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Fishing dynamics associated with periodically harvested marine closures☆

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ABSTRACT

Periodically-harvested fisheries closures are emerging as a socially acceptable and locally implementable way to balance concerns about conserving ecosystem function and sustaining livelihoods. Across the Indo-Pacific periodically-harvested closures are commonly employed, yet their contribution towards more sustainable fisheries remains largely untested in the social and ecological context of tropical small-scale fisheries. To address this, we use an interdisciplinary approach to examine harvesting dynamics that would affect sustainability, namely, fishing effort, yield, gear and method use, periodicity of harvesting, controls placed on harvesting and resource owners' decisions to open and close four fishing grounds in Solomon Islands. We compare these fishing patterns with those on surrounding, continuously open fishing grounds. Our study shows that total effort and total catch from periodically-harvested reef closures are low to moderate compared to reefs open to continuous fishing. When periodically-harvested closures were opened, effort in the closures was relatively intense, however, in most cases yield did not exceed annual benchmarks of sustainability described by previous studies. In some cases, harvesting during openings was restricted to a single taxon and single fishing gear and method, while in others there was unrestricted multi-species and multi-method harvesting. The duration and frequency of openings were highly variable, with open periods ranging from a single night to one month in duration, and occurring between one and 15 times per year. Fishing during openings was permitted for entire fishing communities in some cases, and only for specific rights-holding families in others. Decisions to open periodically-harvested closures tended to be based on immediate social or economic needs, and the openings provided a small boost to fish catch landed in communities. While periodically-harvested closures may alleviate fishing pressure in a small area of fishing grounds by reducing the opportunity to fish, openings of long duration or high frequency, combined with heavy or destructive exploitation, may lead to unsustainable harvesting within the area.

1. Introduction

Small-scale fisheries support the livelihoods and food security of millions of people worldwide, and if well managed can make significant contributions to human and socio-economic development (Béné et al., 2010). However, the resources that support small-scale fisheries are in decline (McClanahan, 2002; Worm et al., 2009). Researchers and managers are searching for management strategies that can sustain livelihoods and ecosystem functions. Marine protected areas are widely applied and promoted for conservation and management, but they may not result in benefits for fisheries in many contexts (Hilborn et al., 2004), and they are often rejected by small-scale fisheries dependent communities (Christie, 2004; Foale and Manele, 2004). An ongoing challenge is to identify socially acceptable and locally implementable controls on marine resource use that will result in long term and effective management of small-scale fisheries. Collaborative management partnerships between local communities, civil society, and/or governments (henceforth co-management) are increasingly emerging as a way forward to address this challenge (Evans et al., 2011; Gutierrez et al., 2011; Pomeroy, 1995).

In a centralised fisheries management context non-permanent, rotational or periodically-harvested closures are recognised for their management potential, mainly for sessile or sedentary invertebrates (Botsford et al., 1993; Nash et al., 1995; Sluczanowski, 1984). However, in open access or weak governance situations, 'pulse-fishing' can be intense when periodically-harvested closures (PHCs) are opened because fishers anticipate improved catch rates and there are few incentives to restrain

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harvest levels (Murawski et al., 2005; Russ and Alcala, 1998). The re-establishment or re-invention of customary PHCs is an increasingly common measure to regulate marine resource use in contemporary co-management initiatives across the Indo-Pacific (Johannes, 2002; McLeod et al., 2009). In co-management contexts, the dynamics of fishing (such as cycles of opening and closure and limits placed on harvests) are generally under the control of the local community or clan that holds tenure rights to the managed area (Hviding, 1996; McLeod et al., 2009).

Some ecological evaluations of PHCs have shown that they can result in higher standing stocks of fish (Bartlett et al., 2009; Cinner et al., 2005), yet whether the practice is likely to result in more sustainable fisheries depends crucially on a range of ecological conditions (e.g., pre-harvest stock levels and the demography of target species) and on the dynamics of harvesting (e.g., intensity, duration, periodicity, and harvesting methods), the latter of which are poorly understood. In this article, we contribute to better understanding the potential for PHCs to contribute to sustainability by examining associated harvesting dynamics, which have five key components: firstly, the catch yielded from areas during openings will determine the level of benefits received by fishers. The type and amount of catch extracted will also influence the potential for recovery during periods of closure, and whether fisheries are rapidly depleted or harvested sustainably (Game et al., 2009; Kaplan et al., 2010; Russ and Alcala, 1996). Secondly, controlling fishing effort is fundamental to managing fisheries, and so sustainability outcomes will be affected by the intensity of fishing during PHC open periods and the overall relief from fishing pressure due to periods of closure. Thirdly, the periodicity of opening and closure cycles is demonstrated by modelling to be critical to fisheries outcomes (Botsford et al., 1993; Game et al., 2009; Pfister and Bradbury, 1996). For example, regular openings may not allow sufficient time for populations to recover (Gerber et al., 2003) or for changes in fish behaviour to manifest and increase catchability (Feary et al., 2011). Fourth, gears and methods employed to harvest will impact conservation and fisheries outcomes, for example certain efficient gears such as small mesh nets, and non-selective and damaging gears such as dynamite, can ultimately affect the ability of ecosystems and populations to recover (Russ and Alcala, 1998). Finally, other resource-use controls that operate in conjunction with PHCs can influence fishing dynamics by restricting catch and effort levels, species harvested, and gears and methods used within PHCs and in surrounding fishing grounds.

As PHCs become increasingly implemented throughout the Pacific, critical questions remain as whether or how they can contribute towards more sustainable fisheries. As a first step in this direction, we explore the five key aspects of PHC harvesting dynamics described above. Our study has three objectives. Firstly, we aim to determine how fishing pressure, in terms of both yield and effort, compares between PHCs and reefs that are continuously open to fishing. Secondly, we aim to describe the cycles of opening and closure applied in practice, and to understand decisions driving those cycles. Finally, we seek to document the gears and methods used to exploit PHCs, and to understand how other concurrently applied management arrangements influence exploitation. We use an interdisciplinary approach to examine four periodically-harvested closures in Solomon Islands.

2. Methods

2.1. Study location

Solomon Islands is a developing Pacific Island nation situated within the global centre of marine biodiversity (Veron et al., 2009). The predominantly coastal and rural population of Solomon Islands depends on coastal fisheries as the primary source of dietary animal protein, and in many areas small-scale commercial fisheries offer one of the few viable livelihood opportunities (Bell et al., 2009). Coastal ecosystems are governed by the state through environment and fisheries legislation, but also to a large extent by communities that have traditional, and constitutionally recognised, marine tenure rights and customary governance systems (Lane, 2006). While most reef ecosystems in Solomon Islands are considered to be in relatively good condition (Green et al., 2006), communities and their partner NGOs have established over 100 co-managed marine areas in response to increasing concerns over resource sustainability. Most co-managed marine areas employ

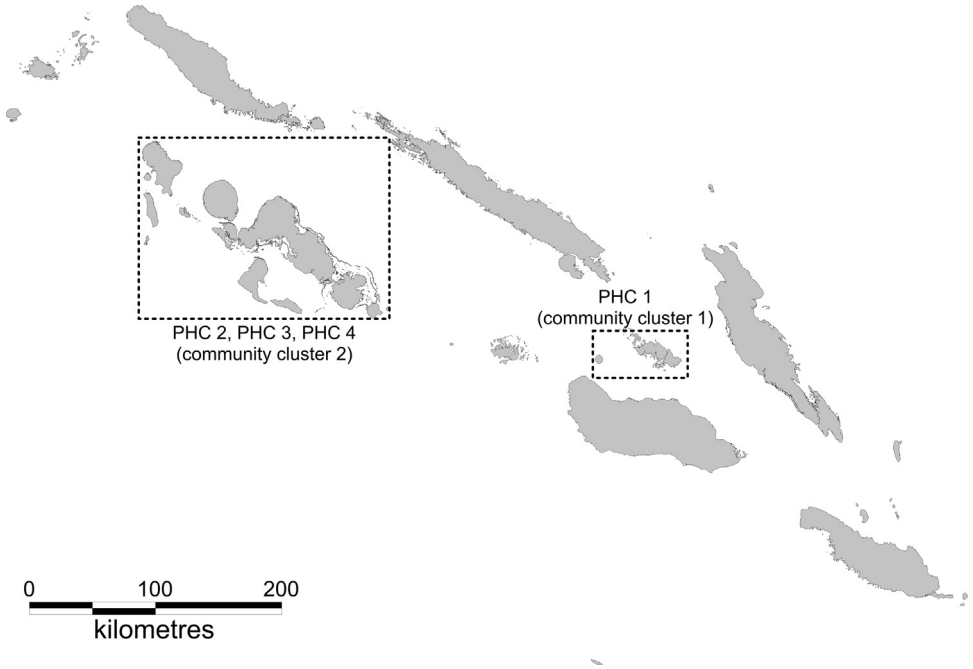

Fig. 1. Map of Solomon Islands showing the regions (demarcated boxes) in which the four periodically-harvested closures (PHC 1, PHC 2, PHC 3, and PHC 4) were situated in two community clusters.