	189	51	this study
		Fishery R&D	0		
		MPAs	72	46	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Asia	Sri Lanka	Fisheries mangt.	94,021	**49**	FAO
		Fishery R&D	66,882	**49**	FAO
		MPAs	3,885	**49**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	20,208	**25**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	2,909	**0**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	89,356	22	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Syria	Fisheries mangt.	622	82	this study
		Fishery R&D	0		
		MPAs	821	42	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Taiwan	Fisheries mangt.	24,448	**13**	FAO/APEC
		Fishery R&D	4,539	**23**	APEC
		MPAs	3,602	**23**	(a)
		Boat constsruct. & renov.	93,151	**22**	FAO/APEC
		Fisheries dev. projects	0		
		Fishing port develop.	74,572	**8**	APEC
		Markt. & storage infrast.	7,391	**23**	APEC
		Tax exemption	0		
		Fishing access	23,642	**0**	APEC
		Fuel subsidies	130,183	**3**	KG
		Fisher assistance	4,354	**8**	APEC
		Vessel buyback	0		
		Rural fisher communities	0		
	Thailand	Fisheries mangt.	18,539	**42**	APEC
		Fishery R&D	2,068	**14**	APEC
		MPAs	2,884	**42**	(a)
		Boat constsruct. & renov.	58,456	**7**	APEC
		Fisheries dev. projects	243	**14**	OECD
		Fishing port develop.	8,016	**0**	APEC
		Markt. & storage infrast.	58,201	**14**	APEC
		Tax exemption	81,493	**25**	(m)
		Fishing access	0		
		Fuel subsidies	185,023	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	19,117	**100**	(m)
	Timor Leste	Fisheries mangt.	0		
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Asia	Turkey	Fisheries mangt.	41,082	**16**	FAO/OECD
		Fishery R&D	1,629	**15**	OECD
		MPAs	4,483	**16**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	33,950	**15**	FAO/OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	22,025	**0**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	60,530	**0**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	174	**100**	(o)
	Untd Arab Em	Fisheries mangt.	2,246	100	this study
		Fishery R&D	2,912	100	this study
		MPAs	842	62	this study
		Boat constsruct. & renov.	3,899	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Viet Nam	Fisheries mangt.	154,459	**32**	FAO/APEC
		Fishery R&D	109,494	**37**	FAO
		MPAs	1,878	**32**	(a)
		Boat constsruct. & renov.	334,342	**0**	APEC
		Fisheries dev. projects	49,076	**37**	OECD
		Fishing port develop.	1,318	**0**	APEC
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Yemen	Fisheries mangt.	41,666	**92**	FAO
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	12,124	**100**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	22,765	**79**	FAO
		Tax exemption	25,685	**79**	FAO
		Fishing access	0		
		Fuel subsidies	26,849	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Europe	Albania	Fisheries mangt.	387	11	this study
		Fishery R&D	199	10	this study
		MPAs	59	12	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	472	2	this study
		Fishing port develop.	107	15	this study
		Markt. & storage infrast.	153	4	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	650	**15**	KG
		Fisher assistance	0		
		Vessel buyback	0		
	Albania	Rural fisher communities	0		
	Belgium	Fisheries mangt.	4,333	0	this study
		Fishery R&D	5,385	0	this study
		MPAs	271	0	this study
		Boat constsruct. & renov.	7,702	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	2,250	0	this study
		Tax exemption	0		
		Fishing access	192	0	this study
		Fuel subsidies	8,060	0	this study
		Fisher assistance	157	0	this study
		Vessel buyback	1,652	0	this study
		Rural fisher communities	0		
	Bosnia Herzg	Fisheries mangt.	0		
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Bulgaria	Fisheries mangt.	5,218	2	this study
		Fishery R&D	514	4	this study
		MPAs	51	4	this study
		Boat constsruct. & renov.	7,507	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	9,667	3	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	3,331	**59**	KG
		Fisher assistance	18	0	this study
		Vessel buyback	0		
		Rural fisher communities	27	22	this study
	Croatia	Fisheries mangt.	525	22	this study
		Fishery R&D	0		
		MPAs	140	24	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	248	4	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Europe	Denmark	Fisheries mangt.	27,710	**8**	FAO/OECD
		Fishery R&D	12,472	**8**	FAO
		MPAs	27,262	**8**	(a)
		Boat constsruct. & renov.	26,509	**7**	FAO/EFF
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	18,193	**18**	OECD/EFF
		Tax exemption	0		
		Fishing access	2,867	**0**	EFF
		Fuel subsidies	288,607	3	this study
		Fisher assistance	23,594	**5**	OECD
		Vessel buyback	7,601	**0**	FAO
		Rural fisher communities	0		
	Estonia	Fisheries mangt.	8,862	9	this study
		Fishery R&D	806	9	this study
		MPAs	1,432	7	this study
		Boat constsruct. & renov.	8,671	6	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	5,850	11	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	36,534	4	this study
		Fisher assistance	1,134	18	this study
		Vessel buyback	2,522	0	this study
		Rural fisher communities	0		
	Finland	Fisheries mangt.	6,021	9	this study
		Fishery R&D	2,295	9	this study
		MPAs	142	7	this study
		Boat constsruct. & renov.	8,206	5	this study
		Fisheries dev. projects	54	9	this study
		Fishing port develop.	1,717	10	this study
		Markt. & storage infrast.	7,670	10	this study
		Tax exemption	698	3	this study
		Fishing access	1,866	0	this study
		Fuel subsidies	57,365	4	this study
		Fisher assistance	3,013	18	this study
		Vessel buyback	1,331	0	this study
		Rural fisher communities	0		
	France	Fisheries mangt.	19,279	**40**	OECD
		Fishery R&D	20,341	**22**	OECD
		MPAs	17,135	**40**	(a)
		Boat constsruct. & renov.	116,223	**16**	OECD/EFF/(p)
		Fisheries dev. projects	11,027	**10**	EFF
		Fishing port develop.	904	**22**	OECD/EFF
		Markt. & storage infrast.	31,165	**22**	OECD/EFF
		Tax exemption	0		
		Fishing access	25,196	**0**	EFF
		Fuel subsidies	159,771	**34**	KG
		Fisher assistance	128,306	**22**	OECD
		Vessel buyback	39,959	**0**	OECD/EFF/(p)
		Rural fisher communities	0		
	Georgia	Fisheries mangt.	3,671	5	this study
		Fishery R&D	88	5	this study
		MPAs	78	3	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	269	8	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	244	8	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	18	22	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Europe	Germany	Fisheries mangt.	13,325	**7**	EFF
		Fishery R&D	8,030	**1**	FAO
		MPAs	12,410	**7**	(a)
		Boat constsruct. & renov.	23,875	**0**	OECD/EFF
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	18,026	**1**	OECD/EFF
		Tax exemption	0		
		Fishing access	18,443	**0**	EFF
		Fuel subsidies	92,897	**67**	KG
		Fisher assistance	5,933	**1**	FAO
		Vessel buyback	2,079	**1**	OECD/EFF
		Rural fisher communities	0		
	Greece	Fisheries mangt.	26,203	**60**	FAO/OECD
		Fishery R&D	6,165	**60**	OECD
		MPAs	5,237	**60**	(a)
		Boat constsruct. & renov.	28,446	**51**	OECD/EFF
		Fisheries dev. projects	3,442	**51**	OECD/EFF
		Fishing port develop.	33,926	**51**	OECD
		Markt. & storage infrast.	15,863	**51**	OECD/EFF
		Tax exemption	5,696	**0**	OECD
		Fishing access	522	**0**	EFF
		Fuel subsidies	30,923	4	this study
		Fisher assistance	3,003	**0**	EFF/(q)
		Vessel buyback	66,407	**0**	OECD
		Rural fisher communities	0		
	Iceland	Fisheries mangt.	32,866	**4**	OECD/(r)
		Fishery R&D	28,495	**3**	OECD/(r)
		MPAs	5,755	**4**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	15,774	**0**	(r)
		Tax exemption	21,839	**3**	OECD/(r)
		Fishing access	0		
		Fuel subsidies	210,456	**9**	KG
		Fisher assistance	28,495	**3**	OECD
		Vessel buyback	0		
		Rural fisher communities	0		
	Ireland	Fisheries mangt.	5,839	**2**	OECD/EFF
		Fishery R&D	8,480	**2**	OECD/EFF
		MPAs	2,754	**2**	(a)
		Boat constsruct. & renov.	14,299	**2**	OECD/EFF
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	2,155	**2**	OECD/EFF
		Tax exemption	4,429	**2**	OECD
		Fishing access	1,060	**0**	EFF
		Fuel subsidies	110,798	1	this study
		Fisher assistance	9,645	**2**	OECD
		Vessel buyback	0		
		Rural fisher communities	0		
	Italy	Fisheries mangt.	37,507	**15**	OECD/EFF
		Fishery R&D	11,333	**12**	FAO
		MPAs	20,393	**15**	(a)
		Boat constsruct. & renov.	111,747	**12**	OECD/EFF
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	41,376	**12**	OECD/EFF
		Tax exemption	0		
		Fishing access	4,438	**0**	EFF
		Fuel subsidies	94,407	**6**	KG
		Fisher assistance	47,458	**12**	OECD/EFF
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Europe	Latvia	Fisheries mangt.	10,759	6	this study
		Fishery R&D	617	6	this study
		MPAs	313	5	this study
		Boat constsruct. & renov.	11,177	1	this study
		Fisheries dev. projects	15,212	3	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	11,487	3	this study
		Tax exemption	0		
		Fishing access	12,458	0	this study
		Fuel subsidies	60,565	1	this study
		Fisher assistance	1,027	5	this study
		Vessel buyback	0		
		Rural fisher communities	0		
	Lithuania	Fisheries mangt.	5,910	5	this study
		Fishery R&D	528	5	this study
		MPAs	834	4	this study
		Boat constsruct. & renov.	5,907	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	5,765	1	this study
		Tax exemption	0		
		Fishing access	20,456	0	this study
		Fuel subsidies	64,082	**18**	KG
		Fisher assistance	1,702	1	this study
		Vessel buyback	0		
		Rural fisher communities	0		
	Malta	Fisheries mangt.	2,695	14	this study
		Fishery R&D	836	12	this study
		MPAs	253	16	this study
		Boat constsruct. & renov.	1,887	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	528	0	this study
		Tax exemption	0		
		Fishing access	528	0	this study
		Fuel subsidies	592	0	this study
		Fisher assistance	7	0	this study
		Vessel buyback	1,142	0	this study
		Rural fisher communities	0		
	Montenegro	Fisheries mangt.	48	38	this study
		Fishery R&D	0		
		MPAs	25	40	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	75	9	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Netherlands	Fisheries mangt.	18,128	**0**	OECD/EFF
		Fishery R&D	12,811	**0**	OECD/EFF
		MPAs	5,436	**0**	(a)
		Boat constsruct. & renov.	20,321	**1**	EFF
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	4,355	**1**	OECD/EFF
		Tax exemption	0		
		Fishing access	29,984	**0**	EFF
		Fuel subsidies	141,804	0	this study
		Fisher assistance	7,586	**1**	EFF
		Vessel buyback	7,417	**0**	OECD
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Europe	Norway	Fisheries mangt.	40,845	**10**	OECD
		Fishery R&D	64,516	**10**	OECD
		MPAs	22,028	**10**	(a)
		Boat constsruct. & renov.	11,650	**8**	OECD
		Fisheries dev. projects	107,505	**8**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	75	**8**	OECD
		Fishing access	0		
		Fuel subsidies	53,956	4	this study
		Fisher assistance	20,977	**50**	FAO
		Vessel buyback	8,213	**0**	OECD
		Rural fisher communities	0		
	Poland	Fisheries mangt.	88,672	**12**	OECD/FAO
		Fishery R&D	1,431	**4**	OECD
		MPAs	1,865	**12**	(a)
		Boat constsruct. & renov.	213,806	**4**	FAO
		Fisheries dev. projects	0		
		Fishing port develop.	761	**4**	(s)
		Markt. & storage infrast.	45,131	**4**	FAO/EFF
		Tax exemption	0		
		Fishing access	2,164	**0**	EFF
		Fuel subsidies	83,082	0	this study
		Fisher assistance	441	**4**	OECD/EFF
		Vessel buyback	38,865	**0**	FAO
		Rural fisher communities	0		
	Portugal	Fisheries mangt.	18,290	**37**	FAO/OECD
		Fishery R&D	4,115	**37**	FAO
		MPAs	6,294	**37**	(a)
		Boat constsruct. & renov.	36,723	**30**	FAO
		Fisheries dev. projects	970	**100**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	26,213	**0**	EFF
		Tax exemption	0		
		Fishing access	9,024	**0**	EFF
		Fuel subsidies	74,351	2	this study
		Fisher assistance	5,855	**30**	EFF
		Vessel buyback	11,488	**30**	FAO
		Rural fisher communities	0		
	Romania	Fisheries mangt.	20,925	**92**	FAO
		Fishery R&D	795	**92**	FAO
		MPAs	393	**92**	(a)
		Boat constsruct. & renov.	9,495	**1**	FAO
		Fisheries dev. projects	167	**1**	FAO
		Fishing port develop.	0		
		Markt. & storage infrast.	25,694	**1**	EFF
		Tax exemption	47	**2**	FAO
		Fishing access	0		
		Fuel subsidies	1,492	0	this study
		Fisher assistance	11	**0**	EFF
		Vessel buyback	0		
		Rural fisher communities	0		
	Russian Fed	Fisheries mangt.	283,070	**0**	FAO
		Fishery R&D	87,610	**16**	FAO
		MPAs	9,908	**15**	(a)
		Boat constsruct. & renov.	148,971	**0**	FAO/APEC
		Fisheries dev. projects	0		
		Fishing port develop.	350,069	**3**	FAO/APEC
		Markt. & storage infrast.	159,261	**16**	FAO
		Tax exemption	0		
		Fishing access	88,615	**0**	na
		Fuel subsidies	1,032,504	0	this study
		Fisher assistance	0		
		Vessel buyback	139,779	**0**	(t)
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Europe	Slovenia	Fisheries mangt.	1,338	25	this study
		Fishery R&D	270	22	this study
		MPAs	0		
		Boat constsruct. & renov.	3,267	0	this study
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	2,688	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	385	0	this study
		Fisher assistance	8	0	this study
		Vessel buyback	0		
		Rural fisher communities	0		
	Spain	Fisheries mangt.	71,934	**5**	OECD/EFF
		Fishery R&D	17,871	**3**	OECD
		MPAs	8,805	**8**	(a)
		Boat constsruct. & renov.	269,786	**1**	OECD/(u)
		Fisheries dev. projects	96,719	**1**	OECD
		Fishing port develop.	30,765	**0**	OECD/EFF
		Markt. & storage infrast.	134,579	**3**	OECD/EFF
		Tax exemption	0		
		Fishing access	73,609	**0**	EFF
		Fuel subsidies	335,837	0	this study
		Fisher assistance	56,221	**35**	OECD
		Vessel buyback	291,780	**0**	OECD
		Rural fisher communities	0		
	Sweden	Fisheries mangt.	15,606	**5**	OECD
		Fishery R&D	71,149	**5**	FAO/OECD
		MPAs	15,964	**5**	(a)
		Boat constsruct. & renov.	12,264	**7**	FAO
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	4,087	**7**	EFF
		Tax exemption	0		
		Fishing access	7,800	**0**	EFF
		Fuel subsidies	75,482	3	this study
		Fisher assistance	3,251	**7**	OECD
		Vessel buyback	29,673	**0**	FAO
		Rural fisher communities	0		
	UK	Fisheries mangt.	22,488	**4**	FAO/(v)
		Fishery R&D	20,924	**4**	OECD
		MPAs	118,894	**4**	(a)
		Boat constsruct. & renov.	36,330	**2**	OECD
		Fisheries dev. projects	59,209	**8**	OECD
		Fishing port develop.	3,540	**8**	OECD
		Markt. & storage infrast.	13,414	**8**	OECD
		Tax exemption	0		
		Fishing access	2,867	**0**	OECD
		Fuel subsidies	219,305	4	this study
		Fisher assistance	3,634	**8**	OECD
		Vessel buyback	43,484	**0**	FAO
		Rural fisher communities	0		
	Ukraine	Fisheries mangt.	9,039	**10**	FAO
		Fishery R&D	0		
		MPAs	816	**10**	FAO
		Boat constsruct. & renov.	16,357	**3**	FAO
		Fisheries dev. projects	7	**0**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	8,739	**15**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,219	**100**	FAO

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
North America	Canada	Fisheries mangt.	185,542	**4**	FAO/APEC/OECD
		Fishery R&D	70,013	**6**	OECD
		MPAs	149,722	**4**	(a)
		Boat constsruct. & renov.	54,506	**0**	APEC/OECD
		Fisheries dev. projects	0		
		Fishing port develop.	67,949	**6**	OECD
		Markt. & storage infrast.	5,692	**6**	OECD
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	10,003	**69**	KG
		Fisher assistance	558,668	**6**	FAO/OECD
		Vessel buyback	0		
		Rural fisher communities	0		
	Mexico	Fisheries mangt.	8,903	**10**	FAO/OECD
		Fishery R&D	19,903	**40**	FAO/OECD
		MPAs	12,107	**42**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	72,855	**0**	KG
		Fisher assistance	77,980	**40**	OECD
		Vessel buyback	0		
		Rural fisher communities	0		
	USA	Fisheries mangt.	2,090,893	**27**	OECD
		Fishery R&D	807,872	**19**	(w)
		MPAs	414,830	**27**	OECD/(a)
		Boat constsruct. & renov.	17,720	**19**	OECD/w)
		Fisheries dev. projects	14,552	**19**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	216,732	**19**	OECD/(w)
		Tax exemption	91,313	**19**	(w)
		Fishing access	52,061	**0**	(w)
		Fuel subsidies	85,296	7	this study
		Fisher assistance	13,352	**19**	OECD/(w)
		Vessel buyback	286,683	**0**	OECD/(w)
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Oceania	Australia	Fisheries mangt.	61,780	**19**	FAO
		Fishery R&D	9,922	**17**	OECD
		MPAs	72,077	**19**	(a)
		Boat constsruct. & renov.	89,015	**17**	OECD
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	59,558	**0**	KG
		Fisher assistance	28,262	**100**	OECD
		Vessel buyback	168,998	**0**	OECD
		Rural fisher communities	0		
	Fiji	Fisheries mangt.	3,455	11	this study
		Fishery R&D	0		
		MPAs	803	40	this study
		Boat constsruct. & renov.	6,209	4	this study
		Fisheries dev. projects	47	17	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	1,748	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	463	56	this study
	Kiribati	Fisheries mangt.	1,967	0	this study
		Fishery R&D	0		
		MPAs	227	0	this study
		Boat constsruct. & renov.	3,818	0	this study
		Fisheries dev. projects	367	23	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	1,075	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Marshall Is	Fisheries mangt.	10,727	0	this study
		Fishery R&D	7,535	8	this study
		MPAs	235	17	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1,328	30	this study
		Fishing port develop.	433	0	this study
		Markt. & storage infrast.	5,788	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Micronesia	Fisheries mangt.	278,478	**0**	FAO
		Fishery R&D	198,098	**4**	FAO
		MPAs	10,067	**9**	(a)
		Boat constsruct. & renov.	53,445	**0**	FAO
		Fisheries dev. projects	111,072	**26**	OECD/FAO
		Fishing port develop.	88,808	**0**	FAO
		Markt. & storage infrast.	1,236,111	**0**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Oceania	Nauru	Fisheries mangt.	13	0	this study
		Fishery R&D	10	0	this study
		MPAs	0		
		Boat constsruct. & renov.	26	0	this study
		Fisheries dev. projects	17	100	this study
		Fishing port develop.	4	0	this study
		Markt. & storage infrast.	7	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	New Zealand	Fisheries mangt.	67,461	**14**	OECD
		Fishery R&D	0		
		MPAs	7,371	**14**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	255	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Palau	Fisheries mangt.	109	0	this study
		Fishery R&D	0		
		MPAs	245	4	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	710	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	59	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Papua N Guin	Fisheries mangt.	115,886	**0**	FAO
		Fishery R&D	82,436	**5**	FAO
		MPAs	1,192	**9**	(a)
		Boat constsruct. & renov.	224,902	**0**	FAO
		Fisheries dev. projects	34,506	**5**	FAO/OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	63,316	**0**	FAO
		Tax exemption	71,438	**0**	FAO
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	16,758	**16**	FAO
	Samoa	Fisheries mangt.	2,785	10	this study
		Fishery R&D	1,981	11	this study
		MPAs	540	39	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	35	43	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	1,717	0	this study
		Fishing access	0		
		Fuel subsidies	766	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	403	31	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
Oceania	Solomon Is	Fisheries mangt.	4,211	3	this study
		Fishery R&D	0		
		MPAs	150	9	this study
		Boat constsruct. & renov.	355	3	this study
		Fisheries dev. projects	88	14	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	25,702	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	1,205	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	609	47	this study
	Tonga	Fisheries mangt.	544	9	this study
		Fishery R&D	387	9	this study
		MPAs	573	33	this study
		Boat constsruct. & renov.	1,056	10	this study
		Fisheries dev. projects	128	48	this study
		Fishing port develop.	174	0	this study
		Markt. & storage infrast.	297	0	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	253	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Tuvalu	Fisheries mangt.	0		
		Fishery R&D	0		
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Vanuatu	Fisheries mangt.	22,309	**21**	FAO
		Fishery R&D	0		
		MPAs	398	**21**	(a)
		Boat constsruct. & renov.	43,295	**7**	FAO
		Fisheries dev. projects	82	**7**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	10,381	0	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
South&Central America and	Antigua Barb	Fisheries mangt.	27	89	this study
		Fishery R&D	720	42	this study
		MPAs	725	88	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	7,338	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	447	100	this study
		Tax exemption	624	10	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Argentina	Fisheries mangt.	74,803	**0**	FAO/(h)
		Fishery R&D	19,179	**17**	FAO/(h)
		MPAs	5,502	**17**	(a)
		Boat constsruct. & renov.	11,128	**0**	(h)
		Fisheries dev. projects	63	**8**	OECD/(h)
		Fishing port develop.	0		
		Markt. & storage infrast.	34,864	**0**	FAO/(h)
		Tax exemption	7,249	**17**	
		Fishing access	0		
		Fuel subsidies	86,688	**0**	KG
		Fisher assistance	8,368	**0**	(h)
		Vessel buyback	30,599	**0**	FAO
		Rural fisher communities	0		
	Bahamas	Fisheries mangt.	164	20	this study
		Fishery R&D	4,326	9	this study
		MPAs	6,368	20	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	3,183	2	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Barbados	Fisheries mangt.	60	62	this study
		Fishery R&D	198	29	this study
		MPAs	93	62	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	0		
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	526	66	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	79	66	this study
	Belize	Fisheries mangt.	276	43	this study
		Fishery R&D	639	100	this study
		MPAs	760	92	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	5,880	1	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	945	1	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	130	7	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
South&Central America and	Brazil	Fisheries mangt.	167,439	**51**	FAO
		Fishery R&D	119,109	**52**	FAO
		MPAs	31,023	**51**	(a)
		Boat constsruct. & renov.	18,880	**0**	FAO/(x)
		Fisheries dev. projects	5,261	**52**	OECD
		Fishing port develop.	53,397	**52**	FAO
		Markt. & storage infrast.	0		
		Tax exemption	103,218	**0**	(x)
		Fishing access	0		
		Fuel subsidies	10,222	**79**	KG
		Fisher assistance	46,840	**100**	(x)
		Vessel buyback	0		
		Rural fisher communities	2,139	**100**	(x)
	Chile	Fisheries mangt.	59,617	**0**	FAO/(y)
		Fishery R&D	5,812	**76**	APEC
		MPAs	3,788	**69**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	3,977	**31**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	63,022	**0**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Colombia	Fisheries mangt.	4,697	27	this study
		Fishery R&D	2,610	42	this study
		MPAs	4,195	48	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	10	20	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	2,004	4	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	530	69	this study
	Costa Rica	Fisheries mangt.	5,637	**25**	FAO
		Fishery R&D	4,010	**28**	FAO
		MPAs	1,727	**25**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	280	**0**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	11,030	**47**	KG
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,222	**100**	na
	Cuba	Fisheries mangt.	9,745	**90**	FAO
		Fishery R&D	0		
		MPAs	5,340	**90**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1,074	**82**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
South&Central America and	Dominica	Fisheries mangt.	7	100	this study
		Fishery R&D	180	48	this study
		MPAs	315	100	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	6,861	7	this study
		Fishing port develop.	81	5	this study
		Markt. & storage infrast.	138	9	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	147	8	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	37	8	this study
	Dominican Rp	Fisheries mangt.	4,107	100	this study
		Fishery R&D	0		
		MPAs	5,531	100	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	157	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Ecuador	Fisheries mangt.	28,288	**22**	FAO
		Fishery R&D	18,634	**16**	FAO
		MPAs	2,409	**22**	(a)
		Boat constsruct. & renov.	1,749	**0**	FAO
		Fisheries dev. projects	8,108	**16**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	El Salvador	Fisheries mangt.	1,133	20	this study
		Fishery R&D	2,620	52	this study
		MPAs	81	43	this study
		Boat constsruct. & renov.	207	26	this study
		Fisheries dev. projects	141	16	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	207	43	this study
		Vessel buyback	0		
		Rural fisher communities	533	100	this study
	Grenada	Fisheries mangt.	249	92	this study
		Fishery R&D	177	44	this study
		MPAs	106	93	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,829	66	this study
		Fishing port develop.	79	44	this study
		Markt. & storage infrast.	136	80	this study
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	309	80	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
South&Central America and	Guatemala	Fisheries mangt.	5,240	32	this study
		Fishery R&D	3,475	82	this study
		MPAs	1,184	68	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	109	23	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	3,012	16	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	706	100	this study
	Guyana	Fisheries mangt.	14,007	**52**	FAO
		Fishery R&D	9,964	**51**	FAO
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	30,353	**0**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	2,026	**100**	FAO
	Haiti	Fisheries mangt.	4,445	100	this study
		Fishery R&D	3,089	55	this study
		MPAs	0		
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	1,288	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Honduras	Fisheries mangt.	4,232	39	this study
		Fishery R&D	3,010	99	this study
		MPAs	2,742	83	this study
		Boat constsruct. & renov.	194	58	this study
		Fisheries dev. projects	348	34	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	2,609	24	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	612	100	this study
	Jamaica	Fisheries mangt.	4,459	**100**	FAO
		Fishery R&D	0		
		MPAs	4,463	**100**	FAO
		Boat constsruct. & renov.	8,654	**100**	FAO
		Fisheries dev. projects	29	**100**	FAO
		Fishing port develop.	0		
		Markt. & storage infrast.	2,436	**100**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	2,062	**100**	FAO
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	645	**100**	FAO

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
South&Central America and	Nicaragua	Fisheries mangt.	7,368	**16**	FAO
		Fishery R&D	2,187	**75**	FAO
		MPAs	1,343	**31**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	592	**22**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	3,750	**39**	FAO
		Tax exemption	4,206	**0**	FAO
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Panama	Fisheries mangt.	19,123	**16**	FAO
		Fishery R&D	0		
		MPAs	4,033	**16**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	802	**13**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	10,448	**0**	FAO
		Tax exemption	11,788	**14**	FAO
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	2,765	**100**	
	Peru	Fisheries mangt.	78,172	**9**	FAO
		Fishery R&D	3,515	**25**	APEC
		MPAs	848	**9**	(a)
		Boat constsruct. & renov.	153,392	**25**	APEC
		Fisheries dev. projects	1,222	**0**	OECD
		Fishing port develop.	8,014	**78**	APEC
		Markt. & storage infrast.	1,507	**9**	APEC
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	11,304	**9**	FAO
	St Kitts Nev	Fisheries mangt.	60	100	this study
		Fishery R&D	0		
		MPAs	41	100	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	874	100	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	37	11	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	St Lucia	Fisheries mangt.	344	63	this study
		Fishery R&D	231	30	this study
		MPAs	1,007	63	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	2,713	71	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	178	86	this study
		Tax exemption	200	7	this study
		Fishing access	0		
		Fuel subsidies	294	86	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	47	85	this study

Region	Countries	SubType	Total subsidies (USD x1000)	SSF subsidies (%)	Source
South&Central America and	St Vincent	Fisheries mangt.	545	86	this study
		Fishery R&D	388	41	this study
		MPAs	311	87	this study
		Boat constsruct. & renov.	1,058	30	this study
		Fisheries dev. projects	1,010	25	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	336	2	this study
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	79	30	this study
	Suriname	Fisheries mangt.	11,979	**52**	FAO
		Fishery R&D	0		
		MPAs	2,247	**52**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	4,764	**66**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	2,673	**100**	FAO
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	1,732	**100**	FAO
	Trinidad Tob	Fisheries mangt.	1,286	70	this study
		Fishery R&D	0		
		MPAs	1,362	71	this study
		Boat constsruct. & renov.	2,495	76	this study
		Fisheries dev. projects	298	62	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	702	76	this study
		Tax exemption	793	6	this study
		Fishing access	0		
		Fuel subsidies	1,808	76	this study
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Uruguay	Fisheries mangt.	13,839	41	this study
		Fishery R&D	0		
		MPAs	1,029	74	this study
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	8	25	this study
		Fishing port develop.	0		
		Markt. & storage infrast.	0		
		Tax exemption	0		
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	0		
	Venezuela	Fisheries mangt.	17,754	**94**	FAO
		Fishery R&D	0		
		MPAs	5,385	**94**	(a)
		Boat constsruct. & renov.	0		
		Fisheries dev. projects	30	**33**	OECD
		Fishing port develop.	0		
		Markt. & storage infrast.	9,700	**0**	FAO
		Tax exemption	10,944	**76**	FAO
		Fishing access	0		
		Fuel subsidies	0		
		Fisher assistance	0		
		Vessel buyback	0		
		Rural fisher communities	2,567	**100**	FAO

Appendix A table legend and references

This study:

results are estimated (not assessed individually) using average data from subregion and subsidy subtype as well as percentages of SSF catches, methods explained in Chapter 3.

OECD: Organisation for Economic Cooperation and Development, information obtained from:

OECD. 2000. Transition to Responsible Fisheries. Organisation for Economic Co-operation and Development, Paris;

OECD. 2005a. Review of fisheries in OECD countries. Organisation for Economic Co-operation and Development, Paris;

OECD. 2005b. Subsidies: a Way Towards Sustainable Fisheries? Organisation for Economic Cooperation and Development, Policy Brief, Paris;

OECD. 2006. Financial Support to Fisheries: Implications for sustainable development. Organisation for Economic Co-operation and Development;

OECD. 2013. OECD Review of Fisheries: Policies and Summary Statistics 2013. OECD Publishing;

OECD. 2016. Open Government Data Review of Mexico. Organisation for Economic Co-operation and Development, Paris.

APEC: Asian Pacific Economic Cooperation: Study into the nature and extent of subsidies in the fisheries sector of APEC member economies, APEC Committee on Trade and Investment.

EFF: The European Fisheries Fund made available by the European Commission (2007-2013) http://ec.europa.eu/fisheries/cfp/eff/index_en.htm. Last accessed September 2016 and (EFF 2007).

FAO: Food and Agricultural Organization of the United Nations web resources under fisheries country profiles accessed for each country individually (http://www.fao.org/fishery/countryprofiles/search/en last accessed November 2015).

KG: Data on fuel consumption by fishing sector to estimate SSF fuel subsidies used from Greer, K. 2014. Considering the "effort factor" in fisheries: a methodology for reconstructing global fishing effort and CO2 emissions, 1950 - 2010. Master of Science, University of British Columbia, Canada.

na: information not available, if no information was available I assumed based on the definition for SSF that subsidies for the subtype rural fisher community are 100% provided to SSF and for foreign fishing access agreements 0% are provided to SSF.

Legend:

(a) Global Marine Protected Areas (MPA) costs database Cullis-Suzuki, S., and D. Pauly. 2010. Marine Protected Area Costs as "Beneficial" Fisheries Subsidies: A Global Evaluation. Coastal Management 38(2):113–121;

(b) Article in the Ghanian Chronicle, saved in written documents obtained from database used in Sumaila, U. R., V. Lam, F. Le Manach, W. Swartz, and D. Pauly. 2016. Global fisheries subsidies: An updated estimate. Marine Policy;

(c) http://www.ghananewsagency.org/details/Social/Twenty-one-fishermen-receive-outboard-motors/?ci=4&ai=52374 (last accessed November 2016);

(d) N'dia, Y. 2004.Policy research-implications of liberalization of fish trade for developing countries. Case study of Guinea. FAO,Rome;
(e) World Bank. 2008. Madagascar - Additional Financing for Rural Development Support Project. Washington, DC: World Bank;
(f) Associated press article saved in written documents/morocco;
(g) Belhabib et al. Report for Oceana (2014) Feasibility of Senegal fisheries;
(h) UNEP. 2002. Integrated assessment of trade liberalization and trade related policies. A country study on fisheries sector in Senegal. United Nations Environmental Programme, UNEP/ETB/2002/10, Geneva.
UNEP. 2004. Policy implementation and fisheries resource management: Lessons from Senegal Fisheries and the Environment. United Nations Environmental Programme, UNEP/ETB/2004/13, Geneva.
UNEP. 2005. Fisheries subsidies and marine resources management: Lessons learned from studies in Argentina and Senegal. United Nations Environmental Programme, UNEP/ETB/2005/5, Geneva;
(i) http://www.ippmedia.com/frontend/index.php?l=54160 (last accessed January 2016);
(j) Milazzo, M. (1998). Subsidies in world fisheries: a reexamination, volume 23. World Bank Publications;
(k) Salagrama, V. 2004. Policy research-implications of liberalization of fish trade in developing countries. A case of India. FAO, Rome;
(l) Handbook on Fisheries Statistics (2004), India, found in original database in Khan, A., R. U. Sumaila, R. Watson, G. Munro, and D. Pauly. 2006. The nature and magnitude of global non-fuel fisheries subsidies. Pages 5–37. The University of British Columbia, Fisheries Centre Research Reports 14(6), Vancouver;
(m) Globefish databank, 16/03/06 obtained from original database in Khan, A., R. U. Sumaila, R. Watson, G. Munro, and D. Pauly. 2006. The nature and magnitude of global non-fuel fisheries subsidies. Pages 5–37. The University of British Columbia, Fisheries Centre Research Reports 14(6), Vancouver;
(n) http://www.da.gov.ph/index.php/2012-03-27-12-04-15/2012-04-17-09-30-59/217-da-allots-p1-9b-for-fisheries-program (last accessed January 2016);
(o) Analytical examination of the acquis CHAPTER 8 – Competition policy www.abgs.gov.tr/tarama/tarama_files/08/08AT_Annotated.htm (last accessed December 2012), Turkey, Country session, Draft Agenda, 2005;
(p) Mesnil, B. (2008). Public-aided crises in the French fishing sector. Ocean & coastal management, 51 (10), 689–700;
(q) https://s3-us-west-2.amazonaws.com/subsidy/docs/greece1.pdf In Eurofish - The Greek fish industry (accessed April 2015);
(r) Iceland Ministry Submission (Nov 08), obtained from original database in Khan, A., R. U. Sumaila, R. Watson, G. Munro, and D. Pauly. 2006. The nature and magnitude of global non-fuel fisheries subsidies. Pages 5–37. The University of British Columbia, Fisheries Centre Research Reports 14(6), Vancouver;
(s) http://www.thenews.pl/1/12/Artykul/46579,Polish-fishermen-net-millions-in-subsidies (last accessed April 2015);
(t) Pashkova, E. 2001. Russia distant water fishing: A shoulder to lean on. Samudra Triannual Report. ICFS, Chennai and Brussels: 24-27;

(u) http://www.guardian.co.uk/environment/2012/feb/27/overfishing-european-trawlers-eu-exemption (last accessed April 2015);
(v) EU Fisheries Management UK: Number 357 May 2010 http://www.parliament.uk/documents/post/postpn357-eu-fisheries-management.pdf (last accessed April 2015);
(w) Sharp and Sumaila, 2009.Quantification of U.S. Marine Fisheries Subsidies. North American Journal of Fisheries Management 29, 18–32;
(x) Abdallah, P.R., Sumaila, U.R. 2006. An historical account of Brazilian public policy on fisheries subsidies. In Sumaila, U.R., Pauly, D. (eds.), Catching more bait: A bottom-up re-estimation of global fisheries subsidies. Fisheries Centre Research Reports 14(6), pp. 67-76. Fisheries Centre, the University of British Columbia, Vancouver, Canada;
(y) Website of the Subsecretaría de Pesca y Acuicultura de Chile: www.fip.cl (last accessed April 2015);
(z) Indication for only Diesel fuel subsidies found here: http://www.seafoodsource.com/news (last accessed April 2015).

Appendix B Workshop report (B1) and framework (B2) including original attributes of economic viability and their definitions.

B1 Workshop on Economic Viability of Small-Scale Fisheries in Africa, Bagamoyo, Tanzania, 23-25 April 2014*

Introduction

A workshop on small-scale fisheries and economic viability took place in Bagamoyo, a small fishing town located in Tanzania. Working Group 2 of a project named *Too Big To Ignore (TBTI) – A global network for Small-Scale Fisheries Research,* organized this workshop in conjunction with African regional node of TBTI. *TBTI* consists of seven Working Groups distributed across all continents. Working Group 2 is in charge of strengthening the base of small-scale fisheries research and presently focuses on Africa, where economic underperformance has been identified as one of the major problems fisheries are facing.

Small-scale fisheries are often marginalized and face many threats including climate change, globalization, competition from industrial fisheries and rapid market shifts. To be able to withstand these threats, fisheries need to be prepared. A major step to achieve this is to help improve their economic viability. Therefore, we need to understand, define and assess economic viability of small-scale fisheries. A literature review was carried out which unveiled that economic viability is currently viewed equal to financial viability, where profit is seen as the main driver.

* A version of this report is published: http://toobigtoignore.net/wp-content/uploads/2014/03/EconomicViability_SSF_WorkshopReport_Tanzania_April2014.pdf (last accessed Feb 2017).

However, this view lacks a comprehensive perspective, especially as many small-scale fisheries do not fish for fortune. We therefore argue that economic viability of small-scale fisheries depends not only on financial outputs but also on social, ecological and governance attributes, which need to be considered when assessing economic viability.

A framework was developed based on the results of the literature review and meetings with several scientists and the most important attributes describing economic viability of small-scale fisheries were identified and discussed. The main challenge was how to incorporate socio-economic criteria into an otherwise straightforward financial assessment. This framework will be used to find out what makes a fishery more viable given the current situation, and less vulnerable to large-scale processes of change. The results will help find solutions to increase the resilience of the assessed small-scale fisheries. The attribute-based framework is divided into two parts: (1) a global assessment using national data; and (2) case-study based approach, assessing data on a local level.

To dig deeper and to understand how this framework can be applied most efficiently in the real world, Working Group 2 of *TBTI* decided to organize a workshop to present case studies related to economic viability of small-scale fisheries using the developed framework as a starting point. The workshop was hosted by Dr. Paul Onyango of the University of Dar es Salaam, Tanzania, and co-organized by Dr. Moenieba Isaacs of the University of Western Cape, South Africa, the African regional coordinators for TBTI, in partnership with the Benguela Current Commission, TBTI partner, based in Namibia. The workshop invited fisheries researchers and practitioners from all over Africa. Seventeen people attended, twelve of whom presented small-scale fisheries case studies with a focus on economic viability from nine African countries. There were professors, researchers from government institutions, NGOs, students and fishers, from Morocco, Ghana, Nigeria, Uganda, Kenya, Tanzania, Mozambique, Malawi, and South Africa, with participants from Canada serving as resource persons and facilitators. They represented an incredible diversity of people and topics, including both freshwater and marine small-scale fisheries.

Workshop summary

Each day of the workshop included case-study presentations followed by time for questions and discussion about the presented work in relation to the framework of the assessment of economic viability.

Economic viability and small-scale fisheries

The workshop began with the presentation of each participant and an introduction to the *TBTI* partnership by the workshop organizers. This was followed by a more detailed introduction to Working Group 2 and an interactive presentation and discussion on economic viability, its meaning and definition in general and for small-scale fisheries. Participants were asked which word came to their minds when they heard the word 'economics' and a list on the white board was put together based on the answers (Fig.1). The next question was about the meaning of economic viability and then about the meaning of discounting, answers were noted on the whiteboard (Fig.1).

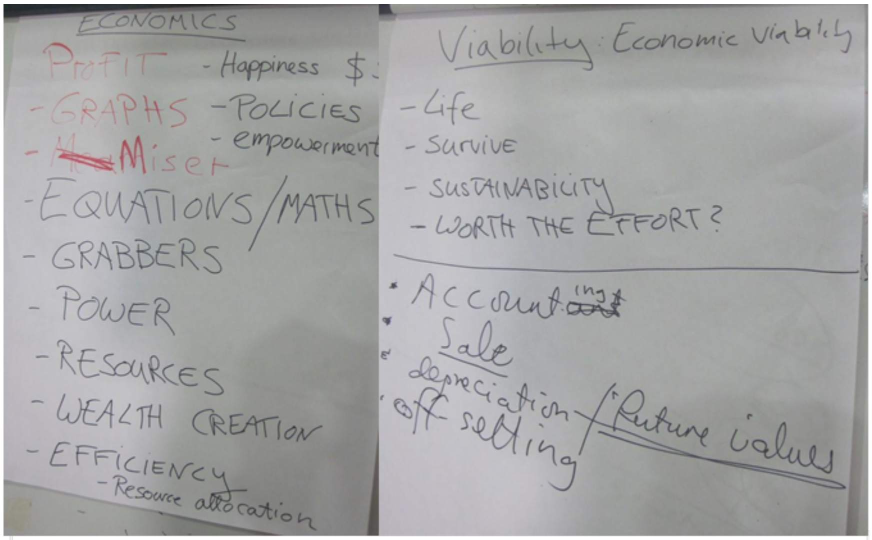

Figure 1 Whiteboard showing brainstorm results from workshop participants on the meanings of 'economics' and 'economic viability'

The main message captured from the brainstorm results was that economic viability describes the long term survival of an economic entity and this very much agrees with what was presented from the literature. The very vivid discussion brought everyone on the same page and it became clearer for all participants how economic viability is defined for the purpose of this study.

The brainstorming exercise was followed by a presentation of the economic viability framework. The presentation described the main differences between economic and financial viability and aimed at explaining why it is essential to have a comprehensive view when assessing economic viability of small-scale fisheries. Furthermore, the methodology using rapid rural appraisal techniques as well as a regression model were presented and discussed. Participants were curious whether the framework had been applied yet and when noted that it had not, they wanted to know how they will be able to use it. It was clarified that at this point in time the framework was not finalized. However, it was explained that once the input from all participants during the workshop was integrated, the framework would be tested at a case-study level.

It was decided that the discussions would continue throughout the workshop. Additionally, the workshop participants were asked to critically review the attributes identified in the presented framework during each of the case-study presentations. To evaluate the attributes in a schematic manner a set of criteria were presented to facilitate the review. Criteria to assess the attributes were: relevance, understandability, time, ease of interpretation, practicality, measurability objectivity and accuracy. The main discussion section was then planned to be at the last day of the workshop.

The following sections describe the main discussion points of each of the presented case-studies in relation to the developed framework to assess economic viability of small-scale fisheries. The outcomes of these discussions will then serve as the basis for improving the current framework, see below.

Case study presentations

Subsistence fisheries of District of Palma, Province of Cabo Delgado, Mozambique

The case study describes a subsistence fishery, i.e., fishers fish to survive and to eat, not to maximize profit. Therefore, it is a big challenge to assess the economic viability of this fishery if no money is made from it. Three main concerns were raised regarding the usefulness of the current framework in regard to costs, employment type and the lack of a formal organization of the sector. Questions raised included: how can costs be divided into fixed costs and variable costs for a fisher who has no boat and collects invertebrates from the reef; how employment types can be categorized if each fisher does many different activities of which not all are related to fishing; and how all the fishing activities can be assessed when there is no formal record of this fishery in the government sector.

Lake Albert Fishery, Uganda

Presentation from the National Fisheries Resource Research Institute:

This fishery is multi-gear and multi-species and has been poorly documented in the past. However, information is now being collected, including: fishing effort (landing sites, number of fishers, number of boats active, registered gear and even some illegal activity); key social issues (shared resources across borders and communities; diseases, oil exploitation); management (co-management in place, Beach management Units, but mainly policies on paper and not properly implemented).

The biggest challenges for this fishery that were mentioned are: the government is not able to play its role effectively as they lack knowledge and skill; there is not a large enough NGO presence to support the government sector with its tasks and the private sector and the fishing communities don't know how to fix current issues.

Important issues raised in relation to the economic viability framework are: e.g., how does the framework deal with trans-boundary fisheries and with illegal fishery (power struggles). Lots of information is being collected now and most of it reported to FAO, however, not much is being done in regard to implementing management strategies to improve overfishing, social issues and economic underperformance.

Interesting interview results show answers to the following question the fishing people were asked: what do you think are the main drivers to profitability of your fishery? Answers were: 1. High demand for the products; 2. Effective fisheries regulations; 3. A stable market (stable prices); 4. Access to roads (that can withstand harsh weather conditions); 5. Access to credit and 6. Refrigeration

Discussion points which are directly related to the framework are:

- How to take into account external factors that can influence the economic viability of SSF e.g., oil exploitation?
- How can trans-boundary issues be represented in the framework?

Lake Victoria Fishery, Kenya

A description of the current situation of the herring (*Rastrineobola Agentia*) fishery of Lake Victoria, Kenya

The main discussion points were that the fishery seems to be currently profitable, however, mainly due to overcapacity, destructive gear and overfishing that it won't be economically viable considering the future. This could be improved by educating fishing people and the community as well as by helping them to change from destructive gears (e.g. small mesh sizes) to more effective and sustainable gears. Furthermore it seems difficult to implement any regulations as there are so many active fishers with very low opportunity cost. However, not much information is available and there is a current lack of control from the government. It was mentioned that women were involved in the fish trade, however no detailed information is available.

Adaptation of artisanal fisher folk to Climate Change, Region of Ondo, Nigeria

This presentation thoroughly discussed results from a study in a small coastal fishing village in relation to threats due to climate change. Main results show how fishers often and willingly adapt to climate variability that occur in the region, however, they do not seem to be prepared for long-term climate changes. Therefore, even though currently the way the fishery operates seems viable, they do not seem to be economically viable when considering the future.

One main question in regard to the framework was about how education is useful for the fishing people to be able to adapt to potential impacts of climate change in their region.

Beach Seine Fishery in Ghana

After a thorough description of Ghana's fishery and its national economic data, the presentation focussed on Ghana's beach seine fishery which comprises 12% of the total artisanal fishery production. The beach seine fisheries operate on 154 beaches and have 1074 beaches seine units in operation. Catches are decreasing, gear is very destructive, women are the main traders and often owners of the gear, fish sizes are often very small and biomass has to make up for low prices, there is a high dependence of people on fishing for their living, canoe owners provide security, low access to loans, open access fishery and there usually are fuel subsidies in place. The institutional framework is weak and monitoring and regulations almost absence.

Currently the fisheries seem to make enough for the fishers to live from, however, due to the very destructible gears used, does the ecological sustainability suffer, which will drive the fishery down in the long-run. Furthermore, social conflicts (between fishers and canoe owners) and other social issues (health, child labour) are common, which negatively impact economic viability. Research has been carried out already showing that the fishery is not sustainable (mainly based on ecological reasoning), however, due to political pressure (amount of people who would lose their jobs) was not closed or restricted.

Continuous socio-economic monitoring is necessary to carry out an assessment of the economic viability of Ghana's beach seine fishery.

Small-scale marine fisheries on the south coast of Kenya

This presentation was aimed to describe a possible PhD project related to livelihood impacts and value chain characteristics of the south Kenyan marine small-scale fisheries.

The fisheries showed an increase of number of fishers since 2004 and most fish in dugout canoes. Frameworks that were presented and discussed to be used in this study were a Value Chain Analysis combined with the Sustainable Livelihood Approach. Measurable attributes where presented based on economic analysis which are currently presented in the economic viability framework. The main discussion was based on which research question and methodology would be best suited to assess this fishery case study.

Overberg district small-scale fishery in Cape Aghulas, South Africa

The description of the small-scale fishery of Overberg shows a very dynamic and variable fishery, which mainly exports its catch rather than selling it to the local community. It is an important fishery for the community. However, the main local industry is tourism whereas the main income from tourism does not benefit the local community.

Each attribute of the economic viability framework was assessed in relation to the current information available on the Overberg's fishery. Most attributes seem to be measurable and relevant to the fishery. Attributes that were seen as difficult to measure were: Employment type, dependence of fishing, access to finance and number of jobs.

It was suggested that immigration could be added to the attribute list of the economic viability framework as it would provide more information on the dynamics of the fishing community.

Economic viability of inshore linefish resources, South Africa

Currently there are four frameworks being developed to assess the South African linefish fishery. Linefish is considered fish that is caught with lines compared to fish caught trawling. The frameworks are being developed to explore and assess economic viability, the governance system in place, the value chain of the products and the food system in place.

One of the main issues this fishery is facing stems from socio-economic problems involving the process of resource allocation. This reflects a generally inequity among people who live in and around Cape Town, this is also reflected by the Gini coefficient which is very high for this area, i.e., an unequal distribution of wealth among the people. Furthermore, ex-vessel prices are very low compared to end sale prices and much profit is made along the value chain. Hence, a value chain analysis related to this fishery is very important.

There is a good amount of data collected and available for this fishery, including information on number of crew on board the vessels, number of fish caught (or landed), price per fish (ex-vessel prices) and revenue made per day. Furthermore, fishers record in their logbooks the reasons for not fishing on specific days, e.g., if the weather was bad or the price of fish too low.

A discussion following the presentation included the need for a definition of SSF, or why it is not needed; a clear definition of economic viability; a definition of a single fishing unit (e.g., a boat, a fisher) and if a fisher can be viable only because he/she has a job, even though that income is below the poverty line.

Tanzanian Fishery, Lake Victoria, A case of Magu district

The small-scale fisheries of Lake Victoria, the largest lake in Africa, contribute about 60% of total fisheries landings in Tanzania. These fisheries contribute about 2.5-3% of Tanzania's GDP, employs 500,000 directly and about 2 million people indirectly. It is a multi-species and multi-gear fishery.

The presentation focused on assessing and comparing current available information of the Lake Victoria small-scale fisheries with the attributes from the economic viability framework. It became clear that most attributes are relevant and measurable.

Main discussion points included how to incorporate management expenses and cultural attachment to the fisheries into the framework.

Tanzanian Fishery, Mafia Island

Mafia Island is located off the central coast of Tanzania in the Indian Ocean. The island's marine park covers most of its coastline, and major economic activities are tourism, fishing, agriculture and mariculture (seaweed farming). There is some information on the fishing activities and its economics. However, Mafia's main income comes from tourism, which has been reported to have positive effects on the marine ecosystem due to the marine park which protects parts of the marine biodiversity. It was discussed how social aspects and problems such as alcohol and drug abuse could be considered in the economic viability assessment as they have been observed to play a major role in the fishing community possibly effecting its viability. Furthermore, it would be interesting to explore how much influence the tourism sector and its activities really have on the fisheries economic viability.

Morocco's Small-scale fisheries

Morocco's fishing fleet consists of an offshore fleet (447 large industrialized vessels), a coastal fleet (2562 decked wooden boats) and an artisanal fleet (15000 wooden boats, with outboard motors). The coastal fleet is considered the medium-scale fishery which presents the main fish supplier for the local market. On the other hand, products from the large-scale fishing fleet are more directed towards the export market. Not much data are available describing the artisanal fleet, however, it has grown substantially mainly due to the profitable octopus fishery. Fisheries altogether account for about 3% of Morocco's GDP. Currently new development and management strategies are being developed. The artisanal fleet has a special interest in these developments as they see a potential for increasing the wealth which is generated from fishing. A first case-study on the fishery was carried out giving out some preliminary data on the situation of the artisanal fishing sector. However, because signs of resource depletion are evident the ecological limitation of the artisanal fishery need to be better understood.

Women and Economic Viability of SSF in Africa

EMEDO – Environmental Economic Development Organization and WFF – The World Forum of Fish Harvester and Fish Workers

This presentation demonstrated a very successful implementation of an Alternative Livelihood Strategy, which helped a group of fishers become sustainable farmers. Not only helping them at the beginning but supporting them throughout the process of developing new skills and adjusting to a new lifestyle was a key factor to success. This strengthened the implementation of the project and therefore reduced the fishing effort/capacity as well as provides the fishers with a sustainable livelihood. An important discussion point in the presentation was how important it is to understand the dynamic of the fishing community in focus, especially networking mainly with women fishers is essential as they are often overlooked when management strategies and livelihood planning are being carried out in fishing communities. As an example of a successful alternative livelihood implementation, this could serve well for other places in the world where fishing communities face similar challenges.

Capacity Development examples from South Africa

The main focus of this part of the workshop was to help the participants find ways and be encouraged on how to mediate or facilitate between fisheries science and policy, how to be involved in policy making and how to tackle challenges in communication.

Questions that were discussed included: How can fisheries research be effectively used and applied, so policy and management can be improved based on research results? How can the fishing sector, specifically when already marginalized be more aware and involved in policy making? Described as trans-disciplinary action research, guiding from local to regional to international policy making, this policy development is crucial for many fishing communities, especially as policy is often not understood or misunderstood by the people. The idea that even without the support of the government, little changes can be made and research can be used to help make fishing communities aware of the policies in place. Rectifying the isolation of the fishing communities from policy is the first step to be able to improve the policy in place where necessary. In South Africa a community handbook was developed which explains the current policy and its changes to the people in an understandable manner.

General discussion regarding the improvement of the current framework to assess economic viability of small-scale fisheries

By bringing together the workshop participants it was possible to hear very different case-studies, each reflecting how the economic viability framework can be used most effectively, which attributes should be revised, which work well and which might be easily misunderstood or very difficult to measure. We acknowledged the uniqueness of each case study and at the same time agreed that all are facing similar issues which need to be addressed.

The above mentioned points of discussions were summarized and presented at the end of the workshop, to reflect how best these can be used to improve the current framework.

To review and possible integrate into the framework and discussed comments:

- Extend involvement of community in post-harvest activity - if post-harvest activity are part of the community then they will be assessed;
- Trans-boundary issues, shared resources with other countries or regions who have different management (or no management);
- Fishers' perceptions to drivers of profitability --> adapt to find perceptions on drivers to economic viability;
- What about waste due to bad processing or bad selection methods --> leads to low EV,
  This is already captured in formula TR = price x (harvest -wasted harvest);
- How are external factors captured? E.g., oil exploitation? -> This falls into the category of large scale-processes. When the fishery is considered economically viable, it will be better prepared to these threats;
- Possibly include in the attribute 'access to finance' an attribute describing on how well the financing is being used once access is granted.

B2 An indicator based framework **

While maintaining a comprehensive view this framework focusses on assessing the key components affecting economic viability, using economic and socio-economic attributes. At the same time other partners and contributors of the TBTI network of SSF research will address and focus their work on governance, livelihoods, rights, stewardship and ecosystem aspects of small-scale fisheries, which in the broader sense, as explained above, also affect the economic viability of a fishery. Viability is a very broadly used term mainly to describe the long term survival of an entity, a sector, a social structure or a population of a given species.

The objective of this document is to present a framework useful to assess economic viability of small-scale fisheries. While maintaining a comprehensive view by understanding the different dimensions that play a role in any fishery, the current framework focuses on assessing the components affecting economic viability, i.e., economic and possibly socio-economic attributes.

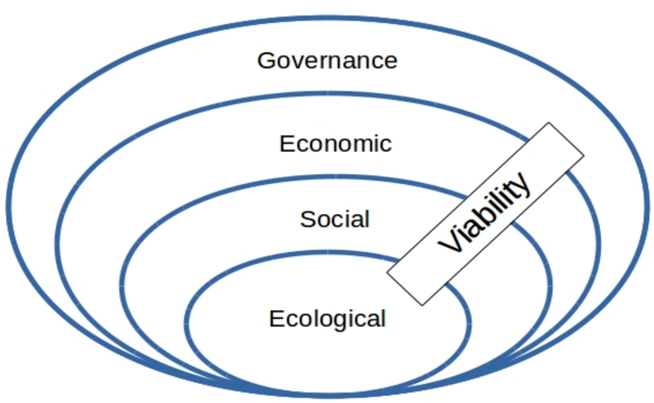

Figure: A framework describing viability for small-scale fisheries.

** A version of the framework is published: http://toobigtoignore.net/wp-content/uploads/2014/10/EV-framework_March-2015.pdf (last accessed Feb 2017).

Framework

Working list of attributes collected to assess the economic viability of

Nº	Economic Attributes (unit)	Definition	Sources and measurements
1	Landings (t)	Amount of fish in weight landed at port in a given period (e.g., a day or year).	For national numbers see FAO and SAUP (*Sea Around Us Project*, specifically catch reconstruction data) database. For case studies check grey literature, e.g., government reports; conduct surveys; and monitor the landing.
2	Ex-vessel price ($)	Price received by fishers at the dock per unit weight of fish sold (Sumaila et al., 2007).	For national numbers see *Fisheries Economic Research Unit* (FERU) and SAUP database (Sumaila et al., 2007 and Swartz et al., 2013) For case studies check grey literature e.g., government reports, conduct surveys, log book, buyer record
3	Total Cost of fishing ($)	Total cost represents the value of inputs at the next alternative best use. Cost is split up into fixed cost, which do not change with production (e.g., capital investment, sunk cost) and variable cost, which can vary based on the output (e.g., fuel, crew, maintenance) per tonne of catch. The total cost includes opportunity cost which makes it different from accounting cost. (Lam et al., 2011).	For national numbers see FERU database (Lam et al., 2011). For case studies check grey literature, e.g., government reports and/or conduct surveys.
4	Subsidies ($)	Subsidies are defined here as financial transfers, direct or indirect, from public entities to the fishing sector which help the sector make more profit than it would otherwise (Sumaila et al., 2010).	For national numbers see Sumaila et al. (2016) For case studies check grey literature, e.g., government reports and conduct surveys and interview key informants.
5	Proportion of SSF to LSF landing (%)	Landings of SSF divided by total landings of a given fishery.	Calculate the ratio of SSF landings to total landings of the fishery .
6	Cost structure (ratio)	Cost structure is the ratio of fixed costs (e.g., capital investment) to variable costs (e.g., fuel).	For national numbers see FERU and SAUP database (Lam et al., 2011). For case studies check grey literature, e.g., government reports and/or conduct surveys.
7	Discount rate (rate)	The economic discount rate (r) is a measure of the current value of future benefits, it allows us to convert values to be received in the future into values today ($1 received today is considered more valuable than $1 to be received in the future).	To take intergenerational justice into consideration it is suggested to use approaches such as the one proposed by Sumaila and Walters (2005) for both national and regional studies.
8	Multiplier (factor)	Describes indirect income (income multiplier) and induced effects on society (economic multiplier) through fisheries. A multiplier is a factor by which we can multiply the value of final demand for an economic activity's output to obtain its total contribution to economic output including activities directly and indirectly dependent on it.	For national numbers see FERU database and Dyck and Sumaila, (2010) for both income and economic multipliers. For case studies adjust the national multipliers (both income and economic multipliers) either using reports and/or surveys.

Nº	Socio-economic Attributes (unit)	Definition	Sources and measurements
9	Number of jobs per employment type	Number jobs highlights the contribution of fisheries employment including both commercial and subsistence marine SSF. Employment type describes how a worker is employed. For example the International Labor Organization (ILO) classifications are: employees, employers, own-account workers, members or producer cooperatives, contributing family workers, workers not classifiable by status. These can be adjusted to fisheries (e.g., boat owner, paid by catch share, employed by a company/cooperative).	For national numbers see (Teh and Sumaila, 2013), ILO and FAO. For case studies review FAO, government reports and carry out surveys (government agencies, NGOs and/or fishers).
10	Degree of economic dependence on fishing (%)	It determines the fraction of total fishing unit or society income that is generated by the SSF sector.	Use GDP assessment and calculate both the income of family member fishing and income of whole household from fishing and compare to the total income of the fishing community. Assess reports (government agencies) and/or conduct surveys and interview key informants.
11	Distribution of benefit within the fishing community (coefficient)	A measure of equity among different groups in society or a community.	The gini coefficient could be calculated here to find out about the wealth distribution among the society.
12	Access to finance (various)	Denotes the extent to which fishers or fishing cooperatives can access financial services (e.g., credit, deposit, insurance).	World Bank: siteresources.worldbank.org/.../Resources/CalariParisSpeech.pdf (also see (Abila et al., 2006; Allison et al., 2012; Charles, 2011).
13	Fish consumption per capita (g/capita)	This is the amount of fish or seafood per capita being eaten by a fishing community in a given period (a month, a year, etc.)	For both national and case study level use existing data from FAO, government reports and conduct household surveys.

Analytical approaches

Three main methods will be used to analyze the collected data: 1) Compute net benefits from SSF to society and to the private sector, respectively; 2) A Principal Component Analysis; and 3) A Generalized Linear Model.

Economic viability

Economic viability, equal to the net benefits to society, will be computed using equation 2 (section 3.2.1.) and financial viability, equal to the net benefits to the private sector (the fishing unit) will be calculated using equation 1 (section 3.2.1). This can be carried out on a global level using national data as well as at a case study level. For this study the focus lies on the global assessment only and available data from attributes 1 to 4 for each coastal country will be used.

Principal Component Analysis

The Principal Component Analysis (PCA) is a form of multivariate statistics. Using PCA, patterns in data can be identified through highlighting similarities and differences, which is often difficult when using data with many dimensions. The PCA is used to reduce the original variables into a lower number of non-correlated synthesized variables (or factors) and the visualization of the correlation. Each measured attribute (table 1) forms a data point in the PCA. Hence, the approach will help us identify correlations and patterns of the assessed attributes.

Generalized Linear Model

To test attributes 5 to 13 and their importance and contribution to economic viability, a generalized linear model (GLM) will be created. Each measured attribute is considered a variable in the model and the goal is to understand each variable's relationship and how each specifically influences economic viability. It should be noted that both quantitative and qualitative data can be used in a generalized linear model, the latter through the use of a dummy variable, which can categorize information into, for example, Boolean indicators such as 0 and 1 or 'absence' and 'presence'.

Appendix B Literature

Abila, R.O., Odongkara, K.O. and Onyango, P.O. (2006) Distribution of economic benefits from the fisheries of Lake Victoria.

Allison, E.H., Ratner, B.D., Åsgård, B., Willmann, R., Pomeroy, R. and Kurien, J. (2012) Rights-based fisheries governance: from fishing rights to human rights. *Fish and Fisheries* **13**, 14–29.

Charles, A. (2011) Small-scale fisheries: on rights, trade and subsidies. *Maritime Studies (MAST)* **10**, 85–94.

Dyck, A.J. and Sumaila, U.R. (2010) Economic impact of ocean fish populations in the global fishery. *Journal of Bioeconomics* **12**, 227–243.

Sumaila, U.R., Lam, V., Le Manach, F., Swartz, W. and Pauly, D. (2016) Global fisheries subsidies: An updated estimate. *Marine Policy*.

Sumaila, U.R., Marsden, A.D., Watson, R. and Pauly, D. (2007) A Global Ex-vessel Fish Price Database: Construction and Applications. *Journal of Bioeconomics* **9**, 39–51.

Sumaila, U.R. and Walters, C. (2005) Intergenerational discounting: a new intuitive approach. *Ecological Economics* **52**, 135–142.

Swartz, W., Sumaila, R. and Watson, R. (2013) Global Ex-vessel Fish Price Database Revisited: A New Approach for Estimating “Missing” Prices. *Environmental and Resource Economics* **56**, 467–480.

Teh, L.C.L. and Sumaila, U.R. (2013) Contribution of marine fisheries to worldwide employment. *Fish and Fisheries* **14**, 77–88.