GENDER AND SMALL-SCALE FISHERIES IN THE CENTRAL PHILIPPINES

by

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Abstract

This dissertation provides new evidence for why women should be included in small-scale fisheries assessments. Women are commonly overlooked in fisheries science and management because they are assumed not to fish, or to fish very little. My research focuses on community-based managed fisheries in the Central Philippines. I begin with a literature review of women's fishing around the world, revealing that it is common, diverse, and dynamic. Women fishers also often focus on species and habitats different from those in men's fishing. Notably, however, the review also identified a considerable data gap in quantitative assessments of women's fishing.

I designed my case study specifically to quantify women's contributions to the total community catch and effort. I found that women – who totaled 42% of all fishers – generated about one quarter of the total fishing effort and of the catch biomass. Explicit consideration of women's fishing cast a spotlight on gleaning, an overlooked fishing method in which animals are collected in intertidal habitats. Almost all the women and half of the men gleaned. I found that gleaning primarily targeted sessile invertebrates, and was an important source of food, particularly when other fishing was not available.

Marine management that affects gleaners – such as no-take marine protected areas (MPAs) placed in intertidal areas – needs to consider distinct ecological and social features of gleaning. On that basis, I used a gender lens to examine community-based management in the form of no-take MPAs. In this cultural context resource management is a male sphere, both in perception and in practice. Women were less likely to feel that the MPA had a positive effect on their fishing, with MPAs mostly identified as a

management measure for finfish. Women were also less likely to participate actively in MPA management.

In summary, my focus on women should prompt reexamination of how fishing is defined, who counts, and who is counted. Integration of women's issues into fisheries management requires attention to gleaning, and exploration of alternative management methods. To overlook women, however, creates substantial underestimation of fishing labour and catch – with consequent worsening of our prospects for fisheries management globally.

Preface

Chapter 2 and Chapter 3 found in this thesis have been published in peer-reviewed journals. The references in order are as follows:

Kleiber, D., Harris, L.M., and Vincent, A.C.J. 2014. Gender and small-scale fisheries: a case for counting women and beyond. Fish and Fisheries. DOI: 10.1111/faf.12075

Kleiber, D., Harris, L.M., and Vincent, A.C.J. 2014. Improving fisheries estimates by including women's catch in the Central Philippines. Canadian Journal of Fisheries and Aquatic Science. **71**: 1–9.

Chapter 4 and Chapter 5 are in preparation for submission.

I am the senior author on all papers, and with the exception of Chapter 4, my co-authors are Leila M. Harris and Amanda C. J. Vincent. In Chapter 4 I am the sole author. I took primary responsibility for the research contained in the papers including the design, data collection, analysis, and all data used in Chapters 3-5 was original data I collected in the field. Dr. Leila Harris and Dr. Amanda Vincent contributed their expertise and advice with ideas, research design, funding for preliminary field research, research facilities and connections, as well as guidance and edits that helped structure the papers. Further details of co-authorship contributions to the research questions in each paper are outlined below.

Chapter 2 – The idea for a review of the gender and fisheries literature was developed by Dr. Leila Harris and myself. I did the literature review, coding and developed and implemented the analysis. I wrote the manuscript and it was edited by Dr. Leila Harris and Dr. Amanda Vincent.

Chapter 3 – I developed the ideas for a focus on the characterization and quantification of women's fishing with Dr. Amanda Vincent and Dr. Leila Harris. I came up with the original idea to also examine the contribution of overlapping categories of gleaners and part-time fishers. I collected and analyzed all the data, and wrote the manuscript. The manuscript was edited by Dr. Leila Harris and Dr. Amanda Vincent.

Chapter 4 – I developed the idea to examine the economic and food security contributions of gleaning fisheries, and to model the social and biophysical attributes of gleaners. I collected and analyzed all the data, and wrote the manuscript. The manuscript was edited by Dr. Leila Harris and Dr. Amanda Vincent.

Chapter 5 – Dr. Amanda Vincent came up with the original idea to examine the role of gender in community-based management of marine protected areas. I developed the research design and carried out the research, analysis and writing. The manuscript was edited by Dr. Leila Harris and Dr. Amanda Vincent.

This research received Human Ethics (H10-00823) approval from UBC.

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I dedicate this thesis with love and countless thanks to Drs. Nancy and Pierre Kleiber, the feminist anthropologist and fisheries biologist, who, with good humor and much patience raised a feminist fisheries scientist

1. Introduction

Context

Gender is a key variable when examining natural resource use and management. This is in part because women and men often interact with the natural environment in different ways. How researchers and agencies have approached and engaged with the gender and environment nexus has evolved over time (Elmhirst and Resurreccion 2008). The examination of the intersection of gender and natural resources began in the 1970's and 1980's, influenced in part by the UN women's decade (1975-1985), which highlighted the absence of women in global development programming. Later influence in the 1990's came from concerns about environmentally sustainable development, exemplified by the United National Conference on Environment and Development in Rio de Janeiro (1992). International and national policies and programs related to gender, development and the environment were heavily influenced by the objectives derived from these meetings. Work related to gender and fisheries has gone through a similar trajectory starting with a focus on women and broadening to incorporate the interactions between women and men using gender approaches within specific cultural contexts (Walker and Robinson 2009), as well as including cultural and political context (Resurreccion and Elmhirst 2008).

Documentation of women's fishing is largely in small-scale fisheries contexts. Small-scale fisheries – frequently characterized as multi-method, multi-species fisheries – are a key source of food and livelihood throughout the world, but are vastly underreported. Small-scale fisheries continue to be unaccounted for in national fisheries statistics, resulting in severe underestimations of catch weight and fishing effort (Zeller *et al.* 2007; Metuzals *et al.* 2010). The quantification and characterization of small-scale fisheries

using traditional fisheries assessment methods are hindered by 1) a lack of research capacity (McCluskey and Lewison 2008), and 2) the diversity of fishing strategies in complex ecosystems (Andrew *et al.* 2007). Small-scale fisheries may account for over half of the catch of developing country fisheries (FAO and WorldFish Centre 2008), and characterize up to 90% of the world's fishers (Béné *et al.* 2007). To overcome deficits in data and research capacity, techniques have been developed to quantify and assess small-scale fisheries using fisher knowledge (Neis *et al.* 1999; O'Donnell *et al.* 2010). To account for fisheries, ecosystem, and social complexity, socio-ecological approaches to fisheries have been developed (Pomeroy *et al.* 2010).

Women's participation in small-scale fisheries has been described but rarely quantified (Quinn and Davis 1997). Descriptions of women's fishing challenge the notion that small-scale fishing is exclusive to men (Weeratunge *et al.* 2010), but the lack of characterization and quantification of women's fishing – or of other minority or marginalized groups – has consequences for the understanding and management of small-scale fisheries. First, it accentuates the data scarcity in small-scale fisheries that results in the underestimation of fishing effort and catch at local, national, and global scales. Second, it overlooks specific fishing methods used, and the diversity of animals and habitats exploited by fishers. The consequence is an incomplete understanding of the human role in the marine ecosystem, which creates a barrier to ecosystem level management. Finally, in a community-based management context it overlooks potential social barriers that may hinder women and other minority groups from participation in decision-making that nonetheless affects them.

A gender approach to fisheries fits well with ecosystem-based management and other approaches that intentionally incorporate social and ecological understanding and work at multiple scales. A gender approach attentive to women's specific fishing practices produces a more comprehensive understanding of the totality and diversity of pressures on the marine ecosystem. Gender is a key variable to the characterization of small-scale fisheries because women and men often fish in distinct ways, and for different reasons (Chapman 1987). While there is a great deal of diversity in how and why women and men fish throughout the world, women's fishing is often found to be primarily for subsistence use (Bliege Bird 2007).

Based on the literature available there is evidence that women's fishing contributes to local economies and food security. While women's catch is often used exclusively for subsistence, it may also have a significant economic value. For example Spain's mostly female *mariscadoras* fishery had an estimated worth of 47 million € in 2001 (European Commission 2003). In addition, women's catch may be an important source of protein, and hence food security in a number of settings. In South Africa shellfish gleaned by women supplied 8% of the annual protein consumption of one coastal community (Hockey *et al.* 1988), and in a village in Fiji the gleaning efforts of 70 women were an important source of food for between 300-500 people from low income households (Quinn and Davis 1997). Furthermore, in the Democratic Republic of Congo women's fishing as a family food source was found to be particularly important to poorer families (Béné *et al.* 2009). Marine management that overlooks women's fishing may inadvertently discount a key source of livelihood both in terms of economic and food security.

Any consideration of women's roles in fishing must also consider their relationship with fisheries management. This is particularly true with regards to community-based management and decision-making (Aswani and Weiant 2003; Pajaro *et al.* 2010; Di Ciommo and Schiavetti 2012; Clabots 2013). In fisheries management, women are often absent because their role in fisheries is assumed to be negligible or subsidiary to that of men (Weeratunge *et al.* 2010). Gender differences in fisheries labour, coupled with the devaluation of women's contributions or social and political barriers can lead to an absence of women's engagement and priorities in decision-making processes.

Marine protected areas (MPAs) have become a central tool in community-based fisheries management (Jameson *et al.* 2002; Wood *et al.* 2008) with little or no reference to their implications for women. The gender dimension of MPAs in ecological terms lies in the often-distinct species and habitats exploited by women and men. MPAs may have different effects (both positive and negative) on the sessile invertebrates women often target in intertidal habitats, and men's target species of finfish and mobile invertebrates in subtidal habitats. The role of MPAs in conserving fish and coral is well recognized (Halpern 2003), but the utility of the MPA as a fisheries management tool is not as clear. This is particularly true with respect to sessile invertebrate species, for which scant literature on MPA impacts can be found (but see Hockey and Bosman 1986; Benzoni *et al.* 2006). The limited work that is available shows that MPAs can improve spill-over and larval dispersal of fish and mobile invertebrates (Halpern and Warner 2002) but that their main role for sessile species may lie with larval dispersal (Aswani and Weiant 2004a). However, MPAs have been placed in intertidal habitats with the potential to displace women and other intertidal fishers.

Approaches

In this thesis I take an interdisciplinary approach to explore the implications of including women in small-scale fisheries characterization and quantification. My research draws from the interdisciplinary fields of fisheries science and gender studies. In both fields, there is an explicit connection between social and ecological frameworks. Taking a gender approach to community characterization of fisheries my research intentionally includes women and men. Specifically, I collected gender-stratified data so that my findings related to women's fishing would be a part of rather than isolated from a broader community scale characterization of fishing. I used a literature review and a case study I conducted in the Central Philippines as my data sources. In my research I quantified and characterized small-scale fishing practices of women and men, and further examined fishing from livelihood and management perspectives. These investigations enabled me to answer four main questions that form the structure of my thesis:

Research questions

1. What is the current understanding of women's participation in small-scale fisheries from an ecological perspective, and what are the main data gaps?
2. How does the inclusion of women's fishing change the characterization of community-wide fishing practices and the quantification of total catch and effort?
3. What contribution does gleaning make to economic and food security aspects of livelihood?
4. What role does gender play in the management of local marine resources through community-based marine protected areas?

Thesis outline

This thesis contains a review (Chapter 2), three chapters based on primary data collected in the Central Philippines (Chapters 3, 4, and 5), and a concluding chapter (Chapter 6).

In Chapter 2, I conduct a literature review of the past 20 years of research documenting women's small-scale fisheries. In the review I include an examination of the diversity and mutability of gender roles in small-scale fisheries, and the social contexts that shape and govern those roles. I also identify some key data, and outline some specific biases in data gathering that may exclude women's fishing.

In Chapter 3, I quantify community fishing effort and catch mass stratified by gender. This responds to a major data gap identified in Chapter 2: the dearth of quantification of women's fishing, I also look at the differences in catch composition for gleaners and non-gleaning fishers to identify potential differences in targeted species groups.

In Chapter 4, I take a livelihoods approach to examine the contributions of gleaning economically and as a source of food security. This responds to the Chapter 2 and Chapter 3 findings that gleaning is strongly associated with women's involvement in small-scale fishing. I also identify key social and biophysical factors that explain variation in the probability of being a gleaner, and individual gleaning effort.

In Chapter 5, I examine the management context of gender and small-scale fisheries by exploring the perceived effects of the MPA on women and men's fisheries and why women and men do or do not participate in community-based management of their MPA.

In the conclusion I discuss the implications of gender analysis for small-scale fisheries and their management.

Case study context and collaborations

My field study research took place in the Northern Bohol section of the Danajon Bank in the Central Philippines. The Danajon Bank region consists of many small communities on atolls but is also generally extended to refer to the coastal communities situated in larger terrestrial islands off the Bohol mainland. Poverty and food insecurity is prevalent throughout the Visayas region (Guieb 2008; Fabinyi 2012). Overfishing and destructive fishing activities have put tremendous pressure on the marine ecosystems in this context (Christie *et al.* 2006). Marine management is decentralized to municipal and community levels – the latter are called barangays – (Lowry *et al.* 2005) and often focuses on marine protected areas (MPAs).

Fishing is often characterized as something only men participate in, but women have been documented fishing in this region (Guieb 2008; Clabots 2013), as well as elsewhere in the Philippines (Illo and Polo 1990; Siar 2003). Fisheries and marine conservation assessments have given much greater attention to the fishing practices of men (Green *et al.* 2004). Previous anthropological studies in this area found that women were primarily gleaners in intertidal habitats, while men typically fished in subtidal habitats by diving or using nets, hooks, or traps (Guieb 2008).

I worked in 12 communities: six communities with MPAs that overlapped with gleaning areas (intertidal habitat), and six communities with MPAs separated from gleaning areas (only subtidal habitat). All MPAs were actively managed by the community. Long-term research related to the creation and protection of MPAs in this area has focused on fish abundance and biodiversity and coral cover, and has only just expanded to include macro invertebrates as well.

Project Seahorse – my research home – has worked in the Danajon Bank region since 1993. Its Philippines activities evolved into a local conservation NGO, Project Seahorse Foundation for Marine Conservation (PSF), which has worked in Danajon Bank communities since 2003. PSF supported my research by providing connections to the local community, rich advice on approaches and issues, and access to facilities and equipment. In turn, the results of my study were presented back to PSF and the study communities to inform ongoing management practices and conservation activity.

This study area offered an excellent opportunity to conduct gender and small-scale fisheries research. Its history of MPAs and community-based management also provided a context in which to explore gender and marine management. The few previous studies of gender as it relates to fisheries and management in the Philippines illustrate the human dimensions of fisheries through ethnography and the study of ecological knowledge (Illo and Polo 1990; Siar 2003; Fabinyi 2007). My focus, in contrast, is on quantitative assessments and characterization of fisheries. My research has allowed me to explore the implication of a gender approach to the characterization and quantification of small-scale fisheries, and examine the implications for our understanding of livelihood and management.

Case study data collection

To characterize small-scale fisheries, fishers, and management a number of different data collection methods were used. I worked with 4 local biologists; so all interactions were conducted in the native language of Cebuano. All methods and interviews were tested, and practiced during a weeklong training session prior to data collection.

1) Survey of women and men (16+ years old)

In each of the 12 communities we gained permission from the community leaders to access the community census data. The community census is recorded every year by community health workers. The census is organized by neighborhood and household with the name, age and gender of each person. Non-resident relatives are often included. The census was mostly handwritten in notebooks, so we transferred the data by first taking photographs of each page, then entering codes related to the page and line of each adult in the community into an excel spreadsheet. Women and men from each community were listed separately, resulting in 24 lists. Each list was randomized separately. The "rand" command - which generates a random number - was used in the in the adjacent cell of each coded individual. The list was then sorted by the corresponding random number, and the codes at the top of the list were translated back into names of respondents in the photographed census pages.

We defined community as people that lived as residents of the community for the majority of the year. Initially we wished categorize randomly selected respondents as either fishers or non-fishers. However the community census included large numbers of family members that were no longer residents, with the result that the population size and sex ratio of residents was not accurately reflected in the community census. To generate accurate population sizes, sex ratios, and number of female and male fishers in each community the randomly selected respondents (752 women, 755 men) were categorized as either 1) resident fishers (they had taken wildlife from the ocean in the last year), 2) resident non-fisheries, or 3) non-residents (Chapter 3). Most randomly selected respondents were asked directly, but in the case of non-residents, we determined their

status by asking a key informant (typically the barangay health worker or other community leader).

2) Fishing interviews

Among the survey respondents that were resident fishers we interviewed 25 women and 25 men in each community regarding their fishing activities. The interviews were semi-structured and began with demographic variables such as age, gender, material wealth, and food security (Chapter 3, 4, and 5). Respondents were then asked questions about their fishing methods, and their typical effort and catch size (see Caltex measures for more details on estimations of catch weight). They were asked to provide the same catch and effort information, but to recall it from when the year they first started using that particular fishing method (Chapter 4). They were also asked if they had ever experienced catching nothing (kg=0) (Chapter 4). Other details pertaining to fishing included how they typically used their catch (proportional allocation to retaining for food, selling, or other uses), and the top 6 animals they caught (Chapter 4). We also asked open-ended questions about change in catch size and composition, and the perceived reasons for any reported changes. Other open-ended questions at the end of the interview discussed gender roles in fishing (Chapter 3), management of fisheries in general, and the marine protected areas in particular (Chapter 5).

3) Household interviews

Among the survey respondents that were resident fishers we interviewed 10 women and 10 men in each community regarding their household activities (these were not the same respondents interviewed about fishing). Respondents listed all household members, their gender, their age, and if they gleaned or participated in other types of fishing (Chapter 4).

Other questions were asked regarding household division of labour, time management, and household decision making, but the data generated was not included in this thesis.

4) Direct catch measures and spatial monitoring

In each community we opportunistically measured the catch from gleaning and other fishing trips. Each animal in the catch was identified by local classification and where possible individually weighed (Chapter 3). If the animal was sold the price was noted (chapter 4). The fisher was asked how many hours the trip had taken and how many people had participated. In smaller number of cases fishers were asked to carry a GPS unit with them while they fished. This produced 128 tracks of fishing trips (Chapter 4).

5) Caltex measures

When reporting fish catch fishers typically used kilograms, but when reporting invertebrate catch fishers were more likely to estimate catch size by the number of *Caltex* or one-liter containers they were able to fill. We created a conversion factor of *Caltex* to kilograms by taking the exact weight of the contents of mixed and single species shells of 229 *Caltex* containers, and found the average to be 1.012kg (±0.012 SE; Chapter 3).

6) Edible yield (EY) measures

In Chapter 3 catch mass was estimated as the whole animal, but in Chapter 4 catch is characterized by it's use as food, hence the edible mass is a more appropriate measure. We measured the total and edible weight and calculated the mean EY of 28 of the most commonly caught gastropods, bivalves, crabs, and urchins (Table 4.2). We also randomly sampled 20 animals from each species, and used them to calculate the mean and standard deviation of each animal category for cases where species specific EY was not available. The categories were 1) bivalves, 2) gastropods, 3) urchins, 4) crabs, 5) shells (both

bivalves and gastropods in the rare cases where the animal was not identified as one or the other; Chapter 4).

7) Key informant interviews

In each community we interviewed community leaders and employees (barangay captain, barangay health workers, police officers etc.) about community participation in fisheries, the history of the marine protected area, and the current management of the marine protected area (Chapter 5).

8) Direct observation

In each community the researcher and team also directly observed community life, paying particular attention to fishing related activities. Direct observation was also included in interviews through observational notes at the end of each interview.

2. Gender and small-scale fisheries: a case for counting women and beyond

Introduction

This paper demonstrates the importance of gender analysis for rigorous and comprehensive understanding of small-scale fisheries in the marine ecosystem. Most small-scale fisheries data is limited in its application at an ecosystem level because certain fishers and fisheries, particularly women fishers and the fisheries they participate in, are frequently overlooked in data collection. The fact that they are overlooked is often embedded in biased sampling methods. The exclusion of women and gender analysis from small-scale fisheries research results in an underestimation of human catch, and also an underestimation of the diversity of animals and habitats targeted by fishers. Furthermore it impedes a broader socio-ecological understanding of fisheries that links human social systems to the marine environment.

A gender approach to fisheries aligns with emerging ecosystem approaches that intentionally work at the intersection of social and ecological systems (Arkema *et al.* 2006; Hall-Arber *et al.* 2009; Garcia 2010)**.** The importance of gender analysis to fisheries social systems such as food security, and livelihood, has been reviewed (Weeratunge *et al.* 2010; Williams 2010; Harper *et al.* 2013), but a synthesis of the application of gender approaches to ecological understanding of marine ecosystems is still needed. Our discussion here offers an analysis to fill this gap, providing a review and assessment of why gender relevant data is often still missing in fisheries research, and how these gaps might be closed.

We focus on small-scale fisheries—characterized as dynamic multi-method, multi-species fisheries that occur throughout the world (Béné *et al.* 2007). Our interest in elaborating the importance of a gender approach for improved ecological understanding leads us to focus on small-scale fisheries for at least two reasons. First most fishers are small-scale fishers. Up to 90% of the world's fishers are in the small-scale sector (Béné *et al.* 2007). Secondly, the diversity of methods used, species targeted, and the use of catch characteristic of small-scale fisheries mean that gender differences in fishing practices may be much more evident in these settings.

To examine the importance of gender approaches to ecological understanding of small-scale fisheries we analyze the past two decades of original small-scale fisheries research and build on key reviews that have given the current state of knowledge and outlined avenues for future research (Bennett 2005; Walker and Robinson 2009; Weeratunge *et al.* 2010; Williams 2010; Harper *et al.* 2013). We outline common patterns found in varied geographic examples, and detail the diversity and the adaptability of how women and men fish. Building on this base, we offer a discussion of how gender approaches to small-scale fisheries are crucial to improve our understanding of the human role in marine ecosystems, and taking marine protected areas as an example, explore how this understanding relates to fisheries management. Finally we explore how specific fisheries research methods may fail to collect relevant gender data and contribute to a data gap in women's fisheries and comprehensive ecosystem level understanding. This article reveals that gender approaches contribute to recent trends and novel directions in fisheries science and marine conservation.

Gender and small-scale fisheries – global review

Research context

In the past two decades there has been an increasing, if still relatively small, representation of gender approaches in fisheries literature and policy. Men's fishing practices and their role in fishing communities and economies are far more likely to be documented than women's, creating a bias in the data used to make management decisions, and a barrier to approaching fishing practices from a gender perspective (Matthews 2002; Bennett 2005). While gender approaches go beyond the study of women, the overall lack of data on women and women's fishing practices often means that there is insufficient baseline data or potential for comparative analysis. Recent reviews have rightly pointed out that an expanded socio-ecological view of fisheries further justifies the need to include gender as a key variable in our understanding of the fishing communities and economies as women participate and often dominate many aspects of the fisheries production chain (Bennett 2005; Weeratunge *et al.* 2010; Williams 2010; Harper *et al.* 2013). For instance, to better reflect the role of the production chain into our understanding of fisheries, sustainable livelihood approaches have been presented as an appropriate research and management framework (Bennett 2005; Weeratunge *et al.* 2010). Similar to an ecosystem approach, livelihood approaches often incorporate both social and ecological factors in the assessment of livelihoods, and provides explicit recognition of gender and other social variables (Allison and Ellis 2001).

While several recent reviews have detailed key data gaps in our understanding of the social and economic aspects of fisheries, they have been less explicit about the role of

gender for ecological process understanding. Providing some insights towards this end, Weeratunge et al. (2010) point out the data gap with respect to the role of gender in the acquisition of marine ecological knowledge, while Harper et al. (2013) emphasize women's ecological knowledge as an untapped resource in data poor systems. We build on the work of these previous efforts by expanding more explicitly on the relevance of gender sensitive approaches and data to key ecological components of fisheries science and management.

Case study literature review methods

We identified the primary literature by searching for original research published between 1992 and 2012 (searching the Web of Knowledge database for articles containing the keywords "gender" OR "women" AND "fisheries"). With no limits on methods of data collection used or geographic focus of the work, we identified 32 peer-reviewed articles that described small-scale fisheries. Examination of references produced a further 16 peer reviewed articles and 5 book chapters. Finally we included research conducted or published by the International Collective in Support of Fishworkers (ICSF), the Secretariat of the Pacific Community (SPC), and the proceedings of Global Symposiums on Gender and Fisheries from 1998 to 2011, producing 30 more articles. In cases where data specific to gender and fisheries was reported in multiple related articles, the peer-reviewed article, or the latest among them, was chosen.

Small-scale fisheries was defined broadly as it is often very context dependent. Many factors including gear type, boat size, habitats exploited, use of catch, and identity of fishers can play a role in the characterization of the scale of fisheries. For the purposes of this review we automatically included all fisheries described as artisanal, subsistence,

non-boat, non-motorized, and single occupant boat fisheries. In the small selection of case studies that did describe commercial fisheries with multi-crew boats, we examined the manuscript for characterizations of the fisheries as small-scale by the authors. We included all studies that used the descriptor "small-scale", but also other descriptors such as "family owned", "in-shore", and "small boat" which were used in the text to distinguish the fisheries of their study from large-scale fisheries. We did exclude fisheries defined solely as "recreational".

Case study review findings

The case studies provide examples from a diversity of cultural and ecological contexts (Figure 2.1). While the map representing research sites is geographically diverse, the fact that data are often unavailable means that this is not a comprehensive geographic representation of women's participation in fishing. In particular the sparse number of examples from Europe and North America may be due to the roots of gender and fisheries research in the field of development, which is primarily focused on developing country contexts (Walker and Robinson 2009). Our deliberate inclusion of literature from regionally specific institutions such as the SPC, and the Global Symposium on Women and Fisheries as part of the Asian Fisheries Forum also gave greater representation to the Asian and Pacific regions. There were many detailed studies of gender and fisheries in North American and European contexts, but they rarely described women's fishing practices and instead focused on women's role in processing, or on-shore management.

Gender roles in fishing were most commonly described in terms of methods, animals targeted, and habitats used. These descriptions highlight that women and men often interact with different parts of the marine ecosystem. However, quantitative measures

commonly used in fisheries science such as biomass of catch and catch per unit effort (CPUE) were not commonly reported (Figure 2.2). In fisheries science, questions related to fishing pressure rely on the quantification of catch and effort and these are addressed far less frequently in the gender literature, representing a considerable gap in our understanding. The description rather than quantification of women's fishing may be due to the assumption that women's fishing is supplemental and hence negligible in terms of overall human pressure on the marine ecosystem (Quinn and Davis 1997). The lack of quantification may also be due to trends in gender research which have increasingly focused on qualitative approaches to understanding power relations, rather than the quantitative documentation of material realities of women's and men's lives (Porter and Mbezi 2010). The characterization of gendered fishing practices may have also been descriptive because it was not always central to the articles. In many instances, women's fishing was discussed as context for a focus on development, marine management, or livelihoods in fishing communities. In other cases quantitative data is given, but only focuses on women's fisheries and so does not allow for a more comprehensive gender analysis (de Boer *et al.* 2002; Ashworth *et al.* 2004; Fay *et al.* 2007). Examples of quantitative gender data were mostly found from human ecology research (Bliege Bird 2007), and SPC studies quantifying the small-scale fisheries of Pacific Island countries (Kronen 2004, 2008; Kronen and Vunisea 2007).

Gender differences in small-scale fishing

The literature illustrates a gender division of labour in small-scale fisheries that suggests a common contrast between women's near-shore gleaning for invertebrates and men's offshore boat fishing for finfish—a pattern first documented by Chapman (1987). In the

small number of cases where quantitative data on women and men's fishing was presented, men have a greater proportional representation in the number of fishers, catch biomass, fishing effort and CPUE, but not in all fishing methods (Table 2.1). There is often a distinction made between gleaning, the search for primarily shell species in intertidal environments, and other types of fishing. While non-gleaning fisheries again suggest greater male representation in fishing, for gleaning fisheries women's proportional representation was either greater than or roughly equivalent to that of men in number of fishers (gleaners being a category of fishers), catch biomass, and fishing effort, but not CPUE (Table 2.1). The quantitative data indicates that gender is an important variable for describing participation in various types of fishing method. While the pattern of women primarily participating in gleaning and men primarily participating in non-gleaning fisheries emerges, it is far from universal and should not be assumed to be true of every system, or unchangeable over time. It may also be due to the greater representation of case studies from Asia and the Pacific.

Fishing methods are often closely linked with the animals targeted, so gender differences are often evident in catch types. The general observation that "*Shells are for women, fish are for men*" (Siar 2003) is well documented throughout the Pacific, and is a distinction we found repeated in South Africa, Egypt, Spain, and the United States (de Boer *et al.* 2002; Ashworth *et al.* 2004; Frangoudes *et al.* 2008; Reedy-Maschner 2009). However, in most case studies where catch composition was described, women and men caught both fish and invertebrates. In the case studies that described invertebrate only fisheries, women were more often the fishers. In contrast, in the case studies that described vertebrate only fisheries, men were more often the fishers (Figure 2.3). Greater detail

reveals gender distinctions even in cases where men and women catch both invertebrates and vertebrates. For example in the Philippines, while both men and women engage in invertebrate and vertebrate fisheries, a greater proportion of women's catch is made of invertebrates while the inverse is true for men (Chapter 4). In different examples from the Philippines and the Comoros Islands, women's vertebrate fisheries concentrated on smaller fish caught near shore while men caught larger fish offshore (Eder 2005; Hauzer *et al.* 2013).

Across the data sampled, gender patterns in the types of marine fishing habitats exploited emerged, with near-shore habitats such as estuaries, mangroves, and intertidal flats being more frequently described as either women-only or shared spaces. Most case studies described habitats such as reef edges or pelagic offshore to be exclusively fished in by men (Figure 2.4). Examining the freshwater examples in greater detail also revealed spatial distinctions. In Mexico women were described as fishing closer to home (Arce-Ibarra and Charles 2008), and in the Democratic Republic of the Congo, women fished along the shore while men fish in the deeper water mid-stream (Béné *et al.* 2009).

Social context for gender differences in small-scale fishing

"*Gleaning shellfish is women's major fishing activity because it can be done close to home, takes relatively little time, require no costly fishing equipment and may be done in the company of children*" (Tekanene 2006)

"*Most women do not want to be equal to men in fishing because the social rewards are not the same for them*" (Reedy-Maschner 2009)

As the Tekanene quote illustrates, women's participation in gleaning over other forms of fishing may be linked to the spatial and temporal limitations on their activities due to

concurrent obligations. Hence, women and men's fishing is often shaped by broader gender roles and as the quote from Reedy-Maschner explains, gender roles also shape the social rewards derived from various types of fishing. In the case of women their roles may result in limited ability to travel long or far and limited access to capital for equipment such as a boat—both of which may narrow women's range for fishing to near shore habitats and species. Hence, intertidal areas may be considered as women's fishing space even as men and women both fish there (Siar 2003). Men's gender roles also mediate their fishing practices, as do other social variables such as age or poverty. For example, in the Philippines, young men with little capital and few dependents are more likely to engage in illegal or highly variable fishing (Fabinyi 2007). Alternatively the established role of women as providers of daily food in the Torres Straight Islands leads them to choose fishing methods that have a better guarantee of return, while men derive greater social benefits from fishing for large but variable catch that is shared in the community (Bliege Bird 2007). Women's common obligation of household food provision may also explain why women's fishing catch is frequently directed for household consumption while men may be more likely to target more commercially valuable or culturally prestigious marine animals (Chapman 1987; Kronen 2002).

The physicality and dangers associated with certain types of fishing were also used by respondents to explain the types of gender differentiated practices observable across many contexts. In several case studies fear of the waves or deep water is given as an explanation for why women do not venture off shore. For example, in Mexico men and women used the same fishing methods, but women chose fishing grounds closer to home which were described as safer (Arce-Ibarra and Charles 2008). Gender differences in

perceived risky behavior are a product of cultural expectations rather than biological limitations (Porter and Mbezi 2010), and in fact in one example from Cameroon women were the primary fishers because men expressed fears of fishing (Brummett *et al.* 2010). In some cases gender divisions of labour are formalized by taboos against women in boats (Rubinoff 1999), and limitations on women's participation may be used as a way to limit the number of fishers and hence competition in offshore fisheries (Geheb *et al.* 2008).

Women's fishing is often described as complementary to men's, and framed within a household livelihood strategy. For instance, in Mexico "women saw their work [bait fishing] as a source of 'support' for the husbands and households" (Savard and Fraga 2005). Similarly in Vanuatu women's fishing was described as helping to "bridge the gap in seafood supply when the active male fishers are sick or busy with other activities" (Gereva and Vuki 2010). In many such examples, even when women's fishing is documented and discussed, it is represented as secondary to men's fishing. For example in Mali girls were described as "assisting" with fishing (Tindall and Holvoet 2008), or in the Philippines and Palau women who fish offshore with their husbands often describe their own work as "helping" (Matthews and Oiterong, 1992; Kleiber *et al.* unpublished data). In other cases the gender of the fisher is only mentioned when the method is female dominated (e.g. Jiddawi and Ohman 2002). In such examples, the placement of women's fishing as secondary suggests it is not fully integrated into the larger analysis.

Variations in gender differences in small-scale fishing

The gender division of labour in small-scale fisheries is not absolute or universal. Instead, these divisions are diverse in ways that reflect both cultural and marine

biophysical diversity. For example, in some Oceanic communities women are forbidden from participating in some types of fishing (Chapman 1987) while among the Btsisi' of Malaysia most fishing is done by opposite sex couples working together (Nowak 2008). Paying closer attention to biophysical conditions, we see that variations and fluxes may alter participation in certain fisheries regardless of predominant gender divisions. In the Philippines men's gleaning is often characterized as secondary to other forms of fishing, but in a community with abundant intertidal habitat ideal for gleaning there was found to be a much higher proportion of male gleaners (Guieb 2008). These variations reinforce the need for greater attention to the cultural and biophysical context in which fishing occurs (Walker and Robinson 2009).

Gender roles are also dynamic and historic norms may vary greatly from current practices. In relation to fishing practices shifts in gender roles may be adaptions to changing environmental and economic realities. Changes in the availability of particular marine species, family economic strategies in response to poverty, commercialization of catch, or diversification of employment opportunities may all lead to changes in how women and men fish. For example, in French Polynesia the overfishing of shell species led women to adopt boat fishing that had been male dominated (Walker and Robinson 2009). In other cases women's participation in non-gleaning fisheries may be part of a household economic strategy to maintain catch and profit within the family rather than paying crew or needing to split profits from the catch (Reedy-Maschner 2009). As such, women's participation in fishing may be framed as economic necessity, also showing the importance of poverty to these issues: "*A few wives have gone to sea . . . only the poorest of us. We have been driven into the fishing boat by necessity, as well as by a strong*

wish." (Pettersen 1996). Finally, external economic changes such as the commercialization of specific species or diversification of employment opportunities may also change gendered fishing practices. In Tanzania men came to dominate the previously female dominated octopus fisheries after it had become a commercial product (Porter and Mbezi 2010), and in the Canadian Arctic women's increasing employment by the government led them to fish less frequently as they were no longer able to take time off during the fishing season (Tyrrell 2009).

How gender applies to ecosystem approaches to fisheries

"[T]he fishing enterprise is not solely undertaken by men, and cannot simply be defined in terms of people on boats" (Reed and Christie 2008)

As we have demonstrated, women and men often fish in distinct ways, making it inappropriate to use men as a proxy for the entire community. Here we elaborate why these distinctions are crucial for management questions that require ecosystem level understanding. Specifically we detail how a gender approach illuminates our understanding of how different fisheries interact with the ecosystem and each other, and adds important insights for evaluation of marine protected areas (MPAs) as a key conservation and fisheries management tool.

Gender and connected fisheries

The inclusion of women's fishing not only highlights overlooked human interaction with specific marine species and habitats, but also illustrates the interaction between different habitats, as well as the targeting of animals at different life stages that might otherwise be missed. For example, gleaning in intertidal areas may have direct impacts on habitat such as coral reefs, and seagrass beds through trampling, or overturning of the substrate. Other

human activities such as shell garden construction in intertidal areas could also create habitat and increase species abundance. These direct interactions may also have wider ecological impacts (Sharpe and Keough 1998).

Women's frequent domain of intertidal habitat is an important component to understanding the role of their fishing in the marine ecosystem, as these habitats, including mangroves, and seagrass beds, may be particularly important for juvenile life stages of many species. For example in El Salvador women's estuary fishing was banned because it was felt to "*threaten offshore fishing by depleting breeding grounds*" (Gammage 2004). In other cases women's fishing in the Philippines and Comoros Islands was seen as detrimental to offshore fisheries because they targeted juveniles of fish species that were of economic importance at older life stages (Eder 2005; Hauzer *et al.* 2013). Indirect fishing of species as by-catch can also have multi-fisheries level affects—such as in Bengal, India where women's participation in river fishing was documented to have stopped due to over-efficient fine-meshed net harvesting done by men (Pramanik 1994). In a different example in Tanzania women octopus fishers attributed the decline of their catch to men diving for the same species in deeper waters, and thereby eliminating a depth refuge that may have been an important component for the sustainablity of the fishery (Porter and Mbezi 2010). All of these examples suggest the important ecosystem level interconnections and dynamics between different marine extraction practices. A gender sensitive approach highlights these different practices, helping to better consider the complex interactions among different fishing practices. Still other important factors such as total biomass and number of fishers may be underestimated without considering the catch of all fishers.

Gender, invertebrates and MPAs

A focus on gender highlights data gaps that hinder the inclusion of all fisheries into ecosystem scale management. For example, the focus of many women on invertebrate species lays bare the data gap on the management of marine invertebrates. The management of sessile benthic invertebrates - the target species of many gleaners – is often complicated by scarcity of life history information. In this section we will first examine these data gaps in the context of MPAs, a very common and increasingly used management measure.

Within the MPA literature most studies of the effects of no-fishing MPAs have focused on fish assemblages and coral health. Only recently have studies included a focus on non-coral invertebrates and, from what we do know, the sessile characteristics of these species make them in many ways ideal candidates for small MPAs. However, the studies that have been done suggest mixed results. In some cases increased biomass and size of animals inside and directly adjacent to the MPA have increased. In other cases lack of change in size and abundance may be due to food chain interactions where closure frees both invertebrates and their predators from human fishing pressure (Gell and Roberts 2003).

The utility of MPAs as a fisheries management measure relies on its ability to produce a spill over of targeted species. Unlike fish, sessile invertebrates disperse during their larval stage (Roberts and Hawkins 2000), lending increasing importance to the consideration of ocean currents and their role in the distribution of larvae when deciding on the placement of MPAs. This was demonstrated in the Solomon Islands when women protected an area they felt was an important “seeding” ground for the rest of the gleaning

areas (Aswani and Weiant 2004a). It may be that the placement and management of MPAs focused on fish species may not lead to optimal management for all fished animals.

Invertebrates and intertidal habitats are integral parts of marine ecosystems. Invertebrates are often keystone species, and intertidal areas can be important habitat for juveniles. To assess the effects of MPAs and other management measures, it is important to consider a broad range of marine species and habitats, including those commonly targeted by women. As such, gender considerations might affect management priorities, extending beyond fish species, and also enabling consideration of broader ecosystem dynamics that might be critical for ecosystem health and the sustainability of fisheries.

Why aren't women included?

As it becomes increasingly clear that women are actively engaged in fishing in many parts of the globe, a key question is why gender specific data is still so scarce. As we have outlined, the gender division of labour has clear implications for fisheries science and marine conservation, but data and especially quantitative data regarding women's fishing practices remains limited. In this section we consider methodological approaches commonly used in the characterization of small-scale fisheries that may perpetuate the invisibility of women's fishing and otherwise impede the collection of data that is both gender relevant and more inclusive of a range of marine extractive practices.

Limiting definition of fishers and fishing

Narrow definitions of fisher and fishing often may overlook key groups of fishers. For example, census data on occupation, which are often relied on to estimate the number of fishers, may exclude part time labour (Teh and Sumaila 2013), or subsistence labour. As

women are often more likely to fish on a part time basis, their participation in fishing is effectively invisible on census forms. For example, official statistics in El Salvador are based on questionnaires that define fishers as those that fish regularly on the open sea and own fishing gear such as a boat, and nets. They found that only 9% of women participated in fishing; however, a more detailed study within select communities found closer to 26% of women fished (Gammage 2004). In other cases women fishers may go unreported in part because it is culturally unacceptable for women to fish, and in such cases both women *and* men may discount or downplay women's participation. This may be further complicated by interacting factors of gender, social class and wealth, where women's participation in fishing is viewed as an indication of poverty and subsequently shame. For example, in the Philippines many respondents expressed pity for women that fished with their husbands. This helps to explain why women so often described their participation as *"Just helping my husband"* (Kleiber, unpublished data). This characterization may lead researchers and managers to underestimate and overlook women's participation. In other cases where women's participation in fisheries is a cultural norm, assumptions by fisheries researchers about gender division of labour may lead them to erroneously exclude women. To unmask the participation of women in fisheries, an understanding of local culture coupled with observational studies is essential. This data may be more readily available in anthropological, ethnographic and human behavioral ecology approaches, suggesting an ongoing need for interdisciplinary evaluation of fishing practices.

Similarly, limited definitions of what counts as fishing may also overlook key fisheries. Gleaning is often not considered as fishing *per se*. Because gleaning occurs in intertidal

habitats and primarily targets invertebrates, it may not be counted as a fishing method—either in cultural terms or indeed in 'scientific' understandings as found in Spain where gleaning was not included in official definitions of fishing (European Commission 2003). However, as we have detailed, to understand fisheries from a broad ecosystemic perspective, it is important to consider all forms of marine resource extraction, including gleaning. This reality invites us both to reconsider some of our gender assumptions about fishing, as well as the very definition of fishing itself.

Missing gender as key variable and gender biased sampling methods

Another tendency is for data to be collected in a way that is gender blind. Gender-neutral words such as "fisher", or even gender specific terms such as "fisherman" might be used to describe women and men. It is therefore necessary to explicitly include gender as a variable. A more general issue observable in the literature is that only data on men is collected. This may be done intentionally, or occur unintentionally through methods that limit respondents to only men. For example, head of household surveys or key informant interviews that rely on political or religious leaders may result in only male respondents. Despite being active participants in the household economics and decision makings, women may be less likely to declare themselves as head of household (Gammage 2004). Interviewing only or predominantly men is a key consideration in situations where the perception of women's fishing differs along gender lines. For instance, men may discount or have very little interest in talking about women's fishing activities (Chapman 1987), or may have completely opposite understandings of the gender division of labour as was found in the Canadian Arctic: *"According to Arviat men, fishing for char along the shoreline is predominantly men's work. According to Arviat women, it is*

predominantly women's work" (Tyrrell 2009). This also suggests the need for complementary observational data collection. Women-only data collection similarly limits the scale of analysis and understanding. It is often done with the explicit goal of focusing on fishers or fisheries that have previously been overlooked and so may provide important information. However, as with data only on men or only a single fishery, our understanding of its role within the broader context of community fishing is limited.

The locality of the data collection may also bias the sample along gender lines. Data collection methods often rely on centralized landing sites such as markets, ports, or fish vendors. This may bias sampling towards men's catch because women's catch is often exclusively for family consumption and does not travel through these sites making them invisible to the researchers (e.g. Green *et al.* 2004). In contrast, a randomized sampling approach of all fishing effort within communities would allow for a more comprehensive understanding of the variety of fishing methods used, animals targeted, and use of catch. It would also give a more accurate understanding of the total catch.

Many of these trends are exacerbated by the fact that most fisheries data collectors and managers are men, which in certain contexts may impede the participation of women. In many cultures it is not socially acceptable for unrelated men and women to talk to one another and in other cases respondents may simply be more comfortable with an interviewer of the same gender. In Nigeria, where fisheries officers were predominantly men, women stated that they preferred talking to women officers (Adeokun and Adereti 2003). These gender gaps can have implications for data collection, misrepresentation of the issues of importance, and can also negatively affect conservation and management efforts. For instance in Tuvalu a trochus reintroduction program failed when the fisheries

manager neglected to discuss the plan with women who unknowingly gleaned the introduced animals (Seniloli *et al.* 2002). It is also imperative to consider other social variables such as class, ethnicity, or caste that have been found to affect data collection (O'Reilly 2008).

Gender evaporation

Even in cases where gender is included as a variable, or as part of a management agenda, gender has often been found to disappear - a phenomenon that has been referred to as gender evaporation, or the loss of gender data during one or more steps of research (term adapted from DFID 2008). Gender evaporation can occur when a gender research agenda is added, but carried out by researchers and managers unfamiliar with and untrained in gender research methods (Harrison 1997). For example a study of small-scale fisheries was unable to include gender analyses, even though gender had been included as a field in the interview. The research assistants had not been trained in gender research methods and the fields on women's participation were mostly left blank (S. Sayson, personal communication).

All of these dimensions of gender bias in research and data have the effect of minimizing women's roles in fisheries, and also, importantly, may lead to a lessened understanding of crucial aspects of the marine ecosystem that are more likely to be used and targeted by women (e.g. sessile invertebrates). These illustrations, together with the growing body of work on gender and social and economic dimensions of fisheries, demonstrate the clear need for fisheries science to embrace gender approaches to research and a stronger appreciation of women's fisheries in particular as key parts of an interdisciplinary ecosystem approach. From a management perspctive as well, it is abundantly clear that

lack of attention to women's fishing undercuts the possibility of women being full stakeholders in fisheries management and decision-making. We suggest that a fuller appreciation of women's diverse fishing roles and practices serves as a critical step to overcome the well documented marginalization of women in fisheries related management institutions and practices, including both international programs (Harrison 1997), as well as more localized community based management initiatives (Seniloli *et al.* 2002).

Without explicit consideration of the fishing patterns and practices (including changes therein) of women *and* men, a considerable wealth of information is ignored. To overcome the invisibility of women's fishing and the barrier it poses to our full understanding of marine ecosystems it is important to start our analyses and evaluations with the assumption that women do fish, rather than the inverse. By beginning with this assumption researchers can choose appropriate methods that capture the fishing practices of all community members, and the assumption can then be adequately tested.

Conclusion

Overlooking women's fishing practices can lead to data gaps in the direct and interconnected impacts of different fisheries, perpetuate often inaccurate assumptions about the gender division of labour in fisheries, as well as potentially underestimate the total human pressure on the marine ecosystem. In this review we have pursued the suggestion offered by Weeratunge and colleagues (2010) to move beyond the increasingly recognized reality that "women do fish." In particular, we have offered an approach that considers women and men's fishing practices to illustrate the importance of gender not only for socio-economic concerns, but also to gain a more comprehensive

and robust understanding of the human role in marine ecosystems. As such, we suggest that progress in terms of gender appraoches to fisheries and appreciation of women's fisheries and practices is a key dimension of realizing more inclusive socio-ecological understandings for fisheries science and management. Our review of published case studies that consider women's fishing practices makes clear that the division of labour by gender in fisheries is common, but also highlights variety and mutability of women's and men's fishing practices. Our review also reveals the sparcity of gender data in general, and quantitative data in particular. Despite these limitations it is clear that the fishing efforts of women and men often play distict and interacting roles in the marine ecosystem. A gender approach has considerable potential to improve our understanding of these varied and interacting roles through greater attention and sensitivity to different fishing methods, species caught, and areas fished. All of these dimensions are essential to provide sound scientific advice, enriched scientific inquiry, and improved management of marine resources. Furthermore, we have also suggested that to truly make progress with respect to ecosystem and livelihood approaches to marine management we also need to change the way we collect data. The implications relate to who is collecting data, how data is collected, and even the very definition and scope of 'fishing' itself. Unchallenged definitions of fishers and fishing, and biased sampling practices present significant obstacles to ecosystem scale data collection. Being aware of these common problems in data collection allows for more suitable and comprehensive collection, enabling higher standards in future research.

While we have chosen to highlight the ecological elements of these debates, this is not to ignore the importance of a gender approach for social aspects of fisheries management,

including livelihood and food security approaches. Gender aware research has highlighted that improvements in fisheries dominated by men (both in catch and economic gains) do not necessarily translate into improvements in household and community level food and economic security. Subsistence catch by women may be especially vital for family food security (Porter and Mbezi 2010). The combination of the ecosystem dimensions with social imperatives makes the centrality of gender perspectives to fisheries science and management undeniable.

As participatory management efforts seek to extend a role to women in fisheries management, clearer understandings of gender specific roles in fisheries as well as the larger fishing economy are vital. These combined realities suggest the need for serious caution whenever we see male fisheries officers only talking to male fishers, or situations where men speak for women related to community needs. Further to this, women's distinct ecological knowledge is likely to be a considerable asset to managers, particularly in data poor systems (Harper *et al.* 2013). While in this review we have emphasized fishing practices, we understand that aspects of this discussion are relevant and potentially even more powerful when viewed with attention to larger socio-economic and political frameworks. The inclusion of gender enables us to more accurately assess the state of fisheries, to better understand the diverse effects of fisheries change and management for populations, and to move towards the interdisciplinary management models that are increasingly demanded by policy makers.

Table 2.1. Global case studies summary of participation in fishing by gender and method.

Measure	Fishing Type	F>M	F≈M	F<M	n
Number of fishers	All	0.10	0.05	0.85	20
	Glean	0.84	0.16	0	25
	Non-glean	0.00	0.13	0.88	32
Biomass	All	0.00	0.31	0.69	16
	Glean	0.29	0.35	0.35	17
	Non-glean	0.00	0.11	0.89	19
Effort	All	0.00	0.12	0.88	17
	Glean	0.50	0.33	0.17	6
	Non-glean	0.00	0.33	0.67	12
CPUE	All	0.00	0.06	0.94	16
	Glean	0.08	0.17	0.75	12
	Non-glean	0.00	0.31	0.69	13

We present a proportion of case studies that measured the participation of women and men in all fishing activities, gleaning or non-gleaning fishing activities using four different quantitative measures. We further distinguished between cases where fishers numbers, catch size, effort or CPUE was either found to be larger for women (F>M), ≤10% difference or described a roughly equal between women and men (F≈M), or larger for men (F<M). The "n" represents the number of case studies the provided the data. Some case studies presented data on all fishing, but didn't distinguish between gleaning and other fishing, while other studies only reported gleaning, or non-gleaning fishing catch. Hence, the number of case studies at each category varies.

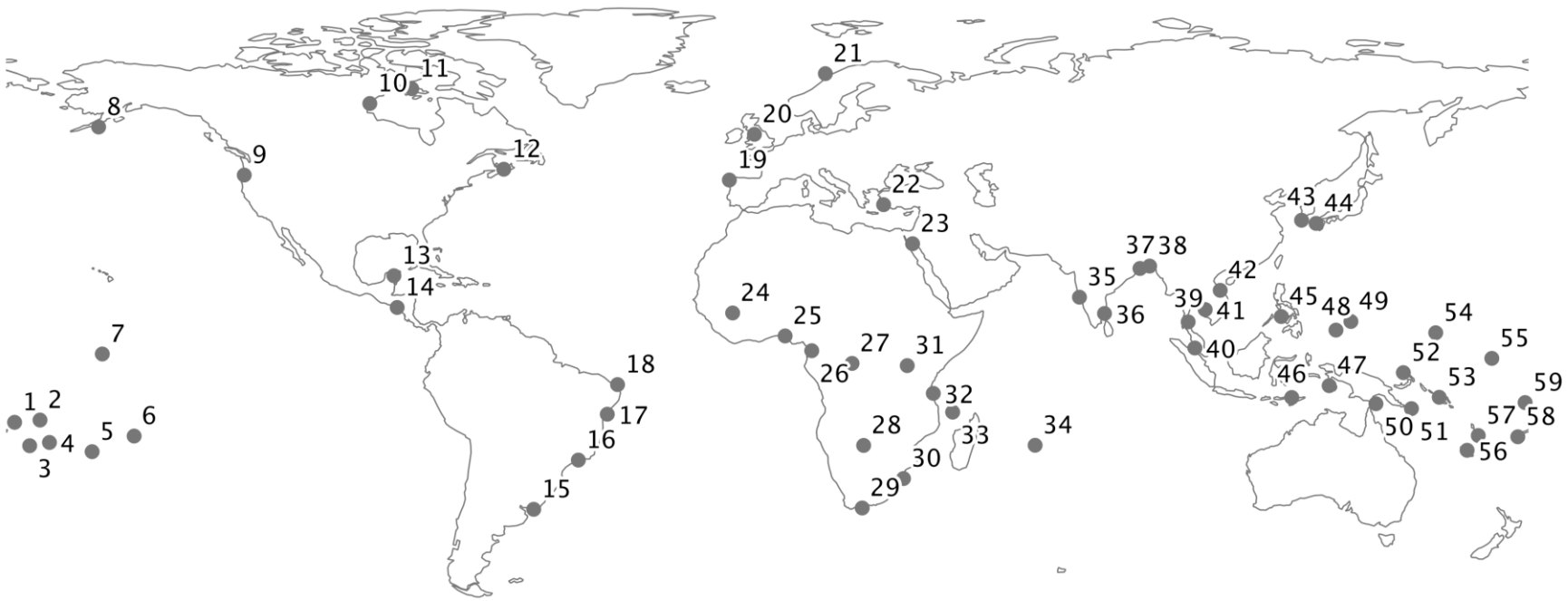

Figure 2.1. Map of reviewed case studies. 1, 2, 4, 5, 6, 7, 49, 52, 55, 56, 57 & 59 (Kronen and Vunisea 2007); 3 (Kronen 2002); 3 (Kronen and Malimali 2009); 3 (Kronen and Bender 2007); 4 (Kronen 2008); 4 & 5 (Lasi and Kronen 2008); 6 (Walker and Robinson 2009); 8 (Reedy-Maschner 2009); 9 (Conway *et al.* 2002); 10 (Tyrrell 2009); 11 (Shannon 2006); 12 & 21 (Thiessen *et al.* 1992); 13 (Savard and Fraga 2005); 13 (Arce-Ibarra and Charles 2008); 14 (Gammage 2004); 14 & 32 (Crawford *et al.* 2010); 15 & 16 (Trimble and Johnson 2013); 17 (Di Ciommo and Schiavetti 2012); 18 (Silva-Cavalcanti and Costa 2009); 19 (Frangoudes *et al.* 2008); 20 (Nightingale 2011); 20 (Zhao *et al.* 2013); 21 (Pettersen 1996); 22 (Göncüoğlu and Ünal 2011); 23 (Ashworth *et al.* 2004); 24 (Tindall and Holvoet 2008); 25 (Iyun 1998); 25 (Akanni 2008); 26 (Brummett *et al.* 2010); 27 (Béné *et al.* 2009); 28 (Ngwenya *et al.* 2012); 29 (Branch *et al.* 2002); 30 (Kyle 1997); 30 (de Boer *et al.* 2002); 31 (Geheb *et al.* 2008); 32 (Jiddawi and Ohman 2002); 32 (Porter and Mbezi 2010); 33 (Hauzer *et al.* 2013); 34 (Peterson and Stead 2011); 35 (Rubinoff 1999); 36 (Thamizoli and MSSRT Team 2004); 37 (Pramanik 1994); 38 (Ahmed et al. 1998); 38 (Sultana *et al.* 2002); 38 (Ahmed *et al.* 2010); 39 (Lim and Apong 2012); 39 (Johnson 2001); 40 (Nowak 2008); 41 (Shams and Ahmed 2000); 41 (Resurreccion 2006); 42 (Hao 2012); 43 (Ko *et al.* 2010); 44 (Lim *et al.* 2012); 45 (Israel-Sobritchea 1994); 45 (dela Pena and Marte 1998); 45 (Sotto *et al.* 1998); 45 (Asong *et al.* 2002); 45 (Siar 2003); 45 (D'Agnes *et al.* 2005); 45 (Eder 2005); 45 (Fabinyi 2007); 46 (Fitriana and Stacey 2012); 47 (Thorburn 2000); 48 (Matthews and

Oiterong 1992); 49 (Kronen and Tafileichig 2008); 50 (Bliege Bird 2007); 51 (Kinch 2003); 53 (Aswani and Weiant 2004a); 53 (Molea and Vuki 2008); 54 (Lambeth 2000); 55 (Tekanene 2006); 55& 58 (Fay *et al.* 2007); 55 (Thomas 2007); 57 (Tarisesei and Novaczek 2006); 57 (Gereva and Vuki 2010); 58 (Quinn and Davis 1997); 58 (Kronen 2004); 58 (Kuster *et al.* 2005); 58 (Tawake *et al.* 2007); 58 (Fay-Sauni *et al.* 2008); 58 (Verebalavu 2009); 59 (Sauni and Sauni 2005). (Kronen and Vunisea 2009) is not presented here as it presents data by Oceania cultural regions.

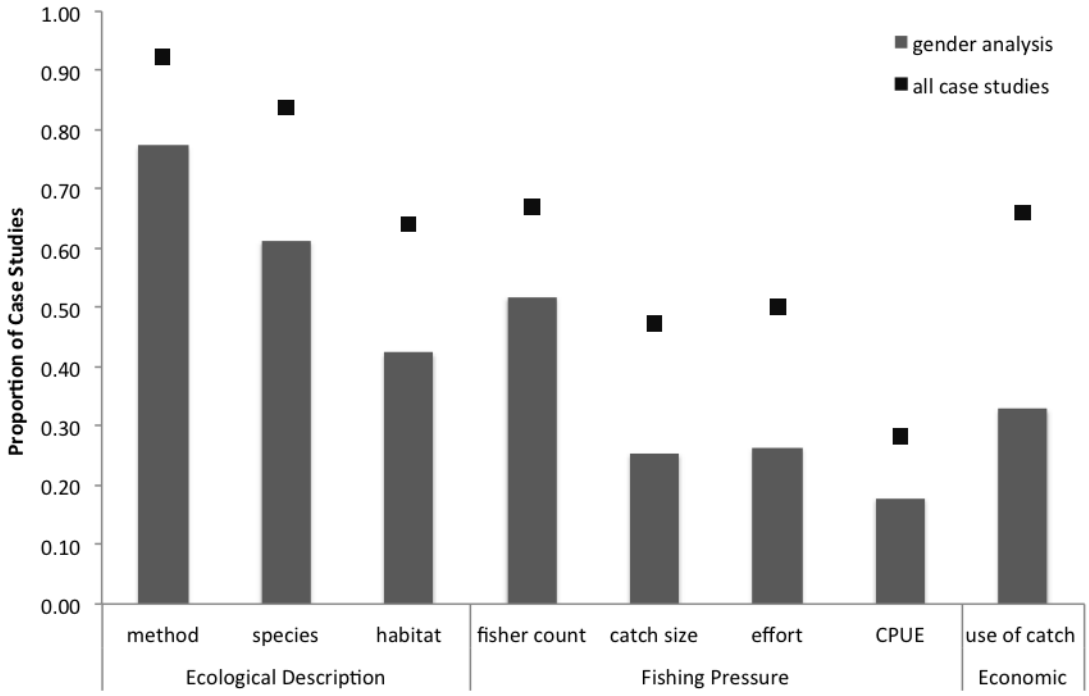

Figure 2.2. Frequency of data types presented in case studies. The 106 case studies of original data found in the 83 articles were each coded for the types of data they used to describe small-scale fishing. Descriptive categories of how, what, where and when fishers interact with the marine ecosystem were placed in the following four categories 1) Method: gear or fishing method names, 2) Species: wild caught marine animals or plants, and 3) Habitat: marine habitats used. Measures of fishing commonly associated with the calculation of fishing pressure were divided into the following four categories 1) Fisher count: number of fishers, 2) Catch size: biomass, animal count, or Kcal measured in total or average, 3) Effort: time or frequency of fishing measured in hours, days, or weeks, and 4) CPUE: calculation of catch per unit effort both of which may vary. Finally the social and economic importance of fishing catch as described by how it was used was placed in the final category: Use of catch: eaten, sold, given away, used as bait. The proportion of studies offering data related to the specific categories are presented (all case studies), as well as a subcategory of case studies that offered data on women and men (gender analysis). It should be noted that within the CPUE category, 73% of all studies are case studies done by the Secretariat of the Pacific Community.

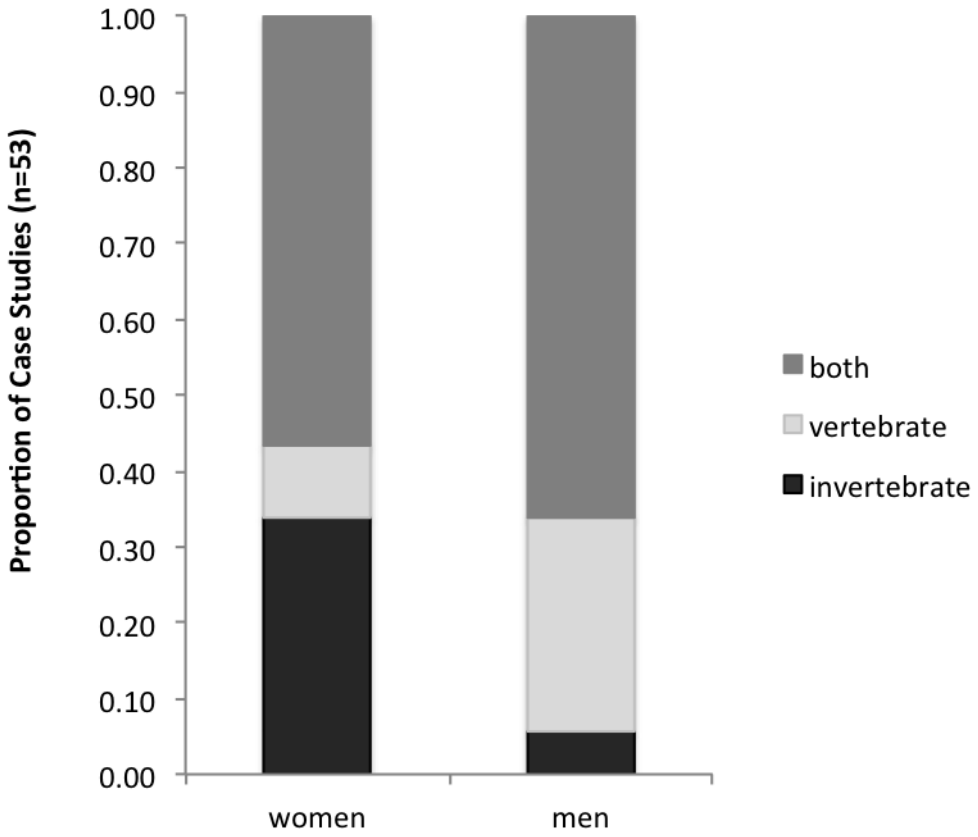

Figure 2.3. Gender and types of animal caught. Fisheries divided into vertebrate only (almost entirely fish, but in some cases including mammals and reptiles), invertebrate only (including shells, arthropods, cephalopods and echinoderms), or participation in fishing that targets all animal types. Only gender analysis case studies were included.

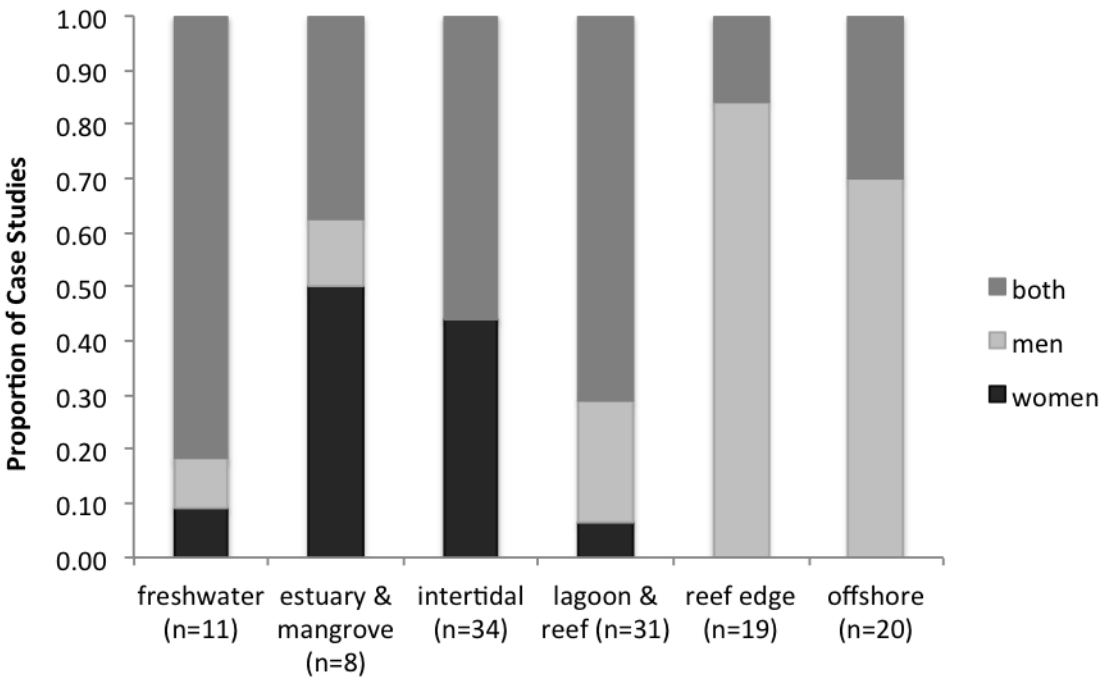

Figure 2.4. Gender and habitats used for fishing. The proportional distribution of case studies (n) that describe use of fisheries habitats by gender. Only case studies that presented data on women and men's habitat use were included (n = 45). The number of case studies represented by each habitat varies because not each habitat was included in every case study.

3. Improving fisheries estimates by including women's catch in the Central Philippines

Introduction

Women's participation in small-scale fisheries has been described but rarely quantified (Quinn and Davis 1997). Descriptions of women's fishing challenge the notion that small-scale fishing is exclusive to men (Weeratunge *et al.* 2010), but the lack of quantification of women's fishing, and the fishing of other minority or marginalized groups, has several consequences for the understanding and management of small-scale fisheries. First, it accentuates the data scarcity in small-scale fisheries that results in the local and global underestimation of fishing effort and catch (Zeller *et al.* 2007). Second, it creates an incomplete understanding of the diversity of and interactions between small-scale fishing strategies, which in turn hinders ecosystem-based management approaches. Finally, it underestimates women's contribution to fisheries (Mills *et al.* 2011), which leads women and women's fisheries to be invisible in the management of small-scale fisheries and marine resources.

Small-scale fisheries may account for over half of the catch of developing country fisheries (FAO and WorldFish Centre 2008), and characterize up to 90% of the world's fishers (Béné *et al.* 2007). And yet small-scale fisheries continue to be unaccounted for in national fisheries statistics, resulting in severe underestimations of catch weight and fishing effort (Zeller *et al.* 2007; Metuzals *et al.* 2010). The quantification and characterization of small-scale fisheries using traditional fisheries assessment methods are hindered by 1) a lack of research capacity (McCluskey and Lewison 2008), and 2) the diversity of fishing strategies and ecosystem complexity (Andrew *et al.* 2007). To overcome deficits in data and research capacity, techniques have been developed to

quantify and assess small-scale fisheries using fisher knowledge (Neis *et al.* 1999; O'Donnell *et al.* 2010). To account for fisheries and ecosystem complexity ecosystem-based approaches to fisheries have been developed (Pomeroy *et al.* 2010).

Ecosystem-based management was developed to address complex systems by focusing on the numerous ecological and social interactions that occur in small-scale fisheries (McLeod *et al.* 2005; Pomeroy *et al.* 2010). To identify ecological and social interactions it is first necessary to define the species, habitats, and fishing strategies that will be included in management (Pomeroy *et al.* 2010). Gender may be a key consideration for identifying fishing strategies as women and men often have distinct and interacting roles in small-scale fisheries (Chapman 1987; Siar 2003; Magalhães *et al.* 2007; Medard 2012), with women and men often targeting different marine life and habitats (Bliege Bird 2007; Hauzer *et al.* 2013). Hence, if women and other minority or marginalized groups are not included, there is a great potential to miss certain fishing strategies, and subsequently key social and ecological interactions.

Ecosystem-based management emphasizes humans as a part of, rather than apart from, the ecosystem and embraces the inclusion of stakeholders in the decision-making process (McLeod *et al.* 2005). The challenge then becomes determining which humans and human activities are counted and subsequently whose voices and management priorities are included in resource management decision-making. There is a widespread underrepresentation of women in natural resource labour statistics (United Nations 2006), and the effect of this invisibility on management and decision-making has been widely examined in the gender and development literature (Upadhyay 2005; Vernooy 2006; Resurreccion and Elmhirst 2008; Agarwal 2009), and more specifically in the

gender and fisheries literature (Walker and Robinson 2009; Weeratunge *et al.* 2010). In the gender and fisheries literature there is often an emphasis on women's labour in catch processing and marketing (Overå 1993; Tindall and Holvoet 2008). Including women's labour in the fisheries value chain fits within the aim of ecosystem-based management to integrate ecological and socio-economic interactions (Allison and Ellis 2001; Béné *et al.* 2009; Weeratunge *et al.* 2010), but it still misses the quantification and characterization of women fishers and their ecological interactions in the marine ecosystem.

In this study we examine how the exclusion of women and other overlooked categories of fishers changes the quantitative assessment of small-scale fisheries at the community scale using a case study of small-scale fisheries in the Central Philippines. Women are known to participate in the many small-scale fisheries that prevail in the Philippines, but quantification is rare (Siar 2003; Illo and Polo 1990). We intentionally included fishers and fishing methods that are often overlooked in small-scale fisheries assessments, such as women, part-time and occasional fishers, and gleaners. First we estimated the number of women and men fishers, and examined their fishing methods. Then we quantified the fishing effort and catch weight to compare the total contribution of women and men, and part-time and full-time fishers. Finally we examined the types of animals targeted by different fishing methods to characterize fishing catch. Our results have direct implications for management as they highlight the contribution of overlooked fishers and fisheries, as well as demonstrate the greater diversity of marine life targeted by human fishing activity.

Methods

To examine the contribution of women and other frequently overlooked aspects of small-scale fisheries we examined data from surveys on the proportional participation of women and men fishing in 12 coastal and island communities in the Central Philippines. We gathered quantitative and qualitative data on fishing methods, catch weight, fishing effort, and target species through individual interviews, and direct measures of catch to characterize small-scale fisheries according to gender and fishing method.

Study area

Our study took place in the Danajon Bank region of the Central Philippines (Figure 3.1). Communities in this region are largely ethnically homogeneous, and while there is variation in access to material wealth, there are overall high levels of poverty (Guieb 2008). The Philippines has one of the highest per capita fish consumption rates in the world (Yap 1999), and in the Danajon Bank marine resources are caught using small-scale fishing practices. The Philippines is a hotspot of marine biodiversity, but the marine ecosystem is under great fishing pressure (Carpenter and Springer 2005; Christie *et al.* 2006). Destructive and over-efficient fishing methods such as dynamite fishing, cyanide, and illegal trawling occur in the Danajon Bank. Marine management in the Philippines is decentralized, with responsibilities falling at the community and municipal levels of governance. Ecosystem-based management is used to account for the myriad of fishing methods used and species caught (Armada *et al.* 2009). Certain management measures such as boat registration and gear restrictions are done at the municipal level. Other management measures such as Marine Protected Areas (MPAs) are mostly managed at

the community level with co-management assistance of local environmental NGOs collaborating with international partners (e.g. Christie *et al.* 2006).

We collected data in twelve communities, representing six municipalities in the north of Bohol province. Half of the study communities were on small islands or cayes, five were found on much larger terrestrial islands, and one was on the mainland of the island of Bohol (Figure 3.1).

Throughout this study we worked closely with a local conservation NGO, Project Seahorse Foundation for Marine Conservation (PSF), which has worked with Danajon Bank communities since 1996. PSF supported our research by providing connections to the local community leaders, facilitating research permits, and providing expert input.

Adult survey and interviews

We obtained census data but were not able to use it to determine total population size or fisher population size. Many of the people counted in the census were not currently residing in the community, and the identification of fishers was infrequent and unreliable. Only three communities recorded information on occupation, and within those records only two women were recorded as fishing. We were concerned that the definitions used to identify fishers in the census did not match our definition, which intentionally included anyone that had gleaned or used any other fishing method during the last year.

The census data for each community was stratified by gender, and adult women and men (here defined as anyone over the age of 16) were randomly selected using the assignment of a random number to each respondent, which were then selected in a descending order.

We determined if randomly selected respondents (752 women, 755 men) were 1) non-residents, 2) resident fishers, or 3) resident non-fishers by either asking them directly or in cases where they were not available, asking a key informant (most often a Barangay health worker or community leader). Because gleaning is not always considered a form of fishing, respondents or key informants were asked if they had fished (*pangisda*) or gleaned (*panginhas*).

To characterize small-scale fishing practices in terms of methods used, fishing effort, and catch weight, we interviewed women (n = 296) and men (n = 292) about their individual fishing practices (Table 3.1). The interview respondents were volunteers from the randomly selected survey respondents who had fished in the last year. In cases where a respondent could not be found, a family member or neighbour was substituted. Interviews from these haphazardly selected respondents were used in the calculation of catch weight, effort, and catch per unit effort (CPUE) but were omitted from the overall calculation of proportional participation in fishing from the survey because they were not randomly selected.

Fishers were asked to describe their fishing from the previous year including the fishing methods they used, and for each method the catch weight of a typical catch, the typical duration (in hours) of a single fishing trip, the frequency of fishing trips per week, and the number of fishers involved. We calculated CPUE as kg x fisher hour^{-1}. In cases where more than one fisher participated the catch was divided by the number of participants. This CPUE measure focuses on human effort, rather than an index of abundance. We chose the smaller unit of hours rather than days to describe effort to

capture variations that might be more relevant for the inclusion of part-time and occasional fishers, as well as for non-boat fishing methods, such as gleaning.

All interviews were conducted by a local research assistant in the Cebuano language and later translated to English by the interviewer. We worked with four local research assistants, two women and two men. In other case studies of small-scale fisheries women respondents reported a preference for talking to someone of their own gender (Adeokun and Adereti 2003), so in our study the gender of the research assistant was matched to the gender of the respondent. A total of 12 interviews were removed from the analysis. Seven respondents had not fished in the last year, four respondents reported weekly fishing effort were outliers to the average reported weekly effort, and one respondents' husband answered all the questions for her. A total of 588 interviews were analyzed (296 women and 292 men).

Catch weight estimation

To estimate catch weight from interviews we used two different methods. When reporting fish catch fishers typically used kilograms, but when reporting invertebrate catch fishers were more likely to estimate catch size by the number of *Caltex* or one-liter containers they were able to fill. We created a conversion factor of *Caltex* to kilograms by taking the exact weight of the contents of mixed and single species shells of 229 *Caltex* containers, and found the average to be 1.012 kg (±0.012 SE). For the purposes of this analysis we included the total weight of the animals measured, so in the case of gastropods and bivalves this included the weight of their shell. We recognize that shell to meat mass ratio in gastropods and bivalves is quite different than bone to meat mass ratio in fish. If we were examining catch in terms of contribution to food security it would be

necessary to compare the meat weight or use a measurement such a kilocalorie (e.g. Bliege Bird 2007). However, in this study animals were caught for commercial as well as subsistence purposes, and in some cases it was the shell that was of value as material for shell crafts, which are sold to tourists. To account for the economic and subsistence use we measured catch weight in terms of total kilograms removed from the ocean as was done in other studies of multi-species reef fisheries (Matthews 2002).

Catch measurements

To examine what types of marine life were targeted by different fishing methods we took a snap shot of fishing catch by directly measuring the catch of 254 fishing trips, 160 of which were gleaning trips. Fishing catches were found opportunistically during the five to seven days of data collection in each community, typically by asking interview respondents if they would be willing to let us measure the catch of their next fishing trip. In other cases fishers returning with their catch were opportunistically approached at many points along the seashore to sample both subsistence and commercial catch. For each catch we noted the fishing method used and the weight of each animal and their species category (shell, sea cucumber, urchin, crab, shrimp, octopus, cuttlefish, squid, or fish).

Statistical analysis

In this study we present overall estimates from all twelve communities. A number of statistical approaches were taken. Total and fishing population estimates of adult women and men in each community were calculated using a multinomial bootstrap method (Chao *et al.* 2008)—the bootstrap function in the R statistical package 'vegetarian' (R Development Core Team 2011; Charney and Record 2013). A data matrix for each

gender was created with the counts of each category (non-resident, resident fisher, resident non-fisher) and total population size from the census as columns, and each community as a row. Proportions of each category were formed in a multinomial distribution, which was used to create a community-specific simulated population. One thousand iterations of the simulated population were used to generate a distribution of values for each category (Table 3.1).

Mean and standard error calculations for proportional measures of methods used and effort per week categories were weighted to account for the disproportional stratified sampling design (Gelman and Hill 2009).

To calculate the mean weekly individual catch weight, fishing effort, and CPUE by gender and by fishing method and fishing effort categories we used a non-parametric bootstrap analysis because our data were taken using disproportional stratified sampling. First we created a simulated population the same size as our sample (n = 588) and populated it with the 24 sub-populations (women and men from 12 communities) in proportions that matched their representation in the total population. For each occurrence of one sub-population in the simulated population, a single random sample of the value being analyzed (e.g. kg x week^{-1}) from the corresponding sub-population was taken (replacement allowed). Finally the mean of the simulated population of women and men was calculated, and 1000 iterations were used to create a distribution of values. We also calculated the total estimated weekly fishing effort and catch size by taking the sum of all mean values of each simulated sub-population multiplied by the estimated sub-population size, again with 1000 iterations.

Finally proportional distribution of animal types by fishing method was estimated by taking the average weight of each animal type within each fishing method. To compare our observed results with the community perception of gender and fisheries, we asked respondents to tell us who in the community is responsible for gleaning and fishing (see Appendix). All 588 respondents were asked, but only 295 women and 285 men answered this question.

Results

Proportion of respondents in different fishing activities

For the purposes of this study we have placed all fishing methods into five broad categories (Table 3.2). Men and women participated in all five categories of fishing methods, but in different proportions. The biggest difference was between gleaning and all other forms of fishing. Almost all women interviewed participated in gleaning, whereas just over half of men glean (Figure 3.2a). Men's participation in gleaning differs as their gleaning is more often in addition to (and sometimes explained as secondary to) other forms of fishing. In all other forms of fishing men participate in higher proportions than women, and women's participation is almost exclusively in the company of a male relative, most often her husband. Of all the non-gleaning fishing methods, women's participation was highest in net fishing.

Respondent perception of fishing responsibilities also found a gender difference in fishing methods used. Most women (98%, n = 295) and all men (100%, n = 285) held the opinion that men were primarily responsible for non-gleaning fishing. On the other hand, gleaning was perceived to be either equally done by women and men (57% and 45% of

women and men respondents respectively), or primarily the responsibility of women (31% and 28% of women and men respondents respectively).

Who fishes?

Women accounted for 42% of all fishers that had fished (including gleaning) in the last year. We estimated a total of 2329 (SD = 35) women fishers and 3173 (SD = 35) men fishers in the 12 communities we sampled (Table 3.1). We found a mean of 80% of women and 84% of men fish in these communities, but in all communities there were more men than women residents, mostly due to a higher occurrence of female emigration (Table 3.3).

Using different definitions of fishing changed the estimated number of fishers, and the proportion of women fishers. The cultural definition of fishing did not include gleaning and eliminated 70% of women and 10% of men respondents with the result that women represented only 20% of fishers. The livelihood definition of fishing only included respondents that identified fishing (including gleaning) as their primary livelihood, and eliminated 76% of women and 10% of men, which resulted in women representing 16% of fishers.

Catch weight and effort by gender

Women were responsible for catching 26% of the total estimated weekly catch weight (kg), and 23% of the weekly fishing effort (hr). Women's mean kg x week^{-1}and hr x week^{-1} were less than half that of men's but their average CPUE was slightly higher (Table 3.4). Most women (78%) fished less than 20 hours a week, while most men (61%) fished more than 20 hours per week (Figure 3.2b).

Fishers that fish less than 20 hours per week (conservatively defined here as less than full-time fishers) were responsible for just over 31% of the total weekly catch weight (15% and 16% from women and men respectively; Figure 3.3).

Women's catch weight (kg x week^{-1}) was mostly from gleaning, while most of men's was from net fishing, although men's catch weight was more evenly distributed amongst the different fishing methods than women's (Figure 3.4). Together gleaning and net fishing brought in over two-thirds of all catch.

Animals targeted by fishing methods

Gleaners extracted mostly gastropods, bivalves, and other sessile invertebrates, while net, hook and dive fishers caught primarily finfish (Figure 3.5). Fishing traps mostly caught crabs, but were also used to catch finfish. The differences may be due to the different habitats where the fishing occurred. For example, gleaning focused on benthic species available at low tide, while net and hook fishing occurred at a greater range of depths to include swimming species. Similarly, diving occurred at multiple depths but often in coral reef edge areas.

Discussion

This study has illustrated distinct and substantial fishing efforts of women, gleaners, and part-time or occasional fishers, emphasizing the importance of including their effort, catch weight, fishing methods, and target species in assessments of small-scale fisheries and ecosystem-based management. Our study adds to the growing evidence of women's participation in small-scale fishing, and the heterogeneity of the small-scale fishing strategies in communities (Bliege Bird 2007; Béné *et al.* 2009; Hauzer *et al.* 2013). Our results suggest that current assessments limited to men, gear-driven methods, full-time

fishers, and finfish may produce inadequate representations of small-scale fisheries by underestimating the diversity and totality of human fishing and overlooking important social and ecological interactions. To assess the diversity and totality of small-scale fisheries at a community scale we suggest 1) broader definitions of fishing that take gleaning into account, 2) broader definitions of fishers that take women, part-time fishers, and gleaners into account, and 3) broader definitions of fished species that take benthic macro invertebrates into account. Our study, unusual in measuring the number of women fishers and women's contribution to the total catch (among other categories of frequently overlooked fishing participation and practices), helps creates a model for just such changes.

Gender and the quantification of small-scale fisheries

Identification and enumeration of fishers is a necessary first step to quantifying fishing effort and catch weight using fisher interviews. To identify fishers at the community scale it is necessary to be aware how being defined as a fisher is mediated by gender roles, definitions of occupation and labour, and definitions of fishing strategies. Women may not be identified or self-identify as fishers in contexts where fishing is culturally considered the occupation of men (Yodanis 2000). Part-time or occasional fishers may be less likely to be counted in occupational or labour statistics (Teh and Sumaila 2013), even though part-time labour fisheries is a common occurrence in areas with high occupational diversity (Hill 2011). Gleaners may be similarly overlooked because it is common for only non-gleaning fishing practices to be translated as "fishing" (Lambeth 1999).

We found that limiting the population of fishers to male, full-time, and non-gleaning fishers underestimated the number of fishers and the totality of fishing catch size at the community scale. In our study, women, part-time fishers, and gleaners represented 35-55% of fishers and accounted for between 25-35% of the total weekly catch weight. Excluding part-time fishers and gleaners disproportionately masked the participation of women (Figure 3.2), but examining these categories also reveals that considerable portions of men's catch may also be overlooked or underestimated without explicit attention to these categories.

In this case study it is clear that limited definitions of fishers and fishing did not adequately quantify fishers or fishing catch weight at a community scale. These statistics may also have a wider reaching impact if they are used to estimate fishing effort (Teh and Sumaila 2013)(Teh and Sumaila 2013), indicate fisher density and fishing trends (Christie *et al.* 2006), or build sustainability models for marine extraction and conservation (Muallil *et al.* 2012), at regional, national and international scales. Although we have focused on gender, labour, and fishing methods as key categories that may be overlooked, in other contexts other groups such as migrants, and ethnic, racial, or religious minorities should also be considered (Mills *et al.* 2011).

Gender and ecosystem-based management

A gender approach to small-scale fisheries dovetails nicely with the mandate of ecosystem-based management to "scale-up" to include key social and ecological interactions (McLeod *et al.* 2005; Pomeroy *et al.* 2010) by broadening the definitions of fisher and fisheries. The inclusion of women fishers allows examination and integration of ecological interactions among fishers and the species they target, as well social

interactions at a household and community level. For example women's mangrove fisheries in El Salvador were thought to damage the nursery habitat of species important to men's fisheries (Gammage 2004). The inclusion of women's fishing highlights the ecological interaction between women and men's fisheries and allows for management from an ecosystem scale. Socio-economic interactions between women and men's fisheries also occur at a household and community scale. In the Comoros Islands women and men's fisheries together formed a household subsistence and economic strategy. Within a household women's catch could be used as food thereby freeing up a larger portions of the men's catch to be sold (Hauzer *et al.* 2013). An example of a community scale economic interaction was found in Mexico where women fished for the bait that men use in their fisheries with the result that any management of men's fishing must absolutely reference women's fishing and vice versa (Savard and Fraga 2005).

In our case study the inclusion of women's fishing broadens the species to be included in ecosystem-scale assessment and management. We found that women's fishing was dominated by gleaning, a fishing method that targets macro invertebrate species such as bivalves, gastropods, sea cucumbers, and urchins (Figure 3.5). While invertebrates are often recognized as an important marine resource in the Central Philippines, most management tools and plans remain primarily focused on fish species (Armada *et al.* 2009; Muallil *et al.* 2012). Such narrowness is worrying, given the role that macro invertebrates play in marine ecosystems as prey (Gell and Roberts 2003), or in maintaining, damaging, or even creating key habitat (Pinnegar *et al.* 2000; Coen *et al.* 2007). The inclusion of women's fishing allows the delineation of the ecosystem under

management to more closely match the community scale at which these resources are being used and managed.

Ecosystem-based management requires the participation of stakeholders in resource management decisions (McLeod *et al.* 2005) although lack of stakeholder integration has been identified as a key gap between the aspirations and applications of this management approach (Arkema *et al.* 2006). To this we would add that a clear process to identify stakeholders is similarly lacking, without which minority or marginalized groups may be more likely to be underrepresented and have adverse affects on management. For example, a *trochus* reintroduction project in Tuvalu failed when managers neglected to inform women fishers, who, unaware of the management plan, gleaned the introduced animals (Seniloli *et al.* 2002). While we have emphasized the need to include women fishers, a ecosystem-based management approach would also need to include non-fishing participants in the value chain such as processors and marketers that would be affected by management measures. Finally, while the inclusion of women's fisheries in small-scale fisheries assessments aid in the understanding of fisheries and can highlight important interactions, it does not guarantee that women and men will be empowered to fully participate in the management of their resources. Hence, the role of gender in community participation in resource management and governance should also be considered (Clabots 2013; Chapter 5).

Gender and data collection

There are increasing attempts to include women in fisheries and management assessments (e.g. Bacalso *et al.* 2013), but data collection on women with the goal of gender analysis and integration, often falls short of original intentions (Harrison 1997).

This may in part be due to situations where the additional logistical requirements needed to collect accurate gender data (see: Wongbusarakum and Pomeroy 2000; Quist and Polotan-De La Cruz 2008; Brugere 2012) are unknown or unimplemented. Future research to expand on the findings of this study should include greater detail on the seasonality of fishing practices, social and economic data on women's and men's participation in small-scale fisheries and management with particular attention to food security, and scale up to national and global assessments by including wider geographic sampling.

To understand and manage small-scale fisheries it is important to challenge the assumptions made about who fishes, and what fishing should be quantified and considered in management decision making. Our quantitative assessment clearly demonstrates the substantial contribution of women, gleaners, and part-time fishers to the total catch weight and effort, and the greater diversity of fishers and fisheries that may be included using broader definitions. We must shift the burden of proof by beginning with the assumption that women, part-time fishers, and gleaners are important to our ecosystem and community level understanding of fisheries, and as a result engaging in data collection that can capture the full diversity and totality of human fishing. It should no longer be acceptable to assume these groups are negligible simply because they do not fit the narrow and more traditional definitions of fishing. It is of course not possible to collect everything, but we have demonstrated here that there is support for broadening who counts and who gets counted.

Table 3.1. Sample size for data collection by method in each community with estimates of residents and fisher populations.

Site	Survey		Individual Interview		Catch measure	Census population size N_{census}		Estimated resident population size (SD) $N_{residents}$		Estimated fisher population size (SD) $N_{fishers}$	
	w	*m*	*w*	*m*	*all*	*w*	*m*	*w*	*m*	*w*	*m*
1	65	77	25	24	27	244	245	131 (8)	184 (7)	116 (8)	162 (7)
2	109	93	25	24	25	403	410	199 (10)	273 (9)	107 (9)	234 (10)
3	60	47	25	25	20	753	779	414 (14)	547 (13)	326 (13)	480 (14)
4	60	45	24	25	17	273	318	200 (7)	247 (7)	141 (8)	184 (9)
5	55	73	25	25	24	294	272	176 (8)	250 (5)	128 (9)	212 (7)
6	57	84	24	22	22	316	385	216 (8)	316 (7)	166 (9)	289 (8)
7	33	35	25	25	21	773	799	446 (14)	616 (12)	399 (14)	480 (14)
8	77	81	24	25	23	388	435	267 (9)	311 (9)	177 (9)	280 (10)
9	49	44	25	25	22	254	280	218 (5)	236 (6)	181 (7)	229 (6)
10	67	82	25	24	14	233	248	133 (8)	191 (7)	111 (8)	163 (8)
11	62	60	25	24	20	252	252	163 (7)	206 (6)	126 (8)	105 (8)
12	58	34	24	24	19	750	754	362 (14)	422 (14)	349 (14)	355 (14)
TOTAL	**752**	**755**	**296**	**292**	**254**	**4933**	**5177**	**2925 (35)**	**3799 (32)**	**2329 (35)**	**3173 (35)**

w = women, *m* = men

Table 3.2. Description of fishing methods used.

Fishing method	Cebuano terms*	Description
Glean	*kaling kaling* *kay kay* *kinhas* *magmata* *manan-aw* *mangasag* *mangguna* *manginhas* *panginhas* *panabutangan* *sibut* *sundang*	This is done is done by walking in intertidal areas, and collecting marine animals. Habitats can include rocky intertidal, reef tops, mangroves, and seagrass beds. The habitat often overlaps with shallow diving habitat, but at different tides. Gleaners often use their hands and collect their catch in a bucket, but they may also use a knife or machete to pry or hack animals off rocks and coral, or they may use a long rod, a spear, or a scratching devise known as *kay kay,* which is illegal. Scoop nets are also occasionally used. As with diving, gleaning is done at night with a lantern or flashlight. While very common for gleaners to use nearby habitat, they will also travel to other gleaning areas by boat.
Net	*baling* *bunsod* *likum* *manapyaw* *pamo* *pamukot* *pamunsod* *pangdumbol* *panimilya,* *pukot*	Nets of various descriptions are used and may be on permanent corral structures, set up as passive drift nets, or actively dragged. Fishers will often use methods to drive fish into the nets either by swimming towards them in a coordinated fashion, or using a large wooden pole that is splashed into the water. Some types of nets such as bottom trawlers or double and triple nets are illegal. There are also limitations of mesh size.
Hook	*bira bira* *kitang* *mamasol* *palangre* *pamasol* *pasol* *vlang vlang* *undack*	Usually done from boats but can also be done from the shoreline. A variety of hooks and lures are used. Many times a single hook is used but there are also two varieties of multi-hook and line used.
Dive	*buso* *pamana* *pamang* *panagabii* *panarap,* *panassa* *panawm* *pangispat*	Free diving is done during the day, but also during the night, either with a lantern on the prow of the boat, or increasingly commonly with a waterproof flashlight attached to the head. Fishers may use their hands, but also use spears, rods, or scoop nets. Divers may go directly from shore, or may take a boat and go further afield. The diving category also includes divers that use compressors, which provide an air supply that allows divers to dive deeper and longer. This method is illegal in many locations around the Danajon Bank. In some cases respondents were specifically targeting species for the aquarium trade.
Trap	*bubo* *pamanggal* *pamubo* *panapya* *panggal* *sapyaw*	Traps of various shapes and sizes are used, made either out of bamboo or plastic mesh.

* Cebuano words given by respondents to describe fishing methods. They are often synonyms, but may also refer to diversity within the fishing categories.

Table 3.3. Proportion of resident fishers and population sex ratio.

Site	Proportion of resident population that fishes $\frac{N_{fishers}}{N_{residents}}$ (SD)		Resident sex ratio $\frac{N_{residents\ w}}{N_{residents\ m}}$ (SD)
	w	*m*	*all*
1	0.89 (0.03)	0.88 (0.02)	0.71 (0.05)
2	0.54 (0.04)	0.86 (0.02)	0.73 (0.05)
3	0.79 (0.02)	0.88 (0.01)	0.76 (0.03)
4	0.70 (0.03)	0.74 (0.03)	0.81 (0.04)
5	0.73 (0.03)	0.85 (0.02)	0.71 (0.04)
6	0.77 (0.03)	0.91 (0.02)	0.68 (0.03)
7	0.89 (0.01)	0.78 (0.02)	0.72 (0.03)
8	0.66 (0.03)	0.90 (0.02)	0.86 (0.04)
9	0.83 (0.03)	0.97 (0.01)	0.93 (0.03)
10	0.84 (0.03)	0.86 (0.02)	0.70 (0.05)
11	0.77 (0.03)	0.51 (0.03)	0.79 (0.04)
12	0.96 (0.01)	0.84 (0.02)	0.86 (0.04)
MEAN	**0.80 (0.01)**	**0.84 (0.01)**	**0.77 (0.01)**

w = women, *m* = men

Table 3.4. Estimation of mean individual weekly catch weight, effort, CPUE, and population weekly catch weight and effort.

Fishing measurement	Women (n = 296)		Men (n = 292)	
	Mean	(95% CI)	Mean	(95% CI)
Individual Catch (kg x week^{-1})	8.72	(7.37-10.21)	18.16	(16.03-20.59)
Individual Effort (hrs x week^{-1})	12.26	(10.55-14.06)	29.74	(27.38-32.27)
CPUE (kg x hr^{-1})	0.97	(0.85-1.09)	0.78	(0.68-0.88)
Population Catch (tonnes x week^{-1})	20.29	(17.21-23.57)	57.66	(50.94-65.22)
Population Effort (1000 hrs x week^{-1})	28.59	(24.43-32.94)	94.37	(86.93-102.15)

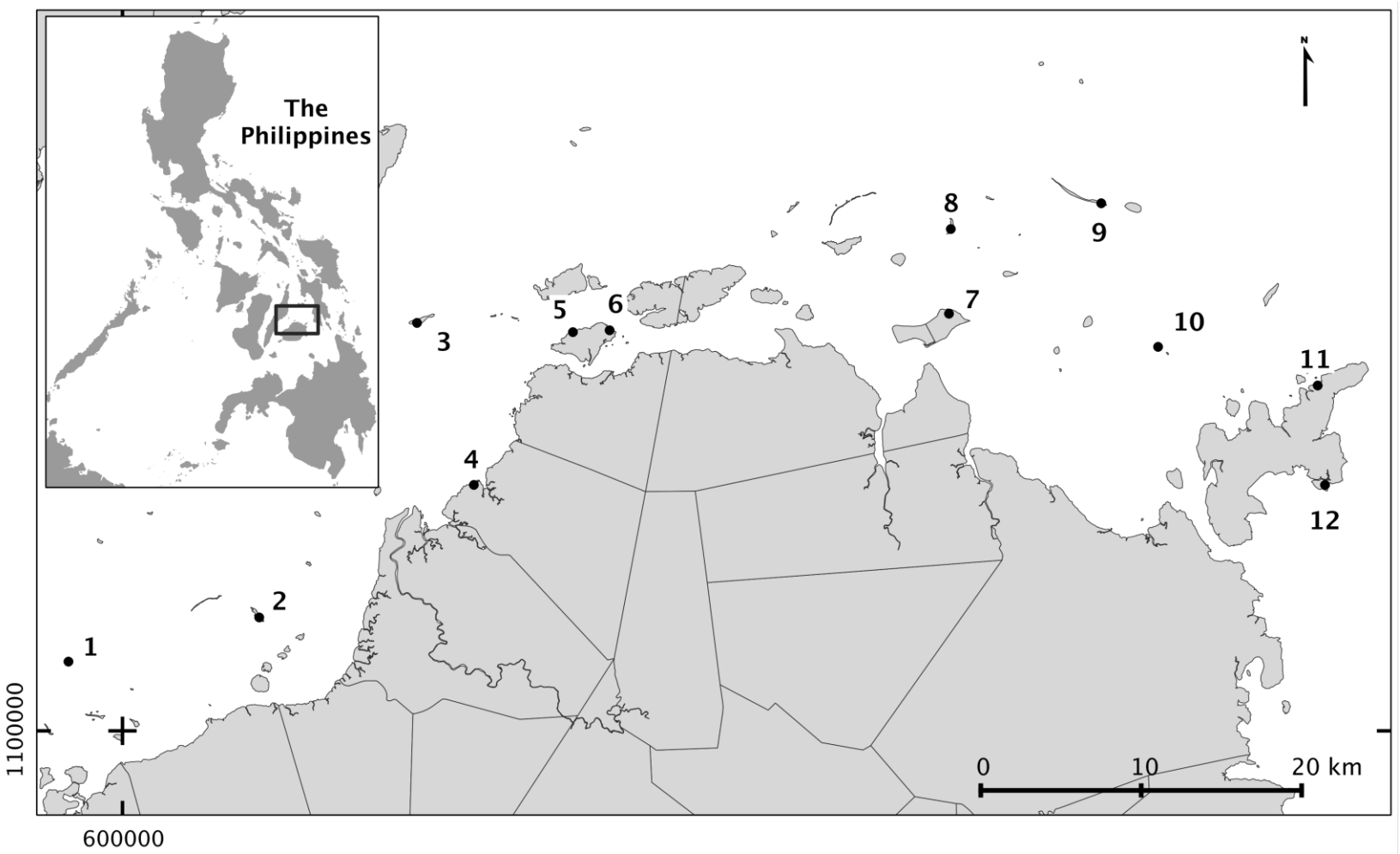

Figure 3.1. Study communities in the Central Philippines. The study sites are as follows: 1) Bilang-bilangan West, 2) Batasan, 3) Pandanon, 4) Asinan, 5) Jandayan Norte, 6) Handumon, 7) Pinamgo, 8) Cataban, 9) Bilang-bilangan East, 10) Butan, 11) Saguise, 12) Aguining.

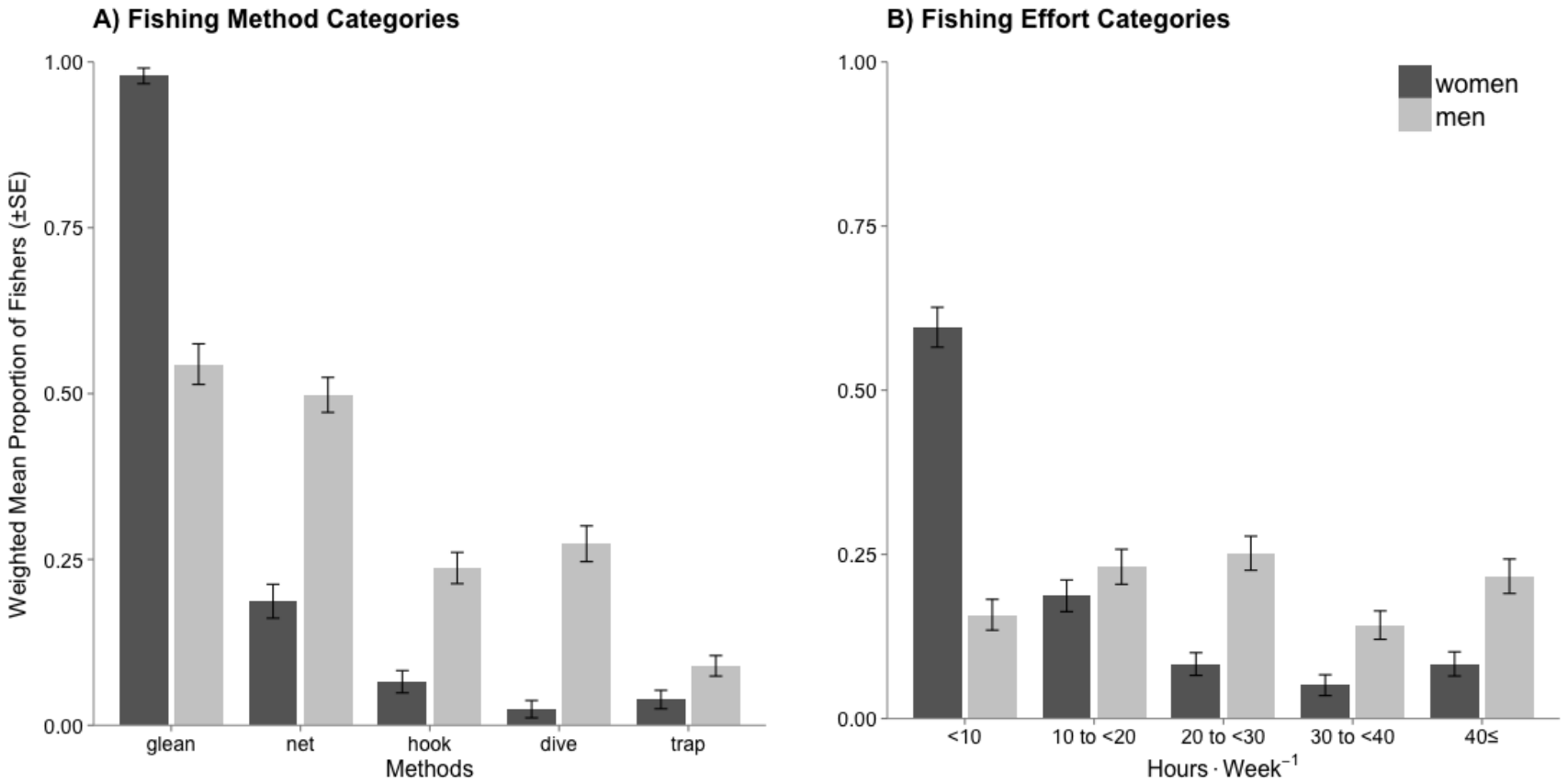

Figure 3.2. The proportional participation of women and men fishers by A) fishing method (each bar represents the proportion of women or men that participated in each fishing method, but categories of fishing are not mutually exclusive because participants often employ more than one form of fishing proportions within each gender do not add to 1) and B) weekly fishing effort (categories are mutually exclusive).

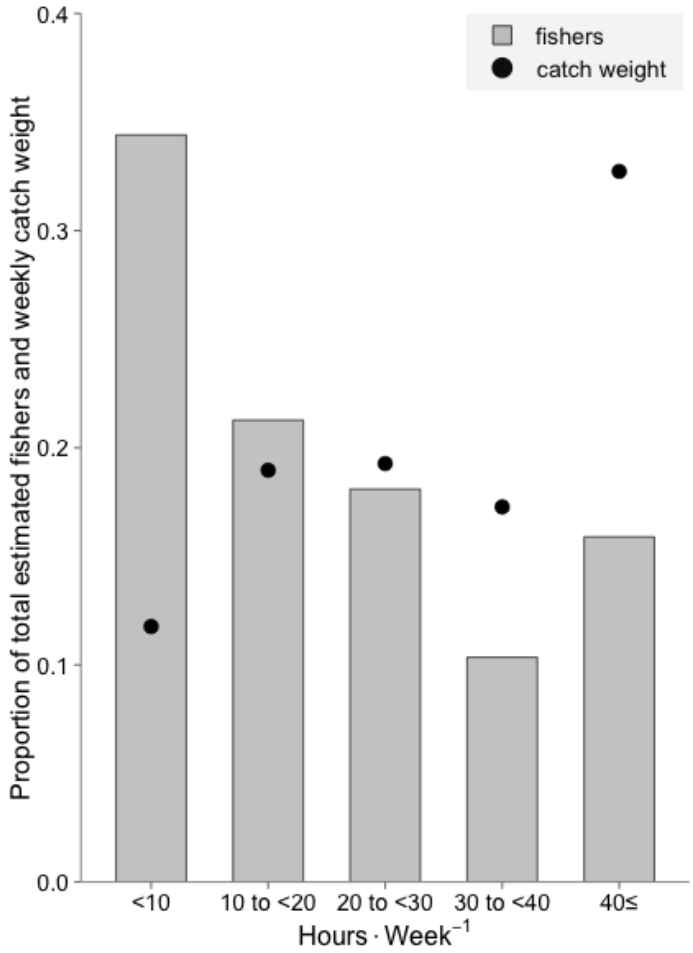

Figure 3.3. Distribution of the proportional estimated total weekly catch weight by fishing effort, and distribution of the proportion of fishers by fishing effort.

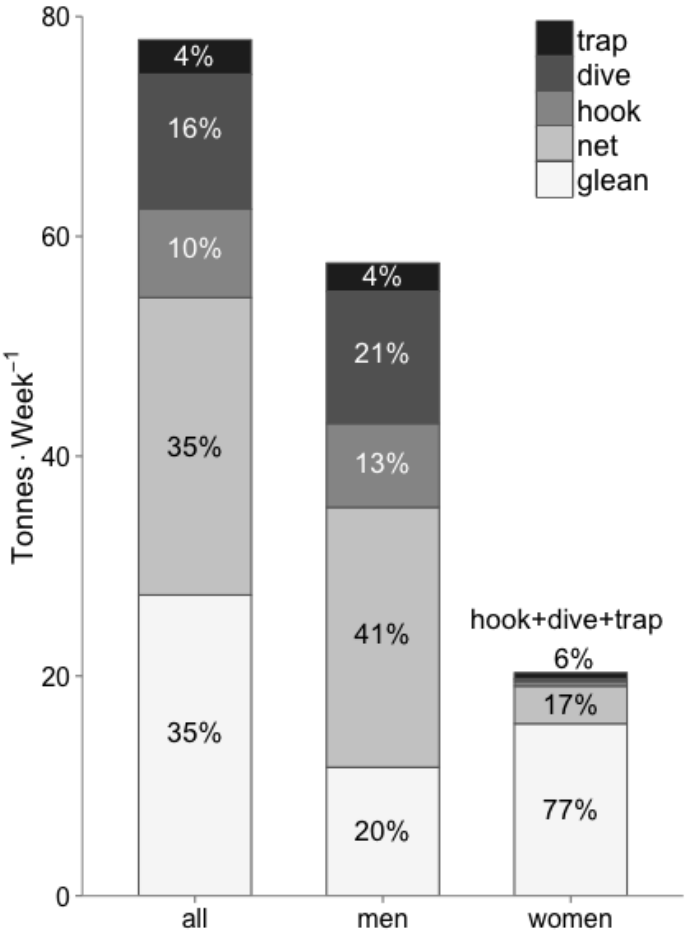

Figure 3.4. The estimated weekly catch weight of women and men from five different fishing method categories. The proportional contribution of each method type within each fisher category (“all,” “men,” “women”) is added with labels.

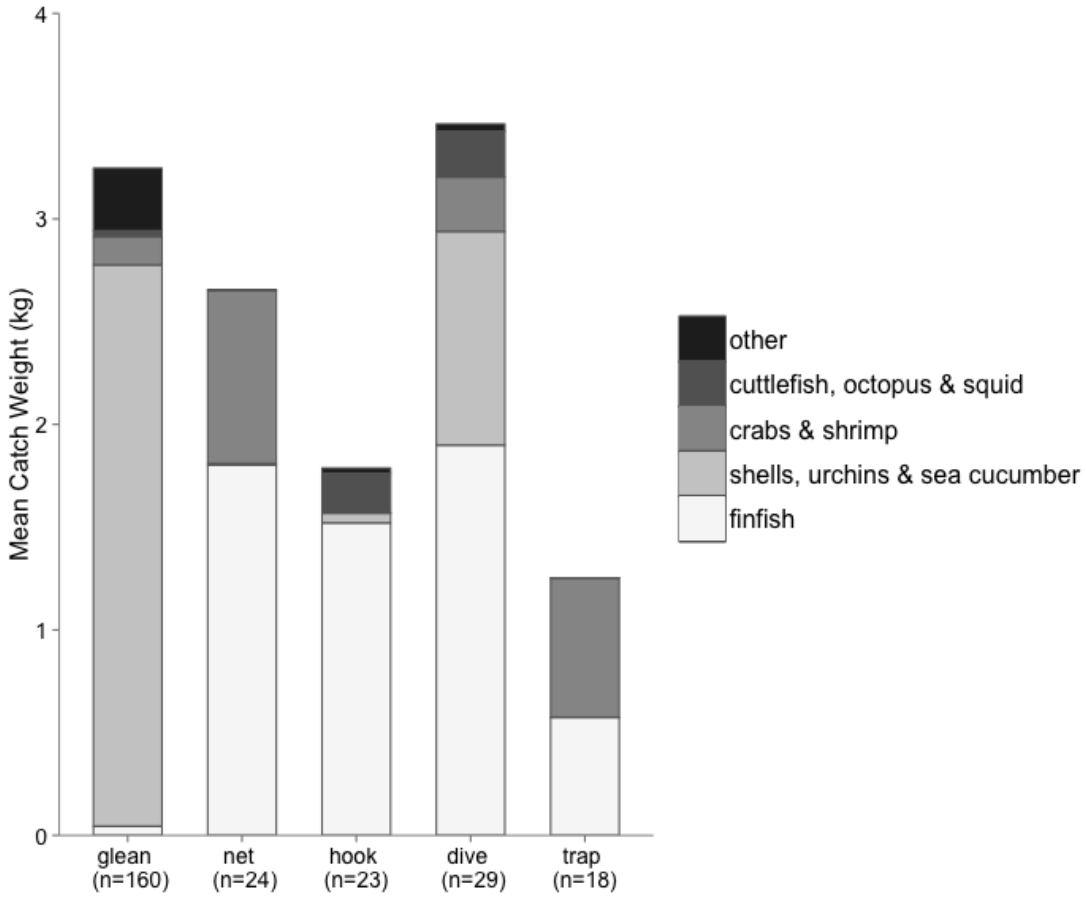

Figure 3.5. Mean catch by animal category of five fishing methods, directly measured from fishing trips. The "other" category includes all animal and plant types that made up less than 3% in all fishing methods. It includes seaweeds, jellyfish, and unidentified animals. The sample size of diving catch was low and contained one catch that included a 37kg ray. For this reason the mean catch and the dominance of finfish in this category is likely to be an overestimation.

4. The invisible walking fishers: gleaning as an important form of marine exploitation

Introduction

Data gaps impede the quantification of fishing catch and effort at local, national and international scales. The causes of these data gaps are often characterized as falling within illegal, unreported, or unregulated fisheries (IUU). Research on IUU fisheries largely focuses on high seas or commercial fishing efforts that are illegal or purposefully underreported. From a management and research perspective IUU fisheries have been given a negative connotation to the point that the FAO has deliberately set out to "prevent, deter and eliminate IUU fishing" (FAO 2001).

What are often missing from these characterizations of IUU fisheries is small-scale fisheries (Metuzals *et al.* 2010). Small-scale fisheries often fall with both the unreported and unregulated categories (Zeller *et al.* 2007), but do not fall within commercial or high seas contexts and so are often left out of IUU assessments. The rigorous inclusion of small-scale fisheries in assessment is often missing, leading to underestimations of these contributions. Yet, it is increasingly recognized that small scale fisheries contribute significantly to food and poverty alleviation (FAO and WorldFish Centre 2008), and they are likely to be a significant proportion of fishing catch overall. Lack of capacity to monitor these fisheries is one reason for the data gap (McCluskey and Lewison 2008), but this may also be exacerbated by the marginalization of many small-scale fishers.

Attempts to estimate IUU fisheries should address the variety of issues that impede national and global scale quantification of fishing catch and effort. Within small-scale fisheries there are specific groups that may be more likely to be marginalized and these

can include artisanal and indigenous fishers (Davis and Jentoft 2001), subsistence fishers (Harris *et al.* 2010), poor fishers (Pattanaik 2007), women and children (Bird and Bliege Bird 2000; Kleiber *et al.* 2014b; Chapter 3), as well as well as people using fishing methods that do not use boats and similar technologies.

Gleaning – walking in intertidal habitat and gathering primarily marine invertebrates – is a fishing method used all over the world (Kleiber *et al.* 2014a; Chapter 2). And yet gleaning is often not included in the definitions of "fishing", and overlooked in the quantification of small-scale fisheries, making it paradoxically both pervasive and invisible (Vunisea 1997; Unsworth and Cullen 2010; Weeratunge *et al.* 2010). Fishing without a vessel or boat is particularly relevant to the discussion of overlooked or marginalized fishing since the enumeration of boats is often used to calculate fishing effort when direct measures of catch and effort are unavailable (McCluskey and Lewison 2008). These methods completely overlook the fishers and fisheries that operate without a vessel. This can also influence the enumeration of fishers. Gleaning labour is recognized nationally by Spain, but at the European level, workers in fisheries and aquaculture are enumerated, but gleaning is not included in either of those categories (European Commission 2003), resulting in the underestimation of fishing catch and labour. In a diversity of geographic and cultural contexts gleaning is mostly done by women (Kleiber *et al.* 2014a; Chapter 2), a factor that likely further contributes to the invisibility and marginalization of gleaning. While men do use gleaning as a fishing method, they are often found to glean less frequently than women (Meehan 1977; Kleiber *et al.* 2014b; Chapter 3). Sex or gender-disaggregated data in natural resources sectors is

rare (IUCN 2014), and is in part due to a general dearth of data on women's labour at national and international scales (United Nations 2006).

The data gap in gleaning lead to an underestimation of the contribution of gleaning to local economies and food security. While gleaning catch is often used exclusively for subsistence, it may also have a significant economic value. For example, Spain's *mariscadoras,* shell fishery had estimated worth of 47 million € in 2001 (European Commission 2003). In other cases, shells may be traded at local curio markets to tourists (Newton *et al.* 1993), or sold internationally for the button trade (Thorburn 2000). Other gleaned species such as sea cucumber and octopus are also found in the international seafood trade (Barnes-Mauthe *et al.* 2013). In addition, gleaning catch is an important source of protein, and hence food security in a number of settings. In South Africa, gleaned shellfish supplied 8% of the annual protein consumption of one coastal community (Hockey *et al.* 1988), and in a village in Fiji, the gleaning efforts of 70 women were an important source of food for between 300-500 people from low income households (Quinn and Davis 1997). Overlooking gleaning also hinders socio-ecological approaches to fisheries that are often recommended as holistic approaches to small-scale fisheries management (Nordlund *et al.* 2011). While conservation approaches might only gather data on commercial and boat fishing, overfishing has been documented in gleaning fisheries (Frangoudes *et al.* 2008), and there are likely to be broader ecosystem level impacts of gleaning practices through habitat disturbance, particularly in important near-shore nursery habitats (Gammage 2004).

This paper, takes a socio-ecological approach to examine a case study of gleaning in the Central Philippines. I collected quantitative and qualitative data from interviews and

fishing trips in twelve coastal and island communities in the northern section of the province of Bohol (Figure 3.1). We examined when people begin to glean, as well as the social, economic, and biophysical factors that contribute to the use of gleaning as a fishing method. To understand the economic and food security contribution of gleaning, we also used community-wide estimations of catch volume by fishing method, catch type, catch use, and economic value of gleaning and all other small-scale fishing catch. We also examined the spatial and economic strategies of gleaners by measuring the distance they travel and the species and size characteristics of the animals they choose to sell. Finally we estimated the reported yearly change in catch per unit effort (CPUE) of gleaning as well as for other fishing methods.

Methods

Study area

Our case study took place in the Danajon Bank region of the Central Philippines (Figure 3.1). Small-scale fisheries characterized by a diversity of gears are used in this region (Selgrath *et al.* in review), and gleaning is the most widespread fishing method (Kleiber *et al.* 2014b; Chapter 3). Gleaning is the most common fishing method used by women and children, although men also glean (Kleiber *et al.* 2014b; Chapter 3). Gleaning is largely open access with the exception of specific no-fishing marine protected areas (D. Kleiber, personal observation). Fishing including gleaning is a major form of livelihood, but there are other income generating activities as well as water carrying and shell crafts (Guieb 2008). In the Danajon Bank, overfishing and destructive fishing activities such as dynamite and cyanide have put tremendous pressure on the marine ecosystem (Christie *et al.* 2006). Marine management is decentralized to municipal and community levels

(Lowry *et al.* 2005), with increasing reliance on Marine Protected Areas (MPAs) as a key management practice. Poverty is prevalent throughout this region (Guieb 2008).

As in many other places in the world, gleaning in the Danajon bank takes place in shallow water, and is often limited to near-shore waters. Habitats that gleaners exploit included rocky intertidal, mangroves, exposed reef, and seagrass beds. Gleaners walk in the shallows gathering mostly gastropods, bivalves, sea urchins, sea cucumbers, but also occasionally fish caught in pools. Gleaners often use their hands and a collecting bag or bucket, but may also use a knife, long pole, or occasionally a small scoop net. Gleaning is usually done at low tide to increase the size of the fishing ground, and the ease of seeing prey. Divers and gleaners often exploit the same habitats but at different stages of the tide, and the distinction between gleaners and divers is often context specific. For the purposes of this study, we define gleaning as a form of fishing done while walking where the fisher keeps their head above water. Other forms of fishing from the shoreline, such as hook and line or cast nets were categorized by their gear type.

Project Seahorse has worked in the Danajon Bank region since 1993, forming a local conservation NGO, Project Seahorse Foundation for Marine Conservation (PSF) in 2003. PSF collaborated on our project, supporting the research by providing connections to the local community. In turn, the results of our study are being used to inform local marine resource managers.

Interview respondent selection

We randomly selected adult interview respondents (here defined as 16 or older) from the census of each community, stratified by gender (for more detail please see Kleiber *et al.* 2014b; Chapter 3). We interviewed respondents that had fished, including gleaning, in

the last year. In cases where a respondent could not be found, a family member or neighbour was substituted, resulting in haphazard sampling. All interviews were conducted by a local research assistant in the Cebuano language and later translated to English by the interviewer. For each interview, we recorded a series of variables that related to the individual, their family, and their community (Table 4.1).

Reported catch biomass, use of catch, and change in catch

To examine the contribution of gleaning and other fishing practices to catch retained for food eaten by the family in all 12 communities, we interviewed women (n = 296) and men (n = 292) about their individual fishing practices. Interviews regarding fishing have been found to produce accurate estimations of fishing efforts and catch biomass (Kuster *et al.* 2006). Interviews were semi-structured and took 30-60 minutes to complete. Respondents were asked about each fishing method they used. For each method, we asked respondents to tell us 1) the biomass of a typical catch, 2) the duration and frequency of fishing trips, 3) the proportion of their catch allocated to household consumption, selling, or other uses, 4) the species they most commonly caught, and 5) if they have ever caught zero catch during a fishing trip. We also asked respondents to recall the year and the catch biomass and duration of a typical fishing trip when they first started using that particular fishing method. If they had moved to the community as an adult, they were asked to report the catch of their first fishing trip in their current community. Calculations of change in CPUE were done for each reported methods. Because many fishers used more than one method, they are represented more than once.

Calculation of the edible weight and economic value of reported catch

Edible yield and the economic value of catch varied by species, or animal category (Table 4.2 and Table 4.3). During the interviews respondents reported up to six marine animals that they most commonly caught using a particular fishing method. We estimated the catch weight for each reported species (Skg), by dividing the total reported catch weight evenly between the number of species reported, unless otherwise detailed by the respondent. The edible yield (EY) of an animal is the proportion of edible mass divided by the total mass of an animal. In this study the EY of fish, octopus, squid, cuttlefish, sea cucumbers, sea stars, shrimp, and jellyfish, was assumed to equal their total weight (EY = 1). We measured the total and edible weight and calculated the mean EY of 28 of the most commonly caught gastropods, bivalves, crabs, and urchins (Table 4.2). We also randomly sampled 20 animals from each species, and used them to calculate the mean and standard deviation of each animal category for cases where species specific EY was not available. The categories were 1) bivalves, 2) gastropods, 3) urchins, 4) crabs, 5) shells (both bivalves and gastropods in the rare cases where the animal was not identified as one or the other; Table 4.2). For each individually reported catch the following equation was then used to calculate the sum of the edible weight:

Eq. 1

$$\sum_{x=species} (Skg_x \times EY_x)$$

We estimated the economic value of two categories of catch use: 1) catch sold and, 2) catch retained for food or other purposes. First we multiplied the total reported mass of catch the reported proportion of catch that went to each of the categories of catch use.

The mass of sold and retained fish catch were then evenly divided amongst the number of reported animals (unless otherwise specified by the respondent) to obtain the catch weight of each reported species within each use category (Skg_{sold} and $Skg_{retained}$).

To estimate the mean monetary value (MV = PHP x kg^{-1}) of five different categories of marine animals we directly measured the catch of 254 fishing trips, 162 of which were gleaning trips (PHP is the Philippine peso). Fishing catches were found and measured opportunistically during the 5-7 days of data collection in each community. For all catches, each animal was categorized as 1) a shell (gastropod or bivalve), 2) an echinoderm (sea cucumber or urchin), 3) an arthropod (crab or shrimp), 4) a cephalopod (octopus, cuttlefish or squid), or 5) a finfish, and the economic value (if sold) of each individual animal was recorded. We calculated the mean monetary value within each of those categories (Table 4.3).

The monetary value by category was then used to estimate the total monetary value of the reported catches by using the following equations:

Eq. 2

$$\sum_{x=animal\ category} \left(Skg_{sold,x} \times MV_x\right)$$

Eq. 3

$$\sum_{x=animal\ category} \left(Skg_{retained,x} \times MV_x\right)$$

Children's participation

We conducted 240 household surveys in the 12 study communities (respondents were selected using the same methods as fisher interviews). We noted the fishing participation and method (gleaning, non-gleaning, or both) for each household member including

children. From the household survey data children were split into four age categories (less than 6; 7-9; 10-12; 13-15). For purposes of comparison, we also examined the adult participation in the same three fishing categories, although those data were obtained from the fishing method interviews and fishing participation survey, rather than the household interview.

Maximum fishing distance

We recorded the GPS tracks of 128 fishing trips (64 gleaning and 64 other fishing methods). Volunteer fishers were haphazardly selected and either carried the GPS on a belt while gleaning, or strapped to their boat for other fishing methods. All volunteers were made aware of the data that were being collected and given the option to decline. The maximum distance of each trip was calculated as the straight-line distance between the starting point of the fishing trip and the trip's furthest point (Figure 4.1). Calculation and mapping were done in QGIS (Quantum GIS Development Team 2013).

Individual, household and community level factors

Gender, age, and boat ownership status, were collected during the interviews with individual fishers. Questions related to the allocation of catch also allowed us to categorize fishers as either a subsistence fishers or a commercial fisher. Many fishers did both, so any fisher that sold any part or all of their catch was categorized as a commercial fisher.

During the interviews we also asked questions related to food security. We measured food security through a Coping Strategies Index (CSI). The CSI is used as a continuous variable to measure relative levels of food insecurity (Maxwell *et al.* 1999). In the index, five different food shortage strategies were identified, each with different levels of

severity (Table 4.4). Respondents were asked how often their family engaged in these food strategies every week in the last year. To calculate the family CSI the frequency of each strategy was multiplied by a weighting related to its severity (Table 4.4), and then summed. A higher CSI value would then related to greater reported food insecurity.

As part of the interviews we observed and asked about different aspects of material wealth. We followed methods developed by Hill *et al.* 2012. A score of material wealth was developed from the first axis of a PCA of four measures (Table 4.5). Each individual was assigned a score based on these on these material attributes. Scores ranged from -1.87 (the poorest) to 4.76 (the wealthiest). The first axis explains 50.21% of the variation.

The gleaning area size available within walking distance varies among communities. We combined several methods to estimate gleaning area size. We first used the GPS tracks of gleaners from each community that had volunteered to carry a GPS unit while gleaning. Because of low sample size the tracks were likely not indicative of all gleaning areas. Therefore we also asked between 2 and 5 key informants in each community to indicate gleaning areas on a satellite image of a map of their community. The maps given were either printed and gleaning areas were drawn onto the map in ink, or when available the map was shown in Google Earth and a path was created in the program to indicate the gleaning area (Google 2012). In one case we were unable to ask key informants to draw a gleaning area because a satellite image of the community was not available. In this case we walked around the contours of the gleaning area, and calculated the area within the track. The GPS gleaning tracks and Google earth paths were imported into QGIS and Google Earth Satellite images in QGIS were used to redraw the hand drawn gleaning

areas (Quantum GIS Development Team 2013). All data was converted to UTM coordinates and the gleaning area (km^2) was calculated.

For each barangay we calculated the distance to the nearest market and to Cebu, the nearest city center. We used the analysis tools in QGIS (Quantum GIS Development Team 2013).

We collected data in twelve communities, representing six municipalities in the northern section of the province of Bohol. Based on our initial knowledge of the communities there were six communities with MPAs in the gleaning area and six outside the gleaning area. Upon talking to local authorities we later discovered that the MPA boundaries in the communities of Jandayan Norte had been specifically moved out of the gleaning area, and that gleaning was allowed in the MPA of Pandanon. These MPAs were then recoded as being outside of the communities gleaning area.

Statistical analysis

We used a non-parametric bootstrap analysis of the catch mass data to estimate the total weekly catch volume within specific fishing categories. A bootstrap was used because the data was taken using disproportional stratified sampling (for further details of the sampling and analysis see Kleiber *et al.* 2014b; Chapter 3). We used analysis of variance (ANOVA) to examine the differences of maximum distance by the fishing method (gleaning and non-gleaning fishing) and the gleaned edible mass of sold and unsold animals. In both cases, the log value of the y-variable was used to meet the assumption of normality. Confidence intervals are reported at the 0.025 and 0.975 quantiles.

To examine gleaners and gleaning effort (response variables) of fishers, by individual, household, and community characteristics (explanatory variables, Table 4.1), we used

mixed-effects models to account for the pseudo-replication at the community level (Gelman and Hill 2009; Zuur *et al.* 2009). We used the z-score of continuous explanatory variables (value-value mean/(2*SD)), which allowed for easier comparisons with binary variables by standardizing their scale (Gelman and Hill 2009). Before the explanatory variables were input into the model they were examined for collinearity. If two explanatory variables had a collinearity of >0.6, the variable with the highest variance inflation factor (VIF) was removed (Logan 2010). Gleaning effort is a continuous variable, but due to a high proportion of zeros (indicating respondents that didn't participate in gleaning), we first used a binomial model created with the entire data set (effort either being 1 or 0). We then created a linear model with the subset of the data where effort > 0 (Fletcher *et al.* 2005). For the linear model we took the log of effort to normalize the data distribution.

Using a likelihood ratio test, we found that the model was significantly improved by allowing the intercept to vary by the random factor of community ($L = 23.41$, $df = 1$, $p < 0.0001$) (Zuur *et al.* 2009). Furthermore we found the mean of community gleaning effort differed significantly from the global mean in ten out of twelve communities. This is the only analysis where we take community level variation into account. We used the "lme4" and "lme" R packages (Bates 2010; R Development Core Team 2011). We used a multi-model approach to average the models. Models were ranked by Akaike's information criterion (AIC_c), and the relative weight of evidence for each model was given by Akaike's weight (ω). Since no model was overwhelmingly supported by the data (which is only the case if $\omega > 0.9$) we calculated the average of all models that had an $AIC_c \Delta > 4$ from the top ranking model (Burnham and Anderson 2002; Table 4.6). The AIC Δ

between the null models (models with no fixed effects) and the top ranking models were both > 4 (Table 4.6). Model selection and averaging was done using the "MuMIn" package in R (R Development Core Team 2011).

Open-ended questions regarding gleaning and other forms of fishing were asked during the interview. The translated responses, which include field notes summarizing responses and direct quotes, were coded using Excel. The results are presented as summary statistics.

Results

Who gleans?

A considerable portion of the population gleaned; in the 12 communities between 45% and 83% of residents gleaned. Being female, retaining catch for food, increased reported food insecurity, and increased gleaning area size were the most important predictors of using gleaning as a fishing method (Figure 4.2). Inter-community variation only explained 4.25% of the total variance of the full model. Women were 69% more likely than men to be gleaners, and fishers who retained all their catch for food were 45% more likely to be gleaners than fishers who sold part or all of their catch. Increased food insecurity as well as a larger gleaning area increased the likelihood of being a gleaner by 20% and 14% respectively (Figure 4.2).

Gleaning effort

Among those that did glean, most gleaned an average of 4.2 hours per week (median = 1.4 hours). Although many gleaners are limited to nearshore gleaning areas only available for 1-2 hours a day, other gleaners travel to remote and exposed tidal flats that are exposed for longer periods of time allowing for higher than average weekly effort. In the

linear model the top four explanatory variables that were the most important predictors of gleaning effort were the same as those for the binomial gleaning model (Figure 4.2). A greater amount of inter-community variation was explained in the full linear model (12.42% of variance accounted for). Among gleaners, women gleaned on average 76% more hours than men. Fishers that sold all or part of their gleaning catch also gleaned over twice as many hours as fishers who never sold their catch. Gleaning effort also increased with increasing food insecurity and gleaning area size.

Age, material wealth, distance to the nearby city of Cebu, and the type of MPA did not have any predictive power for either the logistic or linear models (Figure 4.2). Boat ownership had a negative, but not significant relationship to being a gleaner or gleaning effort among gleaners (Figure 4.2). Distance to the closest market and distance to Cebu were highly correlated ($r_s = 0.67$). The distance to market was removed because it had the highest variance inflation factor (2.52).

Children's participation

Children began participating in fishing, in the form of gleaning, as young as two years old. From direct observation we found young children often gleaned in large groups with their mother or other adult relatives. Within the households interviewed, 46% of girls and 40% of boys used some type of fishing method. Girls continued to glean as they aged whereas boys increasingly participated in other forms of fishing as well (Figure 4.3).

Use of catch

Gleaning made a substantial contribution to the total estimated weight and economic value of the weekly catch sold (13% in both cases), but the contribution was even greater

to the estimated total weight and economic value of the catch that was retained (27% and 45% respectively; Table 4.7).

Gleaners mostly caught invertebrates, while non-gleaning fishing was mostly focused on vertebrates (Table 4.7). Shells (gastropods and bivalves), which was the largest portion of animals represented in gleaning catches (39% of animals 162 gleaning trips), was also the least economically valuable per kg of the animal categories (Table 4.3). Gleaners sold larger animals while retaining smaller animals for household consumption. The edible weight of gleaned animals that were sold was 1.24 times larger than the edible weight of animals that were not sold ($F = 248.38$, p-value < 0.0001). Gleaned animals that were mostly sold included *lukot* (the egg sacs of seahare species), sea cucumbers, and bivalves (Figure 4.4).

Distance of fishing trips

The maximum distance gleaners traveled from their community was between 0.03 and 6.00 km during gleaning trips (mean = 0.89 km, median = 0.49 km). Maximum distance of non-gleaning fishers was between 0.12 and 17.11 km (mean = 4.20 km, median = 3.13 km). The maximum distance of non-gleaners was on average 5 times further from the community of origin than of gleaners ($F = 81.39$, $p < 0.001$). Although some gleaners use boats to reach remote tidal flats, most gleaners do not use boats, which may account for the difference in distance traveled.

Catch consistency and change

The average edible catch per unit effort from gleaning was smaller than that from non-gleaning fishing methods with a mean 0.39 kg/hr (CI = 0.35, 0.43) and 0.54 kg/hr (CI = 0.49, 0.59) for gleaning and non-gleaning fishing respectively. Gleaners reported that

they were less likely to come home with no catch than fishers using other fishing methods. Among gleaners 21% (SE = 2.1%), and among non-gleaning fishers 45% (SE = 2.4%) reported having ever caught zero.

Most gleaning and non-gleaning fishing methods report a decline in CPUE calculated from their current and past reported catch and effort (Table 4.8). Among the gleaning and non-gleaning fishing methods where an increase in CPUE was calculated, most respondents explained the increase as a change in fishing strategy or increased efficiency (e.g. a change in gear, or increased ability), while a smaller number suggested ecological and climate variables (Figure 4.5). Among the gleaning and non-gleaning fishing methods where a decrease in CPUE was calculated, most respondents felt it was due to an increase in the number of fishers, with other causes of fishing intensification also mentioned (Figure 4.5).

Discussion

We found that gleaning is a key component to livelihood and food security strategies of fishers in the Danajon Bank. Gleaners contribute 13% of the edible catch that is sold, and 27% of the edible catch that is retained by fishers to feed themselves and their family. A better understanding of the contribution of small-scale fisheries has been identified as a top research priority of fisheries policy makers (Staples *et al.* 2004), but intertidal fisheries are seldom included in fisheries assessments (European Commission 2003; Nordlund *et al.* 2013). By examining the contribution of a marginalized fishery we have created a robust understanding of small-scale fisheries in the region. Our study illustrates how gleaning can be better recognized and included in future analysis of the region, and around the world.

Gleaning is an ancient and currently widespread form of fishing (Salls 1988; Dalzell 1998; Kleiber *et al.* 2014a; Chapter 2), but in many contexts it is characterized as subordinate to other fisheries. For example in the Pacific Northwest of Canada, Moss (1993) observed: "The Tlingit associate shellfish with poverty, laziness, and ritual impurity, and those who sought to be 'ideal' persons avoided shellfish. An individual's rank and gender determined the degree to which such dietary guidelines were actually followed". In our study, one respondent explained the difference in economic and food security terms by stating that "*Gleaning it is* [sic] *only for* viand *so it is also important, but crab fishing is more important because we can buy rice*." In the central Philippines, *viand* is a meat or vegetable side dish that accompanies the rice. The secondary social and cultural status of gleaning may be part of why it is less likely to be included in fisheries assessments and management. Identifying the individual and household factors that are common to gleaners can help identify groups that may be underserved or underrepresented in fisheries management. In our study the inclusion of gleaning made it clear that women were actively involved in fishing, and that fishing often begins at a very young age among children. Our study also highlighted the role of families with higher levels of food insecurity, and subsistence fishers. These populations may have less representation in community-based decision-making, not only because they are less likely to have political capital, but may also have less time to devote to civic activities, as evidenced by the fact that people with greater food insecurity spend more time gleaning.

Economic and livelihood strategies

Gleaning catch is often worth less in monetary terms than catch from other fisheries. For example, in Madagascar fisheries gleaners have the lowest annual income when

compared to fishers that use other fishing methods (Barnes-Mauthe *et al.* 2013). This may be due to differences in economic demand for the marine animals targeted, and subsequently their market value. In our study we found that a kilogram of shells, the primary catch of gleaners, was worth approximately one fifth that of a kilogram of finfish, the primary catch of non-gleaning fishers. This disparity in monetary value may be part of why we found that gleaning catch is more likely to be retained for food. As one respondent said "*[N]one has gone rich because of gleaning*". Overall gleaning contributed 13% of the monetary value of catch sold in a week.

Gleaning catch retained for food may be an important part of the household livelihood strategy. The use of gleaning for *viand* decreases the family expenses on food, and the money can then be used on other items. We found that gleaning contributed 45% of the monetary value of catch retained for food, suggesting that it does play an important economic role even as a source of food. For example one gleaner explained that "*[Gleaning is] important also because you can save money because you don't have to buy your food. Your effort is just your investment because you don't have to spend*". Because gleaners use very little gear, their investment costs are much smaller than most other fishers. This low investment cost may make gleaning particularly important to families and fishers without access to capital to buy gear, including boats (also helping to explain the demographics of those who glean, including men, women, and children). However, we did not find any link between material wealth or boat ownership and the probability of gleaning or the amount of gleaning effort. In this case our measures of material wealth may not have been an appropriate proxy for current access to capital. While material wealth did not come out as an important predictor in our models, greater levels of food

insecurity was positively correlated with an increase in the probability of gleaning and greater gleaning effort.

Food security

"*If we can't glean we don't have food*" Gleaner, 2011

"*Gleaning is not for livelihood*[1]*, those people gleaning are those families who don't have somethings* [sic] *for* viand" Respondent, 2011

Small-scale fisheries have been identified as a key source of food security (Béné *et al.* 2007). In our study of the Danajon Bank, we found that gleaning was an important part of family food security strategies. Gleaning contributed over one quarter of the edible catch retained for food, and there are a number of factors that may make gleaning important as a source of food security. It may be the only fishery available when other fishing is not available due to bad weather. One gleaner explained, "*If it's windy days I go gleaning so that we'll have* viand." Other respondents also suggesting gleaning catch added diversity to the diet. The low variability of gleaning catch may be another reason that gleaning is an important source of food security. For example, in the Torres Strait women mostly chose to glean because it offered a small but reliable food source (Bliege Bird 2007). We found that gleaners had a lower CPUE, and were very unlikely to have the unusually large – or jack pot – catches that non-gleaning fishers sometimes experienced. But we also found that fewer gleaners (21%) reported having had a previous experience of catching nothing, as compared to 45% of those who engaged in other fishing who reported that this had occurred. Hence, the limitations of reward but also risk may

[1] In this case the word livelihood is interpreted as monetary income, so does not include subsistence.

contribute to the more frequent use of gleaning for subsistence fishing (Chapman 1987; Bliege Bird 2007).

Gleaning catch threats and management

Overfishing can deplete targeted species in gleaning areas (Frangoudes *et al.* 2008). Management measures such as limited entry (Frangoudes *et al.* 2008), temporal closures (Cohen and Foale 2013) or marine protected areas (Aswani and Weiant 2003), have all been used to in different contexts to sustain gleaning fisheries. In the Central Philippines gleaning is mostly open access, with the exception of marine protected areas (MPAs) that are managed mostly as no-take areas. Most gleaners in this study had experienced a decline in CPUE, which is a pattern we also found in non-gleaning fishers, and has also been detailed for non-gleaning fishers in this area by other long term monitoring studies (Green *et al.* 2004). In this study gleaning and non-gleaning fishers attribute the decline in catch to an increase in overall effort, which is driven by an increase in the number of fishers. The reported intertidal catch decline and attribution to a greater number of fishers has also been found in Tanzania (Nordlund *et al.* 2011).

The regulation and improvement of gleaning fisheries in our study area may be limited by a number of interacting social and biophysical factors. We found that gleaners fished closer to their communities, and this could be due to limitations in the size of gleaning habitat. The area available for gleaning also varies with the tides, which limits the fishing time available often to just one or two hours. Lack of boats may make it harder for gleaners to access new habitats in an effort to increase their CPUE. Furthermore human use of coastal habitats can have direct effects on gleaning habitat. In the study communities we visited there were examples of mangroves that had been changed into

fishponds, piers built in intertidal habitats, lack of solid waste regulation along the seashore, and the harvesting of coral and rocks, which often form intertidal habitat, to be used in housing materials. Attempts to regulate gleaning must also acknowledge its role in food security. Attempts at absolute closures in the form of MPAs have not always been successful in this area, and the rules regarding gleaning in particular have been more flexible than other fisheries, and the push back is often couched in terms of food security. A similar situation was found in the western Visayas region of the Philippines, when attempts were made to regulate nearshore mosquito net fishing (Eder 2005).

By examining both gleaning and non-gleaning fishing it is possible to also examine the important interactions between the two (Béné and Tewfik 2001). Changes in one fishery can often have effects on other fisheries and lead to fishers choosing to use different fishing methods based on fluctuating availability of resources. In our study one respondent explained: "*If they don't have catch in gleaning they would go fishing. If there's no catch in fishing, then they do gleaning it's either of the two* [sic]". For example in Fiji when there was an increase in offshore catch due to the introduction of motorized boats, near shore fishing decreased (Kuster *et al.* 2005). In a different context in French Polynesia widespread over-gleaning, a fishing method traditionally used by women, has led women to become boat fishers (Walker and Robinson 2009). In our study area the opposite may have occurred. In one community a respondent explained loss of gleaning resources was attributed to an influx of male fishers that had begun to glean when their fish stocks had collapsed. Furthermore the ecological interactions between gleaning and other fisheries may occur. In El Salvador, women's gleaning was thought to have adverse effects on the juvenile nursery grounds of fin fish (Gammage 2004), and in Tanzania,

men's diving in subtidal areas was thought to decrease the gleaning catch in the intertidal habitats (Porter *et al.* 2008). This second scenario was also brought up in our study when one respondent explained that "[Gleaning] will improve if illegal fishers [compressor divers] will be removed. Because they cause disturbance, and ideally, these animals move towards the shores and are being caught also in intertidal areas". Understanding ecosystem level interaction between intertidal and subtidal animals, as well as the use of these habitats by different animals at different stages in their life history would be an important direction for future research.

Conclusion

To engage in meaningful small-scale fisheries science and management that accounts for the diversity of fisheries, it is important to reframe the definition of fishing and fishing effort to include walking fishers. We have demonstrated that when examined in detail, this overlooked fishery contributes substantially to both food security and the total economic value of small-scale fisheries in the Central Philippines. Furthermore the inclusion of gleaning highlights the fishing of marginalized populations including women, children, the food insecure, and subsistence fishers. Our case study suggests that the addition of gleaning to small-scale fisheries assessments would increase our socio-ecological understanding of fishing, and illuminate one of the least studied aspects of IUU fisheries.

Table 4.1. Explanatory variables used in mixed-effects model.

Variables	Scale	Descriptions
Gender [a]	Individual	Female OR Male
Age [a]	Individual	Adult age range between 16-76
Fisher type [a]	Individual	Subsistence fisher (all catch is eaten) OR Commercial fisher (all or part of catch is sold)
Material wealth [a, d]	Household	Score of material wealth
Food insecurity [a, d]	Household	Score of food insecurity
Boat owner [a]	Household	Does not own a boat OR Owns at least one boat
Gleaning area size [b, d]	Community	Gleaning area size (km^2) in walking distance
Distance to Cebu [b]	Community	Distance (km) to the major fish market found in Cebu
MPA type [c]	Community	MPA in the community gleaning area OR MPA outside of the community gleaning area

[a] Data collected during interviews of randomly selected fishers (n = 588).
[b] Data collected through mapping exercises with key informants and GIS tracks of fishing trips. Calculated in QGIS using a UTM map of the area.
[c] Communities with MPAs in the gleaning area labeled "in", those with MPAs outside of the gleaning area labeled "out".
[d] See appendix A for greater detail.

Table 4.2. Edible yield of invertebrate species

Category	Cebuano Name	Mean Edible Yield	SD	n
Bivalves	Balisaha	0.16	0.05	247
	bug-atan	0.17	0.02	26
	lampay-lampay	0.24	0.06	79
	litob	0.25	0.04	62
	punaw	0.44	0.09	20
	tagimtim	0.13	0.03	86
	tagnipis	0.34	0.05	52
	tahong	0.40	0.04	120
	talipsay	0.16	0.09	43
	tambayang	0.23	0.07	68
	tikod-tikod	0.17	0.04	54
	tuway	0.17	0.03	28
	wasay-wasay	0.10	0.02	192
	ALL bivalves	0.23	0.07	260
Gastropods	aninikad	0.26	0.04	104
	bongkaliw	0.16	0.10	52
	bucheke	0.23	0.04	23
	daw-daw	0.18	0.04	260
	gang-gang	0.22	0.03	23
	bayungkot	0.19	0.03	29
	liswi	0.14	0.04	22
	saang	0.12	0.02	23
	samong	0.12	0.09	20
	sihi	0.21	0.02	53
	tandok- tandok	0.21	0.04	203
	ALL gastropods	0.18	0.07	220
Shells	ALL shells	0.21	0.10	480
Crabs	lambay	0.58	0.21	24
	maniit	0.32	0.09	32
	ALL crabs	0.45	0.07	40
Urchins	dapaw-dapaw	0.03	0.01	80
	swaki	0.12	0.04	30
	ALL urchins	0.08	0.08	40

Table 4.3. Monetary value of catch by species category

Animal Category	PHP • kg^{-1}		n
	mean	SD	
fish	54.73	88.06	1302
crabs and shrimp	101.33	138.49	225
squid, octopus and cuttlefish	55.06	20.42	105
urchins and sea cucumbers	23.33	19.24	530
shells	11.46	14.49	4745

Table 4.4. Levels of food insecurity

Food shortage strategy	**Severity weight**
The family ate less preferred food	1
The family ate less food during the day	2
One individual in the family skipped a meal	3
The family skipped a meal	4
The family skipped a day of eating	5

Table 4.5. Measures of Material Wealth

Measure	**Quantification**
Number of rooms in the house	Count of 1-4
Number of working gadgets owned	Count of 0-10
A toilet in the house	0 = no, 1 = yes
Building material (wall + roof + floor)	all native = 3, mixed = 4-8, all non-native = 9

Table 4.6. Summary of Mix-Effect Models

	logistic model	linear model
n	584	447
number of models with $\Delta < 4$	21	29
greatest ω	0.17	0.09
AIC Δ from null model	183.21	42.54
Relative Importance of factors		
gender	1.00	1.00
age	0.17	0.45
material wealth	0.23	0.37
food insecurity	1.00	1.00
selling part or all of catch	1.00	1.00
boat ownership	0.77	0.60
gleaning area size	0.77	0.99
distance to Cebu	0.21	0.33
MPA type	0.18	0.26

Logistic and linear models were ranked by Akaike's information criterion (AICc). The number of models included fell within $\Delta < 4$ of the highest ranking logistic or linear model (Logan 2010). The Akaike weight (ω) gives a relative weight of evidence for each model, and if any one model has a $\omega > 0.9$, then an averaging of the models is not recommended (Burnham and Anderson 2002). The relative importance of each explanatory variable is a sum of the ω of each model where the particular variable is included.

Table 4.7. The proportional contribution of gleaning to the total weekly catch in six different categorizations of catch.

		Yield from Gleaning		Yield from Non-gleaning fishing		% gleaned
		mean	CI	mean	CI	
Catch Type[a]	Invertebrates	7.20	(6.10 – 8.38)	6.41	(4.99 – 8.06)	53%
	Vertebrates	1.45	(0.69 – 2.49)	38.72	(34.46 – 43.51)	4%
Catch Use[a]	Sold	5.80	(4.74 - 7.01)	37.30	(32.68 - 42.51)	13%
	Retained	2.87	(2.05 - 3.91)	7.72	(6.84 - 8.64)	27%
Monetary Value[b]	Earned	329	(218 - 467)	2275	(2020 - 2536)	13%
	Saved	295	(236 - 361)	361	(316 - 408)	45%

[a]Reported in tonnes per week (Confidence intervals 0.0275-0.975)
[b]Reported in hundred thousands of PHP per week (Confidence intervals 0.0275-0.975)

Table 4.8. Proportion of gleaning and non-gleaning fishing methods with calculated change in CPUE.

Fishing Method	Negative $CPUE_{current} < CPUE_{first}$	No Change $CPUE_{current} = CPUE_{first}$	Positive $CPUE_{current} > CPUE_{first}$	n
gleaning	0.59	0.23	0.18	465
non-gleaning fishing	0.71	0.14	0.09	434

$CPUE_{current}$ = Reported weekly catch kg / reported person weekly fishing hours typical of the year interviewed. $CPUE_{first}$ = Reported weekly catch kg / reported person weekly fishing hours typical of the year first using the fishing method in the study community. "n" relates to reported fishing methods that were categorized by the respondents. Respondents often had more than one fishing method, so may be represented more than once.

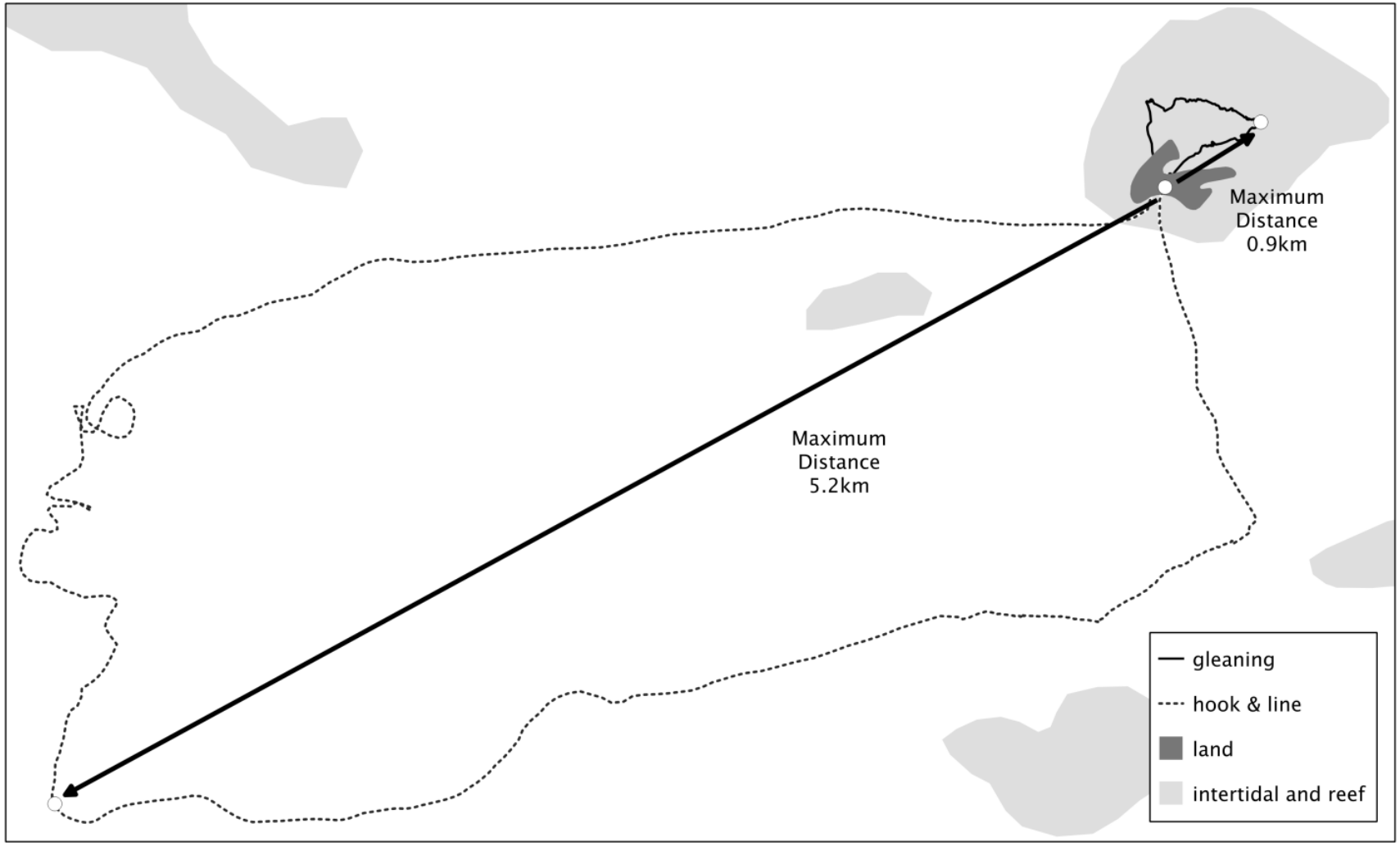

Figure 4.1. Fishing tracks with the maximum distance calculation method illustrated. Tracks are from fishers in Bilang-bilangan West, Tubigon, Bohol and are typical of the widespread pattern we found where gleaners stay close to shore and other fishers travel much further.

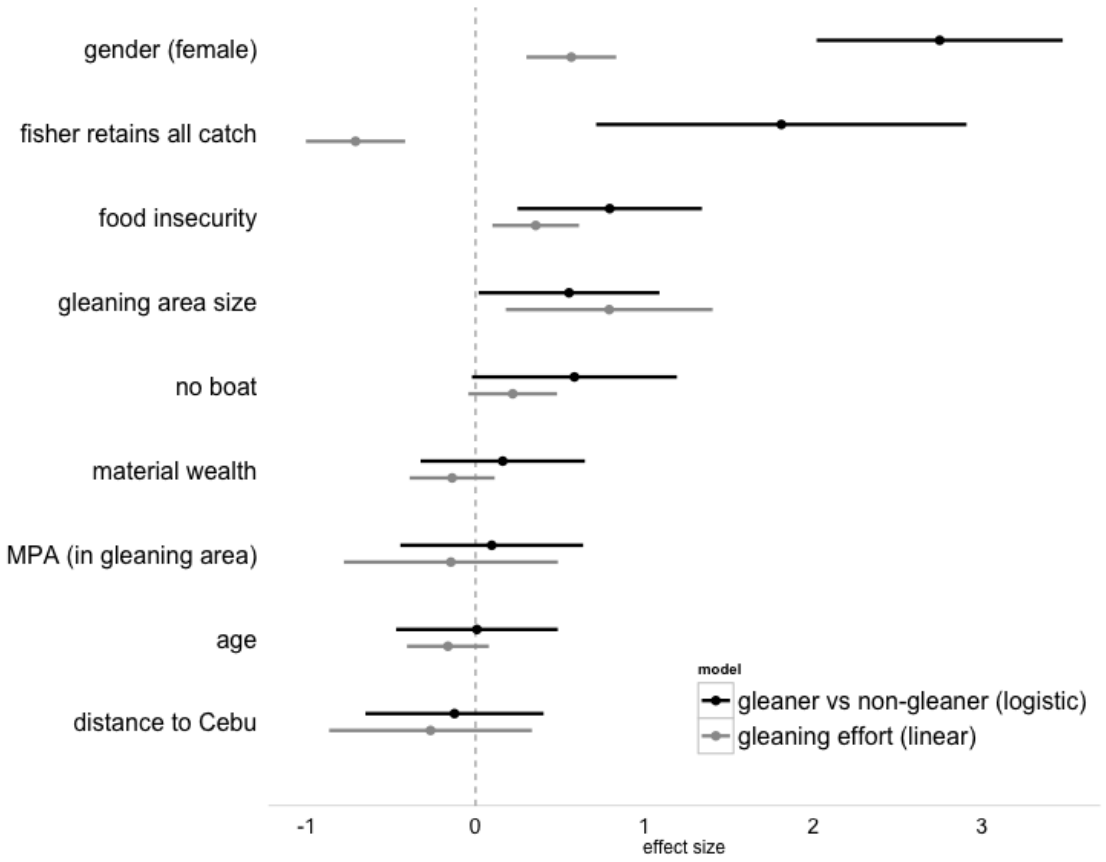

Figure 4.2. Standardized coefficients of logistic model of gleaners and linear model of gleaning effort. This is a graph of the standardized coefficients (dots) and their 95% confidence intervals (lines) for the logistic and linear models of gleaning participation and gleaning effort, by a series of explanatory variables. Any variable including its confidence interval found to the right side of 0 (and not overlapping with 0) indicates it has a significant positive relationship, while to the left of 0 indicates the opposite. Any variable with the dot or the confidence interval line overlapping at 0 means the explanatory variable does not have a significant relationship with the y-variables.

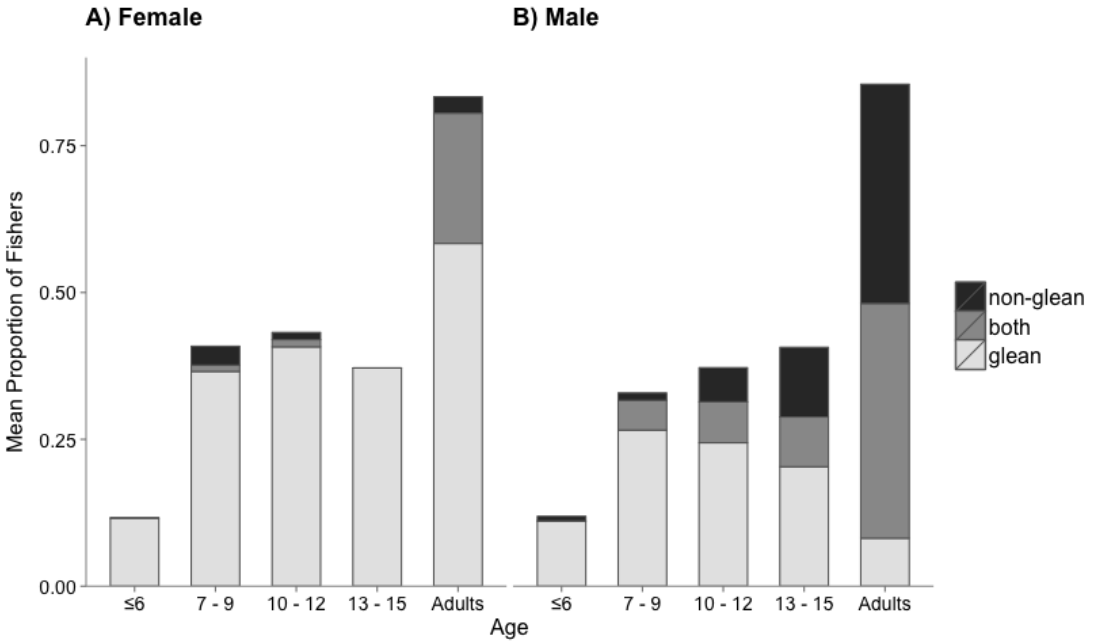

Figure 4.3. Proportion of children that participate in gleaning and non-gleaning fishing over four age categories. Sample size is 706 children in 236 surveyed households. Adult data are from community-wide random surveys and fishing method interviews (n = 588).

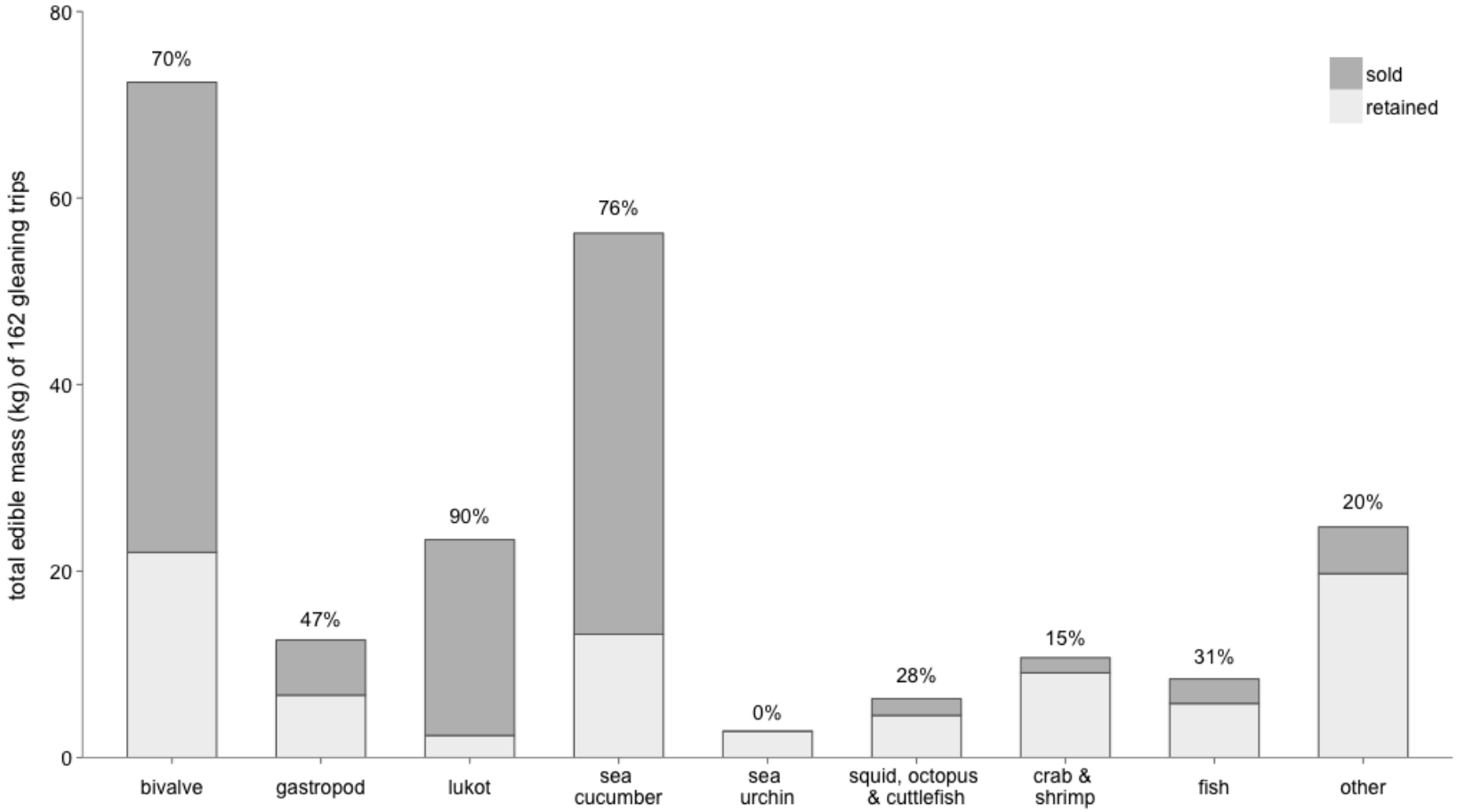

Figure 4.4. Catch biomass sold and unsold by catch type categories. Proportion labels represent the proportion of the total catch in each category that was sold. "Other" includes sea stars, seaweeds, and jellyfish. Lukot is seahare egg sacks. Seahares are gastropods, but we considered lukot separately since it was targeting a different life history stage (eggs) than the other gastropods (adult).

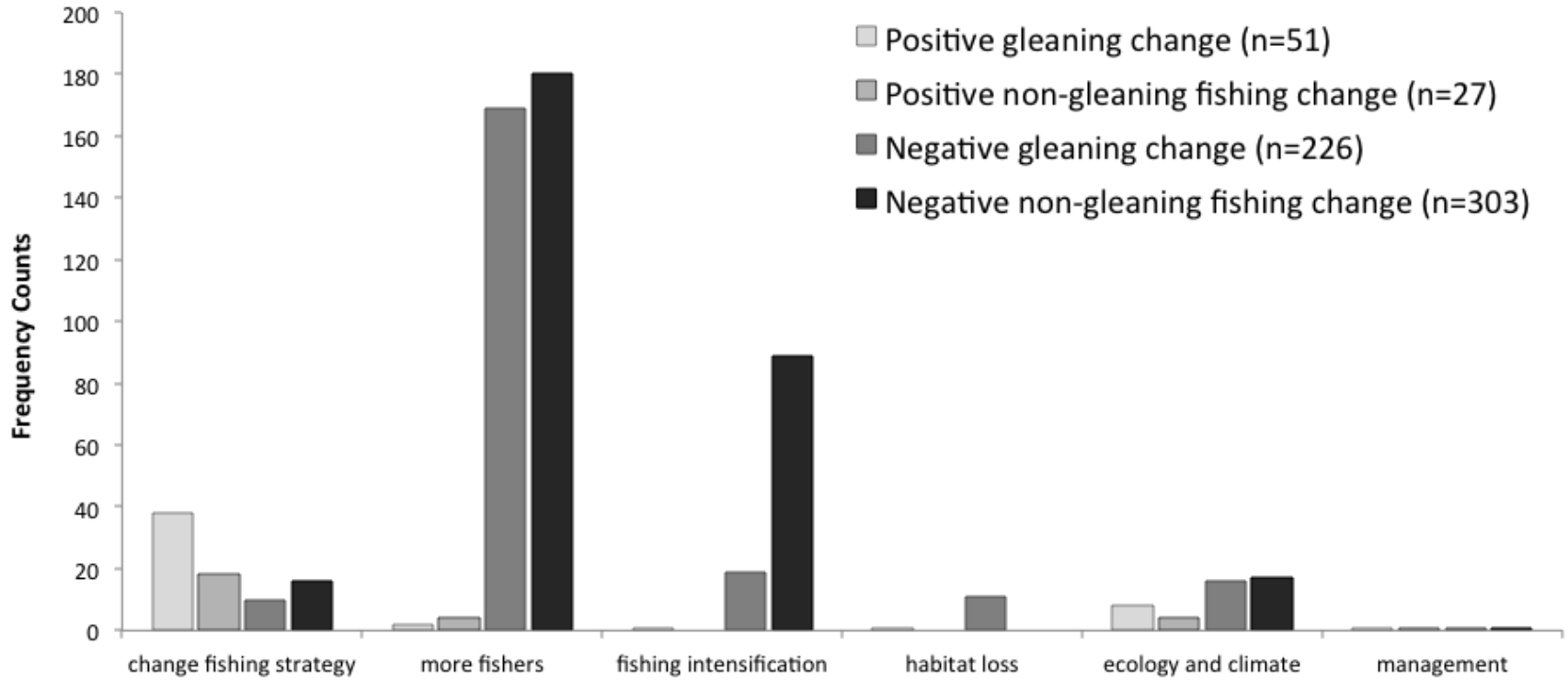

Figure 4.5. Reported reasons for change in catch volume. Gleaners and non-gleaning fishers that reported either a positive or negative change in their CPUE were asked to explain the reason for the change. The responses were coded into six categories. Categories are explained below. Gleaners and non-gleaning fishers with positive change calculated as $CPUE_{current} > CPUE_{first}$, and negative changes are the opposite. $CPUE_{current}$ is the reported weekly catch kg / reported person weekly fishing hours typical of the year interviewed. $CPUE_{first}$ is the same, but for the year first using the fishing method in the study community. Change in fishing strategy includes change in gear, fishing grounds, and efficiency or skill. Fishing intensification includes illegal fishing, more fishing gears, and commercialization of fishing. Ecological and climate variables include seasonality, climate change, tides, and animal behaviour. "n" relates to reported fishing methods that were categorized by the respondents. Respondents often had more than one fishing method, so may be represented more than once. Fishing methods with no change in CPUE are not included.

5. Gender and Marine Protected Areas: A case study of Danajon Bank, Philippines

Introduction

" *...[S]ubsuming 'women' under 'the community' masks the distinctiveness of women's experiences, and claims to inclusiveness [of all community members] wobble once questions are asked about who participates, decides and benefits from 'participatory' interventions*" (Cornwall 2003, pp 1327)

In the past 25 years, community-based management (CBM) of small-scale fisheries has been adopted in a variety of contexts, with varying success (Sultana and Abeyasekera 2008; McConney and Charles 2010). Critiques of CBM approaches challenge the idea that communities have homogeneous resource use strategies and share management priorities (Agrawal and Gibson 1999). Within communities, differences in resource use and fisheries management priorities are common (Schroeder 1993), and one key demographic factor explaining differences may be gender (Elmhirst and Resurreccion 2008).

Women and men both participate in small-scale fisheries, although often in ecologically and socially distinct ways (Siar 2003; Béné *et al.* 2009; Ko *et al.* 2010; Nordlund and Gullström 2013; Kleiber *et al.* 2014b). Beyond their roles in exploitation, women and men's often distinct involvement in pre- and post- catch labour also ties them tightly to the sustainable management of fisheries (Overå 1993; Frangoudes and Keromnes 2008; Deb *et al.* 2014). Yet women are often absent from community-based small-scale fisheries management because their role in fisheries is assumed to be negligible or subsidiary to that of men (Weeratunge *et al.* 2010; Kleiber *et al.* 2014b; Chapter 3). Here,

we will focus on gender in fisheries management, while acknowledging the importance of other distinct and interacting social categories such as religion, age, ethnicity, class, and poverty (Hapke 2001; Fabinyi 2007; Harris 2008; Agarwal 2009, 2010; Béné *et al.* 2009).

MPAs have become a central tool in conservation and fisheries management globally (Jameson *et al.* 2002; Hilborn 2004; Wood *et al.* 2008), but little or no reference has been made to their implications for women (but see Walker and Robinson 2009). The gender dimension of MPAs touches on three overlapping concerns. First, it is important to consider the potential effects of MPAs (both positive and negative) on women and men's often-distinct target species, fishing practices, and allocation of catch (Hockey and Bosman 1986; Benzoni *et al.* 2006; Rajagopalan 2007; Walker and Robinson 2009). Second, there is the need to acknowledge that MPAs have indirect impacts beyond personal fishing that may also be distinct by gender. Hence, overall perception of MPAs by community members is also important to consider. Finally, the roles of women and men in community-based management, particularly with regard to decision-making for the MPA, must be examined (Aswani and Weiant 2003; Pajaro *et al.* 2010; Di Ciommo and Schiavetti 2012; Clabots 2013).

The placement of community managed MPAs incorporates biological, social, and political considerations that affect the size of and habitat within the protected area. MPAs are found in subtidal and intertidal habitats. Gender and the location or site of the MPA may be important variables in how MPAs affect different fisheries. This is because women and men in this region often have distinct spatial fishing practices (Chapter 4). Gleaners, who are primarily women, only fish in intertidal habitats and primarily target

sessile invertebrates. Fishers using other fishing methods, who are primarily men, may fish in both intertidal and subtidal habitats depending on the tide and gear and primarily target fish or mobile invertebrates. For example, divers and gleaners may fish in the same habitats, but at different tide levels.

The value of an MPA as a fisheries management tool for invertebrates (the primary catch of women) remains unclear. This is particularly true for sessile invertebrate species, for which little work on MPA impacts has yet been done (but see Benzoni *et al.* 2006; Hockey and Bosman 1986). The limited available research shows that MPAs can improve spill over and larval dispersal of fish and mobile invertebrates (Halpern and Warner 2002), but that their main role for sessile species may be limited to generating larvae that disperse (Aswani and Weiant 2004b). MPAs also have the potential to negatively affect fishers by displacing them from their fishing grounds. Because the value of MPAs is uncertain for gleaning fisheries, it is not possible to predict whether women and men differ in their attitudes to how MPAs affect their fishing.

MPAs can provide benefits apart from fishing, so we wish to look beyond direct links to fishing and engage with potential indirect effects (Yasué *et al.* 2010). Indirect effects are also likely to be gender specific. For example at a household level women may perceive indirect fishing benefits from the improvement of fishing that they do not engage in. Other possibilities may include alternative livelihoods, which for women may include providing food for tourist (Clabots 2013). Hence, even if MPA effects for particular gender specific fisheries are not clear, women and men may still support the MPA at the same rate, but for potentially different reasons. In this case we would not expect the placement of the MPA to be an important factor.

Regardless of the perceived direct or indirect benefits, participation in community based marine management may also be affected by the cultural context that shape how women and men act and interact in public settings such as management meetings (Agarwal 2010). In many cases women are underrepresented in resource management decision making, but even if they are very engaged it does not guarantee that all stakeholder interests are represented (Cornwall 2003). Even when women are encouraged to participate, they may face cultural barriers that impede public speaking (Di Ciommo and Schiavetti 2012). Further, women's inputs may be systematically ignored either by other community members, or by NGO and state co-managers (Agarwal 1997, 2001; O'Reilly 2008).

Our goal here is to examine the relationship between gender, fisheries, and participation in the community-based management of marine protected areas (MPAs) in Danajon Bank, Central Philippines. MPAs in the Philippines are part of a national strategy to conserve coastal and fisheries resources (Weeks *et al.* 2010), and in many cases are implemented and managed at a community scale (Alcala 1998). Our research makes an important contribution to the literature that links social and ecological factors in community-based management. In particular, we focused on how women and men differ in assessing MPA effectiveness and outcomes. We illuminate a disconnect between women's management priorities and MPA management, and discuss what impacts that may have on the effectiveness of MPAs as community-based management tools.

Methods

Study area

Our study took place in the Northern Bohol section of the Danajon Bank in the Central Philippines (Figure 3.1). Danajon Bank consists of many small communities on two series of atolls, and is also generally considered to embrace the larger terrestrial islands off the Bohol mainland. Poverty is prevalent throughout this region (Guieb 2008), and food insecurity is also common (Fabinyi 2012; Chapter 4). Overfishing and destructive fishing activities such as dynamite, cyanide, and trawling have put tremendous pressure on local marine ecosystems (Christie *et al.* 2006).

Our study design included six communities with MPAs that overlapped with gleaning areas (intertidal habitat), and six communities with MPAs found outside of gleaning areas (subtidal habitat). Community selection was done to include six intertidal and six subtidal MPAs. However two cases the boundary of the MPA was either changed to exclude intertidal habitat, or the MPA was not a no-take area for gleaners. In both cases the MPAs were re-categorized as subtidal MPAs. All MPAs were actively managed by the community. Although both women and men used a variety of fishing methods, women were primarily gleaners in intertidal habitats, while men typically fished in subtidal habitats by diving or using nets, hooks, or traps (Kleiber *et al.* 2014b; Chapter 3).

We collaborated with a Philippines-based non-governmental organization, Project Seahorse Foundation for Marine Conservation (PSF) that has worked in Danajon Bank communities in various guises and capacities since 1993. PSF supported our research by providing connections to the local communities, rich advice on approaches and issues, and access to facilities and equipment. In turn, the results of our study were presented

back to PSF and the study communities to inform ongoing management practices and conservation activity.

Management institutions

The structure and variation of fisheries management in the Philippines is an important backdrop to understanding MPAs in this region. Marine management is decentralized to municipal and village levels (Lowry *et al.* 2005) which can differ greatly in the way they manage ocean resources (Pomeroy *et al.* 2010). Some municipalities actively enforce laws in their municipal waters (D. Kleiber, personal observation) while others lack appropriate staffing. Community level marine management often takes the form of no-take MPAs, which in the past have been identified as preferred management measures (Martin-Smith *et al.* 2004). MPA monitoring and management is influenced by passing political powers, and episodic NGO involvement. In some communities, long-term management of MPAs is done exclusively by elected officials, and paid barangay workers. In other communities, leaders and members of community groups such as People's Organizations, or Fishers' Organizations may play an active role in MPA management.

Data collection

We randomly selected 588 adult interview respondents (here defined as 16 or older) from the barangay census of each of the twelve communities. The respondent selection was stratified by gender. We only interviewed respondents who had fished (including gleaning) at least once in the last year. Where a selected candidate could not be found, we instead interviewed a family member or neighbour, with the result that sampling was haphazard (for further detail please see Chapter 1; Kleiber et al. 2014b; Chapter 3).

Interviews were done after the study had been explained and verbal consent had been sought. Filipino research assistants conducted the interview in the local language (Cebuano), and later translated their notes into English. With the consent of respondents, we made audio recordings and consulted these to clarify responses, but the interview notes served as the primary form of data.

To examine the links between gender, fisheries, and MPA perception and management, we asked the following three questions in each interview:

1. Does the MPA affect your gleaning and/or fishing catch?
2. Would you recommend MPAs to other communities like yours?
3. Do you participate in MPA management meetings?

The questions were developed and translated as a collaborative process between the senior author and the four local research assistants during a weeklong practice and training session prior to data collection.

All three questions were followed by an open-ended question of "why or why not?" For question 1 and 2 the open-ended responses were used to explore the community perception of the purpose, function, and utility of the MPA. For question 3 the open-ended responses were used to distinguish between active and passive participation in MPA meetings and management, as well as examine individual reasons for engagement with MPA management. We defined active participation as including the following activities: voicing an opinion in MPA meetings, organizing MPA meetings, educating others about MPA management, or participating directly in MPA management.

For the open-ended portions of each question, we examined the responses and identified themes (Braun and Clarke 2008). A single respondent may have included more than one theme. After themes had been identified and categorized we found 13, 15, and 15 themes from responses to questions 1, 2, and 3 respectively (Figure 5.1, 5.2, and 5.3). Variations among the four research assistants and the willingness of respondents to answer certain questions led to unequal sample sizes among answers.

We also include observations extracted from participant observation and from discussions about the placement of MPAs in gleaning areas with NGO workers and local leaders.

Statistical Analysis

Three logistic mixed-effects models were used to examine the binary responses to questions 1-3. The open-ended portion of question 3 was coded for a binary response for active participation (see Table 5.1 for details), which was included as a fourth model. Gender (female or male) and MPA placement (intertidal or subtidal), were explanatory variables in all four models (Table 5.1). We used mix-effects models with community as a random factor to account for inter-community variation (Gelman and Hill 2007; Zuur *et al.* 2009), using the "lme4" R packages (Bates 2010; R Core Team 2013). In two models (MPA effect on fisheries and active participation), the mean response at the community level differed significantly from the global mean in half of the communities, indicating that community was an important factor to include in the model. In the recommendation model, this was true of five communities and in the participation model this was true of three communities. For the sake of consistency of interpretation across models we included community as a random variable in each model.

A χ^2 was used to test for differences in the frequency of thematic responses by women and men to the open-ended portion of the questions.

Results

Fisheries and MPAs

Overall, 46% of respondents felt that the local MPA had an impact on their personal fishing. However, women were significantly less likely than men to report that the MPA affected on their fishing (Table 5.1). Respondents' perception of MPAs did not differ by whether their MPA was intertidal or subtidal.

Among the respondents who reported that the MPA had an impact on their fishing, most reported positive effects, but 3% of women and 4% of men commented that the MPA decreased their fish catch by limiting their fishing grounds (Figure 5.1). Overall women and men gave different reasons for why the MPA did or did not affect their fishing (χ^2 (12, N = 510) = 96.71, $p < 0.001$). Women who did not perceive an MPA effect on their fishing said – at four times the rate of men – that the MPA was sited too far from their fishing grounds (Figure 5.1). Men's most frequent response was that the MPA had a positive effect on their fishing by protecting fish. Respondents who explained the positive effect of the MPA on their fishing cited protection of fish far more frequently than protection of invertebrates (Figure 5.1).

Attitudes to MPAs

Most respondents, regardless of gender or MPA placement, said they would recommend an MPA to other communities (71%). It was noticeable that very few respondents of either gender disliked MPAs or felt they were badly managed (Figure 5.2).

Although there was a lot of overlap in the reasons women and men gave for recommending the MPA, overall there was a significant ($p < 0.05$) difference (χ^2 (14, N = 758) = 25.43, p = 0.03). Both women and men most frequently declared fish protection and spill over as justification for recommending MPAs (Figure 5.2). Both women and men also mentioned unspecified current and future benefits to the community. Protection and spill over of invertebrates was mentioned far less frequently than the protection and spill over of fish by both women and men. Among those that would not recommend the MPA, the most common response was that they were too busy to tell other people about the MPA, or otherwise unwilling to do so (Figure 5.2). However, women were more likely than men to state that other communities already had MPAs, so there would be no need to recommend them (Figure 5.2).

Participation in MPA management

Approximately half of the respondents, regardless of gender or MPA placement reported participating in MPA management meetings. However, only 8% of respondents reported participating actively in MPA management. Men were more likely to participate actively than women, but MPA placement did not make a difference (Table 5.1).

Overall women and men gave different reasons for why they did or did not participate in MPA meetings (χ^2 (14, N = 778) = 145.20, $p < 0.001$), although the most frequent reason for attending meetings of both women and men was to learn about the rules and current status of the MPA. The second most common reason for women was out of obligation as a member of the MPA organization, fisher co-op, or community. In contrast for men the second most commonly expressed reason for attending a meeting was as part of their active participation in the management of the MPA (Figure 5.3).

Among those that did not attend meetings, both women and men cited lack of membership in the community level organization that oversees the MPA as the top reason they did not attend. However, the second most common reason women gave for non-attendance was that they were not a man or a fisher[2]. While both men and women cited age and recent immigration to the community as reasons for not attending, no male respondents used gender to explain their lack of attendance. Lower frequency responses also illustrated important differences between women and men. For example, 3% of women that attended reported being there as a substitute for their husband but only one man (0.34%) reported substituting for a female family member. Among those that did not attend MPA meetings the opposite was true: 5% of men stated that they sent a substitute, while no women claimed to send a substitute (Figure 5.3).

Observations of resistance

Although respondents were mostly supportive of MPAs, we observed and were also told about women who resisted MPA rules, or successfully moved MPA boundaries to exclude their fishing grounds from the protected areas. In one study community, the landward MPA boundary was moved from the shore to beyond the intertidal areas, solely to allow for gleaning. This was seen as particularly important as the two neighbouring MPAs also encompassed gleaning areas. The community leader explained "*Both communities to each side of us had an MPA in their gleaning area, we changed ours so that [our] people could have a place to get food*".

[2] We interviewed people that had fished (including gleaning) in the past year, but local definitions of fishing, and occupational definitions of fishers often exclude gleaning and women.

The theme of food security was also found to justify opening MPAs to gleaning in a different community. In one case, community members described the MPA as being open to gleaning in times of hardship, which would reframe the MPA from a no-take zone to a temporal closure with a stated objective of mitigating vulnerability to food and economic insecurity. However other members stated that the MPA was closed to all fishing including gleaning, indicating disagreement or ambiguity regarding the rules. While we were in this community we witnessed gleaning within the clearly marked MPA boundaries. Depending on the interpretation of the rules the gleaning could be a sanctioned exception to the no-take rule, or simply a lack of compliance. In another case, we were told of women organizing to stop the placement of an MPA in the community's gleaning area. By participating in an MPA planning meeting as a group, they were effectively able to negotiate for the placement of the MPA outside their fishing areas (L. Rosario, personal communication).

Discussion

Gender was an important variable in the perceived effect of the MPA on fishing, and in the quality of participation in community-based management of MPAs. The results from our study suggest that MPAs were probably created and are primarily managed with men's fisheries in mind. While the placement of MPAs included intertidal and subtidal habitats, the siting of the MPA did not affect how women viewed or participated in the management of the MPA. However, overall women were less likely to actively participate in the management of MPAs, and MPAs were largely characterized as a fish management tool, but not an invertebrate management tool.

Much of the work on gender and protected areas focuses on the displacement of women from key resource areas (Agarwal 2010). In our study and in other studies of MPAs, the theme of displacement of women is not as clear. In our study few people of either gender mentioned being displaced from their fishing grounds, and in a spatial study in of the effects of no-take MPAs on the distance women and men travel to fish in French Polynesia, no gender difference was found either (Walker and Robinson 2009). However, in India, female seaweed fishers were displaced by the Gulf of Mannar National Park (Rajagopalan 2008).

Women's support for MPAs, even though fewer women than men perceived personal benefit to fishing, may arise from women's perceptions that the MPA benefited fishing by their male relatives or had other social merits (Yasué *et al.* 2010). It's important to note that while we examine the perceived effects of MPAs on women and men's fishing, the gender distinction in fishing practices is not absolute: many fishers use more than one fishing method and approximately 20% of women fish from boats, and 50% of men glean (Kleiber *et al.* 2014b; Chapter 3). Hence, a future examination of the effects of no-take MPAs on gleaning would be relevant to the majority of fishers. It would also be important to consider other spatially limited fisheries such as hook and line fishers that do not use an engine.

Discussion of the displacement of gleaning often included an emphasis of gleaning as a source of food security, as well as a characterization of gleaners as poor, or underserved. Hence, the permeability of MPAs to gleaning in certain communities may reflect the populist appeal of the use of the catch (subsistence) and the identity of the fishers (poor and often female). Gleaning in MPAs may also reflect forms of traditional spatial

management used in these areas called *sitio sitios* (Guieb 2008). Fishing in these areas were generally restricted to specific families, but gleaning and other forms of non-destructive subsistence fishing were tolerated. The permeability of MPAs to gleaning was also described as a method to relieve hunger during times of hardship.

Management meetings were often characterized as being a predominantly male space. On the surface this is somewhat surprising since equal numbers of women and men stated that they participated in MPA meetings. Similarly in a study in the same region of the Central Philippines women were sometimes observed making up 70-80% of attendees at fisheries outreach meetings (Clabots 2013). This was not found to be true in other contexts in Brazil (Di Ciommo and Schiavetti 2012) and the Caribbean (Smith 2012), where women made up a smaller portion of all people attending community marine management planning meetings. However, even in cases where women made up half, or even the majority of attendees, it is not certain that this would translate into active participation in decision making. In Brazil women felt uncomfortable voicing their opinions in the male dominated space (Di Ciommo and Schiavetti 2012). In the Caribbean, women's perceived lack of participation in fisheries was thought to explain their lower participation in management (Smith 2012). We heard similar sentiments in our study when one female respondent explained: "*Men would be best to participate in meetings because it's about their fishing*." Through the interviews many also expressed that they attended to represent their husbands, or as one women said: "*We listen for our husbands*." This suggests lack of active participation, and a prioritization of their husband's management priorities. Hence, in this framework where women's fisheries and management needs are invisible, their participation is also subsidiary.

Lack of membership in the MPA organization was a frequently cited factor for not participating. In some communities, the MPA organization overlaps with the Fishers or People's Organization. Fishers collectives may be especially characterized as male spaces, and often only include fishers that use particular types of gear, excluding women and their fisheries, as well as men. In other cases, elected officials of the community, headed by the barangay captain, manage the MPAs. Women hold positions as elected officials, but often in smaller numbers. Elected officials are also often members of the local elite. Women may be represented in decision-making, but not at a level that reflects the diversity or even the norm of women or men's resource use and management priorities[3]. Hence, the mechanisms of participation may need to be examined for their potential to be exclusionary.

In our study we did not find any evidence of women's groups being actively involved in MPA management, but they have been found to be key participants in other contexts. For example, in the Solomon islands, an all women's group was formed to plan, manage, and collect data on an MPA that was designed specifically for their fisheries – predominantly shell collection while gleaning (Aswani and Weiant 2004b). In a study of the community creation of MPA objectives and success indicators in the central Philippines, women's groups were consulted as well as other key demographic groups (Pajaro *et al.* 2010). In this example, women's fishing was not necessarily a key consideration, although women's groups did not differ very much from other groups in their stated objectives and indicators for the MPA. In another study from the central Philippines, the management of

[3] While MPA management is characterized as a male sphere, there are other areas at the community scale where men are excluded to their detriment. For example health care is seen as a female sphere, which may limit men's access to reproductive health options (L. D'Agnes 2010, personal communication).

MPAs in two communities known to have high levels of women's involvement found that the participation of women's groups was a key factor in the creation and maintenance of the community MPA (Clabots 2013).

A greater inclusion of women and their concerns might contribute to improved MPA implementation and management in general. In a review of collective natural resource management where the factor of gender was explicitly examined, Westermann *et al.* (2005) found that: "collaboration, solidarity, and conflict resolution all increase in groups where women are present. In addition, norms of reciprocity are more likely to operate in women's and mixed groups." The inclusion of women as decision makers has in some cases been found to increase the overall participation of women in community meetings, and increase the advocacy for needs that are directly relevant to women's lives (Chattopadhyay and Duflo 2004). Conversely, the absence of women may have direct negative impacts on the success of resource management projects. For example, in Tuvalu when women weren't made aware of a *Trochus* (mollusk) reintroduction project, they inadvertently fished the animals, leading to the project's early failure (Seniloli *et al.* 2002). Finally, if women's resource management needs are not represented, rules that they have not agreed to may place a disproportionate burden on their resource use (Agarwal 2010).

By focusing on gender we have highlighted links between social and ecological factors associated with effective resource management at a community and ecosystem scale. In this and other contexts it is important to acknowledge stakeholders should include all community members that rely on marine resources for their subsistence and livelihood, including those primarily involved in the processing and marketing of marine resources

(Overå 1993; Andrew *et al.* 2007; Tindall and Holvoet 2008). Livelihood approaches may highlight important and potentially underrepresented groups. For example, a livelihood and gender approach to Tanzania fisheries management found that female fisher traders were excluded from formal fisheries management structures (Fröcklin *et al.* 2013).

Community-based management may fail when diverse and potentially conflicting management priorities are not represented in decision making groups (Agrawal and Gibson 1999). Based on our findings it is clear that a focus on gender and consideration of gender roles and role expectations should begin in the early planning stages of MPA development both to include a wider diversity of stakeholder needs at the very beginning. Definitions of fishing that do not include gleaning mask the participation of most women and many men and exclude them as stakeholders, even though they may be directly affected depending on where the MPA is placed. Management would benefit from considering the flexibility of MPA rules to local needs, and particularly to issues of food security. This is of particular concern to women, given their socially proscribed roles in the domestic sphere. We found two cases where the MPA had either shifted from no-take zones to periodic closures, or had reverted to open access. Spatial marine management in this area had traditionally included flexibility of access to subsistence fishers (Guieb 2008).

Table 5.1. Four logistic mixed effect models examining 1) the perceived effect of MPAs on personal fishing, 2) whether respondents would recommend MPAs to other communities, 3) participation and 4) active participation in MPA meetings.

Dependent Variables	Independent Variables Coefficient (SE)		Random % variation
	Male [e]	Subtidal MPA [f]	Community [g]
MPA effect on personal fishing [a]	**1.07 (0.19)****	-0.40 (0.33)	12%
Recommendation of MPA [b]	-0.24 (0.19)	-0.10 (0.30)	10%
Participation in MPA meetings [c]	0.22 (0.17)	-0.03 (0.23)	7%
Active participation in MPA meetings [d]	**1.47 (0.38)****	-0.61 (0.56)	18%

[a] This is a binary response to the question "Does the MPA affect your gleaning and/or fishing catch?"

[b] This is a binary response to the question "Would you recommend MPAs to other communities like yours?"

[c] This is a binary response to the question "Do you participate in MPA management meetings?"

[d] Active participation is a binary variable.

[e] Baseline is female response

[f] Baseline is intertidal MPAs.

[g] Community is used as a random effect to account for inter-community variation.

* $p < 0.05$, **, $p < 0.001$

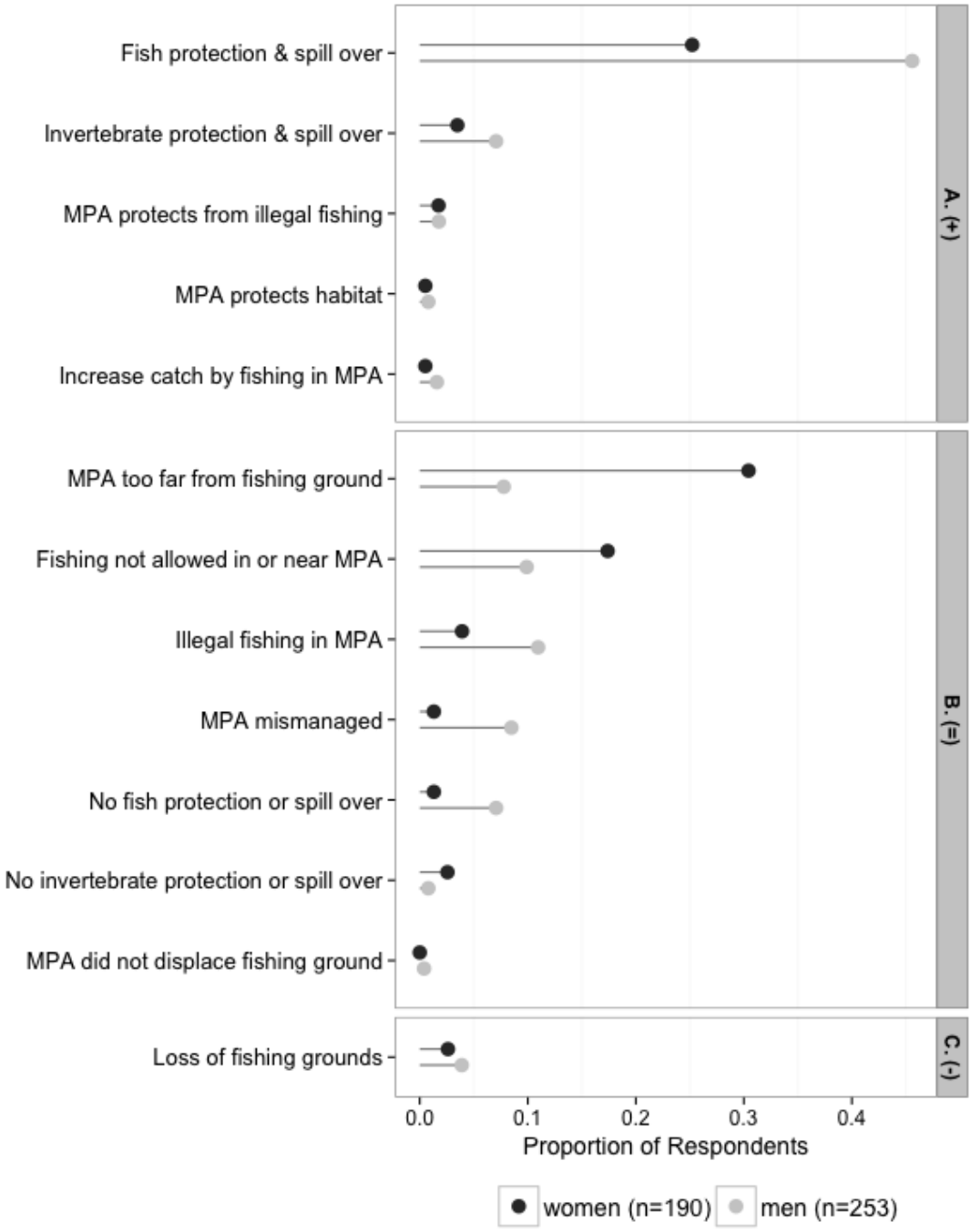

Figure 5.1. Proportion of the coded answers to the open-ended question "Does the MPA have an impact on your fishing? Why or why not? Proportions were calculated by gender and grouped into A. Positive effects (+), B. No effects (=), and C. Negative effects (-). Respondents could give more than one answer.

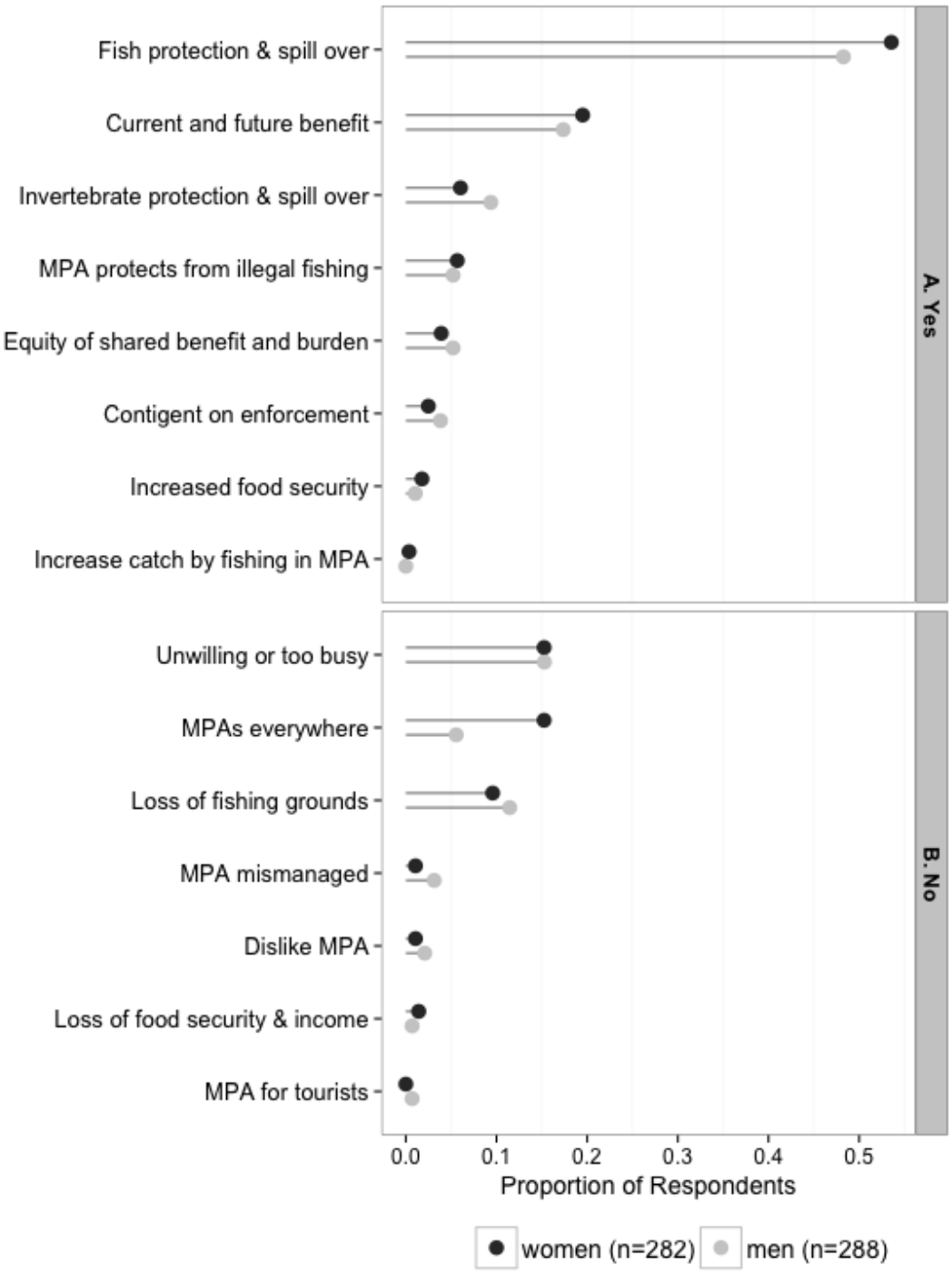

Figure 5.2. Proportion of the coded answers to the open-ended question "Would you recommend an MPA to other communities like yours? Why or why not? Proportions were calculated by gender and grouped into A. Positive answers (Yes), and B. Negative answers (No). Respondents could give more than one answer.

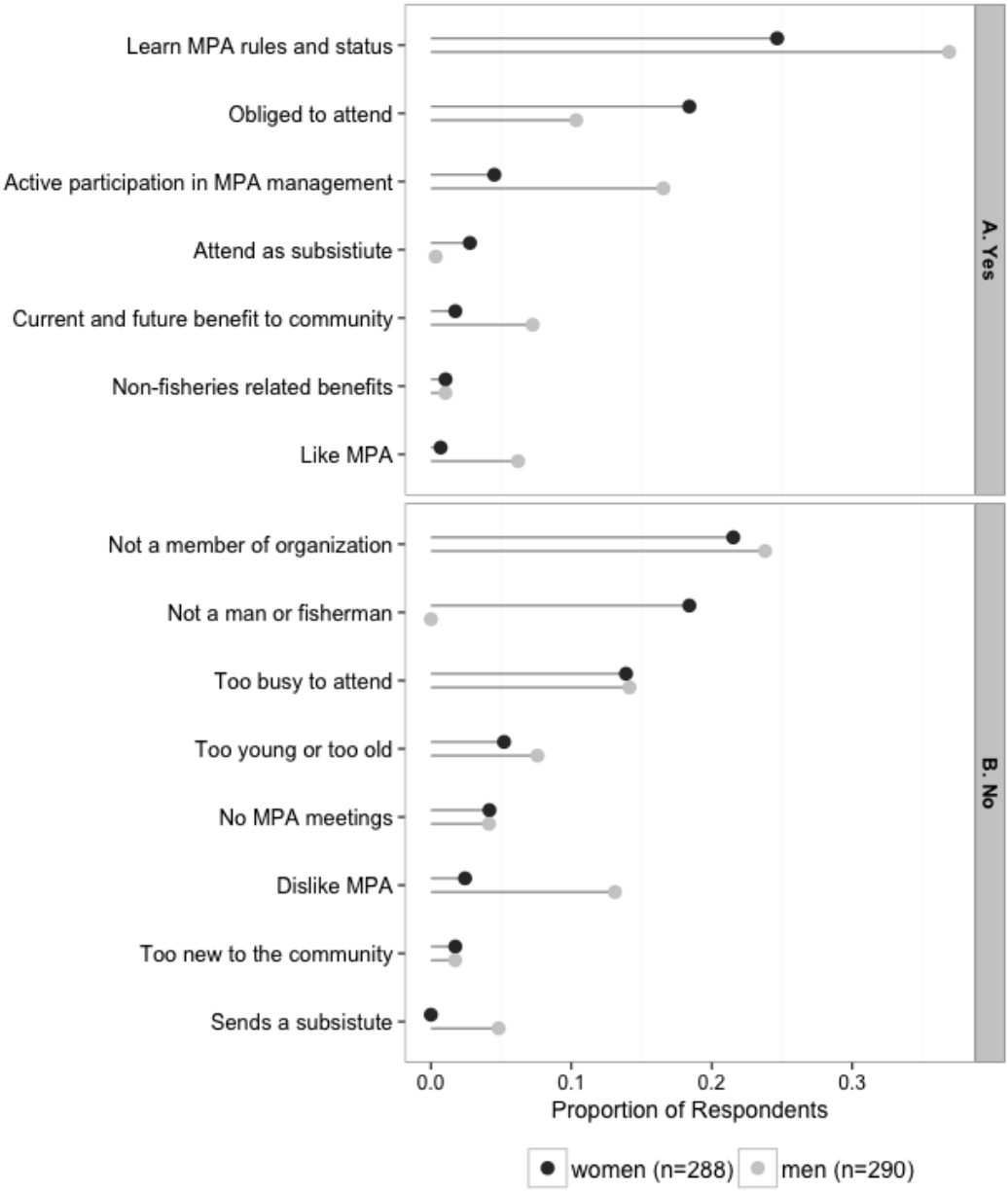

Figure 5.3. Proportion of the coded answers to the open-ended question "Do you participate in MPA meetings? Why or why not? Proportions were calculated by gender and grouped into A. Positive answers (Yes), and B. Negative answers (No). Respondents could give more than one answer.

Chapter 6 - Conclusion

"*Any omission of a gender focus in fisheries decision-making can be said to automatically mean that 50% of the required analysis has been simply forgotten*" (Townsley 1998)

My thesis counted women fishers. It turns out that doing so matters tremendously, whether for estimates of total catch or for understanding food security and social aspects of conservation. Moreover, I measured what women do in fishing, which is a rare endeavor in the field of fisheries research. The inclusion of women leads to other broader and exciting implications. It lays bare the need to define, and in many cases redefine, fishing and reexamine catch. It drives us to take a new look at what fishing gives a family. And it moves us to reimagine management. Engaging with all these new dimensions reveals not only women's contributions, but also new dimensions of men's fishing. It also extends our understanding of the role of fishing in communities and in the marine ecosystem. I now explore the key questions I probed in this thesis.

Key questions

1. What is the current understanding of women's participation in small-scale fisheries from an ecological perspective, and what are the main data gaps?

From the small but growing research on women's fishing I analyzed in the review (Chapter 2), it is clear that gender roles in small-scale fisheries are diverse and dynamic. In a variety of geographic contexts women's fisheries are often spatially confined to intertidal habitats, with catches dominated by sessile macro invertebrates. While this pattern is far from universal, it certainly appears in my case study of the Central Philippines presented (Chapter 3 and 4). The review offered descriptions of women's

fishing methods, as well as the animals and marine habitats they exploit. Such an overview suggests that women and men often occupy different ecological roles in the marine ecosystem. However, the review also revealed a quantitative data gap, which limits understanding the contribution women's fisheries make to catch, effort, and livelihood.

2. How does the inclusion of women's fishing change the characterization of community-wide fishing practices and the quantification of total catch and effort?

Small-scale fisheries catch and effort estimates are often built on recognizably incomplete data. Such deficiencies are magnified when you consider that the estimates also often completely overlook contributions from women's fishing. My study determined that including women increased the estimated number of fishers, the fishing effort and the catch biomass. Women constituted 42% of all fishers and were cumulatively responsible for 25% of the total fishing effort and 25% of catch mass (Chapter 3). Almost all women that we interviewed were involved in gleaning (gathering of benthic macro invertebrates in intertidal areas), usually as their only fishing method. Gleaning catch mostly consists of sessile and slow moving invertebrates such as shells, urchins, and sea cucumber. These animals weren't caught as often by divers or by fishers using hook and line, traps, or nets. Narrow definitions of fishing that exclude gleaning and part-time fishing serve to mask the participation and contribution of most women fishers - and hide notable extraction from the ocean. For fisheries to be more comprehensively understood – in terms of number of fishers, fishing effort, catch biomass, and diversity of organisms removed – it is vital that we include women, part-time fishers, and gleaners.

3. What contribution does gleaning make to economic and food security aspects of livelihoods?

My results from Chapter 4 show the substantial economic and food security contribution of gleaning. After first estimating the total economic value of weekly catch, and kilograms of catch retained for food, I found that gleaning contributed 13% and 27% to those categories respectively. The importance of gleaning as a source of food security was also emphasized when I examined the social attributes of gleaning versus non-gleaning fishers. As I found in Chapter 3, gleaners were predominantly women, but they were also more likely to be fishers that retained all their catch for family consumption and also more likely to be from families that had lower levels of food security. For each fishing method used, respondents were asked if they had ever experienced catching nothing. Gleaners – when compared to non-gleaning fishers – more frequently stated that they always found some catch. The reliability of gleaning, and the reports that gleaning is often done when other forms of fishing are unavailable, add to its importance for food security. Finally gleaners also fished closer to home than other fishers, which may partly reflect women's other responsibilities – and is important to consider in the spatial management of fisheries.

4. What role does gender play in the management of local marine resources through community-based marine protected areas?

Marine Protected Areas (MPAs) are a common tool in marine conservation and fisheries management, but the relationship among women's fishing, MPAs and women's participation in marine resource management is not well understood. By using open-ended questions regarding fishing, MPAs, and participation in MPA meetings, I found

that MPAs were generally perceived to be a management tool for men's fishing and the finfish that they primarily target (Chapter 5). Women were less likely than men to report that the MPA had a positive effect on their fishing activities. The corollary is that respondents more frequently cited the benefits of the MPA to finfish fisheries than to invertebrate catches. Further, although an equal number of women and men reported attending MPA meetings, women were less likely to describe active participation in MPA management, including decisions making, educating others about the MPA, and monitoring the MPA. Women's participation was also often characterized as being on behalf of their husbands. Such differences may explain why we found some evidence of women resisting MPA rules and challenging spatial management that put limits on their fishing practices. Such was their resistance that there were a few cases where MPAs were reshaped to exclude key gleaning areas. My findings lead to the conclusion that women's fisheries are often overlooked in MPA management. Such a deficiency may lead to lower compliance by women, among other outcomes. The net impact of alienating women may be to diminish the effectiveness of the MPAs as a conservation and fisheries management tool.

Gender and fisheries

My research provides important data and also a road map for how future fisheries and conservation research might more effectively include women. Women's fishing is still overlooked, both globally and in Bohol (Chapter 2, 3, and 5). In the Danajon Bank region there is an emerging body of research on fisheries and marine management. Women and their fishing are sometimes mentioned but often not included in qualitative or quantitative assessments of fisheries in this area (Green *et al.* 2004). It seemed to me that

women's fishing might be overlooked because fishing is culturally characterized as a male activity, with this assumption perpetuated by resource users, managers, and researchers. Attempts have been made to include women in data collection, but have often failed due to lack of training in gender data gathering techniques (S. Sayson, personal communication).

My findings – most notably that more than one quarter of the total effort and catch mass can be attributed to women's fishing activities – leads us to seek more understanding about women's participation in fishing elsewhere in the Philippines (Illo and Polo 1990; Siar 2003; Eder 2005) and globally (Chapter 2). The small number of studies that do quantify women's catch are all found in the Oceania region, and the calculated contribution of women to the total catch can vary wildly; from 0-48% (Bliege Bird 2007; Kronen and Vunisea 2007). Given the variation from the small number of geographically similar case studies available, a global estimate is untenable at this time. What is clear is that women's fisheries are still often overlooked and that the inclusion of women could generate a more useful understanding of the productivity of marine ecosystems and the totality of human extraction.

Recognition of the diversity of animals and habitats exploited by women's fishing and gleaning should have a material effect on local marine management (Chapter 3 and 4). Fisheries and conservation research in this region have largely focused on finfish abundance and coral cover. Invertebrates, and in particular sessile invertebrates, have been overlooked. There a great need for research on population responses by a wide diversity of marine arthropods, echinoderms, and molluscs that are important to subsistence fishers. There are deficiencies for habitats, too: marine protected areas and

other management measures in the region have focused heavily on corals. Much more attention needs to be paid to the habitats where gleaning occurs, such as rocky flats, seagrasses, and mangroves. On Danajon Bank, no real effort has been made to evaluate and support intertidal areas or seagrasses, even though these are the core habitats that women fish. Too little attention has also been given to mangroves, which some women in my study fished. Encouragingly, there are new efforts to redress the historic loss of mangrove forests in the region (Walters 2004). Such mangrove recovery projects are often framed in terms of coastal management, and nursery areas for fish species, but they may help support important habitat for gleaners.

Gleaning is an important fishery for livelihood, and particularly food security (Chapter 4). While gleaning and women's fisheries in general are often characterized as secondary to men's fishing, and often described diminutively as "helping", gleaning effort contributes 27% of the total subsistence catch (i.e. catch that was not sold, but eaten by the family of the fisher). When we asked why people gleaned many fishers described it as secondary to other fishing methods, but also an important back-up source of food when bad weather made subtidal fishing unavailable. Hence, while gleaning may not be the primary source of money or food, it is still a cornerstone of many household livelihood strategies.

Women fishers – primarily gleaners – perceive and play little or no role in marine protected areas (MPAs), the primary management tools used in the region. The perception is that MPAs were primarily directed at men's fisheries (Chapter 5). This should be framed within the history of decentralized marine management in the Philippines. Because the law determines that marine management must happen at a

community level, the understanding of women's marine management needs and their inclusion in decision-making should be done at the community scale. Rather than the current model of women resisting or changing current rules, a better solution would be to include women and their fisheries in management planning from the outset (Clabots 2013), but being careful not to exploit women's labour, or assume women to be a homogenous group.

Although my research focuses on one small geographic region – and thus is somewhat context specific – it has global implications. It is true that all the communities in my study were island communities, and half of them were also very small islands with often few options for alternative livelihoods, and strong reliance on fisheries resources. Livelihood approaches in other contexts may have to take into account other sources of income and food such as farming, vending, and within a Philippines context, remittance from family members working abroad (Guieb 2008; Hill 2011). On the other hand, the division labour by gender I documented had been found elsewhere around the world (Chapman 1987; Frangoudes *et al.* 2008; Nordlund and Gullström 2013). Moreover, the conservation and management context of the central Philippines has much in common with other areas: there are great declines in biodiversity and resource availability and considerable commitment by conservation groups – often accompanied by government inertia or lack of attention – to mitigate such declines. Thus, the lessons I learned, and techniques I developed to evaluate women's contributions should be quite broadly applicable to a variety of geographic contexts.

Broader implications and research directions

Taken together my research findings have implications for both current understanding of small-scale fisheries and suggestions for framing future research. For example small-scale fisheries are often missing from assessments of illegal, unregulated, and unreported fisheries (IUU) which is often used to characterize the data gaps in global assessments of catch mass (Metuzals *et al.* 2010). Small-scale fisheries often fall in both the "unreported" and "unregulated" categories (Zeller *et al.* 2007) but are still often left out of IUU assessments, most of which focus on commercial or high seas contexts. Any rigorous inclusion of small-scale fisheries in assessment is often missing, leading to underestimations of these contributions. Even in the infrequent cases where small-scale fisheries are included, women's contributions are seldom understood, let alone included.

My research identifies methods that could be used to integrate and evaluate the fishing of both women and men into small-scale fisheries research. An integrated socio-ecological approach to small-scale fisheries should be taken to capture the interacting spheres of the marine ecosystem, and the human social system. More specifically researchers must shift their starting point to begin with the assumption that women do fish, rather than the more common assumption that they do not, then take the necessary steps to include them. This includes data sampling stratified by gender because both women and men are less likely to identify women as fishers. Moreover, greater attention to subsistence catch, which may not be accounted for in surveys of commercial ports, would be necessary, although would require greater effort to document. And finally, greater attention to sessile invertebrates and their roles in the marine ecosystem would be needed.

Avenues of future research should include understanding the utility of MPAs as a fisheries management tool for invertebrate species targeted by women and gleaners, and the identification of other management tools that have worked in other contexts. MPAs have been successful for sessile invertebrates fisheries in some cases where local ecological knowledge of source populations were used to place the MPA (Aswani and Weiant 2004a). In other cases, fast growing invertebrates such as octopus have been managed by temporal closures (Cripps and Harris 2009), which are also used more generally throughout the Pacific (Cohen and Foale 2013). Limiting entry with territorial use right for fisheries (TURFS) has worked for divers of commercially valuable species (Moreno *et al.* 2007), but may be harder to enforce with large numbers of subsistence fishers.

One avenue of future research would be greater attention to the social value placed on fisheries as a source of food or income, and how this translates into management. Traditional spatial management used in this area in the past has consisted of family ownership of particular fishing grounds. Owners would often allow subsistence fishers, both gleaners and single hook and line fishers, to fish in these fishing grounds (Guieb 2008). Such permissiveness may, in effect, occur in today's MPAs: lack of compliance or changing the boundary of no-take MPA to exclude subsistence-fishing grounds is often explained away in terms of food security (Chapter 5).

My findings challenge the prioritization of men's fisheries and concerns in MPA management, and encourage a deliberate integration of women's resource use and issues in community decision-making. There may, of course, be numerous cultural and political barriers to the full inclusion of women and other minority groups into decision making

(Cornwall 2003; Agarwal 2010). Such obstacles have been explored within the larger literature on natural resource management at the community level, which has been examined in forestry, agricultural, and water use contexts (O'Reilly 2008; Agarwal 2010). Future research and adaptive management approaches could assess the promise and limitations of single gender resource management groups in fisheries, as has been examined in other natural resource management contexts (Agarwal 2010).

My study provides a rare quantitative elucidation of women's fishing, and can therefore justifiably claim to contribute distinctively to fisheries management as a whole. Through my work, it becomes ever more obvious that inclusion of women's fishing is vital if we are to understand the diversity and totality of small-scale fishing pressure on the marine ecosystem, and to understand the social dynamics that shape human fisheries. My gender-based approach, in which both women and men are explicitly included, forces a broader consideration of fisheries that should materially affect ecosystem approaches to ocean management. It becomes inevitable that fisheries management and conservation communities must insist on a gender lens for any research or management ostensibly conducted at a community or ecosystem scale. In conclusion, to understand fisheries it is necessary to include women fishers.

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Appendix - Fisher interview questions and data sheets

ID# MRU.__ __ __ . __

Community Marine Resource Use (Adult)

Date (day, month): 201__ Purok/Sitio: _____
Interviewer(s): _____ Barangay: LGU:
Gender of Respondent: _____ Province:
Recorder File:_____ #_____ GPS N. _____ E._____

Step 1: INTRODUCTION – CONFIDENTIALITY – PERMISSION

Step 2: GENERAL INFORMATION

1. In the last year have you taken animals from the sea? YES / NO
   Sa niaging tuig nanguha ba ka ug mga hayop sa dagat?

2. What is your name? _____
   Unsa imung pangalan?

3. What year were you born? _____
   Unsa ka nga tuig na-taw?

3. Were you born in this barangay? YES / NO
   Mao ba ni ang imung yutang natawhan?

4. (If not) which year did you move here? _____
   (kung dili) unsa ka nga tuig nagbalhin dinhi?

Step 3: FAMILY & MATERIAL STYLE OF LIFE

5. How many family members do you have? _____
   Pila mo kabuok sa inyong pamilya?

6. What is your primary occupation? _____
   Unsa'y imong primerong trabaho/panginabuhian?

7. What is the primary source of income for your family? _____
   Unsa'y primerong tinubdang kita para sa imong pamilya?

8. How many rooms does the respondent's household contain?_____
   Pila kabuok higdaanan/kwarto ang inyong balay?

9. **OBSERVE THE BUILDING MATERIALS USED FOR THE HOUSE**

10.

	Native *Nitibu*	Non-native *Konkreto*	Mixture *Sagol*
Walls *Bong-bong*			
Roof *Atup*			
Floor *Sawg*			

10. Do you have a flush toilet? YES / NO
    Ang inyong kasilyas ba naggamit og inuduro?

11. How many *currently functional* gadgets does the household have?
    Unsa og pila man pod ka mga maayo pa nga mga appliances ang naa sa inyong panimalay?

    ___ radio ___ electric fan ___iron ___refrigerator ___ generator
    ___TV ___ DVD/VCD ___ videoke ___Sound system ___ other

12. How many boats does the household own that are *currently functional*?
    Pila man ka mga bangka nga mosunod ang gipanag-iya sa inyong pamilya nga maayo/magamit pa?

    ____*Baroto* ____Pumpboat ____Other *Uban pa*

ID# MRU.__ __ __ . __

Step 4: FOOD SECURITY

13. What did your family eat: *Unsa man ang gikaon sa imung pamilya:*	Yesterday? *Gahapon?*	One day ago? *Usa ka adlaw ang nilabay gikan gahapon?*	Two days ago? *Duha ka adlaw ang nilabay gikan gahapon?*
Rice *Bugas*			
Corn *mais*			
Noodles			
Bread *pan*			
Dried Fish *Binuwad nga isda*			
Fresh Fish *(Preskung) isda*			
Chicken *Manuk*			
Pork *Baboy*			
Beef *Baka*			
Shells *Kinason*			
Crabs *lambay,mani-l,kubaw*			
Eggs *Itlog*			
Vegetables *Utan*			
Fruit *Prutas*			
Seaweed *Guso*			
Other *Uban pa*			
Other *Uban pa*			

14. Does your family ever: *Nakaagi ba imung pamilya niini:*	15. How many times per: *Pila ka higayun sa kada*		
	WEEK	MONTH	YEAR
Eat less preferred foods? *Gamay ra ang makaon sa gusto nga pagkaon?*			
Eat less food in a meal? *Gamay ra ang pagkaon sa pagpangaon?*			
Some family members skip a meal? *Aduna bay membro sa pamilya nga nalat-angan ang pagkaon?*			
IF "yes" which family members typically skip a meal? *Kung "oo" kinsa man ang membro sa pamilya kasagaran nakalat-ang sa pagkaon?* Wife Husband Daughter Son Other: Why?			
Whole family skips a meal? *Ang tibuok pamilya ba nakalat-ang sa pagkaon?*			
Whole family skips a day of eating? *Ang tibuok pamilya ba nakalat-ang sa pagkaon sa tibuok adlaw?*			

ID# MRU.__ __ __ . __

Step 5: FISHING ACTIVITIES (METHOD # 1)

16. What fishing/gleaning method have you used in the past year? _____
Unsa man ang gigamit nimung pama-gi sa pagpanagat/panginhas?

17. What gear do you use in this method? _____
Unsa may mga gamit nimo ani nga pama-agiha?

18. What year did you start using this method (in this community)? _____
Unsa kang tuiga gasugod ug gamit niining pama-agiha (sa dinhi nga komonidad)?

19. Do you usually go with a companion or by yourself? _____
Aduna ba kay kauban o ikaw rang usa?

20. If you go with a companion, who do you go with? _____
Kung managat/manginhas ka nga naay kauban, kinsa man sad ni sila?

	volume (metric) of catch?	# of trips/ week or month?	# of hours/ trip?
21. What is your typical :			
22. Are there good and bad months? What are they?	Good Months: Bad Months:		
23. In good months what is your:			
24. In bad months what is your:			
25. Have you ever caught zero?			
26. When you first started using this method what was:**			

**Remind them when they first started

27. If your catch volume has changed since you first started, why?
Kung na-usab ang gidaghanon sa kuha sukad sa imong pagsugod, ngano man?

ID# MRU.__ __ __ . __

28. If your time spent has changed since you first started, why?
Kung nausab ang oras nga imong gigahin sukad nga nagsugod ka, ngano man?

29. What do you do with your typical catch volume**?
*Unsa may buhaton sa sagad nimong kuha**?*

	% or typical volume
Eating	
Selling	
Give away	
Other:	

**Remind them of their typical catch volume

30. Where is the catch you sell consumed?
Asa man nimu ibaligya ang imung kuha?

Local Municipal Regional National International

33. What are the 6 most common things you catch using this method?
Unsa man ang 6 nga pinakasagad nga mga butang nga makuha gamit kining pama-agiha?

1. _____ 3. _____ 5. _____

2. _____ 4. _____ 6. _____

34. Are there animals you used to catch when you first started but no longer catch? If YES, what animals do you no longer catch and why? *Aduna ba'y mga kuha nimo sauna sukad nga nagsugod ka nga wala na ginakuha nimo karon?*

**ASK ABOUT THE NEXT METHOD! (METHOD # 1)

Step 7: IN DEPTH QUESTIONS

35. If you don't glean/fish, why don't you glean/fish**? **circle one
*Kung dili ka manginhas/mangisda, ngano mang dili ka manginhas/mangisda**?*

36. How important is gleaning/fishing to your family?
Unsa ka importante ang pagpanginhas/pagpangisda sa inyong pamilya?

37. How is gleaning different than fishing?
Unsa man ang kalainan sa pagpanginhas ug pagpanagat?

38. In your community who gleans? Who fishes? Why is that? Is it changing? How do you feel about that?
Sa inyong komunidad, kinsa may nanginhas? Kinsa'y managat? Ngano man na? Nagkausob ba kini? Unsa may gibati nimo bahin ana?

GLEANING:

FISHING:

CHANGE:

39. Do you think gleaning/fishing could be improved, if so in what way and how?
Sa imung huna-huna mapalambo pa ba ang pagpanginhas, kung puwedi sa unsang paagi ug unsaon?

40. Do you think the number of fish and shells could be improved, if so in what way and how?
Sa imung huna-huna mapadaghan pa ba ang imong kuha sa pagpanagat, kung puwedi sa unsang paagi ug unsaon?

41. Does the MPA affect gleaning and/or fishing catch? If yes what is the affect you've seen? If no, why not? *Ang Sanktuaryo/MPA ba naka-apekto sa imong kuha sa pagpanginhas/pagpanagat?Kung OO unsa man ang imung nakita?*

42. Would you recommend MPAs to other communities like yours? Why or why not? *Ganahan ba ka nga mo-rekomenda ug mga Sanktuaryo sa uban nga mga kumunindad pareha sa inyuha?Ngano o nganung dili pud?*

43. Do you participate in MPA management meetings? Why or why not? Who should participate in MPA management meetings? *Mag-apil-apil baka ug mga pagtigum-tigum alang sa pagdumala sa inyung Sanktuaryo? Ngano o Nganung dili pud? Kinsa man ang mo-partisipar sa mga pagtigum-tigum alang sa pagdumala sa Sanktwaryo?*

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Step 9: CONCLUDE INTERVIEW

44. Do you have any questions for me? *Aduna ba kay mga pangutana par aka nako?*

45. Are you going gleaning today? *Manginhas ba ka rong adlawa?*

46. If so would you agree to carry a GPS unit while you glean so we can map gleaning activities AND/OR measure your gleaning catch?
Kung mao kana, mosugot ba ka nga ibakus nimo ning GPS samtang nanginhas ka aron ma-mapa namo imong agi sa pagpanginhas o dili kaha matimbang/masukod imong kuha?

THANK YOU! *SALAMAT!*

Debrief Notes: