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A Review of the Status and Potential of the Coastal and Marine Fisheries Resources in Kenya

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Abstract The fishery sector is critically important especially in the developing world where millions of people depend on fish for their livelihood. In Kenya, fish is a very important source of food and in some communities, more than half of animal protein is derived from fish. The fisheries sector is made up of three sub-sectors: inland capture fisheries, aquaculture, and coastal and marine capture fisheries with overall contribution to total production of 85%, 9% and 6% respectively. The bulk of the total annual catch is landed along the shores of Lake Victoria. The main aquaculture species are *Oreochromis niloticus* (Nile tilapia*)* and *Salmo trutta* (trout). An average of 8,000 metric tons of coastal and marine capture fisheries valued at USD 4.1 Million is landed annually. This is mostly landed by the artisanal fishers whose fishing activities are restricted within the 0 – 3 nautical mile territorial waters, as these fishers are not sufficiently equipped to venture into the offshore fishing grounds. However, there is small fleet of semi-industrial bottom shrimp trawlers restricted to the only trawlable fishing grounds of the Malindi-Ungwana Bay. Kenya has an Exclusive Economic Zone (EEZ) which extends up to 200 nautical miles (nm) with a recent additional 150 nm. The EEZ remains under-exploited by the artisanal fishers and continue to be illegally exploited by the Distant Water Fishing Nations (DWFN). This study was carried out to establish the current status of fisheries resources along the Kenyan coast and to evaluate the challenges facing the sub-sector. Shore-based catch assessment was used to determine species composition of catches and fisheries frame surveys (2004, 2008, and 2012) were used to determine the fishing effort (number of fishers and fishing vessels). Results of this study reveal that demersal group such as scavengers, rabbit fish, snappers and parrotfish dominate the marine catch, constituting 50 % of the total marine and coastal fish landings. Pelagic group including mullets, bonito, cavalla jacks, mackerel, king fish and sail fish accounted for 28%, and elasmobranchs, crustaceans and mollusks constituted the remaining 22%.

Keywords Artisanal fisheries; potential; Exclusive Economic Zone; fisheries management

Introduction

Globally, coastal and marine fisheries are very important to the economy and well-being of coastal communities. Marine fisheries provide food security, job opportunities, income and livelihoods as well as traditional cultural identity. Maintaining the long term prosperity and sustainability of coastal and marine fisheries is not only of political and social significance but also of economic and ecological importance (FAO, 2011). The United Nations Convention on the Law of the Sea (UNCLOS), the United Nations Fish Stocks Agreement (UNFSA, UN 1995) and the FAO Code of Conduct for Responsible Fisheries (FAO, 1995) all require maintaining or restoring fish stocks at levels that are capable of producing their Maximum Sustainable Yield (MSY). To fulfill the objectives of these international treaties as well as meet the high demand for fish, fishery management authorities need to undertake assessment of the state of fish stocks and develop effective policies and management strategies. The regional fish landing statistics indicate that the Northwest Pacific is the largest contributor (25%) to the global catch, followed by the Southeast Pacific (16%), Western Central Pacific (14%), Northeast Atlantic (11%) and Eastern Indian Ocean (7%). All other FAO areas contribute less than 5% of the global total catch.

Artisanal or small scale fisheries are important socially, nutritionally and economically especially in

the developing tropical countries (Mangi et al., 2007; Davies et al., 2009). About 95% of the world's fishing population and over 60% of the world's marine fisheries resources come from the developing countries where artisanal fisheries account for 25% of the world catch and half of the fish used for direct human consumption (Mathew, 2001). Over the past two decades, artisanal fisheries have grown significantly and their rapid expansion under open access regime exerts fishing pressure on the coastal and marine resources (Mathew, 2001). Over-exploitation coupled with the current climate change phenomenon are the two principal threats posing challenge to the management of especially reef-based fisheries (McClanahan, 2002; Cinner et al., 2009).

Despite the vast ocean waters with different forms of fisheries, the coastal and marine fishery accounts for about 6% of the total production in Kenya. An average of 8,000 metric tons of coastal and marine capture fisheries valued at USD 4.1 Million is landed annually (Aloo, 2006; Government of Kenya, 2010) by 13,706 artisanal fishers using a total of 3,090 fishing crafts in 160 fish landing sites (Government of Kenya, 2012). Artisanal fishers use a variety of traditional fishing vessels and gear including gill nets, shark nets, hook and line, beach seines and traps and take the bulk of the landed coastal and marine fish. The main species of fish landed are the bottom and surface dwelling demersals and pelagic respectively. Broadly categorized, there are several types of coastal and marine fisheries which include commercial inshore prawn trawl fishery, demersal offshore fishery, offshore tuna and tuna-like species, and ornamental fishery (De Souza, 1988). The inland capture fisheries, coastal and marine capture fisheries, and aquaculture together contribute 0.5% of the Gross Domestic Product (GDP).

This study was carried out to establish the current status of the coastal and marine fishery resources in Kenya and to evaluate the potential and challenges facing the marine fisheries sub-sector. The study aimed at providing current information on fishery resources to the stakeholders in the sector including researchers, managers and investors with a view of advocating for sustainable utilization of the coastal and marine fishery resources for posterity.

Methodology

Study Area The most distinctive feature of the Kenyan coastline is its almost continuous fringing coral reef that runs parallel to the coast. Kenya has a vast coastline of between 640–880 km long when all bays and inlets are measured, on the Western Indian Ocean (WIO), bordering Somalia to the north and Tanzania to the south (Figure 1). The coastline forms the baseline for an Exclusive Economic Zone (EEZ) measuring 230,000 km^2, which includes a narrow (3-5 km in width) continental shelf measuring 19,100 km^2. Some 11,000 km^2 of this continental shelf is reported to be trawlable (Fulanda et al. 2011; Munga et al., 2013). Climate and weather systems are dominated by the large scale pressure systems of the WIO and two monsoon seasons, the dry Northeast Monsoon (NEM) from October to March and the wet Southeast Monsoon (SEM) from April to September (McClanahan, 1988). The main inshore fishery is located in the waters inside the fringing coral reef all along the coastline .The rich inshore marine fishing grounds are found in and around Lamu Archipelago, Malindi-Ungwana Bay and North Kenya Bank. The Malindi-Ungwana Bay is where shrimps (prawns) trawling is carried out both by commercial bottom trawlers and artisanal fishers. It is also where trawl surveys in the past and more recent have yielded reasonable catches of demersal fish (Wakwabi *et al*, 2003; Munga et al., 2013).

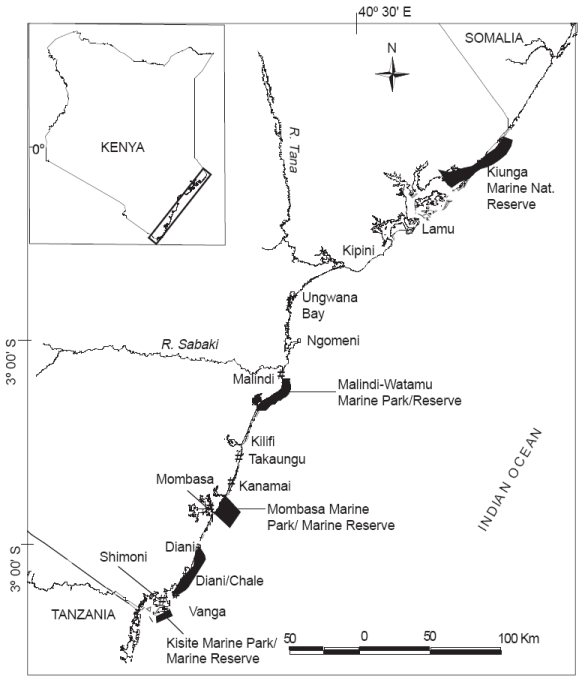

Figure 1 Kenyan coastline showing the major fish landing sites and national Marine Protected Areas (adapted from Kaunda-Arara et al., 2003)

Data Collection

Fisheries catch data were obtained from the records of the State Department of Fisheries. The catch data are mainly aggregated and are based on total weight of fish landed and the monetary value per taxon for the entire Kenyan coast. This catch data is usually collected on daily basis at the fish landing sites along the entire Kenyan coast with assistance from trained Fisheries Assistants and members of the respective Beach Management Units (BMUs). Data on fishing effort (total number of fishers, fishing vessels and gear) for the entire coast covering the counties of Kwale, Mombasa, Kilifi, Tana Delta and Lamu were obtained from the Frame Surveys records for the years 2004, 2006, 2008 and 2012 from the State Department of Fisheries. These frame surveys were carried out in the marine fishery sub-sector to determine fishing effort, fishing vessels and gear use.

Results and Discussion

Fishers and fishing crafts

Results of frame surveys between 2004–2012 indicate that the fishing effort in Kenyan coastal and marine fisheries has shown an increasing trend (Figure 2). This increasing trend in fishing effort (number of fishers and vessels) was experienced in all the counties of Lamu, Tana Delta, Malindi, Kilifi, Mombasa and Kwale. The fishing effort was highest in Kwale County and lowest in the Tana Delta County. The total number of fishers recorded was 9, 17; 010, 276; 12, 077 and 13, 706 in 2004, 2006, 2008 and 2012 respectively.

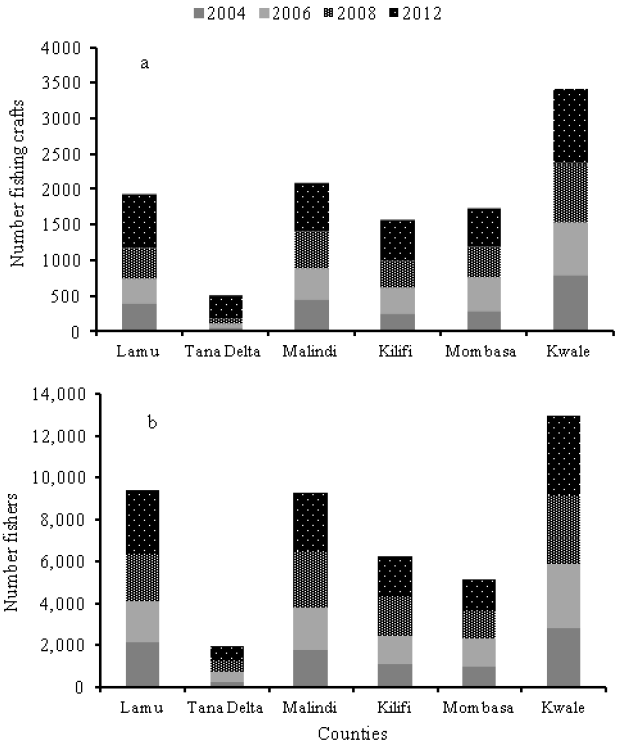

Figure 2 Trends in the number of artisanal fishing effort (a) number of fishing crafts and (b) number of fishers by counties along the Kenya coast (Government of Kenya, 2012)

Artisanal fishing gear

A total of six artisanal fishing gears are commonly used along the Kenyan coast (Figure 3). The most preferred gear is the long line hooks closely followed by gill nets and hand lines. Beach seines and cast nets are the least preferred. Thus the use of long line hooks showed an increasing trend between 2004 and 2012. The number of the other fishing gears fluctuated with no discernible trend over the same period under investigation.

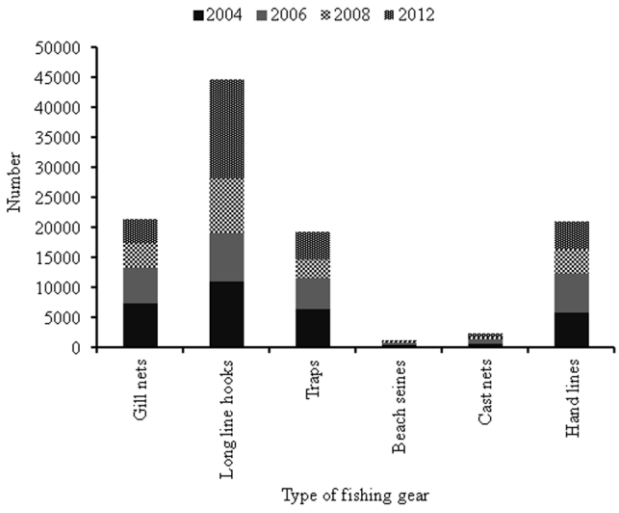

Figure 3 Trends in total number of the main artisanal fishing gears between 2004 and 2012

Results of spatial distribution of the common artisanal fishing gears (Figure 4) showed that gill nets were most preferred in the Malindi County and long line hooks were most preferred in the Tana Delta County. The traps, cast nets and hand lines were most commonly used in the Kwale County and beach seines in the Lamu County.

Artisanal landings trends and fish value (1990-2011)

This study also analysed the trends of artisanal fish landings for the above period. The total quantity of artisanal landings was high between 1990 and 1992. Lower quantities were recorded between 1993 and 2000. There was however, an increasing trend in landing quantities with negligible fluctuations between

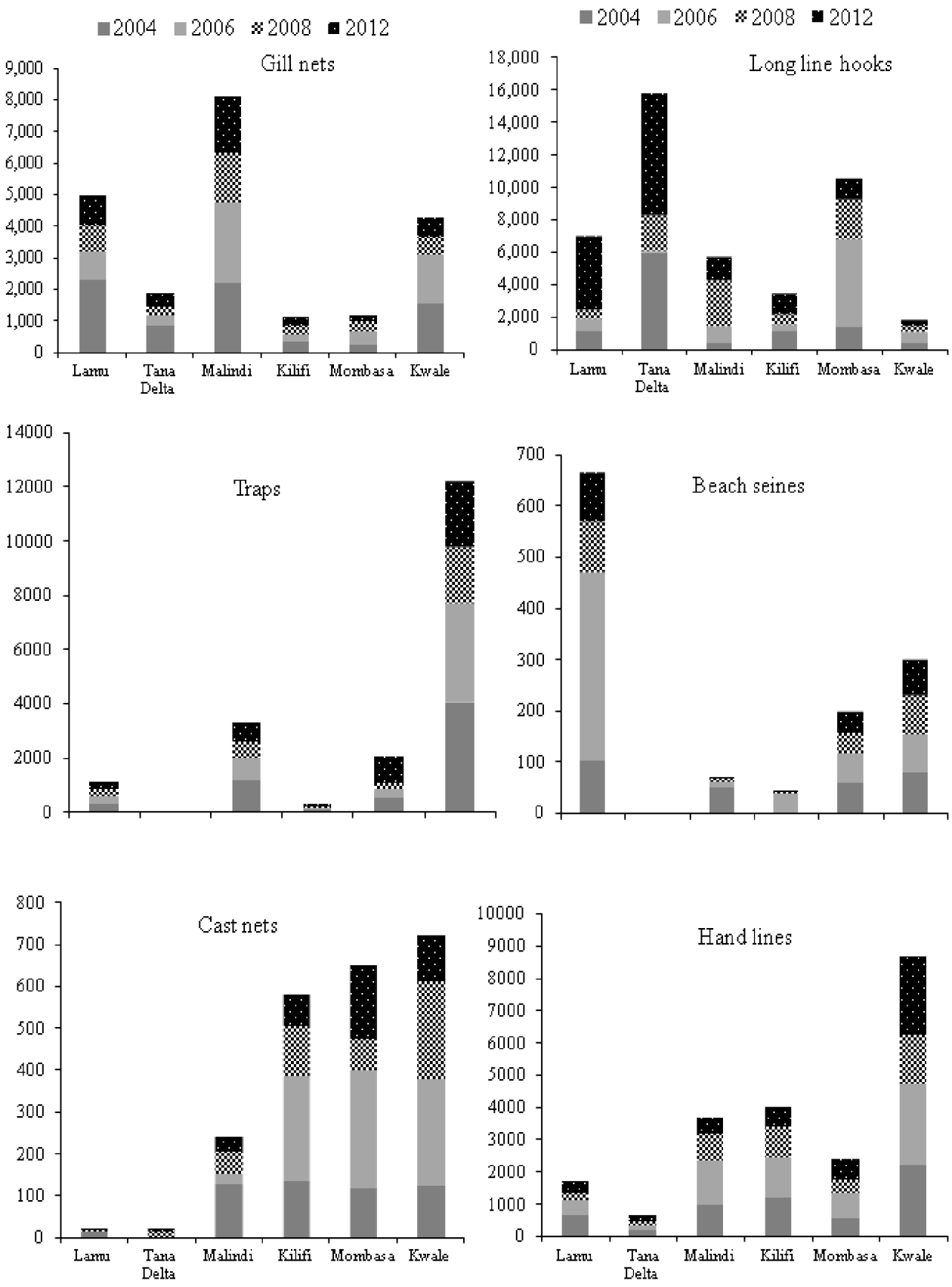

Figure 4 Spatial distribution of the commonly used fishing gears between 2004 and 2012 with the vertical axis indicating the number of gears and horizontal axis showing the counties along the Kenya coast

2001 and 2011. The value of fish on the other hand showed an increasing trend throughout based on the data obtained for this period (Figure 5).

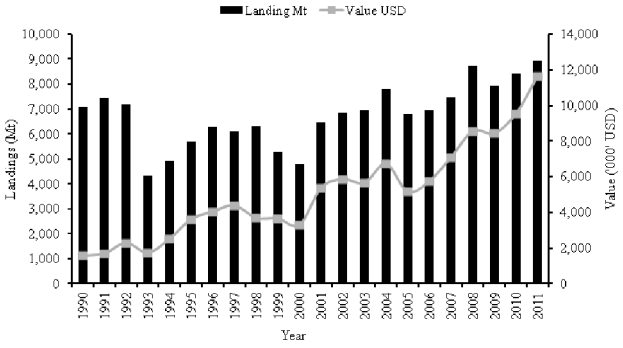

Figure 5 Trends in artisanal landings quantity and value from 1999-2011 (1 USD = 86.6 KES by March 2014) in Kenya

At least five main taxa were targeted by the artisanal fishers (Figure 6). The demersal was the highest taxon of fish landed throughout .A steady decline in total landings of this taxon was observed between 1991 and 2000. However, between 2001 and 2011, a steady increase in landings was observed. The second most landed taxon was the pelagic fish which showed an increasing trend throughout the period under investigation. The three taxa: elasmobranchs (sharks and rays), mollusks (octopus, squids and *beche-de-mer*) and crustaceans (prawns, lobsters and crabs) were the least landed.

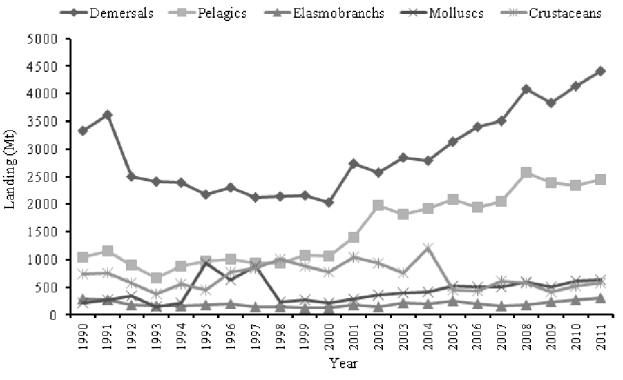

Figure 6 Trends in landings quantity by main taxa from 1990 - 2011 along the Kenyan coast with the semi-industrial bottom trawlers contributing the highest catch of crustaceans, mostly prawns

Offshore industrial fishery

The long liners and purse seiners constituted the offshore industrial fishery in Kenya between 2004 and 2011 operated by the Distant Fishing Water Nations (Figure 7). In 2005 and 2006, the highest number of these foreign fishing vessels was recorded. The long liners operated between 2004 and 2008, and purse seiners operated throughout the period between 2004 and 2011. Between 2005 and 2007, the offshore industrial total landings were made up of bigeye tuna (39%), swordfish (33%), yellow fin tuna (16%), sharks (3%), marlins (3%), sailfish (2%), and others 4%.

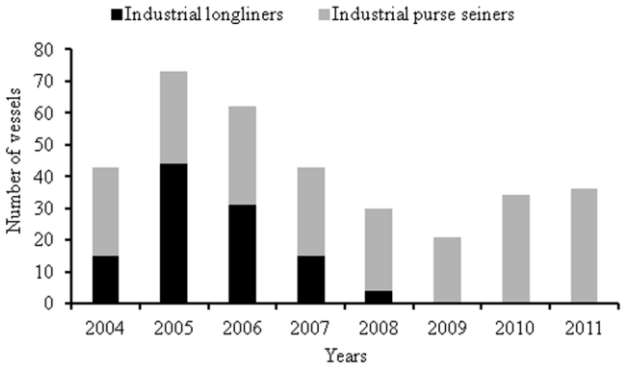

Figure 7 Trends in number of licensed foreign industrial fishing vessels plying the Kenyan EEZ in the recent years

Export of marine fishery products

The coastal and marine fishery resources exports between 2004 and 2006 included fin fish and fish products, mollusks and crustaceans (Table 1). These were exported either frozen or semi-processed. During this period, the largest volume exported was recorded in 2004, and 2005 recorded the highest foreign earnings and Kenya earned between 9.46 and 13.81 Million USD. The export of fish and fisheries products followed the same trend between 2009 and 2011 with tuna loins leading among the export market (Table 2). In 2004, Kenya also benefited from the coastal and marine aquarium exports where several live specimens of fish, invertebrates and shells were exported. A total of 8 aquarium fish companies were licensed to export aquarium fish in the year 2005 alone. The most exported species are surgeonfishes, angelfishes, blennies, butterflyfishes and wrasses (Table 2). During this time a total of 102,000 pieces of fin fish, 81,000 assorted invertebrates, and 98,074 assorted shells were exported and earned Kenya a total of USD 281,106. Italy, Spain, India, Japan, Greece, United Kingdom, Hong Kong, Seychelles, Netherlands, Portugal, France, United Arab Emirates, South Africa, Singapore and Lebanon were the main export market destinations (Table 3).

Table 1 Coastal and marine resources exports from Kenya for the years 2004, 2005 and 2006 (H & G = Headed and Gutted)

	2004		2005		2006	
Frozen Exports	Weight (Tons)	Value (Million USD)	Weight (Tons)	Value (Million USD)	Weight (Tons)	Value (Million USD)
Tuna loins	10,596	5.48	8,657	10.48	9,047	4.10
Octopus	504	1.18	566	1.55	697	1.76
Lobsters	136	0.92	2.8	0.03	3.9	0.03
Squids	–	–	–	–	40.6	1.54
Cuttlefish	17	0.38	–	–	154	0.03
Prawns	234	2.03	287	1.44	390	1.49
Whole fish	–	–	–	–	6.9	0.01
Langoustines	–	–	55	0.22	10	0.07
Crabs	12	0.15	–	–	36	0.08
Swordfish	–	–	141	0.12	192	0.30
Tuna (H&G)	–	–	–	–	28.9	0.02
Sharks (G&G)	–	–	–	–	83.3	0.04
Total	11,499	10.37	9,709	13.81	10,691	9.46

Note: Source; Fisheries Department Annual Statistics , 2005; Aloo,2006

Table2 Coastal and Marine Export of Fisheries products between 2009 and 2011

Year	Export product	Quantity (Mt)	Value (USD)
2009	Tuna loins	7,392	454,11
	Octopus	530	637,751
	Crabs	24	2,648
	Lobsters	47	44,711
2010	Swordfish	80	7,892
	Lobsters	13	7,849
	Octopus	690	158,967
	Sea Cucumbers	16	5,307
	Marine Shells	172	4,803
2011	Whole Lobsters	23	24,686
	Octopus	903	283,159
	Tuna Loins	9,821	607,263
	Bech-der-mer	11	4,079
	Sharks	55	6,367
	Marine Shells	113,	4,136

Note: Source: State Department of Fisheries Annual Statistics, 2012

Table 3 Top ten coastal and marine aquarium exports of fish species from Kenya in 2004

Species	Common name	Number
Pomacanthus chrysurus	Ear-spot angelfish	7892
Paracanthurus hepatus	Regal tang	7830
Pomacanthus imperator	Emperor Angelfish	6643
Centropyge Acanthops	African pygmy	6251
Valenciena Strigata	Blue-streak goby	6243
Acanthurus leucosternon	Powder Blue Surgeon	5580
Pomacanthus maculosus	Yellowbar angelfish	5444
Coris africana formosa	African clown wrasse	4783
Coris africana gaimard	Clown wrasse, red labrid	4379
Chromis caerulea	Green chromis	3800

Note: Source: Wakwabi et al.,2003

The potential of coastal and marine fishery resources

Little work has been done on the coastal and offshore pelagic fishery resources. It is not certain that the inshore reef fishery is close to full exploitation or is actually over exploited since the potential of offshore fisheries is largely unknown. Reports indicate that the offshore waters sometimes harbor abundant stocks of pelagic fish species such as tuna and tuna-like species, and large oceanic sharks (Wakwabi et al., 2003). Qualitative evidence exists on substantial catches, over the years, of the highly migratory tunas and tuna-like species by foreign fishing vessels. Unfortunately, the vessels do not declare their catches as required by law while the license fee charged by the government is way below the amounts charged internationally (Aloo, 2006).

There are signs of high productivity of the deeper coastal waters outside the reef where large pelagic aggregations of kingfishes, wahoo, little tunas, Indian mackerels, barracudas, trevallies, sardines and anchovies undergo coastal migration during the year. The potential of demersal stocks in offshore waters, however, is likely to be quite limited because of the relatively small area with potential for bottom fishing. Current scientific knowledge, albeit very weak and uncertain, estimated a total potential of 125,000 metric tons for the coastal and marine fishery resources in Kenya (Table 4).

The current coastal and marine production of 8,000 metric tons is much less compared to this huge potential. This leaves a huge potential waiting to be exploited possibly through increased capacity and effective monitoring, control and surveillance. If well managed, the fisheries can be a window of opportunities for achieving national development goals including poverty eradication and wealth creation. Moreover, this huge potential is a critical vehicle for the achievement of the Kenya Vision 2030 development plan (Aloo, 2009).

The coastal and marine artisanal fishery is faced with many technological challenges. Fishing is restricted to the shallow inshore areas during a part of the year, by sizes of fishing vessels and fishing gears. This study shows that there appears to be low level of local investment in the marine fishery industry with no significant changes in fishing methods, gears, vessels as well as catches over the years. Limited storage infrastructure in remote areas especially Kwale and Lamu counties, where catches are high, and during the periods of high catches in all areas lead to spoilage and high variation of prices. Challenges in the management of the marine fishery sector include the high number of fish landing sites, which makes monitoring and data collection difficult, time consuming and expensive. The expansive EEZ has not been explored to estimate sustainable catches. Management interventions would include surveillance to minimize Illegal Un-controlled and Unreported (IUU) fishing. Potential areas for improvement include development of fish preservation and transport infrastructure to reduce spoilage and improvement of fish handling techniques between the fisher and the consumer to ensure high quality of the product (Wakwabi et al, 2003). This is hoped to be achieved when the construction of the proposed Lamu Port is completed.

Table 4 The potential of coastal and marine fishery resources in Kenya

Inshore Fisheries	Annual Potential (mt)
Types	
Reef Fish – Shallow Water	15,000
Reef Fish – Deep Water	1,500
North Kenya Bank	2,000
Inshore Prawn	500
Inshore Prawn By-Catch	800
Other Inshore	2,000
Lobster	200
Crabs	200
Octopus	300
Other Crustaceans	300
Squid	300
Beche-de Mer	100
Other Inshore	600
Inshore Small Pelagic	20,200
Sub-Total	42,000
Offshore Fisheries	
Demersal Trawl	10,000
Demersal Line	16,000
Demersal Prawns	600
Demersal Lobster	400
Small Vessel Tuna	10,000
Small Vessel Marlin	5,000
Small Vessel (Other Species)	5,000
Large Vessel Tuna Purse-Seine	36,000
Sub-Total	83,000
Grand Total	125,000

Note: Source: De Souza, 1988; Wakwabi et al., 2003; Aloo, 2006)

Fishery experts' opinion asserts that coastal and marine fish production in Kenya may be increased by exploiting the offshore pelagic fish as well as deep water marine resources. The potential of these resources is estimated between 150,000 and 300,000 metric tons per year (De Souza, 1988). However, no recent surveys have been conducted to determine this potential. Unfortunately, DWFN fleets that operate in Kenyan waters do not provide data on their catches. Indicative data from the Indian Ocean Tuna Commission (IOTC) show that these fleets are already exploiting several tuna species at their maximum sustainable levels. The alternative of improving the income and livelihoods of fisher folk is promotion of mariculture. This needs the development of outreach programmes to provide potential farmers with technical knowledge of various species for culture.

Challenges facing the coastal and marine fisheries

The challenges facing the coastal and marine fisheries in Kenya are varied and include but not limited to the following:

a) *Uncontrolled fishing by Distant Water Fishing Nations (DWFN) off the EEZ*

The marine offshore waters have been fished for tunas and tuna-like species over the years by DWFN from Europe and Asia. They are exploiting Kenya's rich deep water fisheries in the EEZ at a great opportunity cost to the country. While the country has been receiving modest revenue for licensing, the vessels do not provide any data on the resource richness or catch rates. Currently, Kenya is losing millions of dollars due to unpaid royalties and low license fees. The inadequacy of local or national capacity to exploit the resources within the EEZ is also an important dimension of the problem.

b) Lack of effective Monitoring, Control and Surveillance system

There is need to promote an offshore fishing industry to support the development of an effective Monitoring, Control and Surveillance (MCS). The Kenya Navy which is currently assisting with surveillance should be provided with information on fisheries regulation. The government recently acquired a research vessel for research activities and MCS.

c) Destruction of artisanal fishing gears by large commercial trawlers

The above has been a source of conflict between artisanal and commercial fishers but this has been limited to the only trawlable fishing grounds of the Malindi-Ungwana Bay (Munga et al., 2013). It is imperative for commercial fishers to be careful while at sea to avoid such destructions. Moreover, artisanal fishers should also use clear markers to show the location of their gears.

d) Inadequate capacity by artisanal fishers to exploit the offshore fish stocks

The government should build the capacity of artisanal fishers to enable them access the offshore fishery resources. This will reduce the dominance of the DWFN and also ensure that local communities and the country benefit from these offshore fishery resources.

f) Lack of adequate information on offshore marine fish stocks

Currently, fish stock assessment is limited to the inshore waters. Kenya has just acquired an oceanographic research vessel under the Kenya Marine and Fisheries Research Institute. There is therefore, an urgent need to commission an elaborate research programme to assess the available offshore fish stocks. This information is critical for the development of a management plan for the marine and coastal fishery resources.

Recommendations

With the enormous unexploited potential of the marine fisheries in Kenya, this paper recommends the following:

Establishment of a strong Monitoring, Control and Surveillance such as purchase of patrol boats in addition to the research vessel

Establishing the Ministry of Ocean Affairs and Fisheries Development to effectively handle marine fisheries affairs

Enforcement of payment of royalties by DWFN

Increasing the amounts paid for license by the DWFN to match international rates

Building the capacity of artisanal fishers

Promotion of mariculture to complement wild stocks

Enforcement of fisheries regulations to protect the resources

Government and Private Sector funding of research to assess marine fish stocks

Enforcement of regulations to control marine pollution and environmental degradation.

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