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Managing coastal pelagic fisheries: A case study of the small-scale purse seine fishery in Kenya

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ABSTRACT

Balancing sustainability and conservation concerns with the socioeconomic needs of small-scale fishers is a dilemma that is commonly faced by fisheries managers. In this paper, we present a case study on managing the developing small-scale purse seine (or ring net) fishery introduced to Kenya by migrant fishers. The fishery, which primarily targets coastal pelagics in offshore waters, was deduced to have the potential of reducing fishing effort on nearshore demersal reef fish stocks while enhancing fisheries production and fisher livelihoods. The expanding fishery elicited much controversy resulting in resource use conflicts related to gear competition and concerns about the environmental impacts of the gear. We detail the consultative planning process that was undertaken to develop a gear-based management plan spanning over 10 years from 2004 to 2016. We briefly document the catch dynamics and evolution of the fishery, and further detail the challenges and key outcomes of the decision-making process. Regulatory measures agreed by stakeholders include restrictions on gear dimensions as well as spatial restrictions defining the distance and depth of operation. Effective implementation and enforcement of the measures will require collective action from all stakeholders. Future considerations should focus on harmonization of proposed measures in transboundary areas.

1. Introduction

Small-scale fisheries play an important role in food security and income for coastal communities worldwide, particularly in developing countries (Berkes et al., 2001; Béné et al., 2010). The fisheries are characterized by low capital investment, use of simple fishing gears, small dominantly un-motorized vessels and tend to concentrate in shallow nearshore areas (FAO, 2016). Globally, small-scale fisheries are exhibiting excess fishing effort, overfishing, and habitat degradation driven by high population growth rates and poverty levels (Worm et al., 2009; Fenner, 2012; Batista et al., 2014). Consequently, resource use conflicts regarding access to fishing grounds, competition over declining fisheries resources and markets abound (Bennett et al., 2001; Pomeroy et al., 2007; Murshed-e-Jahan et al., 2014).

Balancing sustainability and conservation concerns with the socioeconomic needs of fishers is a dilemma that is commonly faced by fisheries managers (Salas et al., 2007; McClanahan et al., 2008; Mumby and Steneck, 2008; Cinner, 2009). Assessment and management of small-scale tropical coastal fisheries is inherently complex (Pauly, 1989; Andrew et al., 2007; Batista et al., 2014), since they are open access, multi-species, multi-fleet and multi-gear in nature (Berkes et al., 2001; Van der Elst et al., 2005; McClanahan et al., 2008; Salas et al., 2007; Worm et al., 2009). Consequently, adoption of conventional management approaches based on quantitative stock assessments is often not practical, while gear-based and area-based approaches are viewed as suitable (Cinner et al., 2009). Effective management and governance of small-scale fisheries is further constrained by inadequate scientific

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data (Mora et al., 2009; Dowling et al., 2016), weak monitoring and enforcement capacity (Nielsen et al., 2004; Gutiérrez et al., 2011), lack of political good will (Ludwig et al., 1993; Pauly et al., 2002; Carbonetti et al., 2014), limited alternative livelihood sources (Davies et al., 2009; Daw et al., 2012), and external factors such as climate change (Brander, 2010; Graham et al., 2011).

The complexities discussed above are well documented in Kenya (Glaesel, 2000; Kaunda-Arara and Rose, 2004; Mangi and Roberts, 2007; McClanahan et al., 2008; Cinner, 2009; Evans, 2009; Cinner et al., 2012a; Samoilys et al., 2017). The number of small-scale fishers involved has increased from about 9000 in 2004 to over 13,400 in 2016 (Government of Kenya, 2016a). The fishers land approximately 90% of the estimated 9000 MT that is produced annually (ASCLME, 2012; Le Manach et al., 2015). Pelagic fish production ranges between 977 MT and 2096 MT annually, accounting for 27% of the total catches (Maina and Osuka, 2014). In comparison, the annual global pelagic fish production is estimated at 7.7 million tonnes (FAO, 2016). Small and medium pelagic species range in size from 10-20 cm and 20–60 cm in total length respectively (Fréon et al., 2005), and contribute over 50% of the global marine catches (FAO, 2016).

Kenya's National Oceans and Fisheries Policy emphasizes the distribution of fishing effort to the offshore resources and targeting of new and under exploited stocks to realize economic viability and resource sustainability (Government of Kenya, 2008). Thus, the emerging small-scale purse seine fishery which targets pelagic fish resources in offshore areas was endorsed as a strategy that would help alleviate fishing pressure on demersal reef fish stocks while enhancing fisher livelihoods by increasing fishery production. As the use of small-scale purse seines became widespread, resource use conflicts emerged due to heightened concerns about resource competition, overexploitation and the environmental impacts of the gear (Ochiewo, 2004). To mitigate the conflicts, a consultative decision-making process was initiated by the State Department of Fisheries to develop a gear-based management plan for the small-scale purse seine fishery. In this study, we briefly describe the evolution and characteristics of the developing fishery. We further detail the consultative process as well as the challenges experienced and lessons learned from decision-making process. Finally, we discuss future considerations to ensure effective implementation of the Plan.

2. Methodological approach

2.1. Study area

The Kenya coastline (Fig. 1) measures approximately 640 km long and is fringed with coral reefs, mangroves, sea grass beds and intertidal mudflats which support a high diversity of fish and other biota. The continental shelf ranges between 5 and 10 km wide with depths reaching up to 200 m (UNEP, 1998). The climate is tropical with a long rainy season experienced between March and May, and a short rainy season between November and December. Seasonality in oceanographic conditions along the coast is driven by alternating southeast and north easterly winds which influence the sea conditions as well as fishing activities (McClanahan, 1988; Obura, 2001). Relatively calm and warm waters are experienced during the northeast monsoon (NEM) season from November to March, and this coincides with high fishing activity due to more accessible sea. The strong currents, rough and cool sea conditions during the southeast monsoon (SEM) restrict most small-scale fishing operations to shallow nearshore fishing grounds (Maina et al., 2008). The seasons and weather also affect fish migration patterns, changing the behaviour of fishers with respect to target species and fishing methods (Mangi and Roberts, 2007). Sea surface temperature is generally higher during the NEM season, fluctuating between 27 and 28 °C and lower temperatures ranging between 24.5 and 25.8 °C are recorded during the southeast monsoon (SEM) season, (UNEP, 1998; Obura, 2001).

The small-scale purse seine fishery is currently open access and there are no specific controls or regulations on the use of the gear in Kenya. The Fisheries Management and Development Act (Government of Kenya, 2016a) provides an overarching framework for the development of fisheries management plans; which allows for subsidiary legislations arising from such plans to be developed and gazetted. There has been a steady evolution in decision -making from a 'top down' centralized approach towards a participatory and adaptive co-management approach through establishment of Beach Management Units with specific area-based mandates (Government of Kenya, 2007; Cinner et al., 2012b). Additionally, marine protected areas (MPAs) play an essential role in sustaining and replenishing reef fish populations (McClanahan and Mangi, 2000; Kaunda-Arara and Rose, 2004), and provide an avenue for ecosystem-based management as stipulated by the Wildlife Conservation and Management Act (Government of Kenya, 2013).

2.2. Characterization of the small-scale purse seine fishery

Data collection: Existing literature was collated and reviewed to gather information on the evolution of the fishery, augmented with information obtained through a series of stakeholder consultations. Data for characterizing the fishery was based on biennial frame surveys (2004–2016) conducted by Kenya's State Department for Fisheries (Government of Kenya, 2016b), as well as catch assessment surveys conducted in Shimoni, Gazi, Vanga, and Kipini from 2008 to 2014 (see Fig. 1 for locations). The catch parameters recorded for each vessel sampled (representing one fishing trip) included fishing gear used, fishing grounds, number of crew onboard, and total weight of the catch. The entire landed catch was sampled for species composition and sizes for most gears. However, a sample of approximately 10-20% of the total catch in weight (see Stobutzki et al., 2001) was scooped using a 20 litre plastic bucket to sample the species composition of exceptionally large catches. The fish were then sorted to species level using identification guides (Smith and Heemstra, 1986; Lieske and Myers, 2001), counted and fork or total length (cm) measured.

Data Analysis: The nominal catch per unit effort (CPUE) was estimated as kg/vessel/day and kg/fisher/day. The annual value of the small-scale purse seine fishery landings and the number of household members directly supported by the fishery was estimated using the average CPUE assuming a boat activity coefficient (BAC) of 20 days per month (a probability that fishers will be actively fishing for at least 20 days in a month) for the total number of vessels reported during frame survey estimates.

Three measures of diversity: species richness expressed as the total number of species, Shannon-Wiener diversity index (H') (Shannon and Wiener, 1963) and k-dominance curves (Lambshead et al., 1983) were used to describe the species composition of the fish catches. The use of multiple measures of diversity is generally preferred to evaluate gear selectivity and competition (e.g. Stergiou et al., 1996; and to understand ecosystem impacts (e.g. Greenstreet and Rogers, 2006; Pillans et al., 2007; Zhang et al., 2009). Plotting of k-dominance curves was based on the percentage cumulative abundance against log species rank to graphically compare the species selectivity of the small-scale purse seines against other fishing gears.

2.3. Stakeholder consultations towards development of management objectives and measures

Stakeholder perceptions were documented throughout the