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Review

Evolving trends in the Kenyan artisanal reef fishery and its implications for fisheries management

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ABSTRACT

Marine capture fishery in Kenya is small contributing only 4% to the overall fish production in the Country. This is because the fishery is artisanal characterized by relatively simple gears and vessels and has as yet received little attention due to the limited understanding of its contribution to coastal livelihoods. Nevertheless the Kenyan reefs are considered to be among the most heavily exploited reefs in East Africa. A review of the coastal artisanal fisheries landings for the past sixty years indicates that significant changes have occurred in the fisheries. There has been an increase in effort evidenced by the increased number of fishers, fishing vessels and change in fishing gears. Overall the landings have remained relatively stable over the past decade fluctuating between 5000 tonnes and slightly more than 8000 tonnes annually which are within the range of the predicted sustainable limit of the fishery based on both the Schaefer and fox model prediction of the maximum sustainable yield (MSY). Our estimate of MSY (8264–8543) and the corresponding effort of 11,171–15,467 fishers, derived from the Schaefer and Fox models, would suggest that yields higher than the presently obtained levels cannot be expected in future and that the inter annual variation in total landings may have to do with environmentally triggered changes in resource productivity. The model results also suggest that the overall effort of the present fishery already exceeds sustainable effort levels by at least 20%, suggesting a general state of overfishing. Therefore, there is an urgent need to not only apply stricter gear restrictions but also regulate new entrants in to the fishery while improving on the collection and monitoring of catch and effort data.

1. Introduction

Artisanal fishery remains one of the most important livelihoods associated with the coral reef ecosystems in tropical countries. Estimated to yield approximately 6 million tonnes annually, the artisanal fishery contributes significantly towards the livelihoods of over 200 million people (Munro, 1996; Teh et al., 2013). The contribution is particularly high in developing countries and is expected to rise given the predicted further increase in population for most coastal cities (Allison and Ellis, 2001), which is expected to exacerbate the pressure on the coral reefs. Nevertheless, artisanal fisheries still remain largely neglected and their contribution overlooked (Pauly, 2006; Worm et al., 2009). On the other hand, there is a growing concern over fisheries in general considering that fish stocks have globally been greatly impacted by fishing (Hilborn et al., 2003; Myers and Worm, 2003). Artisanal fisheries due to their scale of operation have often been considered benign. Characterized by the use of relatively simply fishing gears and small, often not even motorized vessels, the impacts of artisanal fisheries have often been underestimated in comparison to industrial fisheries (Hawkins and Roberts, 2004). However, there is mounting evidence suggesting that artisanal fisheries can have serious impacts on coral reefs and fish communities (McClanahan, 1994). In the East African coast, the explosion of sea urchin populations and the decrease in fish size and biomass is considered to be the direct cause of fishing (McClanahan and Muthiga, 1988; McClanahan and Shafir, 1990). Similarly, fishers density was found to affect the ecological state of the coral reefs leading to lower trophic level of the catches and decreases in the size of target resources (Teh et al., 2013). However, the lack of independent monitoring data limits the extensive evaluation of the full impacts of artisanal fishing making it difficult to get a realistic understanding of the changes that have occurred in the fishery

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(Tesfamichael and Pauly, 2011). As such, most of the artisanal reef fisheries remain poorly managed and monitored and their impacts are thus difficult to assess (Pauly, 2006; Sadovy, 2005; Worm et al., 2009). In Kenya, the coastal artisanal fisheries have as yet received little attention due to the limited understanding of its contribution to coastal livelihoods (Malleret-King et al., 2003). Overall, fish production of Kenya contributes only about 4.7% to the national Gross Domestic Product (GDP) with an estimated annual production of 200.000,-t, and a value of over ksh 4 billion (US$ 50 Million) in foreign exchange earnings. However, the marine capture fishery is small and only contributes 4% to this overall production.

The fishery is mainly artisanal operating within an area of about 800 km^2 and is based on a small number of demersal coral reef- and sea grass-associated fish species (McClanahan and Mangi, 2004; Obura, 2001). The total annual catch landed has been oscillating between 5000 and slightly above 8000t and has never surpassed the 10,000t. This amount is less than half of the estimated potential yield for the inshore fishery (~20,000t per year) (Odero, 1984; Sanders et al., 1988). The Kenyan reefs are considered to be among the most heavily exploited reefs in East Africa with some considered overfished well above the maximum sustainable yield (MSY) level (Malleret-King et al., 2003; McClanahan et al., 1997; McClanahan and Obura, 1995). There are indications of declining trends in overall landings paralleled by an increase in catch contribution by pelagic fish and invertebrates (Obura, 2001). This largely reflects increased levels of fishing effort, number of landing sites as well as changes in fishing techniques over the past few decades, which may have contributed to the decline in catch volumes and change in target species (McClanahan and Mangi, 2004). Fisheries are regulated by gear restrictions and despite the banning of the beach seine and spear gun already in 1990, the use of these gears has continued (and even increased in some areas) putting great pressure on the reefs. Compounded by the absence of reliable fisheries data, there is some evidence that the declining catch per unit effort recorded in the degraded reefs could be an indicator of a declining fishery (Obura, 2001). Most of the studies on the status of the artisanal fishery have been based on data from independent research institutions that give an insight into the fishery but are restricted only to specific areas. The catch data collected by the government agencies have been cited to possibly greatly underestimate overall catches by almost half (Malleret-King et al., 2003). Nevertheless, these data remain the only long-term information available that is representative of the entire fishery, and it is this data that is submitted to the United Nations Food and Agricultural organization (FAO), to compute part of the global fisheries statistics. Despite of the apparent concern over the reliability of these data, they provide the basis upon which the health of the fishery is to be inferred.

The study presented here seeks to analyze the fishery trends from the artisanal fishery in Kenya based on the official catch data, to identify the changes that may have occurred over the past decade (s) and to estimate the current harvest level for the target species. Based on this analysis, recommendations for management shall be formulated. Our study responds to the growing interest in the use of simple fisheries analysis tools that are based on catch data from data poor fisheries. We assume that underreporting may have occurred and may have led to underestimates of catches. However, we consider this a systematic error, which should still allow for meaningful identifications of trends based on the time series used. We expect our contribution to be important for policy and management decisions considering that the number of people living in the coastal areas is most probably going to rise, as is the fishing effort.

2. Methodology

The usefulness of catch and effort data compared to independent fishery survey data has been widely debated (Pauly et al., 2013). Despite the fact that long term fishery independent surveys present a better picture of the fishery (Kleisner et al., 2013), they are often expensive and are scarcely applied in developing countries, which, despite contributing significantly to the global fisheries, are often still data poor (Pauly et al., 2013). The Kenyan fishery has been subjected to a number of independent surveys since the early 1970s. They have been undertaken offshore from the grounds fished by the artisanal fishers and include surveys by R/V Prof. Mesyatsev and later R/V Dr Fridtjof Nansen (Sanders et al., 1988). These surveys were undertaken to determine the country's potential to venture into offshore fishery as a means to reduce the impact on inshore fishery and to increase overall yield levels. According to the surveys conducted, the potential annual yield for the demersal and small pelagic species combined was estimated at about 20,000t (Odero, 1984). These estimates were based on the offshore surveys undertaken from the R/V Prof. Mesyatsev and R/V Dr Fridtjof Nansen, which estimated the potential annual yields of about 10,000t for each of the demersal and small pelagic species (de Sousa, 1988), Table 1. The total standing biomass for the trawlable area was estimated to be 32,100t over an estimated area of 12,676 km^2 (corresponding to about 2.5 t/km^2) with a maximum sustainable yield of about 9000t (Sanders et al., 1988). These surveys provided the average densities of the fish in the trawlable areas but did not cover the areas with water shallower than 10 m. The potential yield was estimated using the Gulland formula (Gulland, 1971).

$$Y = 0.5MB_0$$

This relates the potential yield of a species (Y), to its annual natural mortality (M) and B_0, is the unexploited biomass. This was geared towards getting an estimate for the potential yield for the fishery but was considered to have been underestimated considering that only the trawlable areas were surveyed and the yields in the non-trawlable areas taken as 0.5 t/km^2 (Venema, 1988). However, the exploitation of these offshore resources was considered unlikely due to the low densities and the poor commercial value of the species present on the narrow continental shelf (Iversen, 1984; Sætersdal et al., 1999).

The reef fisheries, which contribute greatly to the artisanal fishery supporting the local livelihoods, have not yet been surveyed. The first catch assessment survey for the artisanal fisheries was set up in 1984 to provide monthly catch estimates by gear, by species and by region for the marine artisanal fishery (Carrara and Coppola, 1985). The results revealed that previous catch estimates had been greatly underestimated by almost half of the true value.

Table 1
Estimated potential yields of the Kenyan coastal fisheries based on estimates from independent surveys.

Year	Survey type/ vessel	Resource	Estimated potential yield	Area
1982	Prof. Mesyatsev	Demersal fishery	8933	10,677 km^2
1983	Dr. Fridtjof Nansen	Total inshore	20,000	
1984	Prof. Mesyatsev	Demersal fishery	9790	20,500 km^2
1984	Dr. Fridtjof Nansen	Small pelagics	10,000	
	FAO/UNDP	offshore	32,100	12,676KM^2