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The total economic value of small-scale fisheries with a characterization of post-landing trends: An application in Madagascar with global relevance

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ABSTRACT

Small-scale fisheries make key contributions to food security, sustainable livelihoods and poverty reduction, yet to date the economic value of small-scale fisheries has been poorly quantified. In this study, we take a novel approach by characterizing post-landing trends of small-scale fisheries resources and estimating their total economic value, including both commercial and subsistence values, in a remote rural region in Madagascar. We construct annual landings and characterize gear and habitat use, post-landing trends, fishing revenue, total market value, costs and net income, profitability, employment and dependence on small-scale fisheries. Our results show that the small-scale fisheries sector employs 87% of the adult population, generates an average of 82% of all household income, and provides the sole protein source in 99% of all household meals with protein. In 2010 an estimated 5524 metric tons (t) of fish and invertebrates were extracted annually by small-scale fishers in the region, primarily from coral reef ecosystems, of which 83% was sold commercially, generating fishing revenues of nearly $6.0 million (PPP, 2010). When accounting for subsistence catch, total annual landings had an estimated value of $6.9 million (PPP, 2010). Our results demonstrate the importance of small-scale fisheries for food security, livelihoods, and wealth generation for coastal communities, and highlight the need for long-term management strategies that aim to enhance their ecological and economic sustainability. Our findings should catalyze national and regional policy makers to re-examine existing fisheries policies that neglect this sector, and spur researchers to better quantify small-scale fisheries globally.

1. Introduction

Recent research and policy have increasingly recognized the importance of small-scale fisheries in terms of wealth generation, poverty alleviation and food security (Allison and Ellis, 2001; Satia and Staples, 2003; FAO, 2005; Béné et al., 2007; Garcia and Rosenberg, 2010). Small-scale fisheries are generally defined by a minimal amount of capital, low-level technologies and household-unit entities (FAO Glossary: http://www.fao.org/fishery/topic/14753/en). Over 90% of people employed globally in capture fisheries and related activities can be classified as small-scale (World Bank/FAO/WorldFish Center, 2010), and when accounting for those participating in occasional or seasonal fishing activities and indirectly dependent on the small-scale sector, small-scale fisheries support the livelihoods and well-being of over five hundred million people worldwide (Béné et al., 2007; FAO, 2012a). Indeed, small-scale fisheries resources are an important source of income and subsistence in many parts of the world, particularly in developing countries where millions of poor people live near the coast and nearly all (97%) of the world's fishers reside (Béné et al., 2007; Pomeroy and Andrew, 2011). Small-scale fisheries can make substantial contributions to food security and poverty alleviation by providing a crucial source of dietary protein (Kent, 1998; Van der Elst et al., 2005; Bell et al., 2009; FAO, 2012b), and, perhaps more importantly, by supporting production and marketing activities which can generate revenues (FAO, 2005).

With effective management, small-scale fisheries can contribute to sustainable livelihoods (Andrew et al., 2007). However,

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small-scale fisheries are typically characterized by remote landing sites and sporadic, decentralized post-harvest and marketing activities that hinder efforts to collect data illustrating their scope, impact, importance and economic value (Salas et al., 2007). This substantial lack of data causes fisheries policies across the globe to neglect small-scale fisheries, and generally hampers efforts to ensure their long-term ecological sustainability and resilience. Moreover, because the contribution of small-scale fisheries to local, national and regional economies is often poorly quantified, they are habitually overlooked at the national policy level (Andrew et al., 2007; World Bank/FAO/WorldFish Center, 2010; Mills et al., 2011). In effect, small-scale fishers, who are typically already disadvantaged by their socioeconomic, political, cultural and physical remoteness, are often further marginalized by national fisheries policies that typically favor large-scale industrialized fishing sectors (Pauly, 1997).

Meanwhile, marine fisheries are facing increasing pressure on a global scale from widespread overfishing (Jackson et al., 2001), habitat destruction (Diaz and Rosenberg, 2008), climate change (Hoegh-Guldberg and Bruno, 2010) and other anthropogenic effects (Halpern et al., 2008). These cascading impacts can severely erode the ability of marine and coastal ecosystems to absorb fishing pressure and continue to provide key ecological goods and services, thereby threatening the livelihoods of millions of people who depend on them for subsistence and income. In many developing countries, this situation is exacerbated by weak institutional frameworks and a lack of enforcement capabilities, both of which are necessary to design, implement and support effective fishery resource policies (Andrew et al., 2007; Pomeroy and Andrew, 2011).

The developing country of Madagascar is a prime example of a convergence of these issues surrounding small-scale fisheries. Madagascar is one of the poorest countries in the world, with annual income per capita barely reaching PPP $950 and over 75% of all households living under the poverty threshold (World Bank, 2012a). Chronic political instability and declining economic trends have plagued the country over the past few decades, intensifying poor socioeconomic conditions (World Bank, 2012a). Nationwide, the majority of households rely on the exploitation of natural resources to support their livelihoods (Horning, 2008; Morisset, 2010) and over half of the population lives within 100 km of the coast (WRI, 2003).

As the fourth largest island in the world boasting one of the largest exclusive economic zones in the Indian Ocean, Madagascar's small-scale fisheries sector is highly significant and has potential to both feed people and support livelihoods. This is particularly the case along the west coast where agricultural production is largely infeasible and employment options are limited (Laroche and Ramananarivo, 1995; Le Manach, 2012). However, the region's marine environments are increasingly threatened by climate change and direct anthropogenic impacts, including coral bleaching events, hypersedimentation, population growth and increasing rates of migration to the coast (Harris, 2007, 2011; Maina et al., 2008; Cripps, 2009; Le Manach et al., 2012; Raberinary and Benbow, 2012). Amidst the growing external pressures on the region's natural capital, recent reports have warned that small-scale fisheries and other marine resources in Madagascar are over-exploited (Harris, 2007, 2011; Cripps, 2009; Le Manach et al., 2012; Raberinary and Benbow, 2012). Acknowledging the considerable role of the small-scale fisheries sector in terms of food security and poverty alleviation and its vulnerability to overexploitation, national level decision makers are showing growing interest in including small-scale fisheries in Madagascar's fisheries management plan, presently under revision. Yet, analogous to the lack of data surrounding small-scale fisheries on a global scale, currently little information exists about the specific inputs, outputs and economic value of the country's small-scale fisheries, and data characterizing the sector are needed for policy development (Harris, 2011; Le Manach, 2012).

Globally, some research efforts have collected biological/ecological small-scale fisheries catch statistics (Pauly and Mines, 1982; Craig et al., 1993; Stergiou et al., 1996; Laroche et al., 1997; Hernandez-Garcia et al., 1998; Marquette et al., 2002), and others have reconstructed small-scale fisheries landings to estimate their contribution to GDP (see: http://www.seaaroundus.org/). There have also been a handful of socioeconomic case studies on small-scale fisheries that estimate revenue and income based on total landings (Bailey, 1982; Tzanatos et al., 2006; Battaglia et al., 2010; Teh et al., 2011), but these studies do not analyze post-landing trends. Post-landing distribution patterns of small-scale fisheries resources vary and can consist of selling, sharing, trading and consuming portions of the total catch (Glazier et al., 2012, 2013; Kittinger, 2013; Vaughan and Vitousek, 2013). An analysis of small-scale fisheries' post-landing trends followed by a total economic valuation based on these trends would provide a more thorough examination of the sector's contribution to food security and poverty alleviation, yet we are unaware of any such attempt that currently exists in the literature.

Here, we attempt to fill this crucial data gap. Specifically, we construct annual landings and post-landing trends for all target species groups in a remote locally managed marine area in Madagascar to analyze the sector's total economic value and socioeconomic contribution. We do this by examining catch characteristics (including gear and habitat use), total fishing revenue, total market value, costs to fishers and net income, profitability, employment and local dependence on small-scale fisheries.

To the best of our knowledge this study is the first total economic valuation of a small-scale fisheries sector that includes post-landing trends and determines both commercial and subsistence values. The current study is also the first that we are aware of to provide a comprehensive estimate of the socioeconomic contribution of small-scale fisheries within a locally marine managed area. In the absence of effective institutional marine and coastal management, locally and community managed marine areas have been rapidly proliferating across the Western Indian Ocean (Harris, 2011), the South Pacific (White, 1989; Pomeroy, 1995; Govan, 2009) and all across Oceania (Johannes, 2002), thus broadening the direct applicability of our methods and results.

This study fills a critical knowledge gap concerning small-scale fisheries which is likely to be useful in a variety of settings. Information on the total economic value of the small-scale fisheries sector can directly benefit resource and environmental policy development and management in Madagascar, and is likely to be applicable to other developing countries on a broader scale. Moreover, by providing first-hand information on post-landing trends of small-scale fisheries resources, this study provides crucial information on the food security role of the small-scale fisheries sector and its potential contribution to poverty alleviation, also with global implications.

1.1. Study area

Madagascar lies in the western Indian Ocean to the east of Mozambique, separated from Africa by the 400 km wide Mozambique Channel. Our study site, Velondriake, lies in the arid Toliara province of southwest Madagascar, where twenty-four villages supported by Non-Governmental Organizations and the National Marine Sciences Institute have united to collaboratively manage a complex array of islands, mangroves and coastal ecosystems (Harris, 2011) (see Fig. 1 for a map of the study area). Velondriake, a locally managed marine area, spans more than 1000 km^2