FAO EAF-Nansen Project Report No. 23 (Part A – English) EAF-N/PR/23

Baseline Reports

PREPARATION OF MANAGEMENT PLANS FOR SELECTED FISHERIES IN AFRICA

Ghana, Kenya, Liberia, Mauritius, Mozambique, Nigeria, Seychelles, Sierra Leone and Tanzania

NANSEN PROJECT

Food and Agriculture Organization of the United Nations

THE EAF-NANSEN PROJECT

FAO started the implementation of the project "Strengthening the Knowledge Base for and Implementing an Ecosystem Approach to Marine Fisheries in Developing Countries (EAF-Nansen GCP/INT/003/NOR)" in December 2006 with funding from the Norwegian Agency for Development Cooperation (Norad). The EAF-Nansen project is a follow-up to earlier projects/programmes in a partnership involving FAO, Norad and the Institute of Marine Research (IMR), Bergen, Norway on assessment and management of marine fishery resources in developing countries. The project works in partnership with governments and also Global Environment Facility (GEF)-supported Large Marine Ecosystem (LME) projects and other projects that have the potential to contribute to some components of the EAF-Nansen project.

The EAF-Nansen project offers an opportunity to coastal countries in subSaharan Africa, working in partnership with the project, to receive technical support from FAO for the development of national and regional frameworks for the implementation of Ecosystem Approach to Fisheries management and to acquire additional knowledge on their marine ecosystems for their use in planning and monitoring. The project contributes to building the capacity of national fisheries management administrations in ecological risk assessment methods to identify critical management issues and in the preparation, operationalization and tracking the progress of implementation of fisheries management plans consistent with the ecosystem approach to fisheries.

FAO EAF-Nansen Project Report No. 23 (Part A – English) **EAF-N/PR/23**

STRENGTHENING THE KNOWLEDGE BASE FOR AND
IMPLEMENTING AN ECOSYSTEM APPROACH TO
MARINE FISHERIES IN DEVELOPING COUNTRIES
(EAF-NANSEN GCP/INT/003/NOR)

PREPARATION OF MANAGEMENT PLANS FOR SELECTED FISHERIES IN AFRICA - BASELINE REPORTS

Ghana, Kenya, Liberia, Mauritius, Mozambique,
Nigeria, Seychelles, Sierra Leone and Tanzania

Edited by

Kwame A. Koranteng

Marcelo C. Vasconcellos

Benedict P. Satia

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2014

PREPARATION OF THIS DOCUMENT

The preparation of a fishery management plan using the ecosystem approach to fisheries (EAF) framework starts with scoping. During this process, a clear definition of the scale and type of fishery is agreed, and a shared understanding of the social, economic and ecological objectives of the management plan is established. A Baseline Report that presents an agreed state of knowledge on the fishery prior to the introduction of EAF in its management is prepared.

A number of countries in coastal Africa have been assisted by the EAF-Nansen Project to prepare management plans for fisheries of economic or social importance. For each fishery, a Baseline Report was prepared, either by a national expert with knowledge of the fishery, or by a team of EAF National Task Group (NTG) members. The report was discussed and validated by the NTG and used in subsequent steps of the planning process.

This document is a compilation of 16 Baseline Reports and it is presented in two parts. Part one (this part) contains nine reports prepared in English and Part 2 contains seven reports prepared in French. The original reports have been edited and re-formatted for completeness and accuracy, with missing or additional information provided by the authors.

CONTENTS

CONTENTS

CHAPTER 2:
AN EAF BASELINE REPORT FOR THE SMALL AND MEDIUM PELAGIC FISHERIES OF KENYA
George Waweru Maina, Kennedy Osuka

CONTENTS

CONTENTS

CONTENTS

CHAPTER 5:
AN EAF BASELINE REPORT OF THE LINEFISH FISHERIES IN MOZAMBIQUE
Rui J Mutombene, Lucinda Mangue, Estela Mausse, Hadija Mussagy, Mateus Filipe, Rudy van der Elst

CONTENTS

CONTENTS

CONTENTS

CHAPTER 8:
AN EAF BASELINE REPORT FOR THE ARTISANAL FISHERIES OF SIERRA LEONE
A.B.C. Jones, Sheku Sei, Victor H. Kargbo

CONTENTS

CONTRIBUTORS

GHANA

Alabi Bortey, Policy Planning, Monitoring & Evaluation Department, Ministry of Food & Agriculture, Accra, Ghana. E-mail: alabi_bortey@yahoo.com

Francis K.E. Nunoo, Department of Oceanography & Fisheries, University of Ghana, Legon, Accra, Ghana. E-mail: fkenunoo@ug.edu.gh

KENYA

George Waweru Maina, P. O. Box 96737-80110, Mombasa, Kenya. E-mail: gwmaina2000@yahoo.com

Kennedy Osuka, P. O. Box 96737-80110, Mombasa, Kenya

LIBERIA

D. Wisseh Kay, Bureau of National Fisheries, Ministry of Agriculture, P.O. Box 9010, Monrovia, Liberia. E-mail: d.wissehkay@yahoo.com

Paul Larry George, Bureau of National Fisheries, Ministry of Agriculture, P.O. Box 9010, Monrovia, Liberia.

Glasgow Togba, Bureau of National Fisheries, Monrovia, Liberia. E-mail: glasgowtogba@yahoo.com

MAURITIUS

Munesh Munbodh, Impasse Coombs, Vacoas, Mauritius. E-mail: mumunbodh@gmail.com

MOZAMBIQUE

Rui J Mutombene, Instituto Nacional de Investigação Pesqueira (IIP), Av. Mao Tsé Tsung, N.389, Maputo, Mozambique. E-mail: ruimutombene@gmail.com

Lucinda Mangue, Administração Nacional das Pescas (ADNAP), Av. Consaglieri Pedroso, N. 347, Maputo, Mozambique. E-mail: lucindaisabel@yahoo.com.br

Estela Mausse, Administração Nacional das Pescas (ADNAP), Av. Consaglieri Pedroso, N. 347, Maputo, Mozambique. E-mail: telamausse@gmail.com

Hadija Mussagy, Administração Nacional das Pescas (ADNAP), Av. Consaglieri Pedroso, N. 347, Maputo, Mozambique. E-mail: hadija.mussagy@gmail.com

Mateus Filipe, Instituto Nacional de Desenvolvimento da Pesca de Pequena Escala (IDPPE), Maputo, Mozambique. E-mail: mafimo2002@yahoo.com.br

Rudy van der Elst, Oceanographic Research Institute (ORI), P O Box 10712, Marine Parade, Durban, South Africa. E-mail: rudyvanderelst@gmail.com

CONTRIBUTORS

NIGERIA

P.O. Abohweyere, Nigerian Institute for Oceanography and Marine Research, P.M.B 12729 Marina, Lagos, Nigeria. E-mail: ochukoparcy@yahoo.com

A.B. Williams, Nigerian Institute for Oceanography and Marine Research, P.M.B 12729 Marina, Lagos, Nigeria. E-mail: abwilliams2@yahoo.com

E.E. Edet, Federal Department of Fisheries, Victoria Island, Lagos, Nigeria.
E-mail: evaristusedet@yahoo.com

SEYCHELLES

Joel Nageon, Victoria, Seychelles. E-mail: jnageon@seychelles.net

Vincent Lucas, Seychelles Fishing Authority, P.O. Box 449, Victoria, Mahé, Seychelles.
E-mail: vlucas@sfa.sc

Warwick Sauer, Rhodes University, Grahamstown, South Africa. E-mail: W.Sauer@ru.ac.za

SIERRA LEONE

A.B.C. Jones, Sierra Leone Agricultural Research Institute (SLARI), Freetown, Sierra Leone.
E-mail: abcajones@yahoo.com

Sheku Sei, Ministry of Fisheries and Marine Resources, Freetown, Sierra Leone.
E-mail seisheku@yahoo.com

Victor H. Kargbo, Ministry of Fisheries and Marine Resources, Freetown, Sierra Leone.
E-mail: kargbovictorh@yahoo.co.uk

TANZANIA

Fisheries Development Division, Fisheries Resource Development, P.O. BOX 2462, Dar Es Salaam, Tanzania.

AN EAF BASELINE REPORT FOR THE BEACH SEINE FISHERY IN GHANA

Francis K. E. Nunoo, Alabi Bortey

1. Introduction

Ghana is located in the central part of the Eastern Central Atlantic, along the Gulf of Guinea, between Ivory Coast and Togo, and has a coastline of 550 km. It had a population of approximately 24.0 million in 2011, and annual growth rate has been estimated at 2.6 percent (Mensah *et al*., 2006).

Ghana lies in the tropical equatorial belt where average temperatures are between 25ºC and 35ºC and where climatic conditions change mainly due to the amount and distribution of rainfall, with there being two distinct wet seasons each year, a major one in May-June and a minor one in August-September (Mensah *et al*., 2006).

Ghana has a long fishing history and, together with Senegal, has the largest fishing industry in West Africa. Fishing is one of the most important economic activities in the country (Ferrais *et al*., 1997) and the sector is important for food security, livelihoods and poverty alleviation. The Ghanaian marine ecosystem is severely affected by the two upwelling periods, when fish production increases sharply (MFRD, 2004).

An estimated ten percent (almost two million people) of its population directly (as fishermen and processors) or indirectly (as traders, canoe carvers or petrol sellers) depend on fishing.

Fish is the most important animal protein in the Ghanaian diet contributing to 63 percent of the total animal protein intake in 2000 (WorldFish Center, 2005). Furthermore Ghana is one of the countries in Africa with the highest fish-consumption (Mensah *et al.*, 2006) with a per capita fish supply of about 27 kilograms per annum (Heinbuch, 1994).

The marine subsector is the most important source of local fish production, delivering more than 80 percent of the total supply. The marine fishery sector has been categorized into the following four broad categories (Table 1 provides the number of vessels in each fleet):

(i) Artisanal (Canoe) fishery

(ii) Inshore fishery (or Semi-Industrial) fishery

(iii) Industrial fishery

(iv) Tuna fishery

Table 1. Number of marine fishing vessels in Ghana fleet

Fleet segment	1997	1998	1999	2000	2001	2002	2003	2004	2005
Canoes	8 895	9 981	–	–	–	–	–	12 000	–
Industrial trawlers	48	47	38	46	45	34	54	67	75
Shrimpers	14	11	6	3	3	2	6	4	5
Tuna bait boats	36	35	39	34	33	33	36	35	36
Tuna purse seiners	5	6	8	10	10	10	11	13	16
Inshore vessels	241	239	239	236	244	230	172	151	348

With the exception of the tuna fishing vessels whose fishing activities are limited to fishing outside the continental shelf of Ghana, almost all the other fishing fleet based in Ghana operate within the Ghanaian continental shelf, which is rather narrow with as area of about 24 300km^2.

Although the total quantity of fish caught by Ghanaian vessels is considerable, total production is not enough to sustain Ghana's demand for fish, which has been estimated at 600 000 tonnes per year. Ghana therefore imports fish from Europe and other West African countries, mainly from Morocco, Mauritania, Namibia, Norway, the Netherlands, Belgium, Senegal and the Gambia (FAO, 2004).

Artisanal sector

The artisanal fishery is the most important subsector within marine fisheries with respect to landed weight of fish, contributing 70-80 percent of the national marine fish production (Quaatey, 1997; Amador *et al.*, 2006). There are over 11 000 canoes and more than 124 000 fishers. The latest official figures date from 2001 when there were reportedly 9 981 marine artisanal canoes operating from 304 landing beaches in the vicinity of 185 villages along the Ghanaian coast (MFRD, 2004). Table 1 shows the evolution in the number of fishing vessels up 2005.

Typically, artisanal landing sites are characterized by a dearth of the facilities available at the industrial and inshore vessel landing sites. Important artisanal landing sites are Teshie, Jamestown, Chorkor, Shama, Axim, Elmina, Winneba, Mumford, Akplabanya, Adina, Atiteti, Abutiakope and Moree.

The gear used by the artisanal fishermen can be classified into five groups: **purse seines** (39.8 percent), **set nets** (29.7 percent), **hook and lines** (11.9 percent), **beach seines** (8.9 percent) and **drifting gill nets** (2.9 percent) (the percentages are based on figures from 1992 – Ferrais *et al.*, 1997, as reported in Kraan, 2009); with remaining percentage for other gears found in minority. Besides these, fishermen also use cast nets and traps (Mensah *et al.*, 2006). The common fishing craft is a dugout canoe carved out of a single trunk of wood, symmetrical in shape, double ended and ranging in size from 3 to 18 metres in length and 0.5-1.8 metres in width (Ferrais *et al.*, 1997, as reported in Kraan, 2009).

Each gear has very different geographical distribution along the coast and the dominance of any particular gear type in an area is influences by the target species sought. Gillnets normally catch small and medium sized pelagic fish, drift gill net (DGN) large pelagic fishes such as tunas, dolphins, sharks, sailfish, swordfish and marlins; set nets invertebrate species including crabs and lobsters, while hook and line, Ali-Poli-Watsa (APW) and beach seine gear target both demersals and pelagics such as croakers, sardines and jacks. APW are three different encircling gears that are considered together for statistical purposes because they are operated form the same type of canoe.

1.1. The role of beach seine fishing in Ghana

The beach seine is a commonly used technique all along the coast of Ghana. The beach seine is used throughout the year and that makes it quite an important type of fishing gear in Ghana (Mensah *et al.*, 2006). An analysis into the importance of beach seining in Ghana in terms of catch and value of the catch using 2004 data from the Ghanaian Fisheries Department made by Kraan (2009) showed that the beach seine is the second most important gear as regards total catch (73 848 tonnes), after the Ali-Poli-Watsa (APW) canoe (154 946 tonnes). The analysis also showed fluctuation in catches throughout the year, with peak catches in July and higher catches in the minor upwelling season in January as compared to the low season (March, April).

The Anlo-Ewe ethnic group have become specialised in beach seine fishing. Although some Fanti, Ga and Dangbe fish with this gear (Mensah *et al.*, 2006), most of those who use it are Anlo-Ewe.

2. Overview of the fishery and resources exploited

2.1. Fishing gear used and areas fished

The beach seine category comprises the seines operated from land. They are generally used in shallow waters, near the surface. The bottom and surface acts as natural barriers that prevent the fish from escaping from the area enclosed by the net. A distinction is made between beach seines with a bag and beach seines without a bag; the latter do have a central part with smaller meshes and more slack, which retains the fish caught (FAO, 1990). The gear without a bag is normally used in the lagoons. A wooden canoe is used to assist setting the net.

The beach seine net is mainly operated in the areas of concentration of juvenile fishes, whether pelagic or demersal species. The average distance from the shoreline to where the net is set is about 1 to 2 km. It usually requires 30 to 50 men to haul a small net and 50 to 100 men for a big net. The size of beach-seine nets varies from 480 m long (excluding ropes) by 8 m deep to 1 640 m long by 22 m deep.

In Ghana, the beach seine is widely used in the Volta region, particularly around the mouth of the Volta River and other estuarine areas along the entire coastline.

2.2. Resources exploited

The beach seine exploits a range of pelagic and demersal fish species. Important small pelagic species include the round sardinella (*Sardinella aurita*), flat sardinella (*Sardinella maderensis*), anchovy (*Engraulis encrasicolus*), shrimps such as *Parapenaeopsis atlantica*, *Penaeus notialis* and *Penaeus kerathurus* and demersal species including sciaenidae (e.g. *Pseudotolithus* spp), Polynemidae (*Galeoides decatactylus*) and big eye grunt (*Brachydeuterus auritus*) amongst others. In addition the beach seine catches different species of the group Carangidae. Beach seines catch adult sardinellas during the upwelling periods and anchovies, juvenile sardinellas and juvenile demersal fishes during the non-upwelling periods (Mensah *et al*., 2006). The beach seines exploit shrimps as they move from the estuaries into marine waters. Both adults and juveniles are exploited, although a high proportion of the catch is juvenile. Over 90 percent of the fish examined were small, ranging between 1cm and 10 cm TL (Nunoo *et. al*., 2006). Until 1983, the beach seine was the main exploiter of cuttlefish (*Sepia officinalis*) in Ghanaian waters, accounting for 60 percent of annual landings. Thereafter, cuttlefish became the main export high valued fish for the industrial vessels.

2.3. Number of fishers and land-based workers by sector

As mentioned previously the Anlo-Ewe ethnic group has become specialised in beach seine fishing, with some Fanti, Ga and Dangbe also fishing with this gear. The Anlo-Ewe operates mainly in the Volta region and the total number of Anlo-Ewe fishermen has been estimated at 14 355 (Kraan, 2009). Table 2 shows the number of fishermen by region and coastal ethnic group. No information was found as regards the land based workers and the type of employment (full or part time).

Table 2. Relevant characteristics of Ghana's coastal regions with respect to ethnic groups, length of coastline and number of fishermen.
Source: Coastal Zone Profile of Ghana in Mensah et al. (2006) as referred to in Kraan (2009)

Region	Coastal Ethnic Groups	Coastline (km)	Fishermen
Western	Nzema	105	6 750
	Ahanta	80	10 990
Central	Fante	150	28 300
	Awutu-Effutu	25	6 450
Greater Accra	Ga	45	16 150
	Dangbe	70	13 370
Volta	Anlo-Ewe	75	14 355

2.4. Interactions with other fisheries

Although the sub sector is important in Ghana, the technique has been criticised for its negative impact on fish stocks (Nunoo *et al*., 2006). The non-selectiveness of the gear, which catches almost everything within scope of the net due to the small mesh-sizes used, is a major point of concern.

Beach seines with small mesh sizes are said to have quite negative biological effects given that the fishery operates in nearshore waters often in the vicinity of lagoons and estuaries both of which play an important nursery role for many fish species. This has been shown in research performed by Nunoo *et al.* (2006) and Nunoo (2007).

An analysis of length frequency data of *Sardinella aurita* carried out on Ghanaian data showed a difference in size distribution between gears (beach seine and ringnet), the mode being at 5–6 cm for the beach seine and 18 cm for the ringnet (CECAF, 1989).

Some of the small pelagic and demersal species targeted by the beach seines are also targeted by both industrial and semi-industrial trawlers; as well as other gears in the artisanal fisheries. For instance, anchovy (*Engraulis encrasicolus*), African moonfish (*Selene dorsalis*) and juvenile *Sardinella* spp. are targeted by both semi-industrial purse seines and 'poli' fishers of the artisanal fishery. The beach seines target burrito (*Brachydeuterus auritus*), which is also targeted by artisanal set nets and 'poli' gears. In addition, the beach seines compete with industrial and semi-industrial trawl gears for cassava croaker (*Pseudotholithus senegalensis*), Sole (*Cynoglossus senegalensis*), cuttlefish (*Sepia officinalis*) and Lesser African threadfin (*Galeoides decadactylus*). All the named gears in this section land some bycatch species (Bigeye, *Priacanthus arenatus*; Puffer fish, *Lagocephalus lagocephalus,* flying gurnard, *Dactylopterus volitans)* that may be either discarded or sold at very low prices as trash fish (Nunoo *et. al*., 2009).

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

Small pelagics

Two species of sardinella are found in Ghanaian waters: the round sardinella (*Sardinella aurita*) and the flat sardinella (*Sardinella maderensis*). Both of the species are associated with upwelling areas.

Both species are coastal pelagic species preferring clear saline water with a minimum temperature below 24° C; *S. aurita* is found from inshore and near surface to edge of shelf and down to 350 m, or perhaps even deeper; it has a schooling behaviour and is strongly migratory (for feeding and spawning), often rising to surface at night and dispersing. It feeds mainly on zooplankton, especially copepods, but some phytoplankton (especially by juveniles). *S. maderensis* has a more coastal distribution than *S. aurita*. Feeding habits are similar to that of *S. aurita*. Breeding is thought to occur at all times of the year, but with distinct peaks, e.g. around July or August off Ivory Coast and Ghana (linked with upwelling regimes off West Africa). The juveniles tend to stay in nursery areas but on maturity rejoin adult stocks in the colder offshore waters.

Anchovy (*Engraulis encrasicolus*) is a short lived species with rapid growth and short life span. It is one of the characteristic species of the upwelling environment. It is commonly found close to the shore, but can also be found in deeper waters sometimes in depths to 400 m. The juveniles are found in the coastal fringe and anchovy is also found in estuaries. It feeds mainly on plankton.

Demersal fish

Big eye grunt *(Brachydeuterus auritus)* is a semi-pelagic species found in brackish and marine waters at depths of between 10 and 100 m, but most commonly between 15 and 80 m. It remains near the bottom during the day and moves up to open water at night. It occurs over sandy and muddy bottoms and feeds on invertebrates, small fishes and phytoplankton.

The Lesser African threadfin (*Galeoides decadactylus)* is found in coastal waters on sandy and muddy bottoms, at depths of up to 50 m. It feeds on fish, shrimps and crabs.

The demersal group of Sciaenids belonging to the genus *Pseudotolithus* is represented in majority by three species: *P. elongatus*, *P. typus* and *P. senegalensis*. Distribution and habitat of this group of species are similar to those of *G. decadactylus*. These are coastal species associated with muddy and sandy bottoms. *Pseudotolithus elongatus* has an inshore distribution and can occur in estuaries and brackish waters. This species can easily grow to about 30 cm in total length and lengths in excess of 40 cm have been found. The species has a shoaling behaviour and migrates along the shore. *Pseudotolithus senegalensis* and *P. typus* have a greater coastal distribution than *P. elongatus* and can be found to 150 m depth, although *P. typus* is most abundant in waters less than 60 m and *P. senegalensis* 70 m. Juveniles and sub adults of *P. typus* also enters estuaries and rivers. These two species also grow faster than *P. elongatus*. Total length in excess of 60 cm is commonly observed for *P. typus* whilst *P. senegalensis* is commonly observed at around 40–50 cm. The species feed mainly on small fishes and crustaceans. Peak spawning season is from late spring to early autumn in tropical waters off West Africa.

Shrimps

The Southern pink shrimp (*Penaeus notialis*), Caramote prawn (*P. kerathurus*) and the Guinean shrimp (*Parapenaeopsis atlantica*) are all shallow water shrimp species found on sandy and muddy bottoms in coastal marine waters, estuaries and lagoons. They live on muddy bottoms by day and migrate upwards at night. The shrimps spawn between June and July each year.

Penaeus notialis is a shallow-water shrimp species, usually associated with estuaries. Adults can live up to 100 m depth, but they preferably inhabit very shallow waters, from a few meters to 50 m depth. The species uses estuaries as nursery grounds. It spawns at open sea, but after hatching, larvae migrate to the coast. Juveniles live in brackish waters (estuaries, mangroves and coastal lagoons). After a period of 75-90 days, these juveniles migrate back to the sea, where they spend the rest of their lives. This migration process is very influenced by pluviosity, varying between October and April-May.

The species abundance is very dependent on the recruitment which shows high oscillations related to these environmental conditions. *P. notialis* has a lifespan of about one to one and a half years. They have a very fast growth. The species has usually activity at night and it burrows into the sediment when the light intensity increases. But in seems to be that in these western African coasts, their activity is more distributed along the whole day. This is because the animals are not disturbed by the light, due to the turbidity of the waters they inhabits (FAO, 2010a).

3.2. Geographical distribution of the species

Small pelagics

The surveys carried out in the area of the Fishery Committee for the Eastern Central Atlantic (CECAF) show that the two species of sardinella are found in a vast area stretching from the Morocco to south of Angola. The FAO/CECAF Pelagic Working Groups for the moment has agreed on the existence of five stocks for these two species in the CECAF area, one of which is the stock in the Western Gulf of Guinea (Côte d'Ivoire, Ghana, Togo, and Benin). Anchovy, *Engraulis encrasicolus* is also found along the Western African coast, with one of the more denser concentrations found in the Western Gulf of Guinea. In Ghana sardinellas (*Sardinella aurita* and *S. maderenis*) and anchovy (*Engraulis encrasicolus*) are the dominant pelagic species on the inner shelf, while carangids, scombrids and barracudas are more widely distributed over the entire shelf. *S. maderensis* is a more coastal species than *S. aurita* and the adults remain confined over the shallow half of the continental shelf. *S. aurita* can be found over the entire shelf area although the main distribution is within 80 nm from the coast. *E. encrasicolus* is also normally found closer to the coast.

The distribution and abundance of the small pelagic species are affected by seasonal coastal upwelling. The stocks of small pelagics are thus highly variable as they are subjected to variations in abundance due to environmental factors. *S. aurita* is most abundant during periods of the coastal upwelling in July-September (major) and January-March (minor). *S. maderensis* occurs almost all year round. The highest concentrations of sardinellas have commonly been reported to the west of Accra and around Cape Three Points. In general the larger individuals of these species are found in Ghana and Côte d'Ivore whereas the smaller individuals are found in Benin and Togo. The high densities of *Engraulis encrasicolus* have a more patchy distribution with higher concentrations founds to the west and east of the coastal zone as well as some lower densities off Tema.

Demersal resources

As mentioned previously, *Pseudotolithus* spp. and *Galeoides decadactylus* are all coastal species associated with muddy and sandy bottoms. They are all common and widely distributed throughout the shallower areas of the Ghanaian continental shelf. Surveys have indicated that *Brachydeuterus auritus* has the highest mean density in the shallowest depth zone (0-30 m) and also in the 31-50 m zone (Mehl *et al.*, 2006). This species is also common and distributed across the Ghanaian continental shelf. All of these species are usually found above the base of the thermocline.

Shrimps

The Southern pink shrimp (*Penaeus notialis*), Caramote prawn (*P. kerathurus*) and the Guinean shrimp (*Parapenaeopsis atlantica*) are found throughout the west coast of Africa. These are coastal species found on the continental shelf. The Southern pink shrimp, Caramote prawn, and Guinea shrimp are found up to a depth of 100 m, 75 m, and 60 m respectively. Higher densities are found close to estuaries. It seems possible that this species could carry out geographic migrations, due mainly to changes in the local climatologic conditions.

3.3. Status of the stocks

Regional stock assessments of the pelagic and demersal resources in the subregion have been carried out through the Working Groups of CECAF. These Working Groups aim to assess the state of the small pelagic and demersal resources in the CECAF area and make recommendations on fisheries management and exploitation options aimed at ensuring optimal and sustainable use of these resources for the benefit of coastal countries. The Working groups analyse both fisheries dependent and fisheries independent data made available to them by the participating countries. The fisheries data is mainly limited to total catch information and effort (not always available). Biological information including on length composition is almost nonexistent. In the last working group Ghana provided an updated catch and effort series with information on catch and corresponding effort split into main gears for the artisanal fishery. For the pelagic catches this information was not provided. The subregion has also benefited from several regional surveys in recent years. Six surveys have been carried out since 1999 (1999, 2000, 2002, 2004, 2005, 2006) all of them carried it out by the *RV Dr Fridtjof Nansen*. This vessel also carried out surveys in the region in 1981 and 1989.

The most recent assessments were carried out in 2009 for the small pelagic resources (Second meeting of the FAO/CECAF Working Group on the Assessment of Small Pelagic Fish – SubGroup South that met in Accra, Ghana, from 19 to 28 October, 2009 (FAO/CECAF, 2010a)) and in 2008 for the demersal resources (FAO/CECAF Working Group on the Assessment of Demersal resources – Subgroup South met in Freetown, Sierra Leone, from 8 to 19 October, 2008 (FAO/CECAF, 2010b)).

The main method used for the assessment was a Schaefer dynamic production model (see e.g. FAO 2006). The state of the stocks were related to Biological Reference Points (BRPs) adopted by the Working groups whereby the indices B/BMSY and F/FMSY are used as Limit Reference Points, while the indices B/B0.1 and F/F0.1 were chosen for Target Reference Points. A more detailed explanation of these reference points and of their use in fisheries management is given in FAO (2006). In the case that this model cannot be applied, other information available to the group was used for the evaluation of the state of the stocks (trends in catch, CPUE or survey biomass or catch rates).

The results of the assessment of the small pelagic resources are shown in Table 3. The last assessment showed that the stock of *S. aurita* is overexploited and that catches of this species should not be increased. The results of the assessment of *S. maderensis* stock indicate a fully exploited stock, however considering the high F ratio and given that the species is taken together with *S. aurita* caution was called for and the overall assessment of this species was that it considered overexploited. Anchovy was found to be fully exploited.

Table 4a provides the summary results of the assessment of the relevant demersal resources. For some of these species it was not possible to fit the model with the data provided, such as in the case for *Brachydeuterus auritus* and *Pseudotolithus* spp. *Galeoides decadactylus* and *Sepia* spp were found to be overexploited whereas *Peneaus notialis* was found to be moderately exploited. Table 4b shows the relevant management recommendations made as well as the recommendations for future research.

3.4. Direct interactions with the ecosystem

Coastal developments, including tourism, mangrove destruction and dumping of waste potentially affect the fishery. Plastic waste has become a major problem in recent year and the fishery collects a lot of waste in each haul that is often left at the shores and is usually washed back to sea. Some of the plastic waste and human excreta is generated by the large numbers of fishers, helpers and fish traders that are associated with the operation of the gear. The dragging of the gear near the shore disturbs the settlement of invertebrates and aquatic plants on boulders and rocks at the shore. The fishery itself can also have an impact on the ecosystem through the use of illegal mesh sizes near estuaries resulting in the capture and landing of mostly juvenile and gravid fishes.

Table 3. Summary of assessments and management recommendations for 2010/2011 for the small pelagic resources in western Gulf of Guinea (Côte d'Ivoire, Ghana, Togo and Benin). **Source:** FAO/CECAF (2010a)

Stock	Last year catch[1] (tonnes) (5 year average)	$B_{cur}/B_{0.1}$ %	$F_{cur}//F_{0.1}$ %	Assessment	Management recommendations
			S. aurita		
West (Côte d'Ivoire, Ghana, Togo and Benin)	36 585 (71 322)	58	65	Stock is overexploited.	As a precautionary measure, do not increase catches of this species (not to exceed 40 000 tonnes)
			S. maderensis		
West (Côte d'Ivoire, Ghana, Togo and Benin)	18 085 (21 295)	90	124	Stock is considered fully exploited. Given that the species is taken together with S. aurita caution this stock is considered overexploited	As a precautionary measure, catch level should not exceed the average of the 5 last years (20 000 tonnes)
			Bonga *(E. fimbriata)*		
West (Côte d'Ivoire, Ghana, Togo, Benin) [2]	1 819 (684)	-	-	No reliable results from model. Catches fluctuates annually	No recommendation made
			Anchovy *(E. encrasicolus)*		
West (Côte d'Ivoire, Ghana, Togo, Benin)	48 415 (43 582)	77	89	Stock fully exploited. Acoustic survey estimates showed a decrease in biomass in 2005 and 2006	As a precautionary measure, catch level should not exceed the average level of the 3 last years (40 000 tonnes)

[1] 2008

[2] Catches from Côte d'Ivoire not available

Table 4a. Assessments summary sheet – CECAF SOUTH
(Cap Vert, Guinea Bissau, Guinea, Sierra Leone, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon, Gabon, Congo and Angola)
Source: FAO, 2010b. * = 2006 catch

SubGroup/Unit	Region	Status	last year[3] (tonnes)	F_{cur}/ F_{sy} curB %	B/ B_{MSY} %	F_{cur}/ F_{MSY}	F_{cur}/ $F_{0.1}$	B_{cur}/ $B_{0.1}$	CPUE used	Fitting	Comments
Brachydeuterus auritus	Côte d'Ivoire + Ghana + Togo + Benin	Assess-ment rejected	21388	-	-	-	-	-	-	Poor	Three indices used. CPUE PI Ghana, Nansen and CPUE PA purse seiners Ghana
Galeoides decadactylus	Côte d'Ivoire + Ghana + Togo + Benin	Over-exploited	3978*	416%	22%	742%	825%	20%	Côte Ivoire Industrial	Accept-able	Three other indices also used. CPUE PI Ghana, Nansen and CPUE PA set nets Ghana
Pseudotolithus spp.	Côte d'Ivoire + Ghana + Togo + Benin	No assessment	2787*								2004 -2007 Problems with data
Penaeus notialis	Ghana	Moderately exploited	256*	82%	150%	41%	46%	136%	Shrimpers Ghana	Accept-able	Last year 2006; Effort goes down
Sepia spp	Ghana	Over-exploited	2466*	105%	74%	132%	67%	132%	Ghana Industrial	Accept-able	NB, last year average of three years catch and CPUE

[3] "Last year" = 2007, if no other explicit remarks.

Table 4b. Management recommendations summary sheet
(CECAF SOUTH - Côte d'Ivoire, Ghana, Togo, Benin)
Source: FAO, 2010b

SubGroup/Unit	Region	Status	Catches[4] (tonnes)	$F_{cur}/F_{0.1}$	$B_{cur}/B_{0.1}$	Management recommendations 2008 and 2009	Future Research
***Brachydeuterus* auritus**	Côte d'Ivoire + Ghana + Togo + Benin	Assess-ment model did not fit	21388*			As a precautionary approach and pending more information, the Working Group recommends not to increase total catch above the mean of 2002-2006 (18 000 tonnes)	The work carried out revealed important gaps in the current knowledge about the stocks in these areas. In order to address these, the Working Group recommends that the following research lines be pursued: • Cote d'Ivoire and Benin should provide catch and effort data for different artisanal gears. • Togo and Ghana to continue to collect catch and effort data for different artisanal gears. • Intensify sampling for length frequencies and biological parameters from commercial landings. • Continue using survey index and other CPUE data.
Galeoides decadactylus	Côte d'Ivoire + Ghana + Togo + Benin	Over-exploited	3978*	825%	20%	Reduce fishing effort. Total catch should not exceed the catch in 2000 (2 500 tonnes per year)	
Pseudotolithus spp.	Côte d'Ivoire + Ghana + Togo + Benin	No assess-ment	2787*			As a precautionary approach and pending more information, the Working Group recommends not to increase fishing effort until the WG analyses a more complete and quality checked data series	
Peneaus notialis	Ghana	Moderately exploited	256*	46%	136%	As a precautionary approach, the Working Group recommends that fishing effort should not exceed current level. Catch should not exceed the average of 2004-2006 (170 tonnes)	
Sepia spp	Ghana	Over-exploited	2466*	67%	132%	Reduce fishing effort and limitation of catches not exceeding 2 000 tonnes per year.	• Submit retrospective monthly catch and effort data from all the cuttlefish fisheries to the next WG. Series should cover the longest possible time period and always contain the most recent years. • Conduct biological studies on cuttlefish. Specifically, information is needed on monthly mean weight in catches, biometric relationships (length-weight, mantle length-total length), monthly maturity indices and L first maturity. • To prepare retrospective CPUE series from fisheries other than the Spanish fishery in order to dispose of alternative series to fit the assessment models.

[4] "Last year" = 2007, if no other explicit remarks.

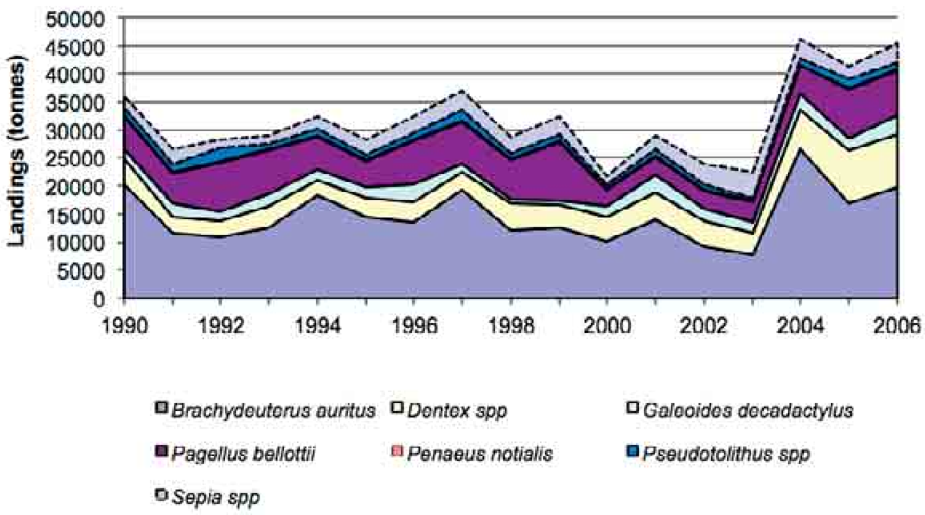
3.5. Traditional knowledge about the fishery and the resources exploited

Traditional knowledge is highly valued in Ghana and the inputs of fishermen are used when decisions are taken in the local comanagement committees. The office of the Chief Fisherman is the most important institution at the village or town fishing communities. Fishermen rely on their experience in making decisions on where and when to fish; and the type of gear to use at any given time of the year. There are designated days of no-fishing activity observed within a week in various communities. The exact day of the week may vary from community to community. It is Tuesdays in most communities, but others do not go fishing on either Sundays or Wednesdays. Enforcement and compliance of non-fishing days are governed by fines or sanctions supervised by the Chief fisherman and his council of elders. Both resident and migrant fishermen observe the non-fishing days. The fishermen are also represented on the Fisheries Commission.

4. Annual catches

Figures 1a and 1b show the trends in landings for the demersal species in Ghana analysed by the FAO/CECAF Demersal Working Group for the period 1990-2006. A general increase of landings can be seen for the last few years of the series, reaching around 45 000 tonnes in 2006. The main species in terms of volume are the big eye grunt (*Brachydeuterus auritus*) followed by *Pagellus bellottii* and *Dentex* spp. From Figure 1b, it can been seen that from a general decreasing trend for the period 1997-2003, landings of Big eye grunt has increased in recent years. Catches of *Galeoides dceadactylus* have decreased considerably since the mid 90s when some high landings were reported. Beach seine accounts for an average of 24 percent of the total catch of these species for the whole period. Figure 2 shows the landings of the above species by beach seine over the same period, indicating that the main species caught are the coastal species *Brachydeuterus auritus*, *Pseudotolithus* spp and *Galeoides decadactylus*. Landings of *Brachydeuterus auritus* fluctuated in the area between 2 000 - 4 000 tonnes for the period 1990-2003, followed by an exceptional landing of around 140 000 tonnes in 2004. In 2005 and 2006, the landings were in the range of 4 000 to 5 000 tonnes. Landings of *Pseudotolithus* spp show large inter annual fluctuations for some of the time series, with many highs and lows, but with a general decreasing trend from the start of the time period until 2003 when only 20 tonnes were recorded, subsequently increasing to over 500 tonnes in 2005 (the highest data point of the series), before decreasing somewhat to around 340 tonnes in 2006. Reported landings of *Galeoides decadactylus* also shows fluctuations with a general decreasing trend from 1995 to 2005, before catches increased to just below 400 tonnes in 2006.

a)



b)

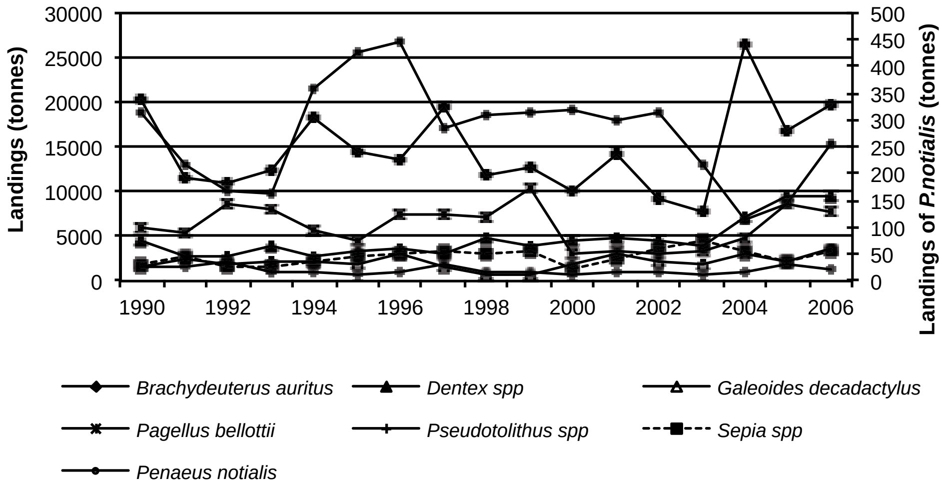


Figure 1. Total a) cumulative and b) individual landings (tonnes) of selected demersal species in Ghana assessed by the CECAF Demersal Working Group, subgroup south
Source: Adapted from FAO/CECAF, 2010b.

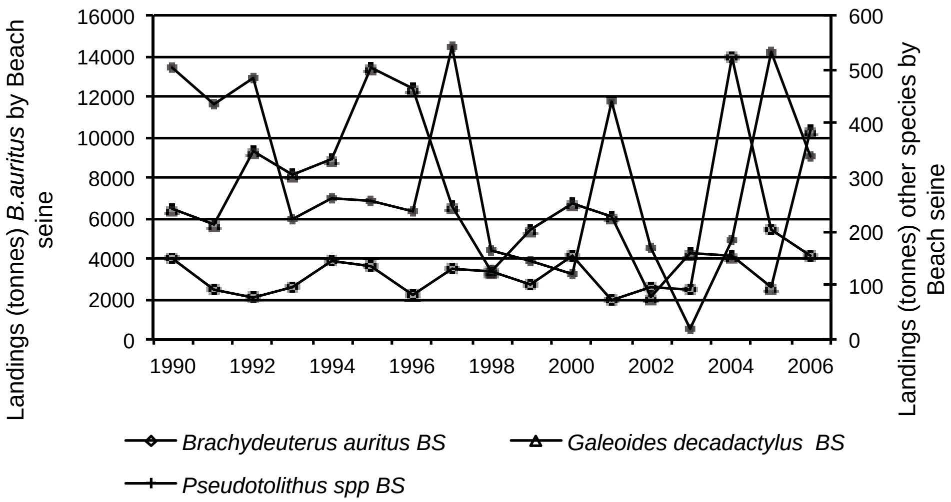


Figure 2. Total landings (tonnes) of selected demersal species in Ghana caught by beach seine.
Source: Adapted from FAO/CECAF, 2010b.

Overall landings of the main small pelagic fish in Ghana showed fluctuations from 1990 to 2008. A small increase in total landings was observed in 2003 from around 140 000 tonnes in 2002 to about 170 000 tonnes in 2003, followed by a decrease in 2004 of about 9 percent. Since 2005 catches of the small pelagic have fluctuated falling to a low of approximately 137 000 tonnes in 2007 then rising to 182 000 in 2008. The total landings of the main small pelagic fish in Ghana in 2008 were dominated by the two sardinella species constituting about 65-70 percent of the total. Landings of these species increased from around 94 000 tonnes in 2003 to around 109 000 tonnes in 2004, representing a 16 percent increase in landings of the two sardinella species (Figure 3). Landings of bonga (*E. fimbriata*) consisted of about 19 percent of total landings of small pelagic fish in 2004, increasing by 37 percent as compared to 2003. Among the total sardinellas, *S. aurita* accounted for 61.2 percent of the resources. Currently landings of the sardinellas, anchovy and bonga/shad in 2008 are 41 000 tonnes, 41 000 tonnes and 1 800 tonnes respectively (FAO/CECAF, 2010b).

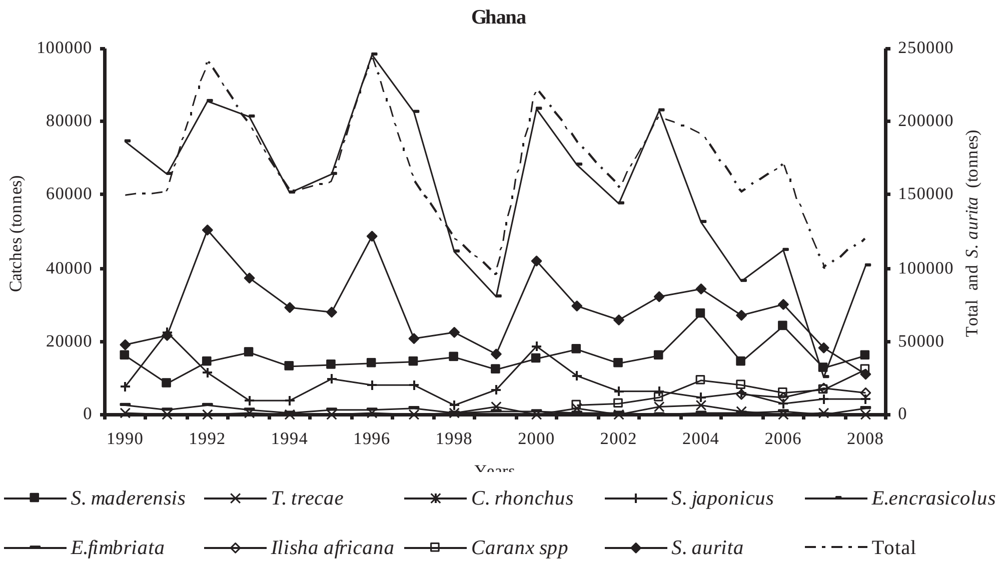


Figure 3: Catches of the main species of small pelagics in Ghana (FAO/CECAF, 2010a).

5. Importance of the fishery in the national economy

5.1. Value of the catches

Looking at the value of the catch in 2004 (Table 5), Kraan (2009) showed that the contribution of the beach seine is more or less the same as regards to volume, given that it contributed 28 percent of the total value of the artisanal marine catch. Fishing by drifting gillnet and hook and line is relatively more valuable and accounts for 15 percent (of a 5 percent catch) and 9 percent (of a 5 percent catch) respectively. APW canoe fishing results in relatively less valuable fish catches per volume (Kraan, 2009).

Table 5. Average catch value per fishing day - the example of company of Half Assini
Source: Kraan, 2009. *1 Ghanaian Cedi= 0.49 USD.

Month	Value total catches (cedis*)	No. of fishing days	Average catch (cedis*) / fishing day
Sep 2004	63 030 000	14	4 502 142
Oct 2004	35 230 000	19	1 854 210
Nov 2004	12 500 000	15	833 333
Dec 2004	41 380 000	16	2 586 250
Jan 2005	28 560 000	19	1 503 157
Feb 2005	15 734 000	17	925 529

5.2. Products and markets

Traditional processing methods such as smoking, salting and drying are used all along the coastline to preserve most of the fish caught – both by the artisanal and inshore fleets. Most of the products from the artisanal fishery go for local consumption.

All the same, fish is the second most significant non-traditional export commodity in terms of foreign exchange (after horticultural products). The share of fish and seafood of non-traditional exports increased to over 30 percent since 2001. The total export value of fish and fishery products was USD186 million in 2007 (Republic of Ghana/Fisheries Department, 2008). The fishing sector is therefore a very important income generating sector in Ghana as well as in terms of livelihoods and food security.

Fish and seafood exports from Ghana consist mainly of tuna (76 percent) (caught by the industrial sector), frozen fish (mostly demersals), shrimps, lobsters, cuttlefish and dried / smoked fish (MFRD, 2004). The key export destinations are the EU (mainly Spain, France, United Kingdom, Portugal and Greece), the US and Japan. The processing industry has struggled to improve quality and hygiene standards since the introduction of Hazard Analysis and Critical Control Points (HACCP) to Ghana in 1999. Few companies have been approved for such important markets as the EU (Republic of Ghana/ Fisheries Department, 2008) and hence the export is done through a limited number of companies.

6. Fisheries management plan and objectives

The overall vision for the marine fisheries sector in Ghana is that: "*The sector is to contribute significantly to socio-economic development through food and nutritional security and poverty reduction in a sustainable and economically efficient manner, within the natural limits of capture fisheries resources and environmental protection requirements, and with strongly established bases for accelerating growth in aquaculture production*" (Republic of Ghana/Ministry of Fisheries, 2008).

However, there is no specific management plan for the beach seine fishery in Ghana. The management of the beach seine fishery is implicit in the general objectives of management for the entire fisheries sector.

The general management objectives of the fisheries sector are to increase production, create employment and alleviate poverty in fishing communities.

Further, a national management plan for the marine capture fisheries sector has been developed. This management plan is broadly compatible with international management and development models, drawing heavily on the FAO Code of Conduct for Responsible Fisheries (FAO, 1995), as well as on integrated rural development and coastal area management models. The management plan relates to the following approaches to ensuring sustainable fisheries:

- Emphasis on effort control based on knowledge of stock fluctuations.
- A precautionary approach that can accommodate the range of interests but take preemptive measures.
- Strong commitment to comanagement.
- A zonal approach to the allocation of user rights on behalf of communities.
- Strong reliance on monitoring, control and surveillance built on sound scientific analysis.
- Attempts to recognize the diversity of interests resolve conflict and increase public awareness.
- A legislative approach to gear restrictions, licensing and other effort control.
- Emphasis on efficient use of resources for food security and wealth generation.
- A commitment to institutional capacity-building.

7. Legal framework

Ghana is signatory to many international agreements with a bearing on the fisheries sector. For example, Ghana has ratified the UN Law of the Sea Convention (UNCLOS) and of the FAO compliance agreement from 1983. The country is, however, not party to the UN Fish Stocks Agreement from 1995.

The fishing industry of Ghana is regulated by the Fisheries Act 2002 (Act 625 of 2002). The Act provides for the regulation and management of fisheries, development of the fishing industry, sustainable exploitation of the fisheries resources and related matters. The Act is a mixture of customary rules and statutory enactments in consonance with Article 11 of the Constitution of Ghana. All other Acts, Decrees, Laws, Legislative Instruments and other subsidiary legislation relating to the fisheries sector that are still in force are not inconsistent with the national Constitution and are also covered by the Act. The Fisheries Act does not contain explicit provisions on navigation, fish health, quality assurance or product safety, but Sections 77 and 139 of the Act make it possible to draw on other laws that address these issues. The Act is a comprehensive piece of legislation with an international character and dimension (Republic of Ghana / Ministry of Fisheries, 2008).

Importantly, Fisheries Regulations 2010 (LI 1968) giving backing to the Fisheries Law Act 625 of 2002 was passed on 3 August 2010. It provides further elaboration on fishing gears, devices and fishing equipment, and monitoring mechanisms. Section 9 of the LI 1968 prohibits the use of beach seine gear in estuaries and areas designated as Marine protected areas by the **Fisheries Commission** (FC) while Section 12 describes the minimum mesh sizes for fishing gears including beach seines.

8. Institutional and administrative frameworks for fisheries management

The **Ministry of Food and Agriculture (MOFA)** is the Ministry charged with the development and growth of the agriculture sector in Ghana with the exception of the Cocoa, Coffee and Forestry sectors. Its primary role is the formulation of appropriate agricultural policies, planning & coordination, monitoring and evaluation within the overall national economic development. The Ministry is serviced by different technical departments, including one department dedicated to fisheries matters.

For a brief period (2005-2009) fisheries and aquaculture were decoupled from the Ministry of Food and Agriculture and during that time the Ministry of Fisheries was the overarching government structure responsible for national fisheries management

The **Fisheries Commission (FC)** was established in 1993 and its purpose is to advise the Minister on matters pertaining to ensuring the sustainable exploitation of fisheries resources. It is represented in all the 10 regions of the country but virtually has no offices at the district level. The Hon. Minister of Food and Agriculture has oversight responsibility over the Fisheries Commission. Under the Fisheries Act 625 of 2002 the Commission works through the **Directorate of Fisheries (DoF)** as an implementing agency. The Directorate of Fisheries operates with approved manpower level of 330 (Republic of Ghana/ Ministry of Fisheries, 2008). The mandate of DoF is broad and includes management, development and regulatory functions, such as the development of technical regulations and the implementation of Monitoring, Control and Surveillance (MCS) through its **MCS Division**, which is mandated to enforce fisheries laws. Technical backstopping on development of the artisanal fishers including facilitation of input availability, gear use, education of fisheries and promotion of comanagement systems in the marine and inland water bodies is undertaken by the **Marine Fisheries Management** and **Inland Fisheries Management Divisions** respectively. Research on monitoring and evaluation of fish stocks, the marine environment and fishing gear is undertaken by the **Marine Fisheries Research Division (MFRD**).

The functions of the MFRD are as follows:

- Monitor the marine environment and assess its changes in so far as they affect fisheries;
- Estimate annual fish production by the various fishing fleets operating in marine waters;
- Undertake biological studies of commercially important fish species;
- Assess stocks of demersal and pelagic fishery resources;
- Undertake studies and development of fishing gears;
- Provide information required for the preparation of the fisheries management plans; and
- Collaborate with subregional, regional and international organisations in the study and management of shared fish stocks.

Ghana has committed to a formal policy of decentralisation and the Department of Fisheries has adopted a process of decentralisation of fisheries management. This policy allows for the comanagement of fisheries through increased active participation of fisherfolk and constitutes a departure from strictly top-down approach to fisheries management.

A large number of fishing communities have established **Community Based Fishery Management Committees (CBFMC)** whose by-laws have either been gazetted or are in the process of obtaining legal recognition. The CBFMCs are intended to enforce national fisheries law and local by-law as appropriate. **District Fisheries Management Committees (DFMCs)** have been established in three districts bordering Lake Volta which are recognized legal entities of the District Assemblies, with budgets and authority to finance fisheries management from approved revenue sources. In the marine sector, the DFMC at Effutu has recently been inaugurated. Significant work is still required for these mechanisms to become fully operational, even if they form the backbone of a robust policy for fisheries comanagement and conservation.

8.1. National and regional forums for discussions on fisheries management

There are several regional forums discussing fisheries management issues relevant to fisheries management such as the Committee for the Eastern Central Atlantic Fisheries (CECAF) and the newly established Fisheries Commission for the Central Gulf of Guinea (FCWC). CECAF covers the coastal area from Morocco in the North to Angola in the South and provides advice on stocks status and fisheries management. The CECAF Committee meets every second year. The Committee is supported by a scientific subcommittee that also meets every second year and three working groups (demersal, pelagic and artisanal) that meet regularly (annually, biannually or with three years intervals); the exact timing depending on availability of funding. The newly established FCWC is mandated to look at the harmonisation of policies in the region from Liberia to Nigeria.

The Fisheries Commission is the main national forum for discussion on fisheries management issues.

The Ghana National Canoe Fishermen Council represents the artisanal fishermen. Through the traditional Chief fishermen, representatives of all fishing communities are appointed and sit in a regional artisanal fisheries committee. These committees are united in the Council, which represents the artisanal fishermen to the Ministry responsible for fisheries or by word of mouth to their members.

At subnational level, fisher groups undertake managing activities in their local management committee by setting down rules and making access arrangements. As a committee engaged in comanagement of fisheries resources it sometime produces by-laws for governing their operations, which are subsequently proposed to district assemblies of local government. The district fisheries officer facilitates the operation of these groups and disseminates information to relevant national bodies. The beach-seine fishermen are organised in such groups whereby they agree on fishing areas and timing slots for setting of the nets. New entrants to the fishery must also report to their local community group.

9. Management measures and tools currently in use and status of implementation

The Department of Fisheries has implemented a distinct set of control measures for the marine capture fisheries (Table 6). Regulations range from limiting inputs, in particular through minimum mesh sizes, to restricting the use of non-selective gears, closed seasons and protected areas. In addition, within the marine context, there is an embargo on the importation of new vessels, and industrial vessels are excluded from the Inshore Exclusion Zone (IEZ) - an area up to the 30 meter-depth-line from the coast that is officially allocated to the artisanal sector.

Enforcement of regulations is under the responsibility of the Monitoring Control and Surveillance Division (MCS) of the Department of Fisheries in collaboration with the Ghana Navy through at sea observer missions and beach inspection at the larger landing sites, such as Tema, Sekondi and Takoradi.

The Department of Fisheries is also implementing a new licensing policy in which fees are extracted to recover costs of some of its services. The contribution of fishing licenses to total revenue was 8 percent in 2001 and is now around 30 percent (Sarpong *et al*., 2005).

Table 6. Summary of management measures in place in Ghana.

Minimum Mesh Size	It is illegal to use the following: (i) gill nets the mesh size of which is less than 50 mm in case of multifilament net. (ii) seine nets the mesh size of which is less than 25 mm for the purpose of taking fish in marine waters (approximately one inch, in stretched diagonal length.) (iii) bottom trawl nets the mesh size of which is less than 60 mm for the purpose of taking fish in marine waters (iv) shrimp trawl nets the mesh size of which is less than 40 mm for the purpose of taking shrimps in marine waters.
Regulation on Fishing with Explosives and Chemicals	The Fisheries Law prohibits the use of dynamite and/or any other explosive substances or poisonous substances to fish.
Restriction on the Size and Area of Operation of Vessels	The Fisheries Law prohibits the use of fishing vessel of 50 Gross Registered Tonnage (GRT) or more to use bottom trawl in waters of depth less than 30 meters. It has pegged the size of bottom trawlers and shrimpers at not more than 450 GRT.
Inshore Exclusive Zone	An inshore exclusive zone up to the 30 meter-depth-line from the coast has been created for the exclusive use of the artisanal sector.
Fishery reserve zone (e.g. MPA)	Yet to be established.
Vessel Monitoring System (VMS)	A vessel monitoring system (VMS) was commissioned in November 2005 to help monitor and control fishing. According to a report from the Ministry of Fisheries, 70 Industrial fishing vessels have been fitted with vessel tracking devices to ensure the monitoring of their operations at sea by 2006. It is expected that all the remaining vessels will be fitted with the device and efficient measures instituted to ensure compliance in the next few years.
Observers on vessels and in ports	On going for tuna vessels
Licensing fees	In place for industrial and semi-industrial vessels; no licenses for the artisanal sector.

9.1. Effectiveness of the current management measures

Despite measures taken many of the important stocks in Ghana are overexploited including the round sardinella. Although various management measures have been adopted, the actual implementation of some of these measures remains a challenge and beach seine fishermen do not always comply with the regulations relevant to their fishery such as e.g. mesh regulations adopted for this fishery. Local management communities have recommended “a comanaged (fishers and government) three-month ban on beach-seining (between May and July) as the most appropriate control measure towards the sustainability of Ghanaian fish stocks”, however how this is to be implemented and controlled is not clear.

Furthermore the beach seine fishery is only one of the subsectors that compete for the same resource as the canoe, semi-industrial and industrial fisheries; conflicts and gear damage can therefore occur. Complain about the potential impact of beach-seine activity on the resources by targeting the juvenile part of the population remains. Any management measures therefore need to be seen in this context and consistent monitoring and control needs to be provided throughout sectors.

The value added from this sector still remains low and export earnings are still linked mainly to catches from other subsectors. Ghana steps towards local management arrangements, and the involvement of fisherfolk in management decisions in the fisheries relevant to them has not led to an improved state of the resources they depend on or increased income or value.

9.2. Enforcement and compliance issues

The monitoring of catch and effort data from artisanal fisheries requires substantial inputs in terms of human and also in terms of financial resources. This information also needs to be processed and analysed in a timely manner in order to ensure proper monitoring of the resources and fisheries. From a biological perspective this information also needs to be analysed together with information from the other fisheries targeting the same resource: at present there is a lag in the system of data processing and thus “at time” date follow up on catch and effort monitoring is not carried out (data entry efforts sometimes have a lag of 1 year). Clear scientific monitoring plans also have to be developed. A system for routine data collection, monitoring and analysis system for biological data (e.g. size composition, maturity etc) is also not in place.

Currently, there are general attempts by the government to regulate the operation of fishing vessels in Ghanaian waters, and onboard VMS systems have been established. However control of activities and enforcement of regulations is weak, both due to a lack of appropriate equipment for surveillance and lack of political will to ensure appropriate resources for a regular inspection and control regime. Illegal fishing activities is widespread throughout West Africa and activities potentially compromise the implementation of management strategies and can in extreme cases, undermine the rational exploitation of the resource.

10. Other comments relevant to current management of the fishery and the way forward for the introduction of EAF

Migration is an integral aspect of the artisanal fishing industry. The artisanal fishermen are highly mobile and many have migrated within and beyond Ghana to fish. The possible impact of this on the management system needs to be considered.

Also the fish being exploited in this fishery migrate, especially the small pelagic species such as sardinella and anchovy perform migrations along the coast and their distribution expands the area of Ghana, and hence these resources are shared with the neighbouring states.

Marine fishing is generally seasonal, following closely the major (June to August; bumper season) and minor (December to January; lean season) upwelling periods in the Gulf of Guinea. Fishing is also largely dependent on weather, past catch history and availability of fishing inputs such as fuel for outboard engines. Traditional customs and behaviour also affects fishing practice. For instance Tuesdays are observed as a traditional no fishing day in the Elmina and Apam communities and enforced by traditional authorities and community based fisheries management committees (CBFMC) at both fish landing sites.

The draft fishery policy for Ghana note the importance of regulating and controlling "*destructive fishing practices (e.g. beach seining, poli fishing, winch fishing in inland water bodies, fishing with bamboo, etc.) with the consideration of banning the practice*". This has been done in some other West African countries (Gabon and The Gambia). However given the importance and "*social function*" of beach seine in Ghana (as in neighbouring countries such as Togo and Benin), providing work, income and fish to many fishing communities where alternatives are often not available, an outright ban could be politically difficult to implement. The beach seine is in that sense a controversial technique. The draft policy also stresses the importance of "*regularly updating fisheries specific management plans and promote stakeholder awareness of their content*", and the potential contribution of EAF to shed a light on all possible issues in this fishery is evident.

11. Conclusion

The beach seine fishery is socio-economically and nutritionally very important to the nation. Contributing about 12 percent to marine fish production and supporting many livelihoods along the coast. Beach seining is normally practiced close to estuaries and within the nearshore marine areas, which are notable breeding and spawning areas for a large number of species. The catch from the fishery include both pelagic and demersal species, most of which are juveniles. There is in place a legal framework and institutional arrangement to ensure its' management but enforcement of regulations are presently weak. Discussions on a total ban of the fishery continue at many fora over the past two to three decades but its implementation is hindered by considerations of socio-economic implications on livelihoods of fishers and their dependants. The EAF approach to fisheries management could therefore contribute in helping to sustainably manage this fishery.

References

Amador, K.; Bannerman, P.; Quartey, R. & Ashong, R. 2006. Ghana canoe frame survey, 2004. Inform. Report Number 34 (2006). 43 pp.

CECAF. 1989. Report of the technical consultation on small pelagic species of the statistical division western Gulf of Guinea. CECAF/ECAF SERIES 89/47.

FAO. 1990. Definition and classification of fishing gear categories. FAO Fisheries Technical Paper, No. 222, Rev.1. Rome, FAO. 92 pp.

FAO. 1995. Code of Conduct for Responsible Fisheries. Rome, FAO. 41 pp.

FAO. 2004. Fishery country profile: the Republic of Ghana. FID/CP/GHA March 2004. Available at: http://www.fao.org/fi/oldsite/FCP/en/gha/profile.htm.

FAO. 2006. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Banjul, Gambia, 2–11 May 2006. Rapport du Groupe de travail de la FAO sur l'évaluation des petits pélagiques au large de l'Afrique nord-occidentale. Banjul, Gambie, 2-11 mai 2006. FAO Fisheries Report/*FAO Rapport sur les pêches*. No. 811. Rome, FAO. 192 pp.

FAO/CECAF. 2010a. Report of the second meeting of the FAO/CECAF Working Group on the Assessment of Small Pelagic Fish – SubGroup South, Accra, Ghana, 19 -28 October 2009, CECAF/ECAF Report Series, 2010 (in press).

FAO/CECAF. 2010b. Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – Subgroup South, Freetown, Sierra Leone, 9–18 October 2008, CECAF/ECAF Report Series, 2010 (in press).

Ferrais, J.; Koranteng, K. & Samba, A. 1997. Comparative study of the dynamics of small-scale marine fisheries in Senegal and Ghana. Paper presented at the First International CEOS Symposium, 6−8 Sept 1994, Monterey Colloques et Séminaires. Paris: ORSTOM.

Heinbuch, U. 1994. Animal protein sources for rural and urban populations in Ghana. FAO, IDAF Technical Report 58.

Kraan, M. 2009. Creating space for fishermen's livelihoods. Anlo-Ewe beach seine fishermen's negotiations for livelihood space within multiple governance structures in Ghana. *African Studies* Collection (19). African Studies Centre.

Mehl, S.; Olsen, M & Bannermann, P. 2006. Surveys of the fish resources of the Western Gulf of Guinea (Benin, Togo, Ghana & Côte d'Ivoire). Survey of the pelagic and demersal resources 19 May−7 June 2006. FAO/NORAD-EAF-NANSEN Project//GCLME. Cruise reports *Dr Fridtjof Nansen*. IMR

Mensah, M.; Koranteng, K.; Bortey, A. & Yeboah, D. 2006. The State of world fisheries from a fishworker perspective: the Ghanaian situation. ICSF: Samudra Monograph.

Marine Fisheries Research Division. 2004. Information on Fisheries in Ghana. Accra, Marine Fisheries Research Division.

Nunoo, F.K. & Ameka, G.K. 2005. Occurrence of macro-algae in the bycatch of beach seine fisheries at Sakumono, Ghana. West African Journal of Applied Ecology 8: 79−87.

Nunoo, F.K.; Eggleston, E.D. & Vanderpuye, C. 2006. Abundance, biomass and species composition of nearshore fish assemblages in Ghana, West Africa. African Journal of Marine Science 28(3−4): 689–696.

Nunoo, F.K. 2007. Management of fish biodiversity in Ghana – threat posed by beach seine fisheries. Journal of Afrotropical Zoology. Special Issue: 157−164.

Nunoo, F.K.; Asem-Hiablie, S. & Patu, D.O. 2007. Trends in fish species diversity found in nearshore marine waters along the coast of Ghana, West Africa. Journal of the Ghana Science Association 9: 10-19.

Nunoo, F.K.; Boateng, J.O.; Ahulu, A.M.; Agyekum, K.A. & Sumaila, U.R. 2009. When trash fish is treasure: the case of Ghana in West Africa. Fisheries Research 96:167-172.DOI:10.1016/j. fishres.2008.10.010.

Republic of Ghana, Ministry of Fisheries. 2008. National fisheries and aquaculture policy. Final draft.

Quaatey, S. 1997. Synthesis of recent evaluations undertaken on the major fish stocks in Ghanaian waters: a working document for the eleventh session of the CECAF Working Party on Resource Evaluation, Accra, Ghana. 35 pp.

Sarpong, D.B.; Quaatey, N.K. & Harvey, S.K. 2005. The economic and social contribution of fisheries to gross domestic product and rural development in Ghana. FAO Sustainable Fisheries Livelihoods Programme (SFLP) GCP/INT/735/UK. p.53.

Worldfish Center. 2005. Fish and food security in Africa. Penang, Malaysia: WorldFish Center.

AN EAF BASELINE REPORT FOR THE SMALL AND MEDIUM PELAGIC FISHERIES OF KENYA

George Waweru Maina, Kennedy Osuka

1. Introduction

Kenya has a coastline of about 640 km stretching from 1° 30'S at the Somali border to 5° 25'S at the Tanzanian border (Figure 1). The continental shelf is narrow with fringing coral reefs that extend between 0.5 and 2 km offshore. Coastal waters off Kenya are warm tropical and are influenced by the monsoon seasons – warmer during the NE monsoon and cooler during the SE monsoon. The ocean current regime along the Kenyan coast is influenced by the East Africa Coastal Current and the seasonally reversing Somali Current. Most of marine fishing in Kenya is small-scale artisanal that operate in the coastal near-shores (McClanahan and Mangi, 2004; Samoilys *et al*., 2011a).

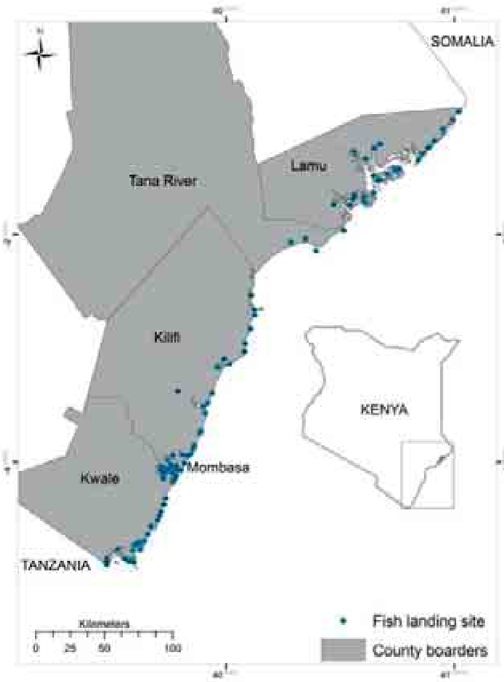


Figure 1. A map showing the coastal counties and the spatial distribution of fish landing sites.

Some of the rich inshore grounds include areas around the Lamu Archipelago, Ungwana Bay, the North Kenya Bank and the Malindi Bank. Gill nets, longlines, beach and reef seines are the main gears used in the exploitation of small and medium pelagic. Large-mesh sized gill nets capture large pelagic. The artisanal fishery is confined to a small strip of 2.5 to 3.0 nautical miles within the reef. The annual production for Kenya's marine fisheries has remained between 4 336 tonnes to 8 736 tonnes over the last two decades from 1990. Marine fisheries production recorded declines from 1991 to 1995 and from 1997 to 2000. The current production is low considering that Kenya has a 640 km coastline, a 200 nautical miles of EEZ (230 000 km^2) and is said to be located within the richest tuna belt in the Indian Ocean. Information concerning the status of the Kenyan EEZ is limited in spite of an increase in offshore fisheries in the region from 1990s. The marine capture fisheries potential is largely unknown with only a few estimates. The inshore waters are reported to have a potential to yield ~20 000 tonnes per year (Odero, 1984). FAO (1990) reported that annual marine catch from reef areas might be closer to 12 000 tonnes. The pelagic fishery over the 20 year period accounted for 27 percent of the landings, with catches oscillating between 977 to 2 096 tonnes. Wakwabi *et al*. (2003) estimated the pelagic fishery accounts for 18 percent of the marine fishery landings, with 80 percent of the total marine products coming from shallow coastal waters and reefs, and about 20 percent coming from off-shore fishing.

Kenya is in the process of introducing an Ecosystem Approach to Fisheries (EAF) for the management of the artisanal fisheries under the umbrella of the EAF Nansen Project "Strengthening the Knowledge Base for and implementing an Ecosystem Approach to Marine Fisheries in Developing Countries". This document gives the baseline information pertaining to the Kenyan marine small and medium pelagic fisheries that will contribute towards the development of the plan for the management of artisanal fisheries in accordance with the principles of Ecological Approach to Fisheries.

Methods

This study focused on collating fisheries information small and medium pelagic fisheries of the Kenya's coast through literature review and analysing available fisheries catch data, mainly from Ministry of fisheries development. Information on mesh sizes for gillnets was collected by visiting or interviewing fisheries officers at key fish landing sites that target small and medium pelagic fisheries. The national data gap-analyses report on pelagic fishes of the nine countries of the Western Indian Ocean (WIO) was used to guide the categorisation of different pelagic fisheries groups (Lucas *et al*., 2009; Table 1).

Table 1. Prioritized pelagic species by functional group and family according to the South Western Indian Ocean Fisheries Project (SWIOFP; Lucas *et al*., 2009).

Categories	Functional group	Family
Large pelagics	Pelagic sharks (coastal and oceanic)	Carcharinidae (8 spp), Lamnidae (2) Sphyrnidae (1)
	Billfishes	Istiophoridae (4), Xiphiidae (1)
	Tunas	Scombridae (7)
Medium pelagics	Large & medium Carangids (trevally, threadfin, amberjack, rainbow runner)	Carangidae (16)
	Small tunas & bonitos	Scombridae (3)
	Spanish mackerels (seerfishes)	Scombridae (3)
	Gempylids and other discard, bycatch spp.	Bramidae (1), Gempylidae (2), Alepisauridae (1)
	Other medium pelagic (dolphin fish, barracuda, cobia, shad)	Coryphaenidae (1), Sphyraenidae (2), Pomatomidae (1), Rachycentridae (1)
Small pelagics	Small mackerels	Scombridae (2)
	Scads	Carangidae (5)
	Sardines and round herrings	Clupeidae (13)
	Other small pelagics (needlefish, halfbeaks, anchovy, flying fish)	Belonidae (2), Hemiramphidae (2), Engraulidae (1), Exocoetidae (1)

2. Overview of the fishery and resources exploited

2.1. Fishing gear used and areas fished

Most of marine fishing in Kenya is small-scale artisanal that operate in the coastal near-shores (McClanahan and Mangi, 2004; Okemwa *et al*., 2009a,b; Samoilys *et al*., 2011a). The major fishing areas reported along the Kenyan coast are the Kiunga coastline and Lamu islands in the North, Tana River mouth, Ungwana Bay and Malindi area including the offshore North Kenya Bank and Shimoni, Vanga, Funzi Island and coral reef areas on the Southern border (Oduor, 1984; Fondo, 2004). Some of the rich inshore grounds include areas around the Lamu Archipelago, Ungwana Bay, the North Kenya Bank and the Malindi Bank (Odero, 1984; KMFRI, 2002; Fondo, 2004, Munga *et al*., 2012). As a multispecies fishery, several gears are used to capture pelagic including nets (castnets, gillnets, beach and reef seines, purse seine/ ring nets) and hook and line (vertical line, longline and trolling line) (Tables 2 and 3). Gill nets, longlines, beach and reef seines are the main gears used in the exploitation of small and medium pelagic whereas large pelagic are captured by large-mesh sized gill nets. Ring nets and set nets are intended for use outside the reef, so their use is restricted to the calm north east monsoon (NEM). However some ringnets have been modified to suit use within shallow waters hence used during southeast monsoon. Use of beach seines, is predominant in the southeast monsoon (SEM) (Tuda *et al*., 2008) due to turbulent waters in the open sea. Accordingly higher catches are recorded during the NEM compared to the SEM season (McClanahan, 1988, Okwemwa *et al*., 2009a,b, Fulanda *et al*., 2011). Factors affecting observed seasonality include: reduced effort by fishermen during the SEM due to rough sea conditions, fish migrations and decreased density and activity due to a deeper thermocline and cooler waters in the SEM (McClanahan, 1988).

The artisanal fishery is confined to a small strip of 2.5 to 3.0 nautical miles within the reef. The small and medium pelagic fishery mainly consists of sardines (Clupeidae), anchovies (Engraulidae), and scads (Carangidae). The medium sized pelagic are mainly captured outside the immediate inshore areas. Industrial fishing is limited operating within the EEZ. This offshore fisheries zone is mostly exploited by vessels from Distant Water Fishing Nations (DWFNs). Information concerning the status of the Kenyan EEZ is limited in spite of an increase in offshore fisheries in the region from 1990s (Kamau *et al*., 2009). The sports fishing operate from the outer reef out to about 15 nautical miles from the shore along the entire coast. As a recreational activity, it has been taking place all along the Kenyan coast within the confines of various registered tourist clubs and at times on an individual basis. The fishing season normally lasts eight or nine months operating from the outer reef out to about 20 km from the shore targeting tunas and other big game fishes. The main sport fishing areas are Shimoni, Diani, Mombasa, Mtwapa, Kilifi, Watamu, Malindi and Lamu (Ndegwa, 2011).

Table 2. Main fishing gears targeting the small and medium pelagic fishery
Source: Samoilys *et al*., 2011a.

Fishing gear type	Description	Main pelagic target families/ species
Hand line (Mshipi)	A single monofilament nylon line attached to one or more steel hooks onto which baits are fixed.	Jack/trevally *(Carangidae),* tuna/ mackerels *(Scombridae)*
Longline -dropling and drift longlines. (*zulumati*)	Single main line of nylon anchored and buoyed in a horizontal position on or near the bottom (set longlines), near the surface or at a certain depth (drift longlines) at times deployed vertically (droplining).	Tuna/mackerels (*Scombridae, Scomberomorus commerson)*, Sharks *(Carcharhinidae)*, swordfish *(Xiphiidae)*, billfish *(Istiophoridae).*

Fishing gear type	Description	Main pelagic target families/ species
Trolling (***mshipi wa kurambaza***)	Nylon monofilament main line(s) used within the pelagic offshore waters beyond the fringing reef. The line is attached to either an artificial lure (rapala) or a baited hook and towed through surface waters.	*Scombridae; Scomberomorus commerson; Scomberoides* spp.; barracuda *(Sphyraenidae);* Dolphinfish *(Coryphaenidae);* billfish *(Istiophoridae).*
Set gillnets (***Jarife, nyavu ya kutega***)	Gill nets made of multi-filament nylon, suspended with floats and held vertically with sinkers. Set on or near the bottom but often catch pelagic. Lest	Sharks, rays, herring, sardines, and also larger pelagics such as tuna, and squid. Tuna/mackerels *(Scombridae, Scomberomorus commerson),* Sharks *(Carcharhinidae),* swordfish *(Xiphiidae),* billfish *(Istiophoridae*
Drift gillnets (***Jarife, nyavu ya kuogelesha***)	Gill nets made of multi-filament nylon with large mesh size set suspended mid water but drifting and/ or connected to the operating vessel.	Sharks, rays, tuna
Ringnets (***nyavu ya kufunga***)	A multifilament nylon mesh netting similar to a purse seine suspended from floats and weighted at the bottom to hold the net vertically in the water. A foot-rope threaded through metal rings at the bottom of the net is used to close the net (hence the name “purse”) to enclose a school of fish.	Intended for pelagics; *Carangidae, Scombridae; Clupeidae, Engraulidae*
Cast nets (***kimia***)	Circular nets often made with monofilament nylon line, with weights attached around the edge. They usually comprise three parts: the upper section, the middle section and the weighted lower section. A foot-rope is used to close the net during retrieval.	Sardines *(Sardinela)*
Beach and reef seine (***juya, buruta, nyavu ya kukokota***)	Small variable mesh sized nets made of multifilament nylon with a floatline and a weighted footrope. A section of larger-mesh netting on each wing of the net corals fish towards the smaller-mesh centre (codend) of the net.	Sardines, half beaks. *Hemiramphidae*
Fence traps (*uzio, rasaka, wando*)	Stationary semi-permanent traps and fences set in the intertidal zone. Usually made of mangrove stakes, plaited mats, or palm frond with midribs tied tightly together.	Sardines *(Sardinela)*

Table 3. Synopsis of the fishing gears by sector and extent of fishing.

Method	Sector	Fishery	Pelagic groups targeted	Fishing areas
Cast nets	Artisanal	Artisanal	Small pelagics	Coral reef platforms, mangrove creeks
Gillnets	Artisanal	Artisanal	Small, medium pelagics	Tidal, subtidal and reef areas
Purse seine nets	Artisanal	Artisanal ringnet fisheries	Small, medium pelagics	Coastal
Beach seines	Artisanal		Small pelagics	Shallow coastal bays and seagrass
Vertical line without FADS	Artisanal	Commercial line fishery	Medium large pelagics	Coastal, coral reef platforms
Vertical line without FADS	Recreational	Recreational boat-based line fishery	Medium large pelagic	
Longline	Industrial	Commercial longline fishery	Tuna, swordfish	General offshore area (EEZ)
Longline	Industrial	Commercial longline fishery	Pelagic sharks	

Fishing effort along the Kenyan coast varies by geographical area and across the gear types (Figures 2 and 3). Gillnets and hook and line gears are the most dominant in the entire coast. The most common mesh size for gillnets was 6 inches with over 1 200 nets recorded by FiD (2008). According to Okemwa *et al*. (2009a;b), the use of gillnets was highest in Lamu (Kiunga, Kizingitinini and Amu). Pelagic fish such as tuna are fished by artisanal fishers using gillnets, troll lines, longlines and handlines. A synopsis of the fishing gears by sector and extent of fishing is presented in Table 4 while the spatial distribution of artisanal fishing gears and crafts used along the Kenya's coast is presented in Figure 4.

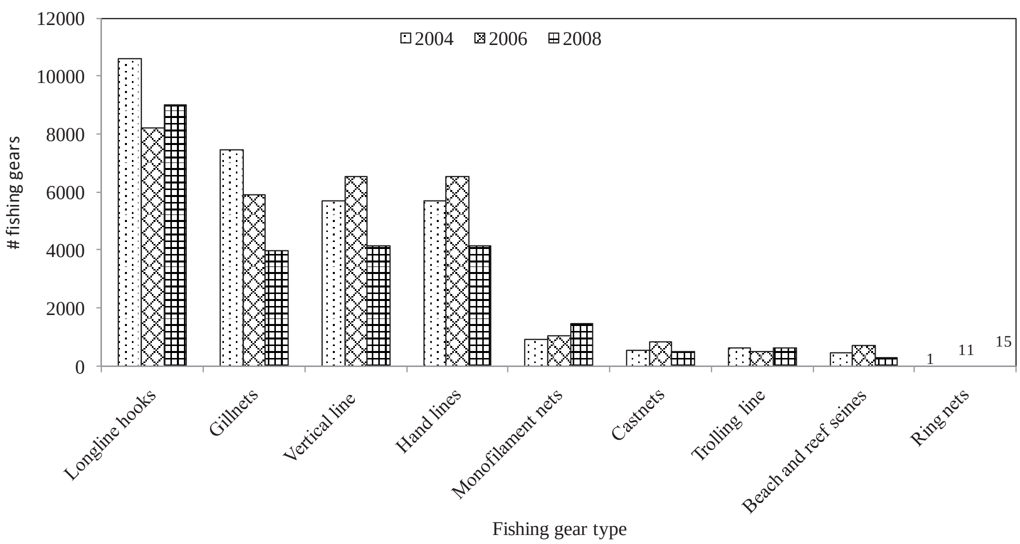


Figure 2. Number of fishing gears targeting small and medium pelagic in year 2004, 2006 and 2008, (FiD, 2008).

Longline fishing effort indicates hooks smaller than size 10 are the most common with over 4 000 hooks of size class <4, size 4-7 and size 8-10 being recorded in 2004, 2006 and 2008. The majority of longline lines use hooks smaller than size 4 (Figure 3). Longline fishery is artisanal, recreational or industrial/ commercial (Table 4) operating from coastal, reef platforms, bays, and offshore areas. The longlines catch a wide range of species including the tunas yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), and albacore (*Thunnus alalunga*), the billfishes striped marlin (*Tetrapturus audax*), black marlin (*Makaira indica*), blue marlin (*Makaira nigricans*), shortbill spearfish (*Tetrapturus angustirostris*), sailfish (*Istiophorus gladius*), and swordfish (*Xiphias gladius*), the sharks including thresher shark (*Alopias vulpinus*), black shark (*Carcharhinus melanopterus*), hammerhead shark (*Sphyrna zygaena),* tiger shark (*Galeocerdo cuvier*), and mako shark (*Isurus glaucus*), dolphin fish (*Coryphaena hippurus*), barracuda (*Sphyraena* spp.), rainbow runner (*Elagatis bipinnulatus*), moonfish (*Lampris regius*), and wahoo (*Acanthocybium solandri*).

A wide range of net mesh sizes is used along the Kenyan coast (Samoilys *et al*., 2011a; This Study). Offshore stationary gillnets are usually 2–5 inches; inshore nets 1–4 inches; drifting 4–18 inches; monofilament ~2–2.6 inches; ringnets ~0.5–3 inches; Prawn seine ~2 inches; Cast net: <0.3–1.2 inches; beach seine ~1 inch. A rapid assessment of net mesh sizes used in 15 landing sites (Appendix 1) established that set nets had the highest mesh size averaging 8.8±5.1 (SD) inches whereas cast nets and ringnets had the least mesh sizes at 0.9±0.8 (SD) and 0.6±0.3 (SD) inches respectively. Only two gears were found to have a mesh size of above 3 inches; drift and set nets.

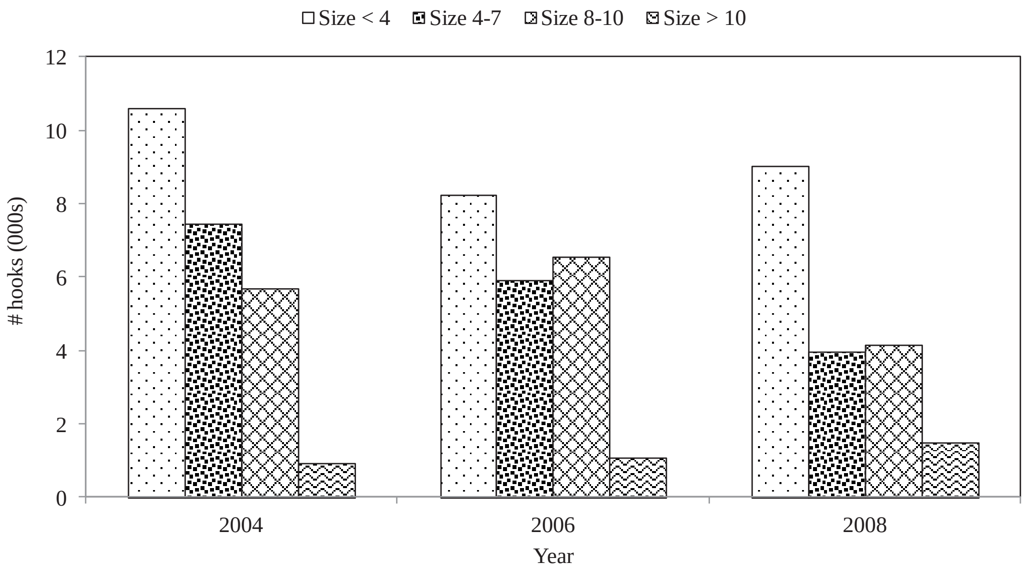
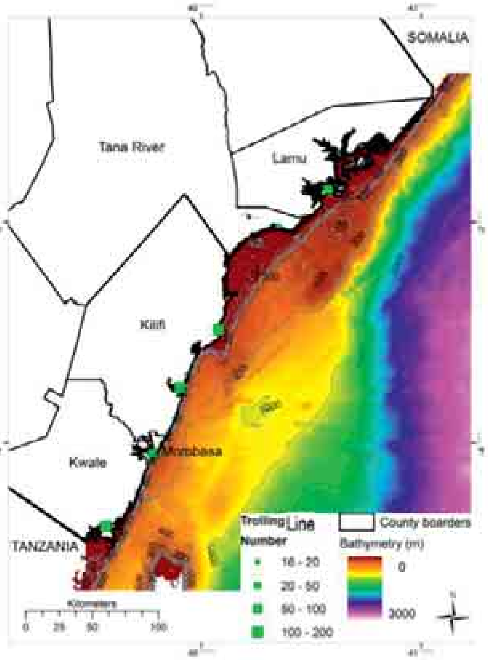
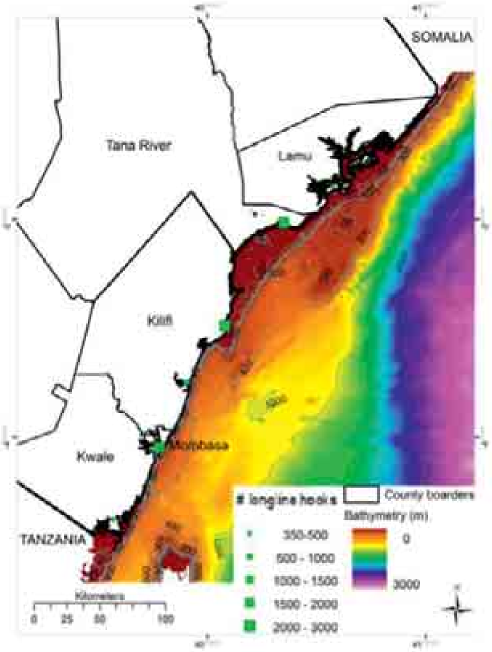


Figure 3. Number of hooks used in the longline artisanal fishery in year 2004, 2006 and 2008, (FiD, 2008).

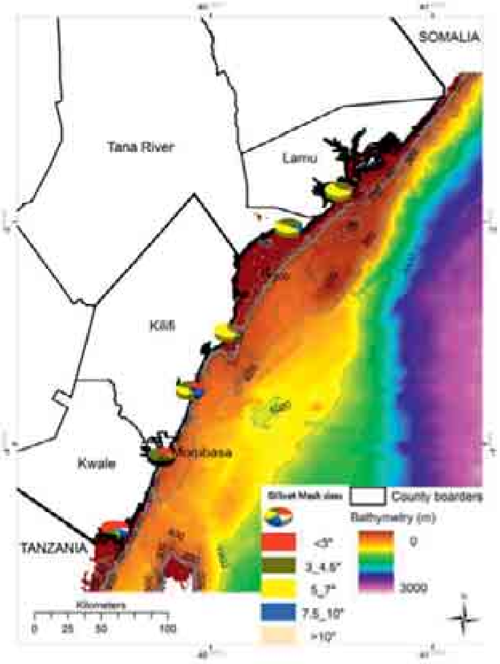
The Spatial distribution of fishing effort by gears and vessels in 2008 along the Kenya's coast is shown in Figure 4. Malindi, in Kilifi county, had the highest concentration of gillnets in 2008 (1599) followed by Msambweni (FiD, 2008).



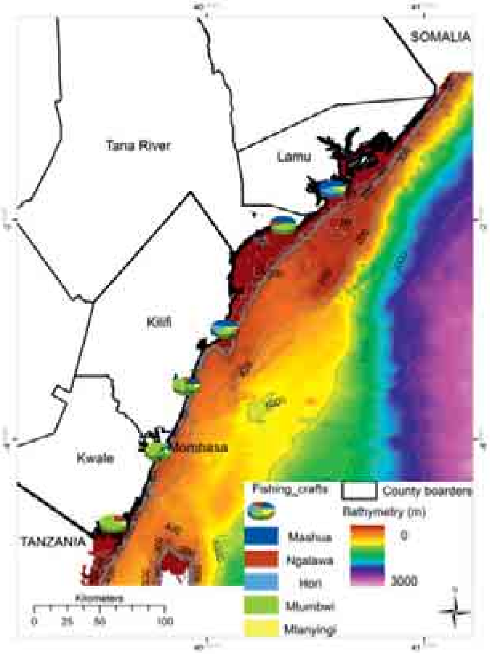
(a) # Trolling lines



(b) # longline hooks



(c) Gillnet Mesh sizes



(d) Fishing crafts

Figure 4. Spatial distribution of the number of fishing gears and crafts along the Kenyan coast commonly used in targeting pelagic fisheries: (*a*) trolling lines; (*b*) longline hooks; *(c) gillnet* mesh sizes; and *(e)* fishing crafts. Rectangle sizes are proportional to the number of hooks or lines

Data Source: FiD, 2008

The fishing crafts can be described as: dugout canoes (*mitumbwi*) curved out from a log of wood or tree trunk with no joints or planks boats; *ngalawa* pointed at both ends, with outriggers on both sides (*mirengo*) and propelled using sail; d*hows/mashua* pointed on one end with V-shaped bottom and sail propelled or engine; *Jahazi* a bigger *mashua*, >12 meters long; Dau (*mtanyingi*) are flat bottomed fishing craft with ribs at the bottom and pointed at one end; *hori*, flat bottomed fishing boat used mostly in the shallow waters and propelled by sail or paddles and strengthened by ribs (*mataruma*) on sides and the floor. Only about 10 percent of fishing craft are motorized (Okemwa *et al*., 2009a;b). Dugout canoes *Mtumbwi* and sailboats *mashua* are the most prominent fishing crafts in use along the Kenyan coast (Figure 5). In Shimoni for instance 85 percent of fishing vessels are dugout canoes (Okemwa *et al*., 2009a;b). Most of fishing crafts are small and hardly go beyond the reef during the Southeast Monsoon (May to August) due to the strong winds and rough seas. However sailboats (*mashua*) and outrigger canoes (*ngalawa*) are made to suit rough weather and open offshore pelagic fishing expeditions. They are mainly equipped with shark net, drift net, ringnet; other set gillnets and line gears (Fondo, 2004; Okemwa *et al*., 2009a;b).

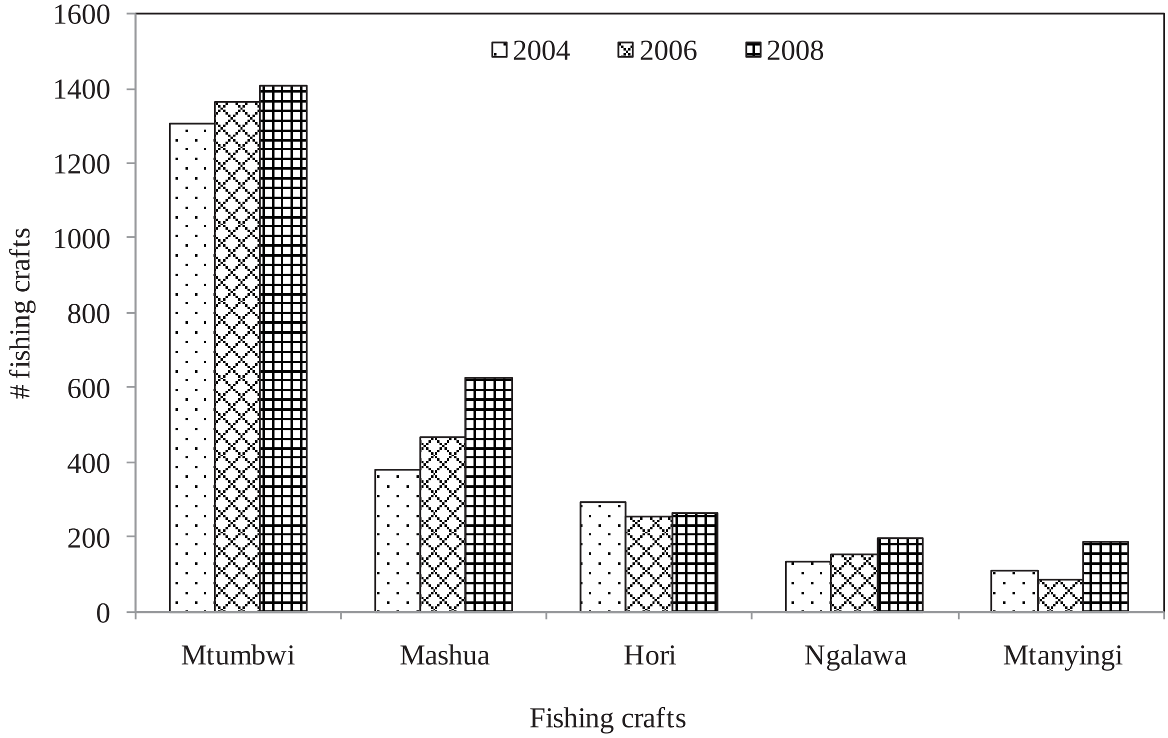


Figure 5. Trend and type of fishing crafts used in marine artisanal fisheries (FiD, 2008)

2.2. Resources exploited

The pelagic fishery is more effectively exploited by artisanal fishers during NEM when non-powered boats can venture into the open waters as opposed to SEM. It has been pointed out that large schools of migratory pelagic stocks abound in the offshore waters of Kenya during the SEM period. Such large shoals include tuna, skipjack, travelly, sardinella, mackerels, marlins, sailfish and swordfish (Mbuga, 1984).

The first pelagic fisheries resources survey was conducted by the East African Marine Research Organization in 1951. The survey established that considerable stocks of unexploited pelagic fish aggregate in large surface schools in coastal waters. Thus subsequent surveys conducted from 1951 to

1954 also focused on pelagic fish (Williams, 1956; 1958; 1962; 1964; 1965). Pelagic species encountered include *Scomberomorus commerson*, yellow fin tuna *Thunnus albacares*, *Thunnus alalunga*, frigate mackerel *Auxis thazard*, the dogtooth tuna *Gymnosarda unicolor*, small tuna *Euthynnus affinis* and skipjack *Katsuwonus pelamis*, striped marlin *Tetrapterus audax*, black marlin, *Makaira indica*, blue marlin *Makaira nigricans*, the round scad *Decapterus* spp. and horse mackerel *Trachurus* spp. The sardines and anchovies (mainly round herring *Etrumeus micropus*) were caught in substantial quantities of completely different species, suggesting that schools are discrete and locally distributed. In terms of depth, the larger pelagic fishes comprising the tuna and tuna-like species and the larger carangids were caught in large numbers between 15–200 meters depth mostly in June and July.

Based on surveys from *RV Dr Fridtjof Nansen* in 1980-1983 along the Kenyan coast, small-sized pelagic species were caught in waters shallower than 200 m particularly within 10–50 m depth. The main families caught were Clupeidae (mainly *Pellona ditchela, Sardinella gibbosa, Sardinella longiceps, Dussumieria acuta*), Carangidae (*Scomberoides commersonianus*, *Decapterus macrosoma*,), Scombridae and to some extent Sphyraenidae. Spanish mackerel *Scomberomorus commerson*, *S. plurilineatus* and Indian mackerel *Rastrelliger kanagurta* were reported to be caught accidentally in nets.

The contribution of pelagics families and species in landings is variable in terms of gear and location. In the biological and socio-economic assessment of ring net fishing in Kipini, the family Carangidae (*Carangoides ferdau, Gnathanodon speciosus*, *Carangoides bajad*, *Caranx ignobilis, Caranx sexfasciatus*, *Seriola lalandi* and *Elagatis bipinnulatus*) had the highest species composition of 33.3 percent, followed by Scombridae (*Euthynnus affinis, Rastrilleger kanagurta, Scomber japonicus* and *Scomberomorous commersoni*) with a composition of 19 percent and Sphyraenidae (*Sphyraena forsteri* and *S. jello*) with a composition of 9.5 percent (Munga *et al*., 2010 a;b). The Malindi fishing grounds are equally important and significantly contribute to the fisheries catch of mixed pelagic and Carangidae at 13.8 percent and 9.2 percent respectively (Munga *et al*., 2012). The shark net fishery operating in south coast (Msambweni - Vanga) was dominated by Scombridae accounting for 50 percent of the entire catch (Okemwa *et al*., 2009a). The Diani-Chale fishery had Scombridae, Sphyraenidae, Carangidae and Hemiramphidae accounting for 5.2, 4.5, 2.4 and 1.3 percent respectively (Maina *et al*., 2008). Individual pelagic species caught by the common gears operating between Marina and Chale landing sites accounted for less than 3 percent of the catch (McClanahan and Mangi, 2004). In a beach seine survey by Kimani *et al*. (1996) in Gazi area, small-sized pelagic fish species: *Herklotsichthys quadrimaculatus*, *Gerres oyena*, *Atherinomorus lacunosus*, were the most abundant species accounting for 77.3 percent. Clupeidae, principally *Herklotsichthys quadrimaculatus* dominated the population. Number of pelagic species by family ranged between 1-5, Clupeidae (3), Scombridae (1), Sphyraenidae (3), Hemiramphidae (3), Engraulidae (2) and Carangidae (5).

In general small pelagic commonly harvested in from inshore waters include sardines (Clupeidae), anchovies (Engraulidae), and Scads (Carangidae). The majority of other small and medium sized pelagic fish is found outside the immediate inshore areas. Other species such as Spanish mackerel (*Scomberomorus commerson*), frigate tuna (*Auxis thazard*), Eastern little tuna *Euthynnus affinis* and other large tunas, usually categorized as 'medium pelagics' are found far offshore. High priority medium-sized pelagic fishes include the larger carangids, smaller scombrids (i.e. small tunas and seerfishes), some gempylids, dolphinfish and cobia (Table 4, Lucas *et al*., 2009).

Table 4. Medium (MP) and small (SP) pelagic fishes exploited along the Kenyan Coast, the asterisk (*) indicates the SWIOFP prioritized species. These species are important to fisheries in various sectors (i.e. artisanal, sport, and industrial fisheries)

Species	Family	Common name	MP	SP
Euthynnus affinis*	Scombridae	Eastern little tuna	√	
Sarda orientalis*	Scombridae	Striped bonito	√	
Elagatus bipinnulata*	Carangidae	Rainbow runner	√	
Coryphaena hippurus*	Coryphaenidae	Dolphinfish Dorado	√	
Scomberomorus commerson*	Scombridae	King mackerel	√	
Scomberomorus plurilineatus	Scombridae	Queen mackerel	√	
Auxis thazard*	Scombridae	Frigate tuna	√	
Carangoides chrysophry*	Carangidae	Longnose trevally	√	
Carangoides gymnostethus*	Carangidae	Bludger	√	
Carangoides malabaricus*	Carangidae	Malabar trevally	√	
Carangoides bajad	Carangidae	Orange spotted trevally	√	
Caranx heberi	Carangidae	Blacktip trevally	√	
Caranx ignobilis*	Carangidae	Giant trevally	√	
Caranx melampygus*	Carangidae	Bluefin trevally	√	
Caranx sexfasciatus*	Carangidae	Bigeye trevally	√	
Alectic indicus*	Carangidae	Indian threadfish	√	
Gnathodon specious	Carangidae	Golden trevally	√	
Sphyraena barracuda	Sphyraenidae	Great barracuda	√	
Decapterus macrosoma*	Carangidae	Slender scad		√
Decapterus macarellus*	Carangidae	Mackerel scad		√
Decapterus russelli*	Carangidae	Indian scad		√
Selar crumenopthalmus*	Carangidae	Bigeye scad		√
Scomber japonicas*	Carangidae	Chub mackerel		√
Trachurus delagoa*	Carangidae	African scad		√

Species	Family	Common name	MP	SP
Rastreliger kanagurta*	Scombridae	Indian mackerel		√
Megalaspis cordyla*	Carangidae	Torpedo scad		√
Ablennes hians*	Belonidae	Barred needlefish		√
Sardinops sagax*	Clupeidae	Pilchard		√
Amblygaster sirm*	Clupeidae	Rainbow sardine		√
Dussumieria acuata*	Clupeidae	Spotted herring		√
Herklotsichthys puntatus*	Clupeidae	Blue strip herring		√
Sardinella abella*	Clupeidae	White sardinella		√
Seriola lalandi	Carangidae	Yellowtail amberjack		√
Sardinella gibbosa	Clupeidae	Goldstripe sardinella		√
Sardinella longiceps	Clupeidae	Sardinella		√
Pellona ditchela	Clupeidae	Indian pellona		√
Etrumeus teres	Clupeidae	Red-eye round herring		√
Etrumeus micropes	Clupeidae	Round herring		√
Sardinella sirm,	Clupeidae	White sardinella		√
Herklotsichthys quadrimaculatus	Clupeidae	Blue stripe herring		√

2.3. Number of fishers and land-based workers by sector

There were about 15 000 fishermen on the coast in early 1990s operating some 4 800 boats with over 80 percent being un-motorized. The number of fishermen reduced to about 7 700 in late 1990s and the number of boats to 2 400, reducing the fishing effort by half. The total number of artisanal fishermen increased from 9 017 in 2004 to 10 254 in 2006 and 12 077 in 2008 increasing at the rate of 12 and 15 percent respectively over a four year period (Figure 6). With a dependency ratio of 1:7 reported in south coast of Kenya (Maina *et al*., in prep), there were about 84 539 people directly dependent on the artisanal fishers along the coast in 2008. A number of facilities have been established the government and other stakeholders to enable proper fisheries management and minimize post harvest losses (Appendix 2).

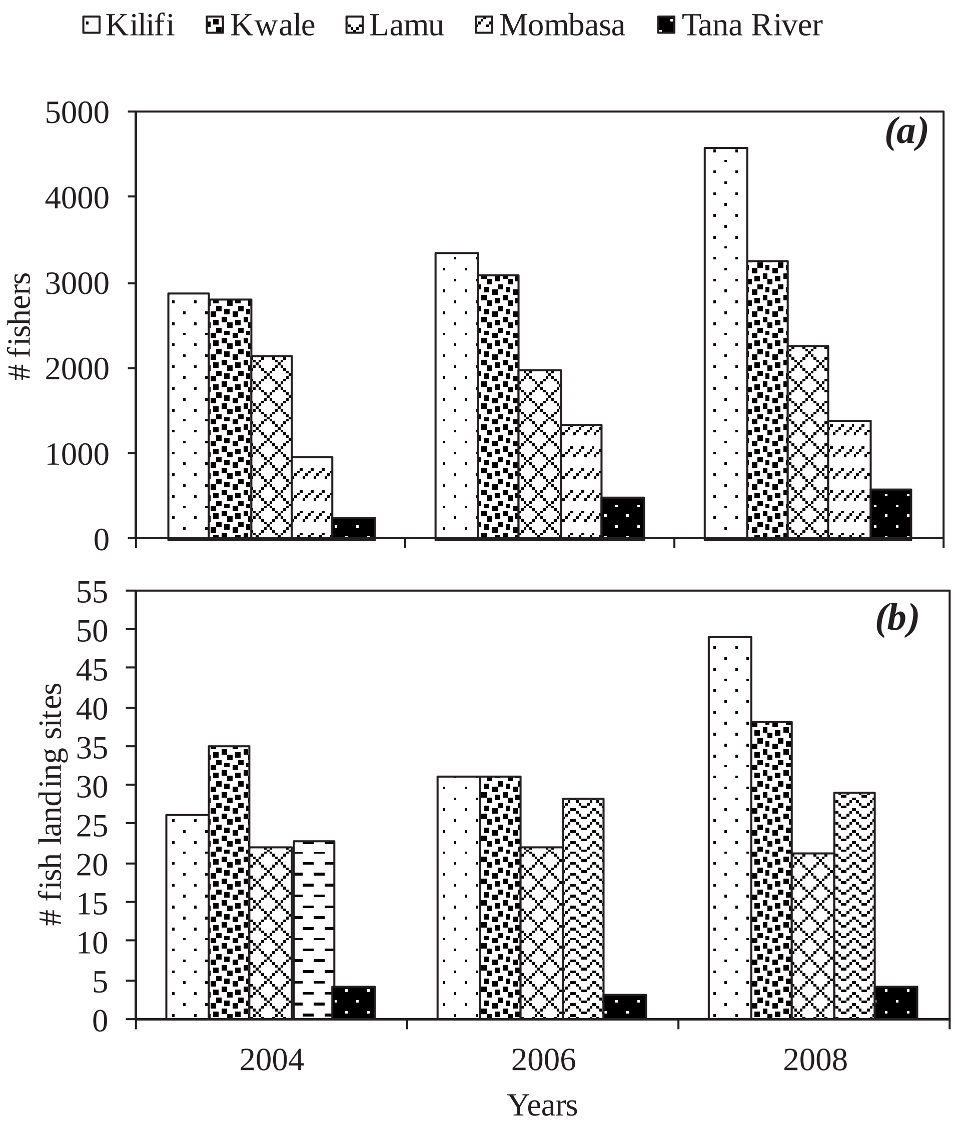


Figure 6. Artisanal fishermen ***(a)*** and fish landing sites ***(b)*** distribution by County along the Kenyan coast (Data source: FiD Marine fisheries frame surveys, 2004; 2006; 2008).

2.4. Interactions with other fisheries

Interaction of pelagic fishery with other fisheries is mainly seen through capture of bycatch and demersal reef species by various fishing gears (see Tables 3 and 5). Apart from targeting small pelagic, beach and reef seines also target demersal reef fish species such as rabbitfish (Siganidae), snapper (Lutjanidae), emperor (Lethrinidae), goatfish (Mullidae), sweetlips (Haemulidae) and parrotfish (Scaridae) (Mclanahan and Mangi, 2004; Church and Obura, 2004). Important demersal families caught by ringnet include Lutjanidae (*Lutjanus gibbus*, *Lutjanus rivulatus and Aprion virescens*) with a composition of 14.3 percent (Munga *et al*., 2010a). Table 6 and Appendix 3 annotates the interaction in capturing pelagic and demersal fishes including the likely general status of the pelagic fishery. There is also competition on the use of coastal areas between various resource users, which has increased the intensity of conflict among various stakeholders (McClanahan *et al*., 2005; Munga *et al*., 2010b; Ndegwa, 2011). Conflicts between fishers using beach seine and ringnet versus other gear have been registered in South coast, Watamu and Kipini in the north. Incidences of resource use conflicts between the artisanal and commercial fishers are reported to be on the rise (Fulanda *et al*., 2011). Declining fishery production, huge amount of discard/by catch mainly juveniles loss of valuable diversity including pelagics, degrading aquatic and terrestrial ecosystems has led to loss of sustainable livelihood of the local communities.

Table 5. Interactions of small and medium pelagic fishery with other fisheries and competition on the same target species, bycatch fishery affecting other fisheries

Fishing gear type	Habitat	Interactions with ecosystem (threats)	Bycatch
Hand line	Inshore area and reef slopes, platforms and bommies	May get entangled in corals so fishers will cut the line abandoning it on the reef. Small hooks are responsible for high capture of juveniles	
Longline (droplining and drift longlines)	Offshore pelagic waters	Targets vulnerable and endangered large predators such as sharks	Seabirds, whales, sharks and turtles
Trolling	Offshore pelagic waters		Sharks, turtles, sea birds and other marine mammals
Set gillnets	Inshore area	Snagging of corals	Turtles, sharks, marine mammals (dugongs) and sea birds.
Drift gillnets	Inshore area	Snagging of corals	Marine mammals, seabirds, turtles, dolphins and whales
Ringnets	Reef slopes	Damages sea grass and corals when deployed close to the beach or on the reef. Sand used as sinkers cause increased sedimentation	Dolphins, turtles and lobster, reef fish
Cast nets	Sheltered areas - creeks, sea grass and coral reef habitats	Abrade polyps and the upper layers of corals.	
Beach and reef seine	Seagrass beds, shallow coastal bays, intertidal zone and inshore areas	Destruction of seagrass beds	*Trichiurus lepturus, Hemiramphus far, Odonus niger*
Fence traps	Intertidal zone	Capture of juvenile	
Trawling	Shallow areas 12–18 m deep and bays	Capture of juveniles and excessive discarding of low value bycatch at sea	*Otolithes ruber*, *Johnius sp.* (Sciaenidae) and *Pomadysis sp*. (Haemulidae),

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

The main catch for the pelagic families comprise of families Carcharidae, Rhinobatidae, Clupeidae, Sphyrainidae and Scombridae (see section 4). The small pelagic fishery comprised mainly of sardines, herrings, anchovies and mackerel. Specific studies and data by species and categories are limited to those noted during the SWIOFP national gap analysis workshop (Lucas *et al.*, 2009). Small epipelagic tuna / tuna-like species such as *Euthynnus affinis, Sarda orientalis, Scomberomorus commerson* were identified as a priority group that is not adequately covered by the IOTC for the SWIOFP region. The biology and distribution of some of the species commonly found in the Kenyan waters and catches (see section 4) is highlighted below.

Rainbow sardine, Amblygaster sirm

Amblygaster sirm is a fast-growing schooling fish that occurs in coastal waters and lagoons. The species feeds mainly on copepods, nauplii and zoea larvae, larval bivalves and gastropods, as well as *Peridinium* and *Ceratium*. This sardine is medium sized fish having a maximum length of 27 cm (Randal, 2005) with a short lifespan (Conand, 1991). Reproduction takes place from October to December. First maturity is attained when fish reach one year of age and at this time their size is about 16-17 cm (Conand, 1991). Mortality is high and most fish die before the age of two years. The species has been recorded in temperatures of 28.5-29.8°C and salinities of 31.6-32.3 ppt (Burhanuddin *et al*.,1974). Used as bait in the tuna fishery.

Dolphinfish Dorado, Coryphaena hippurus

The species forms schools in open waters but also near the coast (Collette, 1995). Their foods comprise all forms of fish and zooplankton; crustaceans and squid. A study by Collette (1995) determined *C. hippurus* become sexually mature after 4-5 months and spawns in the open sea when water temperature rises. Eggs and larvae are pelagic. Marketed frozen and fresh and is of high value.

Mackerel scad, Decapterus macarellus

A fast moving schooling pelagic fish that prefers clear oceanic waters, frequently around islands and sometimes near the surface, but generally caught between 40 and 200 m depth (FishBase, Froese and Pauly, 2011). Found along the reef edges near deep water feeding mainly on zooplankton. Eggs are pelagic and the fish products are marketed fresh and salted or dried.

Slender scad, Decapterus macrosoma

As a pelagic schooling species, *Decapterus macrosoma* is occasionally seen in small groups along reef slopes adjacent to deep water in pursuit of zooplankton. Feeds mainly on small invertebrates and is marketed fresh and salted or dried.

Rainbow runner, Elagatis bipinnulata

Form large schools, occurring in oceanic and coastal waters, generally near the surface over reefs or sometimes offshore. Feed on invertebrates (larger crustaceans of the zooplankton) and small fishes. Eggs are pelagic (Smith-Vaniz, 1986). Good food fish and a valued game fish; marketed fresh and salted or dried; also frozen and used for sashimi.

Eastern little tuna - Kawakawa, Euthynnus affinis

Euthynnus affinis occurs in open waters but always remains close to the shoreline and are suspected to spawn near the coast. The young may enter bays and harbors and attains maturity at about 38 cm. Forms multi-species schools by size with other scombrid species comprising from 100 to over 5 000 individuals. A highly opportunistic predator feeding indiscriminately on small fishes, especially on clupeoids and atherinids; also on squids, crustaceans and zooplankton (Collette, 2001).

Striped bonito, Sarda orientalis

A coastal species (Collette, 1995) found schooling with small tunas and known to occur at depths from 1 to 167 metres. Also found around some islands (Collette, 2001). The fish feeds on clupeoids, other fishes, squids and decapod crustaceans. Spawning varies with the monsoon season (Collette, 2001).

Chub mackerel, Scomber japonicus

A coastal pelagic species, to a lesser extent epipelagic to mesopelagic over the continental slope (Collette and Nauen, 1983). Schooling by size is well developed and initiates at approximately 3 cm (Collette and Nauen 1983); may also form schools with *Sarda chiliensis*, *Trachurus symmetricus* and *Sardinops sagax* (Collette, 1995). Adults stay near the bottom during the day; go up to the open water at night (Maigret and Ly, 1986) where they feed on copepods and other crustaceans, fishes and squids (Collette and Nauen, 1983). They spawn in batches (Murua and Saborido-Rey, 2003). Eggs and larvae are pelagic (Collette, 1986). In Asian waters, they move to deeper water and remain inactive during the winter season (Nikol'skii, 1954). Commercially cultured in Japan.

King mackerel, Scomberomorus commerson

Scomberomorus commerson is distributed from near edge of continental shelf to shallow coastal waters, often of low salinity and high turbidity (McPherson, 1985; Kuiter and Tonozuka, 2001). It is also found in drop-offs, and shallow or gently sloping reef and lagoon waters (McPherson, 1985; Myers, 1991; Kuiter and Ttonozuka, 2001). Usually hunts solitary and often swim in shallow water along coastal slopes (Kuiter and Tonozuka 2001). Known to undertake lengthy long-shore migrations, but permanent resident populations also seem to exist. Found in small schools (Collette, 2001). Feed primarily on small fishes like anchovies, clupeids, carangids, also squids and penaeoid shrimps. Eggs and larvae are pelagic (Collette, 1986).

Bigeye scad, Selar crumenopthalmus

Bigeye scad is a mostly nocturnal pelagic species that can reach 70 cm TL (Froese and Pauly, 2011). The species prefers clear oceanic waters around islands to neritic waters occasionally in turbid waters. The species feeds on small shrimps, benthic invertebrates, and forams when inshore, and zooplankton and fish larvae when offshore. It travels in compact groups of hundreds of thousands of fish.

3.2. Geographical distribution of the species and estimated status of the stocks

Data available from the Indian Ocean Tuna Commission (IOTC) shows that Kenyan waters are some of the richest in tuna and tuna-like fishery stocks, and that the country's EEZ is part of the richest yellow-fin tuna belt in the Indian Ocean. These stocks migrate between Somalia, Kenya, Tanzania, Mozambique, Mauritius, Madagascar, and Seychelles waters during various periods in a year. Figure 7 shows the geographical distribution of some pelagic fish species common in the Kenya's marine waters.

The country's marine fisheries potential annual production has been variously estimated. Table 6 presents a brief summary of estimated marine fishery stocks or production based on available information.

Table 6. Some estimates of status of pelagic fishery stocks along the Kenya's coast.

Year	Estimated fishery stocks	Comments	References
1979/83	150 000 -350 000 tonnes	Kenya's potential annual production	1979/83 Five-Year Development Plan
1997/2001	200 000 tonnes	Potential annual production of the tuna and tuna-like fisheries	1997/2001 National Development Plan
1990-2010	4 000 – 9 000 tonnes/year	Artisanal fisheries	FiD and this study
-	20 000 tonnes / year	Potential yield of inshore waters comprising demersal and pelagic fish, crustacea, and other species	Odero, 1984
1981	125 000 tonnes	Total exploitable stocks with Kenya's 12 nautical miles coastal area	FAO, 1981
(F/V Professor Metsyatsev survey)	10 000 tonnes	Small pelagics around Ungwana Bay	Burczynski, 1976
	18 000 – 20 200 tonnes	Small pelagics mostly scads and mackerels	Habib, 2003

Large concentrations of highly migratory tunas and billfishes and large pelagic sharks have been known to pass through the Kenyan zone each year although the size of those concentrations is yet to be fully determined. Inshore coastal pelagic survey by F/V *Professor Metsyatsev* found stocks of small pelagics around Ungwana Bay to be about 18 000 tonnes. Species in this fishery included anchovy (*Engraulis* sp., *Stolephorus* sp.), round herring (*Etrumeus teres*), spotted herring (*Herklotsichthys* sp.), sardinellas (*Sardinella sirm, S. jussieu*), Indian oil sardinella (*Sardinella longiceps*), scad (*Decapturus macrosoma* and *D. maruadsi*), bigeye scad (*Selar crumenophthalmus*), hairtail scad (*Megalaspis cordyla*), and Indian mackerel (*Rastrelliger kanagurta*). Other notable species included coastal pelagic tuna and tuna-like species such as kawakawa (*Euthynnus affinis*), wahoo (*Acanthocybium solandri*), dogtooth tuna (*Gymnosarda unicolor*), frigate tuna (*Auxis thazard*), striped bonito (*Sarda orientalis*), kingfish (*Scomberomorus* spp.), barracudas (*Sphyraena* spp.), and fusiliers (*Caesio* spp., *Pterocaesio* spp, *Gymnocaesio* spp.). Most of these species, because they have a propensity to aggregate in large schools, lend themselves to capture by the purse-seine method and so any fishery exploiting this range of species would apply that method. Habib (2003) estimated its potential to be 20 200 tonnes.

By location, the potential yield of Lamu, Ungwana Bay, Mid-Coast, South Coast as surveyed by *Professor Mesyatsev* were estimated at 1 700, 5 200, 1 800 and 990 tonnes respectively. Exploratory fishing with bottom set longlines undertaken by East African Marine Fisheries Research Organization (EAMFRO) during 1969 – 1976 identified the North Kenya Bank as a place that could provide catches at very high catch rates. As a major fishing areas in the northern part of the Kenyan zone, the North Kenya Bank is stratified in the following manner: i) shallow waters out to 20 m depth, area 5 sq miles; ii) 20 – 50 m depth, 75 sq miles; iii) 50 – 200 m, 905 sq miles; iv) 200 – 500 m depth, 415 sq miles; v) over 500 m depth, 270 sq miles (Iversen, 1984). Using bottom set longline surveys, Tarbit (1976) estimated the total standing stock of fish on the Bank at 10 000 to 17 000 tonnes. The sustainable yield calculated from the standing stock estimates was 1 000 to 1 700 tonnes. Venema (1984) gave the following potential yields for the Banks fishery: sharks and rays 161 tonnes; big commercial fish (snappers, grunters, groupers, emperors, sicklefish, jacks, mackerels) 517 tonnes; small commercial fish (jacks, silver bellies) 14 tonnes; small non-commercial fish (mainly deep water species) 141 tonnes; swimming crabs 1 000 tonnes; cephalopods (squids, cuttlefish, Sepia, Loligo) 77 tonnes. The potential is therefore estimated at 2 000 tonnes.

A survey using monofilament gillnets conducted off Mombasa between March 1976 and February 1977 produced 255 kg of fish, the bulk of which was needlefish (Belonidae), sharks and rays (Nhwani, 1980). Also taken were barracudas, carangids, parrotfishes, sweetlips, and other species. Bottom nets produced about 400 kg of fish, including carangids, snappers, needlefish, rabbitfish, barracudas, swetlips, parrotfishes, surgeonfishes, sharks, rays, and other species.

Nzioka (1984) noted that yellowfin tunas are present in Kenyan waters throughout the year, with marked increase during the Southwest Monsoon, being capable of being found as close as 4 km from the shore. Catches of albacore (*Thunnus alalunga*), have been made in southern parts of Kenya at depths exceeding 120 m in the cooler waters below the thermocline; dogtooth tuna (*Gymnosarda unicolor*) also reported from the of the area particularly during the NE Monsoon; frigate tuna (*Auxis thazard*) abundant in inshore waters during the NE Monsoon; and bonito (*Euthynnus affinis*) present year-round but found in abundance during August/September and January/February (Williams and Newell, 1964). Occurrence of sardine fishery in Kenyan waters mainly comprised goldstripe sardinella (*Sardinella gibbosa*) and bluestripe herring (*Herklotsichthys quadrimaculatus*) species was noted by Wakwabi (1981).

Early surveys also recorded a number of billfishes including striped marlin (*Tetrapturus audax*), a species of wide distribution in the Indian Ocean that was found in heavy concentrations from Pemba Island and around Malindi, and registered high catch rates in East African waters during the NE Monsoon when the fish were on post-spawning feeding migrations (Williams and Newell, 1959b; 1959c; 1960; Williams, 1967; Uenagi and Wares, 1975); black marlin (*Makaira indica*) widespread in the western Indian Ocean and reported as occasionally caught close to shore near Malindi; blue marlin (*Makaira nigricans*) also widespread in the west Indian Ocean and reported from time to time in sports fishery in Kenya; sailfish (*Istiophorus platypterus*) abundant in coastal waters on the Kenyan coast with the main seasons being December to February and April to September; and swordfish (*Xiphias gladius*) relatively rare in inshore surface waters but common in offshore longline catches (Nzioka, 1981).

Pelagic species found in considerable abundance in nearshore coastal waters included the kingfish (*Scomberomorus* spp.), occurring in large offshore schools from about October through March, and large inshore schools from April through August/September; wahoo (*Acanthocybium solandri*), occurring in small schools close inshore, and Indian or little mackerel (*Rastrelliger kanagurta*), occurring sometimes in very large schools particularly during the NE Monsoon (Nzioka, 1981; Williams, 1956; Williams and Newell, 1957; 1958; 1959a; 1965).

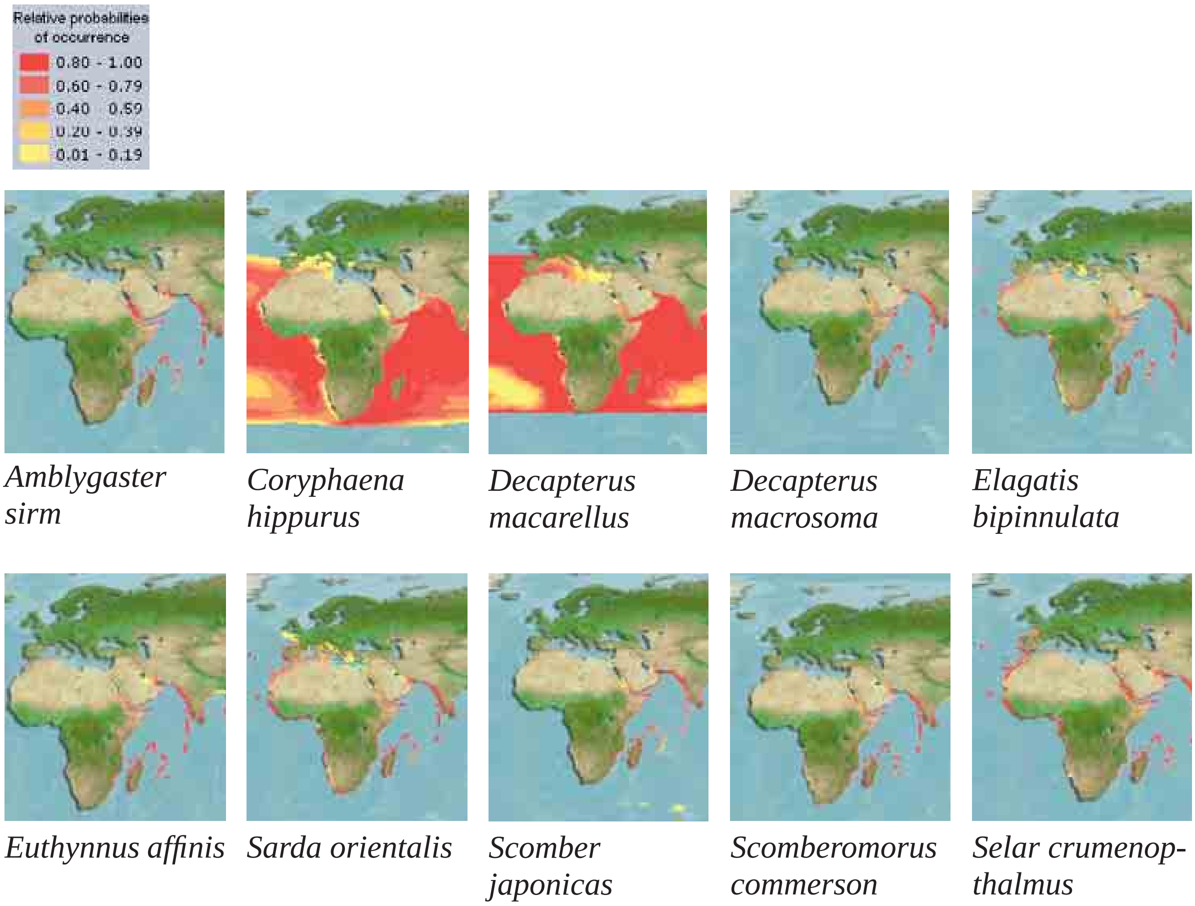


Figure 7. Global distribution of some pelagic fish species common in Kenya's marine waters
Source: Aquamaps.

3.3. Direct interactions with the ecosystem

Information on small and medium pelagic fisheries interactions with other fisheries and competition on target or non-target species is presented in other sections (see section 2).

3.4. Traditional knowledge about the marine fishery and the resources exploited

The coastal strip of Kenya is an area with rich traditions (Spear, 1978). Cultural traditions are transmitted in the form of social attitudes, beliefs, taboos, sacred sites, principles and conventions of behaviour and practice derived from historical experience. The coastal communities have practiced these traditions for ages. The key community elders are the traditional keepers and users of local traditions, knowledge and wisdom and are involved in many community level decisions. Along Kenya's coast, some of these traditions particularly those practiced by fishing communities and enforced by social and cultural means have been known to have positive impacts on fisheries management, and are as good as modern forms of management (McClanahan *et al.*, 1997; Table 7). However, societal change over time has resulted to weakened cultures and adoption of new practices and technologies replacing these traditions. This is due to the loss of identity, culture and traditional resource areas and erosion of community structures, mainly as a result of influences from economic developments, formal education, religion, immigrants, change in land tenure systems, governmental command and controlling regimes. As a result, in many coastal locations, the local traditions that governed fisheries or practiced to appease spirits within fishing areas are slowly becoming irrelevant.

Subsistence fishing is culturally and economically important to many coastal rural communities in Kenya. Traditional fishing gears used include basket traps (*madema*), hooks and lines (*mshipi*) and gillnets (*nyavu*) while spearguns (*bunduki*), beach seine nets (*juya*) and ringnets are introduced gears. The traditional system had some social and cultural controls on fishing where disciplined behavior before, during and after fishing was strictly required (Rubens, 1996; Glaesel, 1997; McClanahan *et al.*, 1997; Tunje, 2002). Fishing was controlled in time and space without disrupting important fisheries habitats and processes thereby providing for sustainable harvest of fisheries resources in the process of appeasing spirits. These beliefs are concurrent with contemporary management system such as restrictions on gear types, limited access (*ubani*), time limits (*sadaka*), size restrictions and sacred sites or protected areas (*mzimu*) (Rubens, 1996; Glaesel, 1997; McClanahan *et al.*, 1997; Tunje, 2002).

Studies on traditional community-based fisheries management systems along Kenya's coast are few. Thus, comprehensive studies are required to harness the potential usefulness of traditional management systems or local traditions as a tool for local fisheries management. Some of the local tradition practices relevant to fishery management, and which could be in-cooperated in to the fishery management planning along Kenya's coast is highlighted in the Table 7 below.

Table 7. Local tradition practices relevant to fisheries management

Tradition	Description	Relevance to fisheries management
Kaya	Sacred forests on land	Some landing sites are associated with *Kaya*. *Kaya* elders were responsible for management of land as well as fish landing sites
Bandari	Fish landing sites	Fishers form socio-groupings around the *bandari* constituting of key stakeholder within that fisheries. Key decisions concerning fisheries management are made at the *bandari*
Mzimu	Sacred sites at sea	They include fishing grounds where fishing was restricted or not allowed, acting as no take areas
Sadaka	Traditional ceremonies	Held once a year to appease spirits, or when catches declined, or when there are unusual incidents or happening at sea. Draws fisher to the attention of precautions when fishing, wise use of the resource and appreciation of nature. Fishing effort goes down during days of *sadaka.*
Ubani	Fee to allow access to landing site or fishing territory.	Controlled fishing effort by limiting access to fishing grounds. Protects the fisheries resources from overexploitation. Screening of fishers using the area.
Kivumbi /harusi ya samaki	Fish spawning aggregations	Traditional knowledge of fish spawning aggregations among fishers exists and the aggregations are targeted. Opportunities for protecting the sites and aggregating species. Fishers used to offer *sadaka* before or during the spawning aggregation period.

Restrictions on fishing areas, time of fishing and gear use

Mzimu were viewed as sacred sites and areas of unusual phenomena or dangerous areas believed to be inhabited by spirits (McClanahan *et al.,* 1997). Fishing within and around *mzimu* was prohibited by the community acting as a self-imposed marine refuges. Sacrifices and prayers meant to appease spirits were held in the *mzimu*. No fishing was allowed during the day of offering *sadaka (*sacrifices*)*. In non-Digo areas, fishers ate fish caught on the morning of the *sadaka* instead of slaughtering animals. Sacrifices consisted of foods such as bread made of rice, flour-based sweet (*halua*), sweets, animal blood and incense (*ubani, udi*). The sacrifices were done annually ostensibly to increase catches, to ensure safety at sea, provide relief from illness and other troubles. The ritual ceremonies were also held when schools of pelagic fish such as tuna and sardines pass (November - February). Offering of *sadaka* is elaborate and can be expensive and time-consuming beginning at sacred sites on land (*Kaya* or *Mzimu*) to sacred sites at sea (*Mzimu*).

Other restrictions included prohibitions on the use of certain gear types such as pull seines, use of harmful poisons for fishing, prohibitions on over harvesting fish and landing of high catches of juvenile fish. Traditional elders from two fish landing sites in south coast Kenya were very instrumental in stopping landing of beach seine catches at their fish landing sites in mid 2000s. Elderly fishers in some areas regularly castigate use of destructive fishing gear such as speargun. Traditional fishers associate poor catches with breaks from traditions such as sacrifices, prayers or the use of untraditional fishing gear. Elder fishermen are supposed to call for meetings in response to declined catches or occurrence of unusual events. Decline in fish stocks and culture have resulted to relaxation of rules and the sacred sites have become unrestricted to fishing (McClanahan *et al.,* 1997).

Restrictions on access to fishing territories

Although, Kenya's marine waters are an open access, a village's fishing territory was in most cases defined by proximity or adjacency to the settlement with prominent land marks acting as boundaries. Fish landing sites and settlements are associated with sacred coastal forests known as *Kaya*. *Kaya* elders represent and uphold the traditions of the sacred forests including fish landing sites and associated culture. The elders pass down knowledge and leadership to their eldest sons. Landing sites have four leaders (two elected and two inherited) independent of government appointed positions. Access controls were applied to outsiders particularly fishers from distant fish landing sites (local migrant fishers) and foreign fishers (migrants from neighboring countries) but allowed migrant fishers associated with the residents either through marriage. The visiting fishers were required to pay a certain fee (*ubani*) or an agreed portion of the catch, to be permitted use of fish landing site and village's sea territory. The foreign fishers had to seek clearance from resident community leadership. Economic (improving income, poverty), social (marriage, change of life) and ecological (ecological degradation, seasonal migration of fish) factors drive fishers to migrate and their choice of destinations (WIOMSA, 2011). Despite the positive impacts (such as boosting economy, new technology, helping locals and intermarriage, etc.) that migrant fishermen bring to their destinations, they are associated with the declining fisheries among other negative impacts.

The *Bajuni* and *Wapemba* fishing communities have been migrants for decades (Fulanda *et al.,* 2009). Their movement is seasonal and during the North East monsoon (between October and April) when the sea is calmer and prevailing winds favorable for fishers to access more distant and productive fishing grounds (WIOMSA, 2011). Seasons (NEM and SEM) are influenced by trade winds that control the weather and ultimately fishing patterns. Migration is often related to the type of fish targeted and gears used, which in turn determines choice of time and area of migration (WIOMSA, 2011).

Safety during fishing, hygiene and proper fish handling

Traditionally among the coastal fishing communities, disciplined behavior before, during and after fishing was a strict requirement with traditional coastal fishers establishing general principles for proper behavior e.g., on propriety, order, proper fish handling, personal hygiene, safety etc. In order to avoid misfortunes safety precautions had to be adhered to and have been documented as follows:

- Disciplined behavior was required when fishers were dealing with women during fishing, if not, they get bad luck.
- The person who gets in the boat first should be the first one to get out.
- Animal names such as cattle were not supposed to be mentioned when fishing.
- Making sounds that destruct fishers' concentration such as whistling or making noise during fishing was not allowed.
- Fishing was not done when a fisherman was in a bad mood or annoyed.
- Entering a fishing vessel when the other is hanging may lead to accidents.
- Drunken fishermen were not allowed to go fishing since they may drown or the *dau* might capsize.
- The container (*upo*) used to draw seawater out of the boat should not be placed upside down, so that it is readily available in case of any emergency.
- Females were not allowed to move near or enter a fishing vessel so that fishermen may loose concentration leading to accidents.
- Before a boat is taken into the sea for the first time, chicken had to be slaughtered and the boat repairer paid. If this is not done, someone might get hurt during fishing.

To ensure personal hygiene and proper fish handling during fishing:

- Entering a fishing vessel in shoes was not allowed to avoid contamination of fish that may cause health problems to the consumer.
- Not taking bath and untidiness when fishing was culturally unaccepted so as to avoid contaminating fish.
- Relieving oneself while standing in the fishing vessel is not allowed as urine may contaminate fish caught.
- A pregnant/menstruating woman is not supposed to enter a fishing vessel or hold a bucket with fresh fish. This is because she is considered unclean and may contaminate fish.
- Green raffia was not to be used in tying fish, since it may have a sour taste and contaminate fish.
- Removing fish scales using a stick or green stick was prohibited to avoid fish contamination.
- Fresh fish from the fishing vessel should not be placed in a soot-coated *sufuria* since it may contaminate fish.

Traditional knowledge on tides, fish aggregation and migrations

Fishers have for a long time made observations on the resources they exploit, some of which are consistent with scientific facts. Traditional knowledge revolves around exploitation and conservation. Fishers understand, in their own way fish behavior, biology and ecology. Though the fishers may not fully understand migratory dynamics of pelagics (sardines, tunas, etc.), they possess adequate knowledge that suits their fishing needs, such as the direction and season of migrations. Quite often, fishers are aware of the breeding grounds of species of interests and their feeding habits.

The coastal communities have vast knowledge of the moon calendar. They use this knowledge for timing marine and terrestrial environment events which enables them to plan for fishing trips, predict occurrence of fish spawning aggregations, fish migrations, feeding habits and planting activities. Islam is the main religion among coastal fishing communities hence use of the Islamic calendar is widespread increasing the understanding and use of the lunar periodicity in fishing (Tuda *et al.*, 2008). The phases of the moon generate different tidal patterns and other environmental cues during a 29 lunar day month period. Local communities have adopted a number of terminologies to describe the tidal phases or fishing time relative to the moon.

These tidal phases are locally known as: *bamvua* - the days of large spring tides bracketing the new or full moon lasting 3 to 4 days from days 29 to 3 and 15 to 18 of the Islamic calendar; Msindizo - the period between lunar days 8 to 10 and 21 to 23 when the tidal range is smallest, fishers often take break from fishing during period of the month. *Maji ya jioni* falls between days 5 to 7 and 18 to 20 and is associated with *bamvua* and *Msindizo* during which good tides suitable for fishing occur in the late afternoon (*jioni*). *Maji ya asubuhi* occurs between days 11 to 13 and 24 to 27 of the Islamic calendar when neap tides develop into spring tides with good tides for fishing occurring early in the morning. The moon calendar emphasizes certain repetitive biological and ecological processes (e.g. fish spawning, aggregation, and feeding habits) that can be validated by fishermen’s own observations. There are reports of fishers exploiting spawning aggregations of reef fishes in Kenya, mainly from fishers’ knowledge studies and validated through various ways (Samoilys *et al.,* 2006; Robinson *et al.,* 2008; Maina *et al*. In Press). However, validated of spawning aggregations of pelagic fish are non-existent. Targeted fishing of spawning aggregations can lead to dramatic decline of the species. Therefore, knowledge about timing and locations of spawning aggregations is critical for management.

4. Annual catches

Artisanal fisheries

The annual production for Kenya’s marine fisheries has remained between 4 336 and 8 736 tonnes (mean 6743 ± 265.09 tonnes - SE) over the last two decades from 1990, Y = 95.442x + 5692.7, $R^2 = 0.24$ (Figure 8). The pelagic fishery over the same period accounted for 27 percent of the landings, with catches oscillating between 977 and 2 096 tonnes (mean 1,843 ± 128.40 tonnes - SE), increasing steadily by 78 tonnes annually (Y = 77.946x + 985.47, $R^2 = 0.68$). The annual pelagic fish production during 1978–1981 period fluctuated between 997 and 1 150 tonnes. The proportion of pelagic fish recorded for 1990–2010 in this study is higher than the 18 percent reported by Wakwabi *et al*. (2003) which also indicated that 80 percent of the total marine products come from shallow coastal waters and reefs, and about 20 percent from off-shore fishing. In Tanzania, the pelagic fishery accounts for 62 percent of the marine fisheries catches.

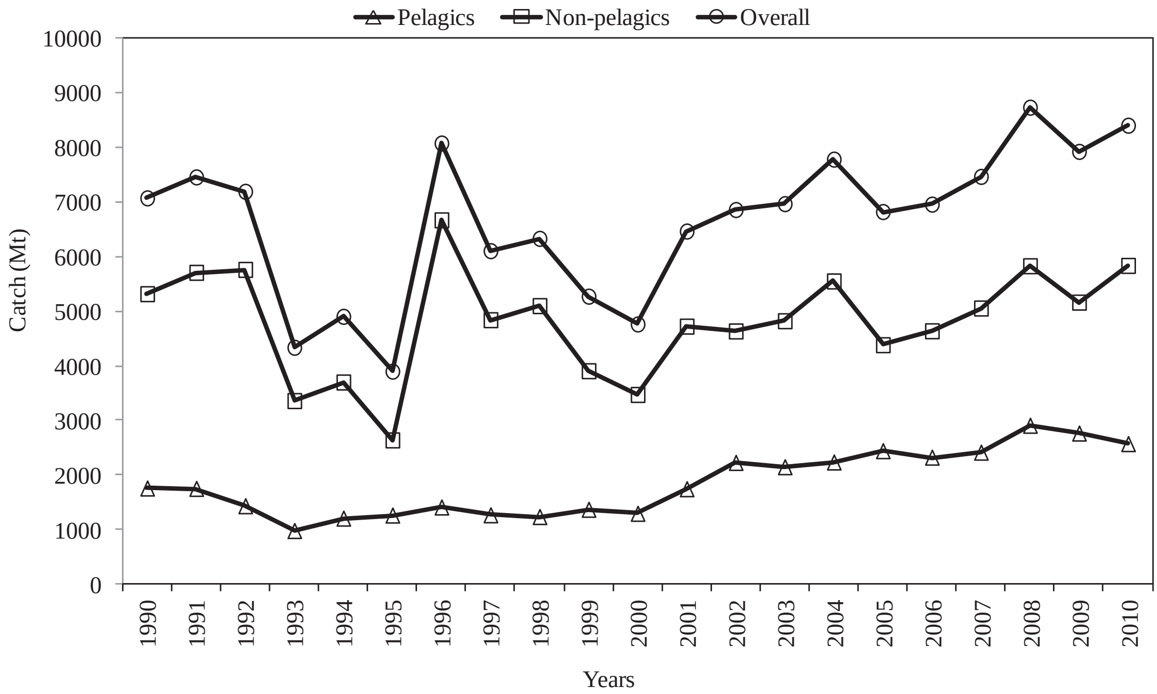


Figure 8. Annual catches from the marine artisanal fisheries over the last ten years
Data Source: Fisheries department catch data.

A decline in production mostly for non-pelagic fish was recorded from 1991 to 1995 and from 1997 to 2000 periods; the latter could partly be attributed to the 1997/1998 El-Nino event and the tribal clashes that occurred at the coast during that period. Tuna exports were also severely curtailed in 2001 by EU Sanitary and Phytosanitary conditions which led to temporary closure of the factory for several months, though catches seems to have remained stable. Acquisition of efficient fishing gears such as ringnets, recovery of habitats and fish species after the El-Nino phenomenon, and improved data collection have contributed to the 76.5 percent increase in artisanal catches from 2000 to 2010 (Figure 8).

Ringnets are among the most productive gears contributing 77 percent of the landed catch in Vanga with a mean catch per unit effort of 11.9 kg/Fisher/day. In Shimoni, ringnet landings constitute 4 percent of the total fish landings and 9 percent in Gazi with an average of 9.4 kg/fisher/trip. Throughout the Eastern Pacific from Canada to Chile, catches of small and medium pelagic, demersals and other species were also negatively affected by the El-Nino event (FAO, 1999; Obura 2005). The growth in the production of the pelagic fishery vis-a-vis the overall production can be gauged from Figure 8.

The recorded marine artisanal fisheries production is low considering that Kenya has a 640 km coastline, a 200 nautical miles of EEZ (230 000 km^2) and is said to be located within the richest tuna belt in the Indian Ocean. The marine capture fisheries potential is largely unknown but is estimated at 125 000 tonnes, excluding EEZ fishery (FAO, 1981). The inshore waters are reported to have a potential to yield ~20 000 tonnes per year (Odero, 1984), while FAO (1990) estimated that annual marine catch from reef areas might be closer to 12 000 tonnes per year. The bulk of marine catch is landed by artisanal fishermen using simple gears and vessels while the country's EEZ is exploited by Distant Waters Fishing (DWF) Fleet, which target mainly tuna. The catches from DWF fleets operating in the country's EEZ are landed and processed at local fish processing establishments while some is landed and transshipped from the same facilities (see section 5).

County-wise contribution to the artisanal marine fisheries landing indicates that Kwale, Lamu and Kilifi Counties contributed 82 percent of the 2001-2010 landings (Figure 9). Kwale County recorded the highest annual catches ranging from 1 792 tonnes in 2001 and 3 062 tonnes in 2010, mean 2 370 ± 417 tonnes (Figure 9). Lamu and Kilifi counties recorded high annual catches, slightly over 1 390 tonnes throughout the same period. Mombasa county landings include fish transported by boats from neighboring counties for better prices. Rich inshore marine fishing grounds are found in and around Lamu Archipelago, Ungwana Bay, North Kenya Bank, Malindi Bank and on the south coast around Majoreini and Vanga. The northern banks are much productive because of being located within an upwelling region created by the meeting of the southern flowing 'Somali Current' with the north flowing 'East African Current' during the northern monsoon season (November to March).

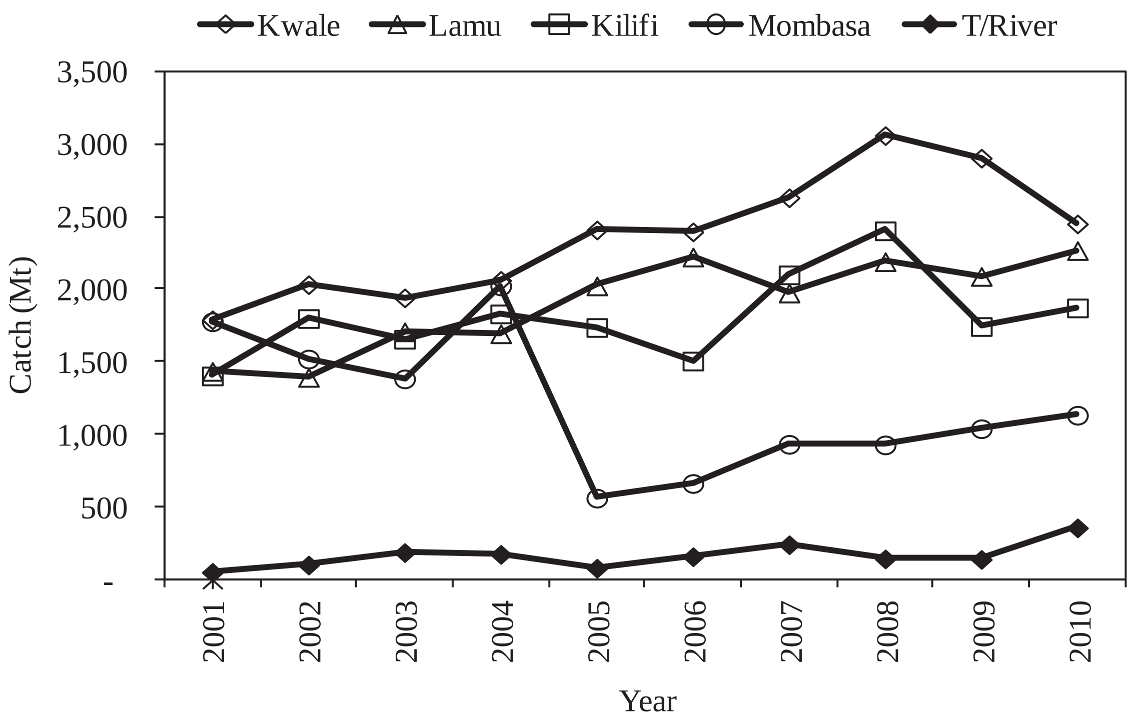


Figure 9. Trends and distribution of artisanal marine fishery landings (tonnes) by county along the Kenya's coast

The main marine fishery products are demersal, pelagic, sharks and rays, crustaceans, molluscs, echinoderms and deep sea/big-game fish. The demersal fish were the most dominant (>38 percent) with Lethrinidae, Siganidae, and Scaridae being the dominant families recording an annual mean of 448 tonnes, 435 tonnes and 230 tonnes respectively, over a 20 year period (Figure 10). The mean catch for the pelagic families Carcharidae/Rhinobatidae, Clupeidae, Sphyrainidae and Scombridae ranged from 127 tonnes to 185 tonnes. The annual production from 1990 to 2010 by family is shown in figure 11 with a maximum production of 829 tonnes in 1996 for family Lethrinidae and minimum 53 tonnes for Sphyrainidae in 1992. Families contributing less than 2 percent to the 20 years catch are categorized as "others" (Architeuthidae, Gerreidae, Cryptochiridae, Haemulidae, Nephropidae, Serranidae, Istiophoridae, Terapontidae, Acanthuridae, Chanidae, Plotosidae, Mullidae, Holothuriidae, Coryphaenidae, Ostreidae). Catches recorded as 'unaccounted for' and 'mixedfish/others' (36.0 percent of the total landing) could not be categorized into family level and therefore are not included in the graph.

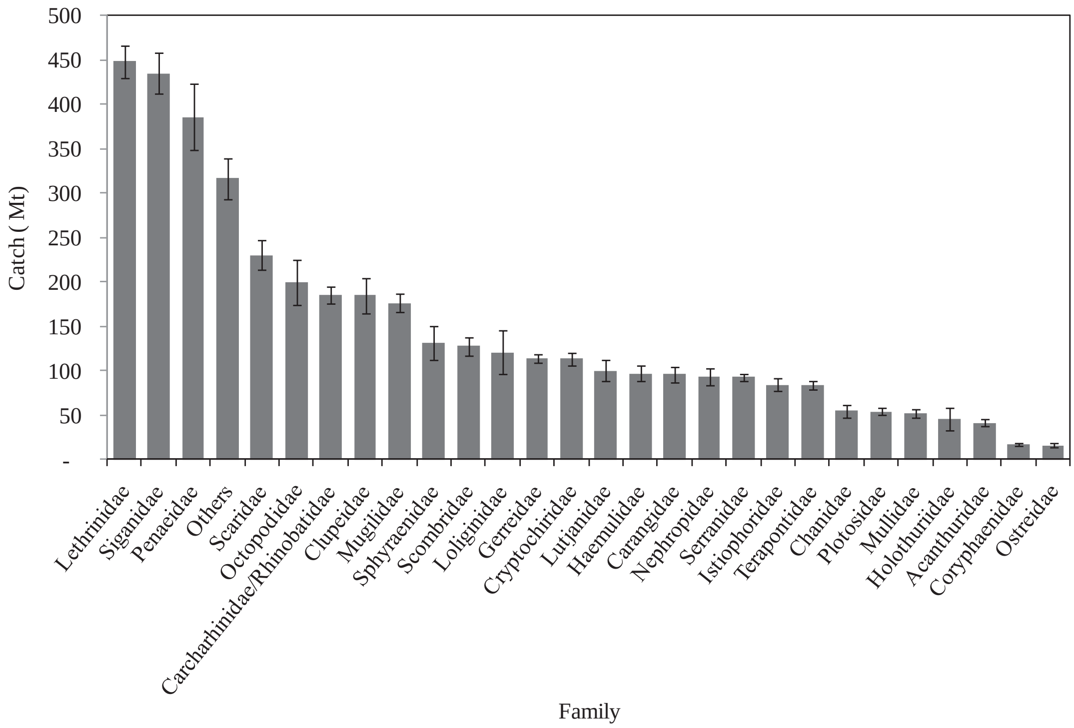


Figure 10. Average marine artisanal fisheries catch by family for the last 20 years: 1990 - 2010. Catches recorded as 'unaccounted for' and 'mixed/others' was combined and categorised as "Others". **Data Source:** FiD.

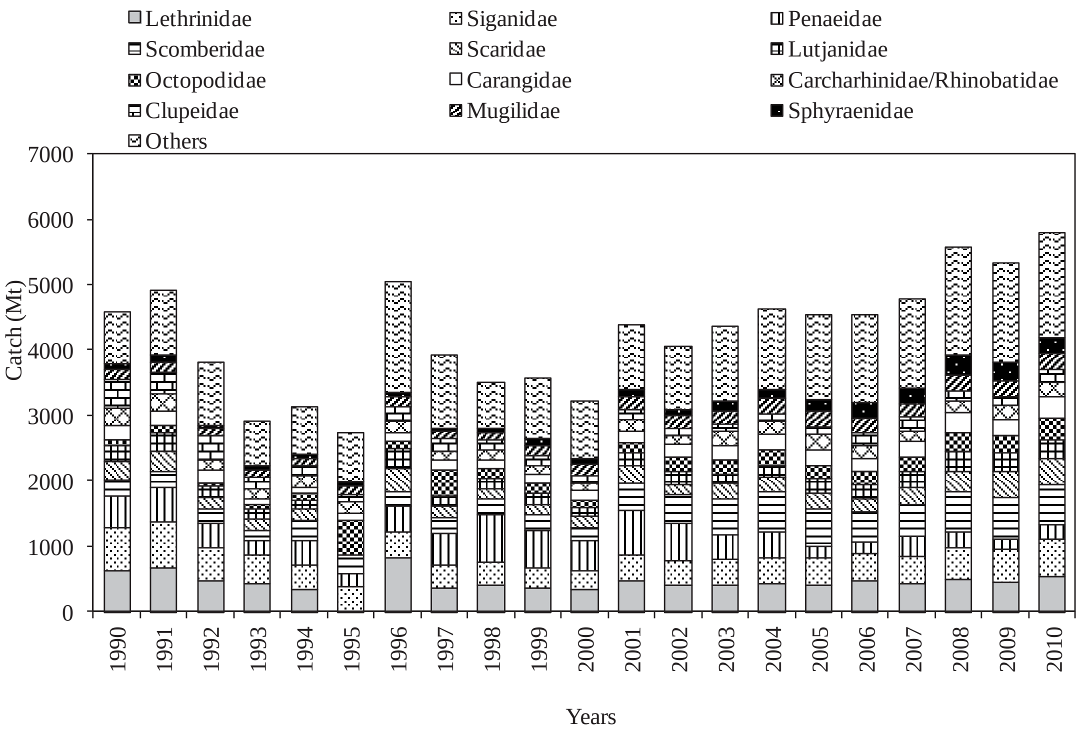


Figure 11. Annual catch production for main pelagic fisheries and other fisheries by family along the Kenyan coast
Data Source: FiD.

Annual yield from the small and medium pelagic fisheries over the last 20 years ranged from 429 to 1 290 tonnes and from 347 to 1 357 tonnes, respectively (Figure 12). The small and medium pelagic fisheries comprised 85.4 percent of the pelagic fishery and recorded increased production (> 47 percent) from year 2000 (500 tonnes) to 2010 (1 000 tonnes). The small pelagic fishery comprised mainly of sardines, herrings, anchovies and mackerel from in the inshore waters and exploited primarily by gillnets.

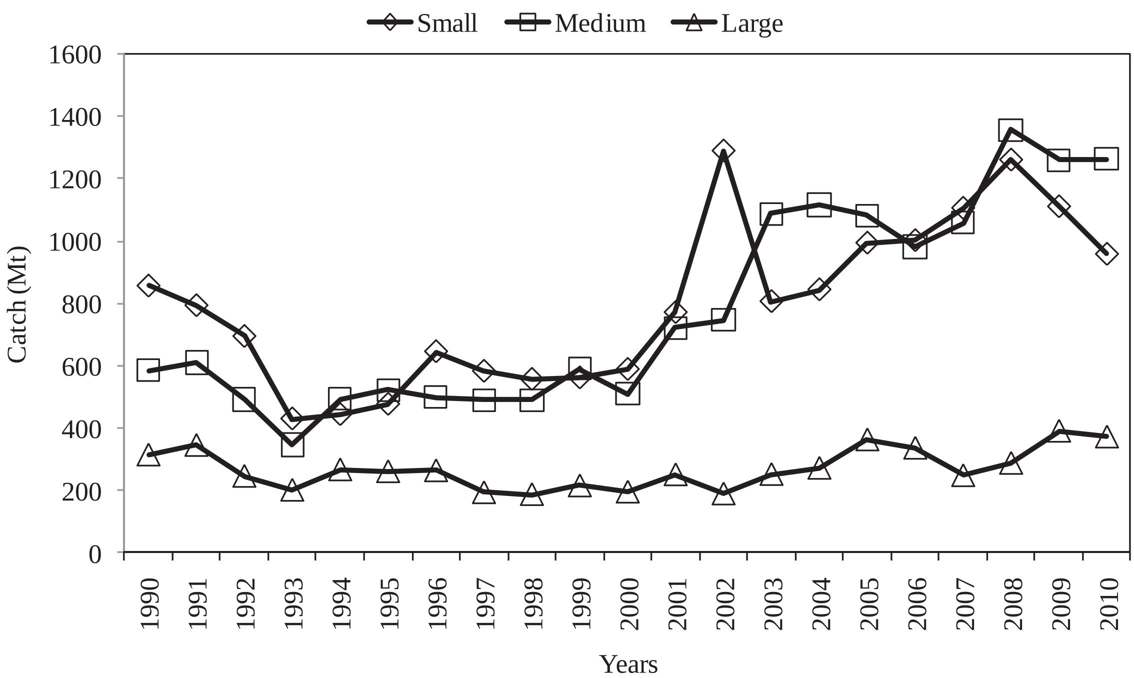


Figure 12. Annual yield of marine artisanal small, medium and large pelagic fishery, 2001 to 2010. Small pelagic fishery = 43.3 percent, medium pelagic fishery = 42.1 percent and large pelagic fishery = 14.6 percent.
Data Source: FiD.

The quantity and value of major small and medium pelagic fish groups recorded between 1990 -1999 from artisanal marine fisheries is reported in section 5. Most of the small pelagic fish are recorded in the catch landings as mixed-pelagics. The mixed pelagics comprise a significant portion of the artisanal pelagic catch recording an annual average of 222.19 ± 19 tonnes (section 5). Of all the small and medium pelagic fisheries recorded in the artisanal marine fisheries landings, a declining trend was only recorded for sardines, from 439 tonnes in 1990 to less than 150 tonnes annually for the most part of the last decade, Y = -8.2421x + 274.96, $R^2 = 0.33$ (Figure 18). Catches of the highly valuable bonitos/tunas, cavalla jacks, little mackerels and barracudas ranged between 125 and 172 tonnes annually, each group.

Recreational/sport fisheries

The proposed fisheries and development bill (Nov 2011) defines recreational fishing as "non-commercial fishing by an individual for leisure or relaxation". Kenya's sport fishing industry is well known within the WIO region for its prominence in big-game fishing. The commonly used methods of sport fishing along the Kenya's coast include; trolling (offshore), fly-fishing (shallow waters or open waters), bottom fishing (5-50m deep using baited hooks), drift fishing (>50 m depth) and spearfishing. Collection of sport fishing data by Kenya's fisheries department started in the 1940s, but it was until 2006 when computerization of the historical data was started with support from the Indian Ocean Tuna Commission and the Overseas Fishery Cooperation Foundation (IOTC-OFCF) (Ndegwa, 2011). This was to enhance the data collection and processing systems for the Tuna resources in the Indian Ocean, capturing into a database the historical sport fishing information stored by various clubs. Despite the efforts, the sport fishery statistical records still need further improvement to avoid under reporting. The fishery recorded an annual mean catch of 206 ± 14.01 tonnes (± SE) from 1993 to 2006, with maximum catches of 318 tonnes in 2009 and a minimum of 94 tonnes in 2006 (Figure 13). The sport fishery landings increased by 129 percent from 90 tonnes in 1984 (de Sousa, 1988).

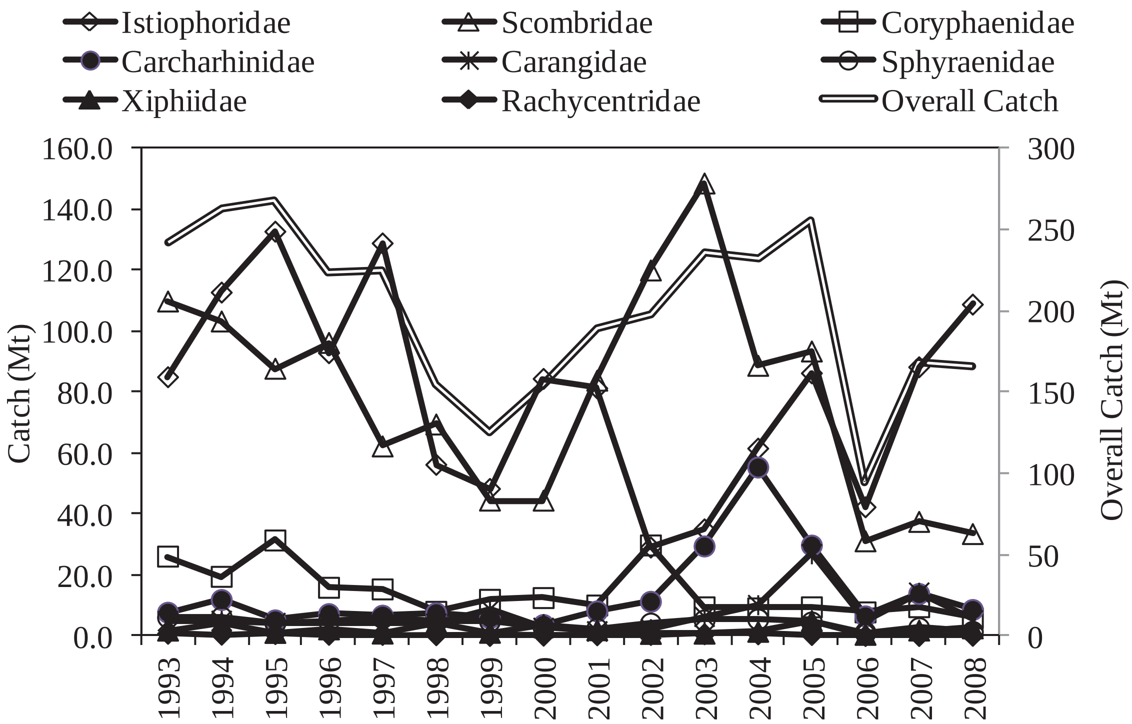


Figure 13. Trends in sport fishery landings by family, 1993-2008. Total annual average catch = 206 ± 14.01 tonnes (SE), maximum = 318 tonnes, minimum = 94 tonnes

Sport fishing is most pronounced during the calmer Northeast monsoon season (August - April); mainly targeting the big games such as bill fish, sail fish and sword fish (Ndegwa and Sigana, 2010; Figure 13). Sport fishery catches are dominated by large pelagic fish families such as Istiophoridae (Sailfish) and medium pelagic Scombridae such as Tuna/Bonitos, Kingfish, and small mackerels among other families (Figure 13).

Catches of some key sport fishery pelagic fish are shown on Figure 14. Wahoo, Dolphin fish (Dorado or felusi), and Kawakawa (little tunas) recorded the highest catches at Malindi sports club, > 2 tonnes annually. Kawakawa are the most abundant of the three neritic tuna species caught in the Kenyan waters (Ndegwa, 2011). Wahoo are reportedly common in the month of September while December onwards is season for marlin (black, blue, striped) (Habib, 2005). The early season is generally characterized by large schools of yellowfin tuna. The catches of the medium and larger pelagic in Kenya's coastal waters indicates the presence of large quantities of species such as tunas (e.g skipjack, yellowfin, dogtooth, and longtail), bonitos, barracudas, wahoos, dolphin fish, mackerels, rainbow runners, cavallas and grunters (Ndegwa and Sigana, 2010).

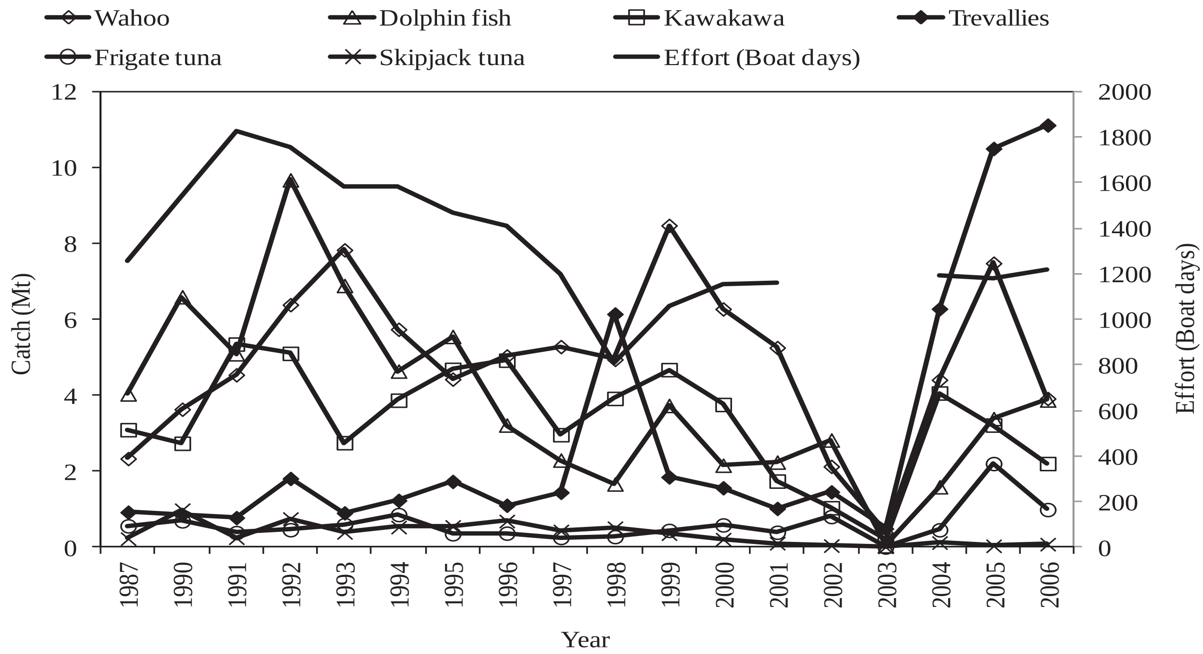


Figure 14. Trends of some key pelagic fish landed by Malindi sports fishing club, Kenya

Malindi-Ngomeni and Watamu in Kilifi County are the most prominent sport fishing grounds recording over 40 tonnes of catch annually from 1993 to 2009, except in 2006 (Figure 15). Shimoni and Pemba Channel, off Shimoni in Kwale County are among the most prominent sport fishing grounds in south coast.

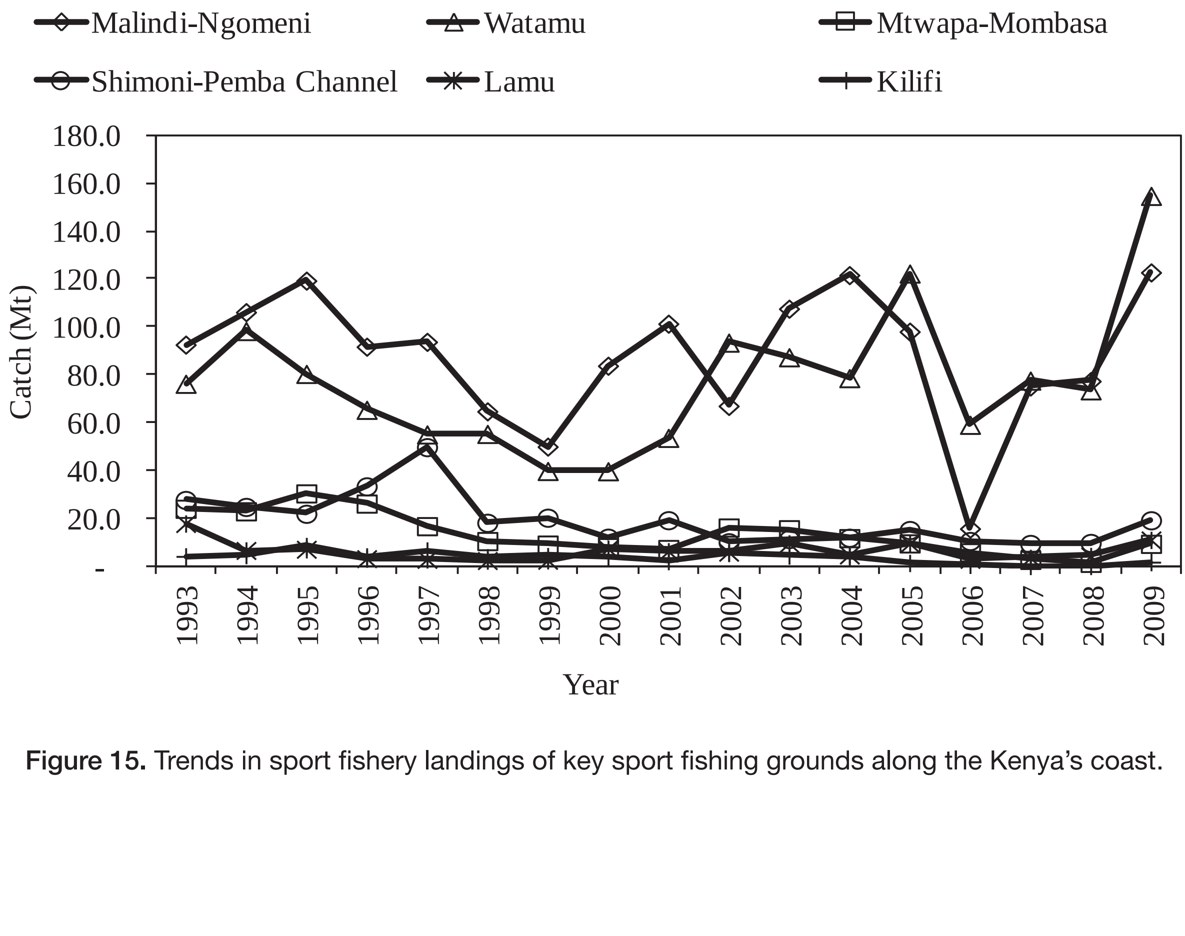


Figure 15. Trends in sport fishery landings of key sport fishing grounds along the Kenya's coast.

5. Importance of the fishery in the national economy

5.1. Value of the catches

The artisanal marine fishery production has remained between 4 336 tonnes and 8 736 tonnes annually over the last two decades, valued between 135 million KES[1] in 1990 and 737 million KES in 2008 (Figure 16). The value of the catches has been increasing at a higher rate than the quantity, as seen in the narrowing of the gap between production and value. This is attributed to the increasing demand for fish proteins both for export and domestic market, coupled with improved quality of fisheries produce as a result of strict quality control requirements. Fishers' preference of selling to the hotels, restaurants and retailers in urban centres to maximize prices has also contributed to increased fish value.

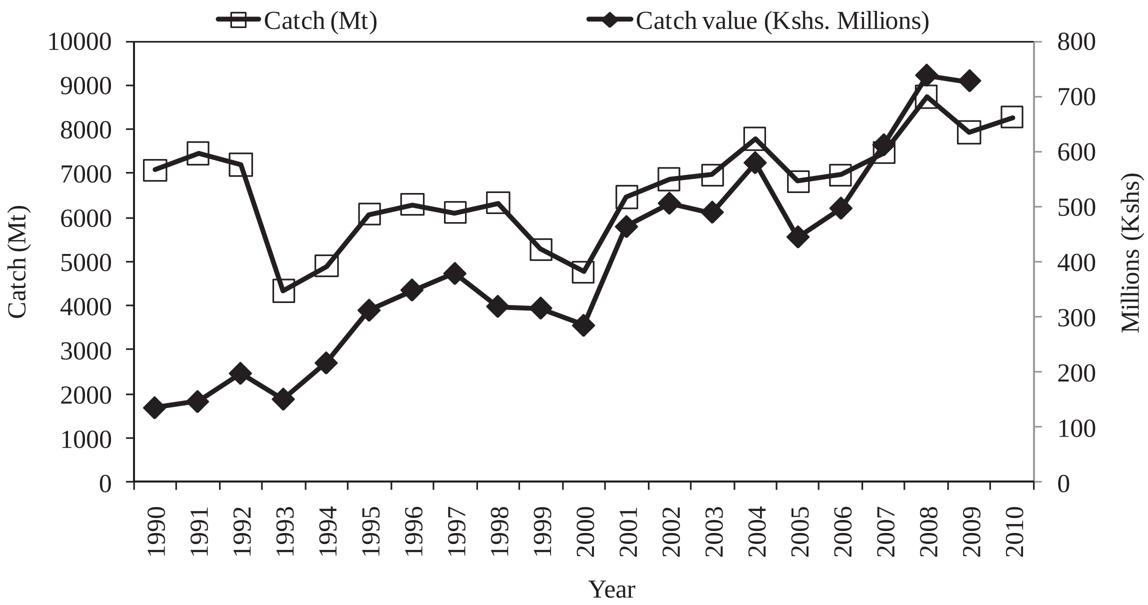


Figure 16. Quantity and value (million KES) of artisanal marine production in Kenya, 1990–2010

The large pelagic fishery recorded the lowest annual catch value compared to the small and medium pelagic fisheries (Figure 17). The medium pelagic fishery comprising of mainly the highly valuable bonitos/tunas, cavalla jacks, little mackerels and barracudas (Table 8; Figure 18) recorded the highest annual catch value compared to other pelagics. The annual catch value of the small and medium pelagic fisheries from 1990 to 2009 ranged from 7.32 million KES to 90.74 million KES (mean 35.69 ± 14.60 million KES -SE) and 7.56 million KES – 107.33 m (mean 42.87 ± 6.88 million KES - SE) respectively (Figure 17).

[1] Kenyan shilling (KES) = 0.0116306 USD (June, 2013).

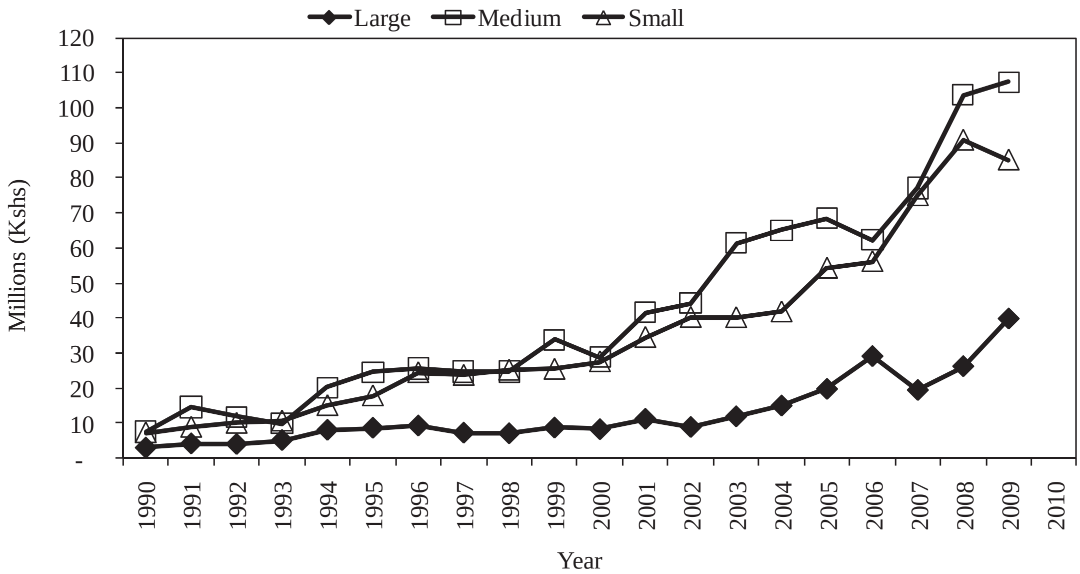


Figure 17. Annual trends of artisanal marine production pelagic fisheries catch value (million KES) from 1990 to 2009

Table 8. Annual average of quantity and value of major pelagic fish groups from artisanal marine fisheries, 1990-2009

Fish group	Average annual Catch (tonnes) ± SE	Average annual Value (Millions KES)
Mixed Pelagics	222.19 ± 31.22	241.44
Sardines	184.00 ± 21.02	109.55
Mullets	172.46 ± 10.89	158.48
Bonitos/Tunas	171.68 ± 23.59	200.99
Cavalla jacks	136.55 ± 10.63	136.55
Little mackerels	128.94 ± 13.61	151.23
Barracudas	125.85 ± 19.75	147.74
Milk fish	53.69 ± 7.75	66.56
Queen fish	49.20 ± 3.51	44.30
Dolphin fish	16.36 ± 1.77	16.75

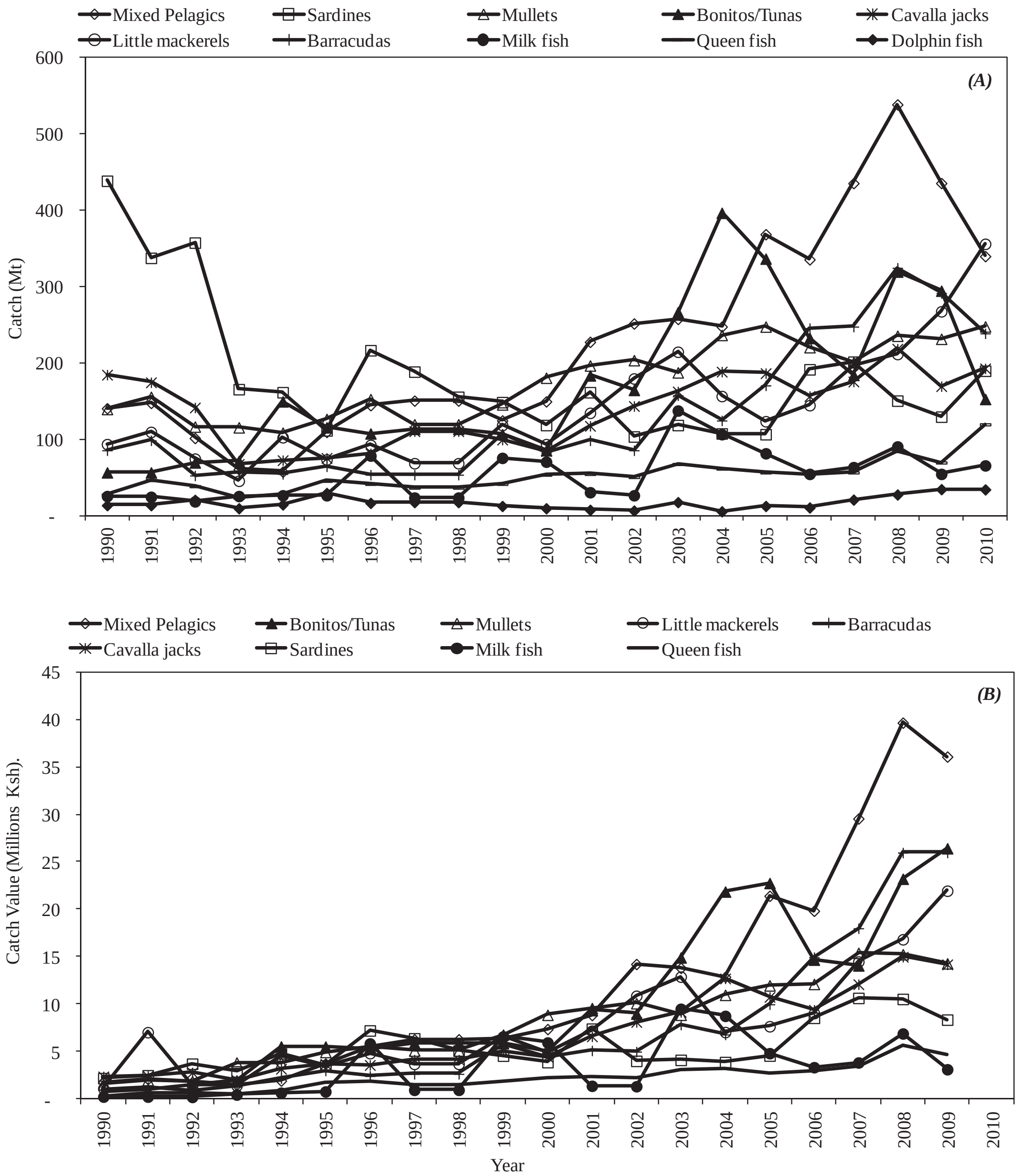


Figure 18. Quantities *(B)* and value *(A)* of pelagic fish groups from marine artisanal landings.

5.2. Products and markets

The bulk of marine fisheries catch ends up into the domestic market with high value fish going to the tourist hotels along the coast and in Nairobi. The local demand for marine fisheries was estimated at about 5 000 tonnes, valued at 400-500 million KES in 2005 (Mwikya, 2005). Pelagic catches are utilized by an intricate of markets ranging from domestic, restaurants, hotels, industrial and exports (Table 9). The domestic fish market is however not well defined or organized and involves buying fish at the beach by small- scale traders and selling to various open-air markets and fish shops. The fish are sold either dried, fresh or processed for later consumption. Artisanal Fish Processors (AFPs) prepare dried and smoked fish mostly for local market, while Industrial Fish Processors (IFPs) freeze or chill fish for export and to a lesser extent, for consumption in Kenya’s urban areas. These companies mainly produce frozen and chilled fish for export to European and other non-European markets (Table 10 and 12). Italy and Spain are the key export destinations.

Table 9. The markets utilised by each fishery (√ or Yes).

Fishery name	Domestic	Restaurant	Hotel	Middleman/ Trader	Industrial	Export
Hand line	√	√	√	√		
Longline (dropling/ drift longlines)	√	√		√	√	√
Trolling		√	√		√	
Set gillnets	√			√		√
Drift gillnets	√	√	√			
Ringnets	√	√	√	√		
Cast nets	√	√	√			√
Beach and reef seine	√		√	√		
Fence traps	√	√	√	√		
Trawling					√	√

Marine fisheries products exports

Marine fishery products for export are supplied by industrial/factory trawlers (e.g for shrimps), artisanal fishers (lobsters, mollusks and finfish) and by distant waters fleet (DWF) vessels operating in the south West Indian Ocean (lobsters, mollusks and finfish mainly tunas). Artisanal fishers are supplied with ice and insulated containers by the establishments to keep post harvest losses to a minimum. Various products are processed by the export establishments (Tables 12-14). Tuna is usually processed into cooked tuna loins by cooking headed and gutted tuna, and then removing the bones and peeling off the skin and dark muscle from the cooked fillet. The pink-colored fillets are then vacuum packaged in cling film and frozen. Tuna loins in destination markets are used as raw material for processing of products such as bottled tuna flakes, tuna salads, tuna pastes and spreads.

Kenya's marine pelagic fishery exports show a varied pattern (Figure 19), which depends more on the product than season. The volumes and value of export follow a similar pattern (Figure 19). Trend in monthly quantity and value of exported pelagic fisheries products ranged from 0.1 tonnes to 1 426 tonnes valued at 0.3 million KES to 3 145 million KES. Annually, an average of 5 226.33 ± 226.33 tonnes valued at 629.04 ± 72.63 million KES (± SE) were exported. This includes marine pelagic fishery products supplied by industrial/factory trawlers and distant waters fishing fleet (DWF). The export products mainly comprised frozen yellowfin, Skipjack and Bigeye tuna loins, frozen Headed and gutted Swordfish, sharks and tuna, dried shark fins and frozen Bonito Loins (Tables 12 and 14).

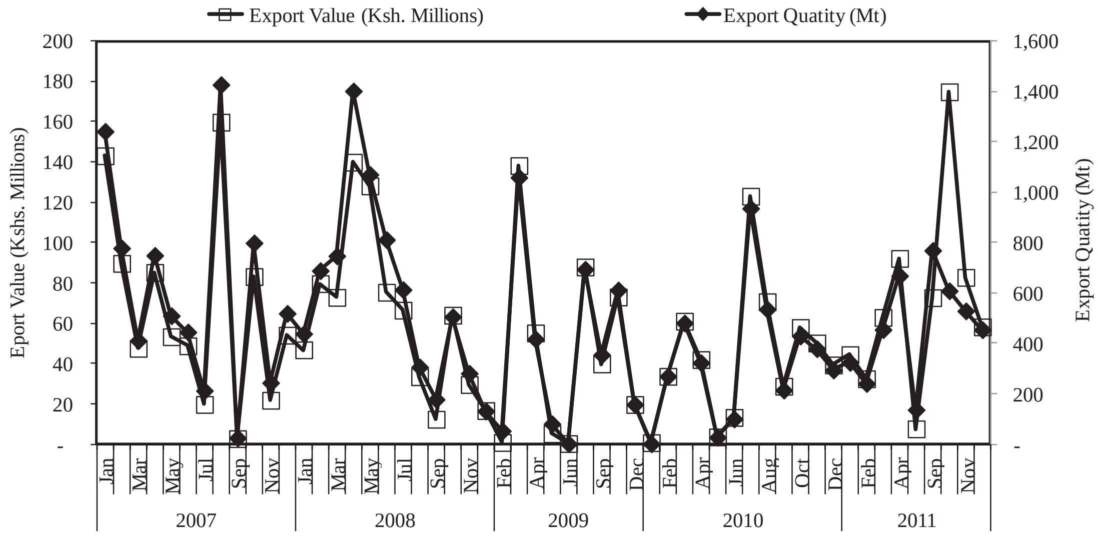


Figure 19. Value and tonnage of marine pelagic fishery export products from 2007-2011. Annual mean: export value = 629.04 ± 72.63 million KES, export quantity = 5 226.33 ± 226.33 tonnes (± SE).

Italy and Spain were the main export destinations for pelagic fishery products during the 2007-2011 period (Figure 20; Tables 10 and 12). Kenya fishery quality control conditions and procedures were harmonized with the EU quality control systems since January 2004 allowing exportation to any EU states (Mwikya, 2005). The Kenya Fish Processors and Exporters Association (AFIPEK) ensure members adhere to the industry's Code of Practice. The export products mainly comprised of large pelagic fishery (85.9 percent) with other fisheries mainly comprising of invertebrates contributing 14.1 percent (Table 11).

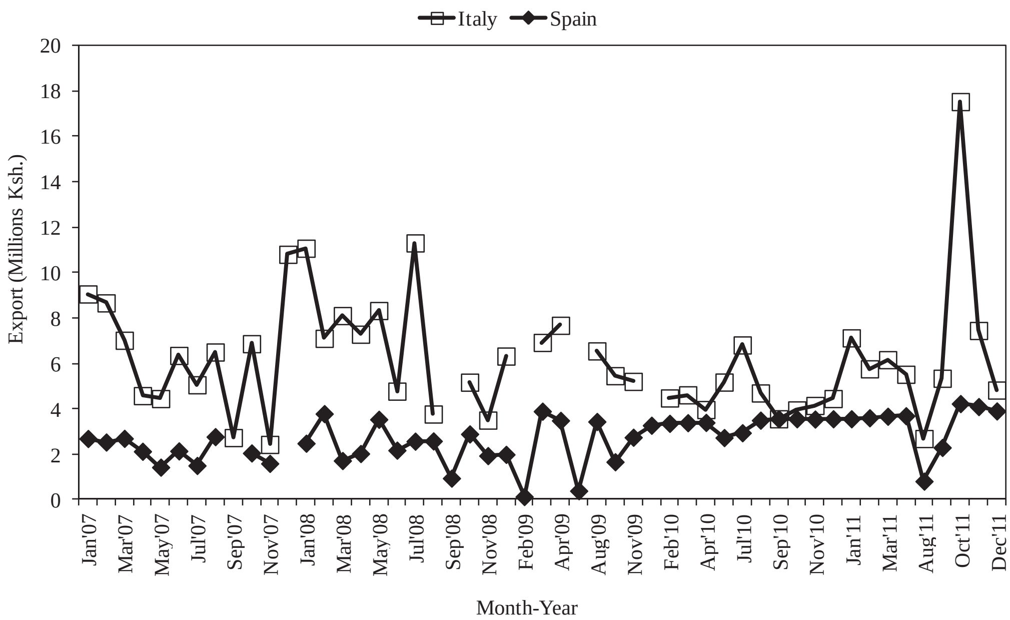


Figure 20. Trend in monthly value of marine pelagic fisheries export products for two major export destinations

Table 10. Quantity and value of marine fisheries export products from 2007 to 2011.

Year	Export Destination	Value (KES Millions)	Quantity (tonnes)
2007	Italy	667.91	5 961.92
	Spain	140.73	1 396.81
2008	Italy	475.84	4 382.90
	Spain	289.11	2 788.56
2009	Spain	265.06	2 196.49
	Italy	154.44	1 229.68
	China	0.47	2.00
2010	Italy	328.72	2 512.79
	Spain	186.86	1 436.49
	Portugal	3.43	26.73
	China	4.79	13.00
	Singapore	0.10	0.05
2011	Italy	529.84	3 404.68
	Spain	96.28	776.15
	China	1.62	3.40
Total		**3 145.21**	**26 131.66**

Table 11. The contribution (percent) of pelagic fisheries to marine fisheries exports, mean tonnage and value over the last five years.

Pelagic fishery type	%		Mean (2007-2011) ± SD	
	Quantity	Value	Tonnes	Millions (KES)
Large Pelagics	85.9	75.2	36.77 ± 40.09	4.35 ± 4.31
Medium Pelagics	1.1	1.0	10.25 ± 11.33	1.22 ± 1.22
Others	13.0	23.9	8.70 ± 7.99	2.14 ± 2.14
Total			25.39 ± 34.20	3.40 ± 3.40

The bulk of marine pelagic fisheries products from Kenya over the last five years ended up to three main destinations; Italy and Spain (Table 12). Other destinations include Portugal, Singapore, Netherlands and China, the later importing 18.5 tonnes of dried shark fins valued at 6.89 Millions KES. Cooked frozen yellowfin loins and cooked frozen skipjack loins were the main fishery export products accounting for 89.6 percent of marine fisheries products exported over the last 5 years (Table 12). Some fish is sold fresh while a significant proportion is processed for later consumption. Artisanal Fish Processors (AFPs) prepare dried and smoked fish mostly for local market, while Industrial Fish processors (IFPs) freeze or chill fish for export and consumption in Kenya's urban areas.

Table 12. Marine fisheries export products by destination for Kenya over a five year period, 2007-2011.

Export Destination	Italy		Spain		Others		Overall		
Products / Qty / Value	Tonnes	Million KES	Tonnes	Million KES	Tonnes	Million KES	Tonnes	Million KES	% (Qty)
Frozen Yellow fin Loins	15 008. 04	1 862.90	4 476.67	557.97			19 484.71	2 420.87	74.6
Frozen Skipjack Loins	2 483.93	293.87	1 421.40	181.50	26.73	3.43	3 932.06	478.80	15.0
Frozen Bigeye Loins			1 071.97	128.34			1 071.97	128.34	4.1
Frozen H&G Swordfish			688.77	67.70			688.77	67.70	2.6
Frozen H&G Sharks			713.96	25.11			713.96	25.11	2.7
Dried Shark Fins					18.458	6.98	18.46	6.98	0.1
Frozen H&G Tuna			90.60	6.76			90.60	6.76	0.3
Frozen Bonito Loins			56.42	6.07			56.42	6.07	0.2
Other Products			74.71	4.58	0.01		74.72	4.58	0.3
Total Exports	17 491.97	2 156.76	8 594.50	978.04	45.198	10.41	26 131.67	3 145.21	
Proportion by Destination %)	66.9	68.6	32.9	31.1	0.2	0.3			

Marine fisheries import products

The monthly trend in quantity and value of marine pelagic fishery products imported over a five year period indicates an increase in the value of products from year 2010 (Figure 21). Highest monthly imports were recorded in July 2009, 565 tonnes valued at 14.4 KES million. An annual mean of 3 993.2 tonnes of pelagic fishery products imports valued at 102.2 KES million were recorded over the five year period.

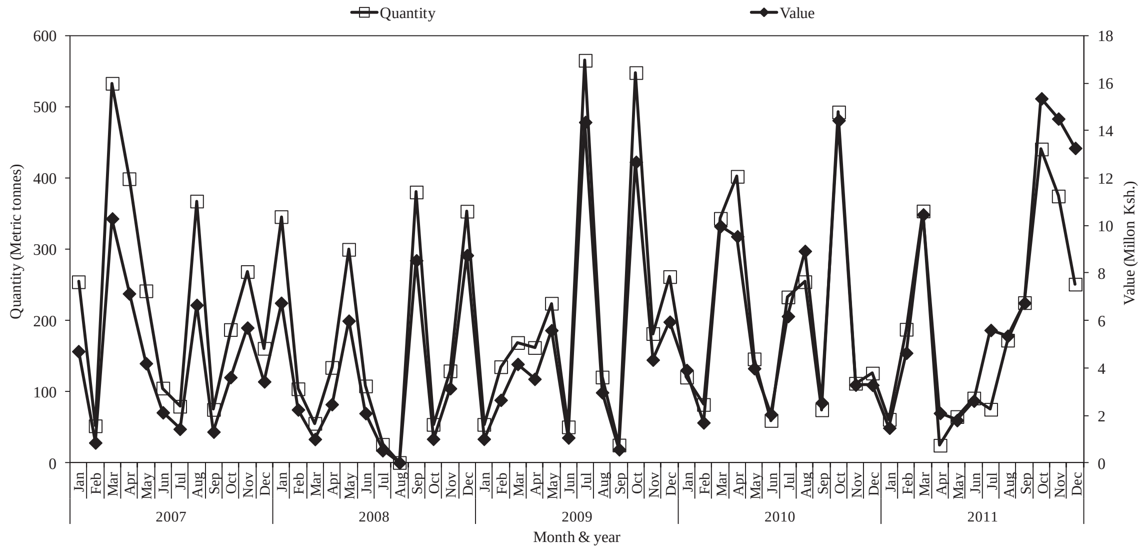


Figure 21. Time series of imported marine fishery pelagic fishery products, 2007-2011.

The marine fisheries imports products from 2007 to 2011 comprised mainly of medium and small pelagic fisheries, accounted for 56.percent and 29.1 percent of the total tonnage, respectively. The small pelagic fishery imports (tonnes) declined by 55.4 percent to 529 tonnes in 2007 over the five-year period (Figure 22). The main countries of origin for imported marine fishery products were Japan (22.4 percent) Korea (20.2 percent) and India (12.7 percent), largely exporting frozen mackerels and sardines to Kenya. These imports are mainly from the distant waters fishing fleet (DWF) operating in the south West Indian Ocean and offloading at the Kenyan port where the fishery products are further processed for export by local establishments. The establishments also facilitate the transhipment of some unprocessed marine fishery products to European processing companies from foreign-flagged vessels.

Table 13. The marine fishery products imported in Kenya, 2007-2011

Year	Products	Quantity (tonnes)	Value (Million KES)
2007	Frozen Herrings	583.0	10.74
	Frozen Mackerels	1 537.4	29.13
	Frozen Sardines	603.5	11.58
2008	Frozen Brazilian Menhaden	0.5	0.01
	Frozen Herrings	610.6	14.63
	Frozen Mackerels	971.5	20.37
	Frozen Sardines	403.0	7.41
	Frozen Yellow Tail Scad	5.0	0.09
2009	Frozen Herrings	96.0	2.43
	Frozen Mackerels	1 689.4	41.43
	Frozen Pacific Saury	25.0	0.58
	Frozen Sardines	658.1	13.57
	Frozen Sharks	3.5	0.26
	Frozen Tuna	23.8	0.54
	Salted Sharks	1.0	0.08

Year	Products	Quantity (tonnes)	Value (Million KES)
2010	Dried Sharks	60.0	1.26
	Frozen Dolphinfish	20.5	0.71
	Frozen Herrings	22.3	0.82
	Frozen Koheru	27.0	0.72
	Frozen Mackerels	1 748.9	50.00
	Frozen Sardines	485.0	10.35
	Frozen Sharks	36.9	3.44
	Frozen Tuna	30.6	2.07
2011	Dried Sharks	67.0	1.34
	Fresh Salmon	0.3	0.06
	Frozen Mackerels	1 604.7	58.67
	Frozen Sardines	529.0	15.71
	Frozen Sharks	13.7	1.88
	Frozen Tuna	107.4	6.24
	Smoked Salmon	0.1	0.01
Total		**11 979.5**	**306.59**

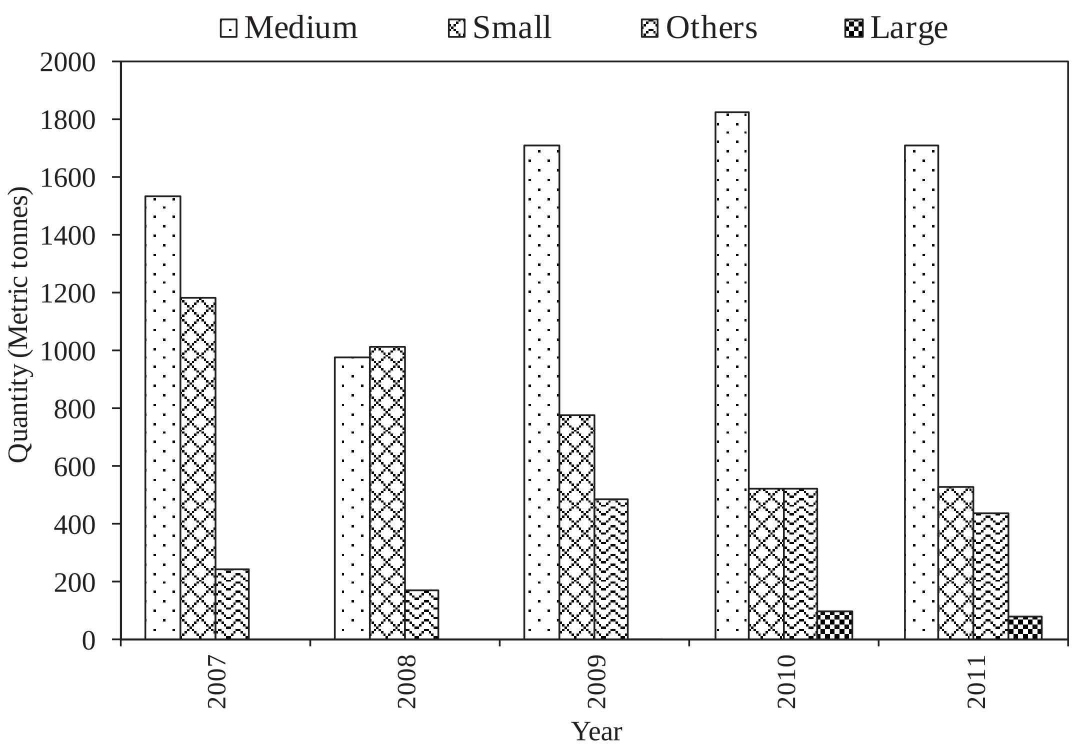


Figure 22. Quatity of imported small and medium pelagic fisheries products from 2007-2011. Medium pelagic = 56.1 percent; small pelagic = 29.1 percent; large pelagic = 1.3 percent and other fisheries such as crustaceans and demersals = 13.3 percent.

Employment of activities in value-addition and linked to the marine fisheries sector

Nationally, 798 000 Kenyans were, directly or indirectly, supported by the marine fisheries sector in 1995 compared to 720 000 in 1993. In the same year (1995), there were 34 000 fishermen with an estimated 238 000 dependants and about 526 000 other people engaged in the provision of support and ancillary services such as trade in fish inputs, fish handling, processing and marketing. The main Kenyan establishments involved in the marine fisheries sector are highlighted on Table 14. These companies mainly produce frozen and chilled fish for export to European and other non-European markets.

Table 14. Main establishments involved in processing of marine fish and fisheries products. **Source**: Ministry of livestock and fisheries development, Mombasa.

Establishment (# of employees)	Location	Raw Product	Source of Raw Material	Processed Product	End Product Destination
Wananchi Marine Products (375)	Liwatoni	• Tuna spp (Bigeye, Skipjack, Yellow fin)	Seychelles, Spain	• Cooked frozen tuna loins	Italy, Spain,
Amco Foods Ltd (16)	Shimanzi	• Octopus	Shimoni, Vanga	• Frozen octopus	• Italy, Spain
		• Nile perch	Lake Victoria	• Nile perch fillets	• South Africa, Italy
Crustacean Processors (20)	Shimanzi	• Octopus	Shimoni, Vanga	• Frozen Octopus	• Portugal, Italy
Transafrica Fisheries (22)	Majengo	• Octopus • Lobster	-Shimoni, Vanga	• Frozen octopus • Frozen whole lobster	• Italy, Malta, Portugal, Greece,
Sea Harvest (89)	Mikindani	• Octopus	Kipini, Ukunda , Vanga,	• Frozen octopus	• Portugal, Italy, Spain, France
		• Lobster	Shimoni,Kilifi, Mayungu	• Frozen whole lobster	
Kenya Dry Products (30)	Kongowea	*Haplochromis* spp (Fulu)	Lake Victoria	Dried Fulu	Denmark

6. Fisheries management plan and objectives

There exists no management plan directly addressing the small and medium pelagic fishery along the Kenyan coast. The Prawn Fishery Management Plan 2010 (Legal Notice 20) (see below) is the only management plan addressing marine fisheries of Kenya. Three other fisheries management plans are at different stages of development and have objectives beneficial to the pelagic fishery ecosystem. These include the draft lobster fishery management plan, the draft aquarium fishery management plan and the draft ringnet fishery management plan, with the later directly addressing the pelagic fishery.

Draft Ringnet Fishery Management Plan (RFMP)

The broad objective of draft Ringnet Fishery Management Plan (RFMP, May 2012) is to ensure an ecologically sustainable pelagic fishery that provides long-term socioeconomic benefits to Kenyans in terms of food security, employment creation and national revenues; and promote comanagement in the sustainable use of ringnets. The specific objectives of the Management Plan are to:

a) regulate the harvesting of pelagic fishes using ringnets;

b) develop mechanisms to enhance responsible exploitation of pelagic fish stocks;

c) improve the net income for fishing community and national revenues;

d) develop regulations and mechanisms to enhance enforcement and compliance for ecosystem management;

e) initiate long term monitoring and implement demand driven research for the pelagic fishery

Ringnet fishing operations are prominent in Vanga, Shimoni, Gazi, Mtwapa, Kilifi, Takaungu, Mayungu, Ngomeni, Kipini and Watamu (see Appendix 3). Ringnet fishing season starts from October to April with peak productivity occurring between the months of November and March (Okemwa *et al*., in prep; Munga *et al.*, 2010a;b; Taskforce Report, 2005). The preparation of the ringnet management plan was triggered by the many socio-economic issues and conflicts arising from mixed perceptions about the gear within the fishing communities between artisanal, fish traders, sport fishers, dive operators, government agencies, and environmentalists (RFMP Discussion paper, Okemwa *et al*., in prep). The consultation meetings on ringnet operations date back to year 2005. The draft of the ringnet fishery management (RFMP May 2012) was circulated to stakeholders for review and a presented to the public in a workshop held in Malindi in May 2012. The final draft is expected to be submitted to the Director of Fisheries after incorporating the stakeholder's views.

The prawn fishery management plan 2010 (legal notice 20) - PFMP

The PFMP is the first marine fisheries management plan in Kenya. The management plan adopted under section 5 of the Fisheries Act covers shallow and deep water prawn species. The management plan covers the method of single vessel otter trawl, stern trawl and paired beam-trawl fishing methods and other methods that are legally approved, such as prawn seine nets and cast nets by artisanal fishers. The prawn fishery (shallow water species of the Family Penaeidae: *Penaeus indicus, Penaeus monodon, Penaeus semisulcatus*) covered in this management plan is concentrated in the shallow coastal waters around Malindi-Ungwana Bays and the deep water prawns species including *Heteropcarpus woodmansonii, Melicertus marginatus, Sqilla mantis and Panaeopsis balsii.* It provides several management measures to ensure a biologically sustainable and economically viable prawn fishery. The aim is to ensure creation of employment, wealth, national revenues and foreign exchange earnings, fish products and protection of the prawn fishery and habitat in the long term. To ensure equitable sharing of benefits, it recognises the need to empower local people to utilise the prawn fishery using artisanal technology and employment of local people in semi-industrial prawn fishery. The plan recommends for the establishment of a Community Trust Fund whose benefits shall be distributed through the Beach Management Units.

The Draft Lobster Fishery Management Plan for Lamu District, 2010 (LFMP)

The need for an ecologically and economically sustainable lobster fishery in Kenya led to the development of a draft management plan led by the Ministry of Fisheries development from 2009. The Management Plan shall cover all species of Lobsters of the Family Pinuliridae including the principal five shallow water species of spiny lobsters: *Panulirus ornatus, P. longipes, P. penicillatus, P. versicolor, P. homarus* locally known as “Mwani”, ‘’Mwilo”, “Kijiwe”, “Kurabu”, “Springi” respectively and *P. dasypus* occasionally appearing in the catches. The Management Plan shall also cover the deep water species

Scyllarides squammosus, S. tridacnophaga and Thanusorientalis sp. The main shallow water artisanal fishing method in the lobster fishery is skin diving, using fins and face mask and using octopus to scare the lobster from crevices into a scoop net (*Kimia na pweza*). Other known and legal methods of fishing include gill netting and trapping.

The broad objective of the management plan is to ensure the continuation of a biologically sustainable and economically viable fishery thereby providing benefits to Kenyans in terms of creation of employment, wealth, national revenues, fish products and certification of the lobster fishery to meet and maintain the Marine Stewardship Certification (MSC) standards. The specific objectives of the management plan are to:

i. Regulate the lobster harvesting so that the size of the stock tends towards that which will give the sustainable yield, through the management of fishing capacity so as to ensure a healthy stock for the present and future generations.

ii. Promote safe, harvesting, handling and transportation of lobsters so as minimize impacts on the environment, non-target species, marine mammals and turtles.

iii. Establish and define mechanisms for management standards, enforcement and compliance.

iv. Establish a monitoring and evaluation mechanism for the prawn fishery.

v. Promote comanagement of the fishery; data collection and development of marketing information system.

The consultation meetings held during the preparation of the draft management plan were an important step in bringing together fishermen, researchers and managers (Mueni *et al*., 2009; Maina *et al.* 2010; Maina and Samoilys, 2010). During the meetings, it was evident that the biological, ecological and socioeconomic implications of fishing for lobsters need to be better understood (Maina and Samoilys, 2010). Since the draft management plan only covered areas within Lamu, there has been a view that the draft LFMP be expanded to cover the whole Kenyan coast. This is also to fulfill the Marine Stewardship Council (MSC) certification requirement. In response to the concerns within the lobster fishery industry, and the high value of the trade, the Ministry of Fisheries Development selected this fishery to undergo preassessment for MSC certification. The fishery is currently undergoing a process of fishery improvement.

The Development of marine aquarium fishery management plan

The aquarium fishery had been under subsistence practice from 1970's to and expanded to attain commercial significance in 2000's. It commercialization has exerted enormous pressure on the coral reef fisheries and has resulted to a myriad of complains from the fisher community. The Ministry of Fisheries Development through the Provincial Director of Fisheries, Coast, initiated a process of drafting the marine aquarium fishery management plan in 2010 (FiD, 2010). Since then, no other activities have been held to steer this activity forward. The purpose the fishery management plan is to develop a vibrant ornamental industry that provides sustainable and equitable benefits to all while conserving the long-term ecological integrity of the targeted species along the coast of Kenya.

Objectives for the small and medium pelagic fishery

In the absence of a management plan, the objectives of the government of Kenya with regard to the small and medium pelagic fishery are addressed indirectly through various policy documents, legislations and Acts particularly the National Oceans and Fisheries Policy 2008 (see section on Legal framework), the Prawn Fishery Management Plan 2010 (see above), Fisheries (Beach Management Units) Regulations of 2007 and the Fisheries Act CAP 378 of 1991 (see section on Legal framework). The ring net fishery management plan (zero draft) seeks to address the marine fisheries waters of Kenya with objectives directly addressing the small pelagic fishery with far reaching impacts on the medium pelagic fishery.

7. Legal framework

The main laws governing fisheries activities in Kenya (including small and medium pelagic fisheries) are the Fisheries Act Cap 378 (1991) and the Wildlife (Conservation and Management) Act Cap 376. The Fisheries Management and Development Bill will become the new Principal Fisheries Act upon approval by the parliament and ascent by The President. There are also a number of other national, regional and international legal frameworks covering Kenyan coast fisheries, and are listed and discussed in detail below.

National legal and policy frameworks

Constitution of Kenya Act, 2010

The importance of environmental protection is elevated though several articles on rights of the people and responsibilities of the state on environmental matters. Article 42 gives “every person the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures”. Chapter 5, Part 2 covers environment and natural resources. To eliminate processes and activities likely to endanger the environment, Article 69 states that “1) The State shall a) ensure sustainable exploitation, utilisation, management and conservation of the environmental and natural resources, and ensure the equitable sharing of the accruing benefits; b) work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya; c) protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources of the communities; d) encourage public participation in the management, protection and conservation of the environment; e) protect genetic resources and biological diversity; f) establish systems of environmental impact assessment, environmental audit and monitoring of the environment; g) eliminate processes and activities that are likely to endanger the environment; and h) utilise the environment and natural resources for the benefit of the people of Kenya”. Article 70 of the Kenyan Constitution deals with enforcement of environmental rights while Articles 71 and 72 deal with agreements relating to natural resources and legislation relating to the environment respectively.

Fisheries act cap 378, 1991

The Act’s objective is to provide a legal framework for the management, exploitation, utilization and conservation of fisheries resources in Kenya. It is however applied in cross-reference with other related laws. The Act restricts destructive practices and advocates for the protection of fish breeding areas. It considers illegal use of certain nets or under-sized mesh, beach seine, spear guns and dynamite fishing. It also protects coral reef fisheries away from protected areas. The Fisheries Act also regulates licensing of local and foreign fishermen and fishing vessels, fisheries scientific research, landings and landing sites and puts restrictions on purchase of fish. The Fisheries Bill (awaiting parliamentary approval) will become the new Principal Act that will cover all fisheries activities.

National Oceans and Fisheries Policy 2008

The policy provides a coordinated framework for addressing the challenges facing the fisheries sector and guides the sustainable development of fisheries in line with the Economic Recovery Strategy (ERS), the Strategy for Revitalizing Agriculture (SRA) and the National Vision 2030. It recognizes inter-jurisdictional aspects of marine fisheries, calling for collaboration and cooperation in the management of migratory/shared stocks. It further encourages the development of specific fishery management plans.

The Fisheries (Beach Management Units) Regulations, 2007 (Legal Notice 402)

The regulations outline the objectives of Beach Management Units (BMUs), their administrative structure, area of jurisdiction and mandate in comanagement. They promote the cooperation amongst fishermen and their participation in the overall management of fisheries resources and landing areas, as is provided for in the Fisheries Act CAP 378, 1991 and its subsidiary legislations. Fishermen are given comanagement rights, enshrined in by-laws, which must be approved by the Director of Fisheries.

Fisheries (safety of fish, fishery products and fish feed) regulations, 2007 (legal notice no. 170.)

The Fisheries Department (FiD) is given the responsibility for the official control of the safety of fish, fishery products and fish feed. The Competent Authority – Fisheries Department – is therefore mandated, in collaboration with other Government agencies, to oversee the implementation of regulations governing proper monitoring of fish from harvest, sorting, handling, transportation, processing, storage and market. The competent authority monitors and controls these processes to ensure that there is no risk to human health.

Fisheries (foreign fishing craft) (amendment) regulations, 2004 (Legal Notice No. 20)

These regulations outline the license fees and conditions for foreign fishing craft operating in the Kenyan waters of the Indian Ocean.

Draft environmental policy, 2009

The policy provides a framework for sound environmental and natural resource governance by mainstreaming environmental considerations into sectoral policies and strengthening regional and international cooperation in environmental management.

Integrated coastal zone management (ICZM) action plan for Kenya, 2011

It aims to "conserve the coastal and marine environment and to ensure that its resources are utilised in a sustainable manner for the benefit of coastal communities and the national economy". It guides stakeholders in conservation and development of the coastal zone. It further supports institution of a legal framework and strengthening institutional framework for ICZM. The action plan hopes to ensure effective and efficient implementation of environmental plans and that they are mainstreamed into development processes.

National environmental action plan 2009-2013 (NEAP)

The plan aims at enhancing the integration of the environment in development planning. It describes the country's main profile, environment and natural resources, human settlements and infrastructure, environmental aspects of trade, industry and service sectors. It also discusses environmental information, networking and technology, Governance, Policy and Legal Framework as well as Institutional arrangements and implementation modalities and monitoring and evaluation strategies. It proposes for instance, interventions against environmental concerns for the fishery industry. Interventions proposed in the plan include enhancing water catchment and land use management, enforcement of relevant legislation, promotion of sustainable fisheries development and management, undertaking research and strengthening collaborations on invasive and alien species management and intensification of surveillance of fishery activities within the EEZ. It further includes an Environment and Natural Resources Implementation Strategy that integrates environmental concerns into development planning and implementation. The strategy states the different sectors such as fisheries and coastal and marine resources, the priority issues, objectives, output expected activities to be undertaken, the lead institutions, the time frame and the budget.

Provincial environment action plan (PEAP) for coast 2009-2013

The Plan provides environmental management strategies and actions that integrate environmental concerns into social and economic development planning at District (DEAPs), Provincial (PEAPs), and National (NEAP) levels as per the provisions of Articles 37 and 38 of EMCA 1999. NEAP highlights priority themes and activities for the country towards achieving sustainable Development.

Environmental management and coordination act (EMCA) 1999

The National Environment Council (NEC) was established by Section 4(1) of EMCA. The NEC's primary function is policy formulation and direction for the purposes of EMCA. EMCA provides for an appropriate legal and institutional framework for the management of Kenya's environment and matters connected to the protection of the environment. Section 7 (1) established National Environment Management Authority (NEMA) as the principal instrument of government in the implementation of all policies relating to the environment. NEMA became operational in 2002. Section 55, of EMCA acknowledges the central role of ICZM in the protection of marine and coastal systems. Section 71(d) of the Act stipulates that the Standards and Enforcement Review Committee, in consultation with relevant lead agencies, shall prepare and recommend to the Director-General guidelines or regulations for the preservation of fishing areas, aquatic areas, water sources and reservoirs and other areas where water may need special protection.

Maritime zones act, chapter 371, 1989

The Act consolidates the laws relating to the territorial waters and the continental shelf of Kenya. It recognizes the existence of a 200 nautical mile Exclusive Economic Zone (EEZ) from the baseline and sets out the limits of Kenya's territorial waters extending up to 12 nautical miles from the baseline. The Act gives the Minister's powers to make regulations on the exploration, exploitation, conservation and management of the maritime zones. The Act also provides a legal framework for the management and development of fisheries resources.

The Act provides rules for the licensing and control of maritime service providers. This Act provides for the registration and licensing of Kenyan ships. It has a crucial role in regulating shipping activities in inshore areas and in the Kenya's EEZ. The Act has provisions for maritime safety, security, pollution control and environmental conservation.

The poverty reduction strategy paper (PRSP) 2001

The PRSP identified the following key issues in fisheries: low incomes for fish farmers and low earnings in the fish industry; low production of fish; and lack of fish marketing infrastructure. The paper proposed priorities for intervention including the need for: improvement of infrastructure such as access roads, portable water, cold storage, land ownership and access to beaches and landing sites. Other proposed priorities include a review of legal framework for fisheries, development of innovative saving and credit system and promotion of fish marketing.

Economic Recovery Strategy (ERS) 2003-2007

The Economic Recovery Strategy (ERS) 2003-2007 proposed several interventions in fisheries such as development of facilitative infrastructure including landing beaches, cooling plants and access roads to reduce wastage and to achieve required sanitary and health standards. It also proposed entering into agreements to promote closer regional cooperation in the management and regulation of transboundary fishery resources.

Strategy for Revitalizing Agriculture (SRA) 2004-2014

The SRA 2004-2014, reiterates the interventions proposed in the ERS paper. It proposes the promotion of the production of salt-water products such as shrimps, whilst providing for better legislation and enforcement of fishing gear, trawling and pollution control. The SRA 2004-2014 also acknowledged that high costs have prevented development of modalities for utilizing fishery resources in the EEZ. Value addition through processing is also emphasized in the SRA 2004-2014.

Vision 2030

Vision 2030 identifies fisheries alongside crop agriculture and livestock as key sectors. It proposes, *inter alia*, to raise incomes in the fisheries sector by processing thereby adding value to products before they reach the market. Innovative, commercially oriented and modern technology will be adopted in the fisheries sector. It is expected that improved fishery management will have a significant impact on efforts to achieve Millennium Development Goals (MDGs) in Kenya. Improved fisheries management is expected to assist in reducing by half the proportion of the human population that suffers from hunger and malnutrition. The challenge is to ensure that those who depend on fish for food and livelihoods, particularly coastal/marine populations, continue to get these important benefits.

International legal frameworks

East African Community (EAC) Treaty and protocols

The regional intergovernmental organization of EAC includes Republics of Kenya, Uganda, the United Republic of Tanzania, Republic of Rwanda and Republic of Burundi. The treaty for the establishment of the EAC aims at achieving food security by developing fish farming. It aims at adoption of common policies and regulations for the conservation, management and development of fisheries resources. It also proposes establishment of a common fisheries management and investment guidelines.

The objective of the cooperation in agricultural sector is stated in Chapter 18; Article 105 of the treaty is to achieve food security and rational agricultural production within the Community. Chapter 19 Article 114 b (ii) emphasizes the need for common policies and regulations for the conservation, management and development of fisheries resources. Article 10 (1) of the protocol grants free movement of workers who are citizens within their territories. The protocol allows for free movement of goods, services, labour and capital plus the right of establishment and residence. This means that migrant fishers are allowed to move freely between Kenya and Tanzania.

UNCLOS 1982

The UN Convention on the Law of the Sea Convention constitutes the overall legal framework for the seas and oceans of the world. It provides a more effective framework for the management and conservation of marine living resources. It establishes maritime zones and boundaries, including the territorial waters (12 nautical miles from the baseline) and EEZ (200 nautical miles from the baseline).

The Convention on Biological Diversity (CBD) 1992

The Convention (and its Cartagena Protocol on Biodiversity) provides the main global framework for the protection of all types of biodiversity. The CBD's second conference of parties (Jakarta Mandate) on marine and coastal biological diversity expressed deep concern "at the serious threats to marine and coastal biological diversity". The conference of parties decision also affirms the FAO's Code of Conduct for Responsible Fisheries, the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and the Washington Declaration and Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, and supports their implementation.

The Nairobi Convention 1985

The Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region and its additional protocols constitute the regional legal framework for our maritime zone. Its additional Protocol on Specially Protected Areas and Wildlife (SPAW) applies specifically to coastal and marine biodiversity. The Protocol is applicable to the small and medium pelagic fishery as it supports regulating the fishery to protect endangered species and coral reefs.

The FAO Framework

The Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries and the FAO Technical Guidelines for Responsible Fisheries, as well as various Technical Papers, also provide further context and basis for pelagic fisheries management. Adopted in 1995, it is a voluntary rather than mandatory instrument, and is aimed at everyone working in, and involved with, fisheries and aquaculture, irrespective of whether they are inland or oceanic. It was developed through contributions from representatives from FAO member countries, inter-governmental organizations, the fishing industry and nongovernmental organizations. It therefore represents a global consensus or agreement on a wide range of fisheries and aquaculture issues. Through the FAO Code of Conduct, States are expected to encourage industry and fishing communities to develop codes of good practice that are consistent with, and support, the goals and purposes of the Code of Conduct.

UNCED Agenda 21 (1992), chapter 17

Chapter 17 highlights some of the key issues in oceanic fisheries, including poor management of fisheries resources, over utilization of resources, with problems of unregulated fishing, over capitalization, excessive fleet size, vessel re-flagging to escape controls, insufficiently selective gear, unreliable data bases and lack of sufficient cooperation among the states. Agenda 21 helps clarify the issues in marine and coastal fisheries and proposes management interventions.

UN Fish Stock Agreement, 1995

The agreement is concerned with conservation and management of straddling and highly migratory fish stocks. This is due to the transboundary nature of these stocks, whose conservation and management require cooperation between coastal States and States fishing on the high seas.

REYKJAVIK Declaration on Responsible Fisheries on the Marine Ecosystems, 2001

The declaration recognized among other things that sustainable fisheries management takes into account the impacts of fisheries on the marine ecosystem and the impacts of the marine ecosystem on fisheries. The objective of including ecosystem considerations in fisheries management is to contribute to the long-term food security and to human development and to ensure the effective conservation and sustainable use of the marine ecosystem. The declaration further declared the commitment to implement the FAO Code of Conduct, international plans of action as well as the Kyoto Declaration and Plan of Action on the Contribution of Fisheries to Food Security. Other agreements included the need for effective management plans, strengthening regional and international fisheries management organizations, prevention of adverse effects of non-fisheries activities on marine ecosystems and fisheries and advancing the scientific basis for incorporating ecosystem considerations in fisheries management. It also called for international support and cooperation for developing countries to successfully incorporate ecosystem considerations into fisheries management.

8. Institutional and administrative frameworks for fisheries management

The main institutions and their relevance to the small and medium fishery are highlighted in Table 15 and key institutions discussed further.

Table 15. Main institutions relevant in the fisheries sector

Institutions	Role/Interest
Government institutions	
Fisheries Department	Exploration, exploitation, utilisation, management, development and conservation of fisheries resources
Kenya Marine and Fisheries Research Institute (KMFRI)	Research on aquatic and coastal resources and environment
Beach Management Units (BMUs)	Exploitation and participatory management fisheries resources and landing areas
Kenya Wildlife Service (KWS)	Conservation and management of wildlife and enforcement of related laws and regulations. In charge of Marine Protected Areas
Forestry Department	Management and conservation of Kenya’s forests
Kenya Navy	Security and Surveillance international boarders including EEZ
Kenya Maritime Authority (KMA)	Custodian of laws relating to the territorial waters.
Kenya Ports Authority (KPA)	Port management including cargo handling and regulation
National Environmental Management Authority (NEMA)	Oversee the implementation of EMCA, 1999. Supposed to be Kenya’s lead environmental watchdog

Institutions	Role/Interest
Coast Development Authority (CDA)	Initiates and support developmental projects at the Kenyan coast.
East African Community (EAC)	Promote integration of East Africa states. Provides for a legal framework to effectively streamline the management of trans-boundary ecosystem to enhance the quality of environment and ensure sustainable utilization of shared natural resources
Marine police	Maintain security and order within the maritime zones
Local Universities	Marine and coastal based studies
Non-government organizations	
Worldwide Fund for Nature (WWF)	Environment conservation and management
Tuna Fisheries Alliance of Kenya (TUFAK)	Advocacy on Tuna fishery in the Kenya and regionally.
Kenya Fish Processors & Exporters Association (AFIPEK)	Ensure vibrant fish processing industry and sustainable management of fisheries resources
Kenya Marine Forum (KMF)	Advocacy on marine environment
CORDIO East Africa	Coastal oceans Research and development, climate change
Wildlife Conservation Society	Research and monitoring of coral reefs ecosystems, climate change
EcoEthics International Kenya Chapter	Advocacy, social development, environment education and awareness
Coast Development Research Organization (CDRO)	Advocacy, social development, environment education and awareness
Coastal and Marine Resources Development (COMRED-Africa)	Coastal oceans Research and development
East Africa Wildlife Society (EAWLS)	Environment and wildlife conservation, and Advocacy
KWETU training centre	Promoting diversified and sustainable livelihood activities, management of natural resources and community capacity building.
Act Change and Transform (ACT)- formerly PACT Kenya	Capacity building and development, advocacy
Community Action for Nature Conservation (CANCO)	Advocacy, capacity building and training

Fisheries Department

A government authority charged with the responsibility of regulating commercial and artisanal fishing in Kenya's waters. It is mandated under the Fisheries Act Cap 378 with the development, management, exploitation, utilization, and conservation of the Kenyan fisheries resources. The Fisheries department is rolling out of Beach Management Units (BMU) to strengthen comanagement of marine fisheries resources.

Kenya Marine and Fisheries Research Institute (KMFRI)

KMFRI was established by the Science and Technology Act, Cap 250 of the Laws of Kenya to conduct research on marine and freshwater fisheries, aquatic biology, aquaculture, environmental chemistry, ecological, geological and hydrological studies, as well as chemical and physical oceanography. The institute undertakes research sustainable management and exploitation of coastal and marine resources. Some major regional and national projects relevant to marine fisheries are housed at KMFRI, such as the South West Indian Ocean Fisheries Project (SWIOPF) and Kenya Coastal Development Project (KCDP) which aims to promote environmentally sustainable development at the coast.

Kenya Forestry Service (KFS)

KFS is a state corporation established under the Forest Act 2005 to conserve, develop and sustainably manage forestry resources for socioeconomic development. The service is responsible for the protection and management of forests in Kenya, including mangrove forests.

Kenya Navy

The Kenya Navy primary roles include policing of Kenya's territorial waters, protection of vital areas and surveillance of the EEZ. Recently, Kenya Navy has been involved in ensuring security along Kenya's coastal waters and boarder with Somalia, greatly affecting fishing activities.

Marine police

Marine police assist in maintaining security, law and order along the marine waters. Functions of the Kenya marine police that are relevant to pelagic fisheries include provision of internal security along the Kenyan coast, keeping vigil of maritime operations and activities, controlling terrorism activities, carrying out search and rescue operations for fishermen and enforcement of IMO rules, observations and regulations.

Kenya Maritime Authority

Mandated under KMA Act 2006 to regulate, coordinate and oversee maritime affairs in Kenya. It helps in the protection of the environment (e.g. prevention of maritime pollution which benefits fisheries) in compliance with national laws and international conventions. The KMA is also involved in rescue operations within the sea and in registration of fishing vessels and prescribing regulations for their safety. KMA has powers to regulate the exploration, exploitation, conservation and management of the maritime zones.

National Environmental Management Authority (NEMA)

A government parastatal established to oversee the implementation of the Environmental Management and Coordination Act (EMCA), 1999. It is supposed to be the lead environmental watchdog with the official mandate to ensure environmental compliance and enforcement and undertake public awareness and education, among other mandates. NEMA has been in the lead in development of Integrated Coastal Zone Management (ICZM) action plan and other policies, guidelines and programmes relevant to the coastal and marine environment. This is aimed at ensuring sustainable utilization and conservation of coastal and marine resources

Kenya Wildlife Service

KWS established by an Act of Parliament, Cap 376, (revised edition 1985, see Legislation review report No.3) is mandated conserve and manage wildlife in Kenya for the Kenyan people and the world and to enforce related laws and regulations. KWS has sole jurisdiction over National Parks, supervisory role in the management of National Reserves, local and private sanctuaries, license, and control and supervise all wildlife conservation and management activities outside the protected areas and is also tasked with conservation, education and training and conducting wildlife research.

Coast Development Authority (CDA)

CDA is a statutory body (established by an Act of Parliament, Cap 449, 1990) whose mandate is to initiate, plan, coordinate and implement integrated development programmes and projects mainly within the coastal region and its environs. CDA aims to ensure sustainable utilization of coastal resources including those in the EEZ (e.g. fisheries) for the benefit of communities in the coastal region. The CDA is involved in activities such as construction of fishponds. It also supports artisanal fishermen through establishment of microcredit and savings schemes to enable them acquire capital for purchase of better and improved fishing gears.

Kenya Ports Authority (KPA)

KPA is a statutory body established by an Act of Parliament Cap 391, 1978. KPA is mandated to maintain, regulate and improve seaports. It ensures among other things that there is safe navigation and controls pollution of the coastal waters.

8.1. National and regional forums for discussions on fisheries management

Tuna Fisheries Alliance of Kenya (TUFAK)

TUFAK was formed to support Tuna fisheries management in Kenya's EEZ. For a long time, Kenya has never had a forum for tuna discussions, until the year 2011, when the idea of Tuna Alliance of Kenya was put into practice. East Africa Wildlife Society (EAWLS) and Community Action for Nature Conservation (CANCO) have recently been active promoting a Civil Society Organization (CSO)/Private Sector Alliance on Tuna Fisheries Management through Tuna Fisheries Alliance of Kenya (TUFAK). The Alliance aims to ensure active involvement of CSOs in the management of tuna resources in the Kenya taking into consideration the regional perspectives. So far the Alliance has managed to: a) gather support for a CSO consultative workshop on tuna fisheries management in Kenya; b) facilitate a tuna taskforce for the drafting of national CSO Tuna Engagement Strategy for Kenya; and c) prepare, produce and print tuna advocacy and awareness creation materials. TUFAK intends to continue supporting and strengthening the Civil Society Organization and the private Sector on Tuna Fisheries Engagement Network as well as support implementation of key activities on Tuna Engagement Strategy. This will build positive engagement between the network and the government for the sustainable management of the Tuna fishery.

The National Environmental Civil Society Alliance (NECSA)

NECSA is an implementation committee overseeing the quality of the government's rolling out of environmental legislation within the new Constitution. Any advocacy issues on environmental legislation should take advantage of NECSA's existence and approach the issues from both County and National levels. NECSA also collaborates with the Constitutional Implementation Committee (CIC).

Kenya Fish Processors & Exporters Association (AFIPEK)

AFIPEK is a professional Association of the large-scale industrial fish processors in Kenya. AFIPEK target mainly fish products from artisanal fishermen for domestic and export market. AFIPEK's has works towards fostering public recognition and support for the fishery sector, to promote high quality fish and fish products and to advocate for the effective management of Inland and marine fish resources.

The East African community (EAC)

The EAC was established through the Treaty for the Establishment of the East African Community, 2007. Chapter 18, Article 105 of the treaty aims to achieve food security and rational agricultural production within the Community. Chapter 19 Article 114 b (ii) emphasizes the need for common policies and regulations for the conservation, management and development of fisheries resources. Article 10 (1) grants free movement of workers who are citizens within their territories. The protocol allows for free movement of goods, services, labour and capital plus the right of establishment and residence. This means that migrant fishers are allowed to move freely between Kenya and Tanzania.

Kenya Coastal Development Project (KCDP)

KCDP is a World Bank sponsored project aimed at promoting an environmentally and socially sustainable utilization of Kenya's coastal and marine resources. The project is poised to help coastal zone communities achieve social and economic wellbeing, improve their standards of living and create wealth by empowering them to identify viable livelihood activities. It has four components namely: Sustainable Management of Fisheries Resources; Sound Management of Natural Resources; Support of Alternative Livelihoods and Capacity Building, Monitoring and Evaluation, communication and Implementation of the Coastal Village Fund. KCDP implementation is through partnership of the Ministry of Fisheries Development (Fisheries Department and KMFRI), the Ministry of Forestry and Wildlife (KEFRI and KWS), Ministry of Regional Development (CDA), Ministry of Environment and Mineral Resources (NEMA) and the Ministry of Lands (Development of Physical Planning) in collaboration with a number of CBOs, NGOs and the private sector. KMFRI is the lead institution.

The Agulhas and Somali Currents Large Marine Ecosystems Programme (ASCLME programme)

The ASCLME programme in the Western Indian Ocean (WIO) is a Global Environmental Facility (GEF) initiative that consists of three inter-linked modules that address fisheries, ocean productivity and the influence of land-based activities on the marine environment. The three modules are the Agulhas and Somali Currents LME project (ASCLME project, UNDP), the WIO-Lab project (UNEP) and the South Western Indian Ocean Fisheries Project (SWIOFP) whose overall goal is to see the West Indian Ocean's marine resources ecologically managed for sustainable use and benefit by the region's riparian countries. The ASCLME project aims define clearly the ecosystem boundaries, understand the major transboundary environmental impacts within these ecosystems (by conducting Transboundary Diagnostic Analyses) and develop Strategic Action Programmes (SAP) for effective management and governance of these ecosystems. The ASCLME Project is capturing essential information relating to the dynamic ocean-atmosphere interface and other interactions that define LMEs, as well as data on fisheries, coastal populations and critical habitats. The Project is building capacity at the national and regional level and helping to create effective strategies for evolving information into policies and governance mechanisms that support the sustainable management of marine and coastal resources.

South Western Indian Ocean Fisheries Project (SWIOFP)

The SWIOFP is a 5-year project (2008-2012) that addresses shared, transboundary and migratory fish stocks of nine countries along the WIO countries: South Africa, Mozambique, Tanzania, Kenya, Seychelles, Comoros, Madagascar, Mauritius and France. SWIOFP aims to collect relevant information to support regional management of fish stocks and build scientific and fisheries management capacity. It is subdivided into six operational Components: Data and IT; Crustacean fisheries; Demersal fisheries; Pelagic fisheries; Biodiversity issues; and Fisheries management (van der Elst *et al*., 2009). This document deals with Component 4 of SWIOFP (i.e. pelagic fisheries). All nine SWIOFP countries have significant pelagic fisheries and datasets, and participate actively in this Component.

The Indian Ocean Tuna Commission (IOTC)

IOTC is an intergovernmental organisation mandated to manage tuna and tuna-like species in the Indian Ocean and adjacent seas. It does so by promoting cooperation among its Members to ensure the conservation and optimal utilisation of tuna and tuna-like stocks and encouraging sustainable development of fisheries based on such stocks through proper management.

SmartFish

SmartFish is a European Union funded programme financed under the 10th European Development Fund implemented by the Indian Ocean Commission (IOC) in collaboration with Common Market for East and Southern Africa (COMESA), the East Africa Community (EAC) and the Inter-Governmental Authority on Development (IGAD). The programme covers Eastern and Southern Africa and the Indian Ocean Region (ESA-IO). The SmartFish project focuses on fisheries management, fisheries governance, trade, food security, and Monitoring, Control and Surveillance. Eventual beneficiaries of the programme include fishermen, coastal communities, other stakeholder groups and wider populations of ACP states of the ESA-IO region.

9. Management measures and tools currently in use and status of implementation

Table 16 summarizes the management measures applied to the pelagic fishery sector of Kenya.

Table 16. Set of management measures or tools currently being applied in pelagic fishery sector. "√." indicates existence of the management measure or tool.

Type of Management Tool	Tick	Comments
Spatial (area) restrictions and closures		
Marine protected areas where fishing is prohibited	√	Marine parks and reserves exist since 1968 (Table 17). There are 4 marine parks in Kenya where fishing is prohibited, managed by the Kenya Wildlife Service (KWS). Marine parks are well managed with better compliance and effective enforcement compared to reserves.
Nursery area closures	√	No specific areas set aside as nurseries, but are believed to be covered within MPAs.
No-take zones	√	Marine parks are no-take zones where fishing is not allowed.
Marine reserves where fishing is sometimes allowed	√	A total of six reserves exist where only fishing using traditional gears is allowed (Table 17). Use illegal and disallowed fishing methods are common. Enforcement is inadequate.
Co management	√	Through Beach management units (BMUs)
Other temporary areas closures for specific purpose (e.g., spawning aggregations)		There exist no (government) temporary area closures along the Kenyan coast aimed at e.g. protecting spawning aggregation of fish although there is some evidence of targeted fishing of fish spawning aggregations (Maina *et al., in prep*; Samoilys *et al.,* In Press; Robbinson *et al.,* 2008). Local communities' interest in establishment locally managed marine areas is on rise (Table 18).
Temporal restrictions		
Defined fishing season(s)	√	There is no legal specific fishing season in Kenya except for the Prawn trawling.
Defined number of days fishing	√	Prawn Fishery Management Plan 2010 (legal notice no. 20).
Defined number of hours per day fishing		Consultations ongoing, prawn fishing restricted to day light
Defined number of hours fishing	√	Trawling time may be restricted according to the Prawn Fishery Management Plan 2010 (legal notice no. 20).
Gear restrictions		
Engine size restrictions	√	Prawn Fishery Management Plan 2010 (legal notice no. 20).
Gear size restrictions	√	No reference to mesh size restrictions for marine fisheries gillnets in fisheries regulations, except 'seining net with mesh sizes less than 50 mm when diagonally stretched is prohibited fishing gear except for fishing for Rastrineobola (Omena)'..
Gear type restrictions	√	The illegal fishing gears: beach seines, speargun, spear and harpoon, and some undersize mesh sized gill nets (e.g. mosquito nets), monofilament nets , dynamite and use of scuba gear for fishing lobster and bêche-de-mer.
Size/Age restrictions (i.e., minimum or maximum sizes)		Consultations ongoing.

Type of Management Tool	Tick	Comments
Participatory restrictions		
Licenses	√	Having fisherman, vessel, fish processing, and fish traders license and fish movement permits is mandatory. There are many artisanal fishers who don't comply with these regulations.
Limited entry	√	Fisheries Act 378 Section 6(1), empowers the Director of fisheries to limit the number of persons, vessels, nets, etc. employed in a fishery. The prawn fishery management plan (legal notice no. 20) authorizes the director to limit the number of vessels with a maximum of 300 (GRHP), beyond three nautical miles to a maximum of 4 vessels. Those more than 300(GRHP) beyond five nautical miles may be limited to a maximum of four vessels.
Catch restrictions		
Total allowable catch (TAC) limits	√	There is no specification on allocation of the Total Allowable Catches (TACs). For foreign fishing vessels, the Act implicitly suggests the existence of a form of TAC and ITQ under Section 12(2) (a) and (b) respectively. The Director may issue a license to a foreign fishing vessel only if there are surplus fishery resources, which may be harvested, indicating the quantity as a condition in the license.
Vessel catch limits		Applies to foreign fishing vessels, which have to state the tonnage of the allowable catch.
Rights- / incentive-adjusting regulations		
Individual effort quotas		Consultations ongoing
Individual fishing quotas		Consultations ongoing

The Fisheries Act 1991 empowers the director to impose the following management measures:

a) closed seasons for designated areas, species of fish or methods of fishing;

b) prohibited fishing areas for all or designated species of fish or methods of fishing;

c) limitations on the methods of gear, including mesh sizes of nets, that may be used for fishing;

d) limitations on the amount, size age and other characteristics and species or composition of species, of fish that may be caught, landed or traded;

e) regulate the landing of fish and provide for the management of fish landing areas; and

f) control of the introduction into, or harvesting or removal from, any Kenya fishery waters of any aquatic plant.

Marine protected areas where fishing is prohibited

Establishment of Marine Protected Areas (MPAs) was propelled by interests in the tourism industry but has had benefits to fisheries. Marine Protected Areas increase spill over of fish to adjacent fished areas (McClanahan and Kaunda-Arara, 1996; McClanahan and Mangi, 2000; Kaunda-Arara and Rose, 2004). This has led to increase an increase in fish catch rates in areas closer to the MPA (Kaunda-Arara and Rose, 2004). There is high abundance and species diversity of fish in the marine parks and marine reserves than in open fished areas. Table 17 lists the Marine Protected Areas in Kenya.

Table 17. Nationally gazetted Marine Protected Areas in Kenya
Source: IUCN, 2004.

Site	IUCN Category	Size (Km2)	Date established	Management type
Malindi	II	6.3	1968	Park
Watamu	II	10	1968	Park
Malindi-Watamu	VI	245	1968	Reserve
Kisite	II	28	1978	Park
Mpunguti	VI	11	1978	Reserve
Kiunga	250	1979	1979	Reserve
Mombasa	VI	200	1986	Park
Mombasa	II	10	1986	Reserve
Diani-Chale	VI	75	1995	Reserve

The establishment of MPAs has contributed to conflicts between stakeholders (Versleijen 2001; Munga et al 2010), especially between marine resource users and between managers and resource users. KWS is involved in surveillance within the MPAs which reduces fishing within protected areas, but illegal fishing still persists in the marine reserves. Fisher communities that interact more with the KWS have a higher compliance level.

Nursery area closures, no-take zones and marine reserves where fishing is sometimes allowed

Nursery area closures are believed to be within MPAs. Marine Protected Areas in Kenya are considered as no-take zones. Within reserves, only artisanal fishing is allowed. Marine reserves have been noted to have inadequate management and have not been successful in sustaining the livelihoods of the local communities.

Other temporary area closures for specific purposes

There exists no (government) temporary area closures along the Kenyan coast aimed at protecting spawning aggregation of fish. Information on timing and location of fishing spawning aggregations is insufficient. Recent studies indicate there is targeted fishing of rabbit fish, *Siganus sutor* and exploitation of grouper, *Epinephelus fiscoguttatus* spawning aggregations for dive tourism in south coast Kenya (Maina *et al., in Press*; Samoilys *et al.,* in Press; Robbinson *et al.,* 2008). This could be subjected to management measures in the near future, including gazettment as breeding areas. There are also community initiatives coming up with community marine protected areas (Table 18). Recent developments in marine conservation indicate increasing community initiatives geared towards establishment of community marine reserves, with different forms of management types. These community reserves have been driven by the need to improve the health of the ecosystem, to reduce overexploitation, livelihood development, reduce resource use conflicts, ecotourism and habitat, and species protection. These are positive development and will benefit fisheries.

Table 18. Community marine protected areas initiatives along the Kenyan coast
Source: Harrison and Laiser, 2009; Murage *et al*., 2010; Abunge, 2011; Maina et al, 2011a.

Conservation initiative	Year formed	Size (Km^2)	Management intervention
Kuruwitu	2006	0.29	No take zone
Tiwi (Nyari)	2009	0.125	No take zone
Msambweni	In progress	0.46	Gear restriction
Wasini	2008	In progress	Seasonal closure
Kibuyuni	2010	0.275	Gear restriction/no take zone
Mkwiro	In progress	0.155	Gear restriction
Bureni	2010	0.52	No take zone
Kanamai	2011	0.22	No take zone
Mkwakwani/Tradewinds	2009	0.118	Gear restriction
Shimoni	In progress	In progress	Gear restriction
Jimbo	In progress	In progress	Gear restriction
Vanga	In progress	In progress	Gear restriction
Majoreni	In progress	In progress	Gear restriction
Kiweni, Lamu	2010	3	Gear restriction

Defined season(s) and hours fishing

The Fisheries Act empowers the director (with approval of the Minister and by notice in the gazette) to declare closed seasons for designated areas, species of fish or methods of fishing. The Prawn fishery management plan (legal notice no. 20) for instance, empowers the director authority to enforce closed season from the 1 November to the 1 April every year for the Malindi, Ungwana Bay and adjoining waters. Closed season in prawn fishery is expected to reduce resource use conflicts. Trawling time may be restricted according to the Prawn fishery management plan 2010 (legal notice no. 20). The draft ringnet fishery management plan (June 2012) proposes fishing from October - April during the day time hours - 6am to 6pm.

Gear size and type restrictions

There is no provision in the Fisheries ACT Cap 378 on gear sizes in marine waters. However, under section 5(1)c, the director is authorized by notice in gazette, to impose limitations on the methods of gear, including mesh sizes of nets, that may be used for fishing. Some of the illegal and destructive fishing gears in use by artisanal fishermen include the beach seines, spearguns, spear and harpoon, and some undersize mesh sized gill nets (e.g. mosquito nets), monofilament nets, dynamite and use of scuba gear for fishing lobster and bêche-de-mer (9^{th} November 2001 Kenya Gazette notice No. 7565 Vol. CIII. No. 69 and legal notice number 214 of 2003). These gear types are however still being used in certain parts of the Kenyan coast, leading to conflicts among resource users, destruction and overexploitation of fisheries resources. In some areas more than a half of the artisanal fishers use banned fishing gears. Increasing human population and the use of destructive fishing gear have resulted in declining fisheries.

Licences

In Fisheries Act Section 9(1), “No person shall fish in Kenya fishery waters unless he is a holder of a valid fishing license, he is an employee of a licensee or he is fishing for his own consumption.” Licenses limit the number of fishermen increasing CPUE. Many artisanal fishermen however, lack licenses and are not BMU members making enforcement difficult.

Limited entry

This applies to foreign fishing vessels that must have licenses to operate in Kenyan waters (Fisheries Act 1991 Section 11). According to Section 18 of the Fisheries ACT, foreign fishing vessels are not allowed to access Kenya’s territorial waters. They are therefore limited to the EEZ. However, the Kenya government institutional capacity is inadequate to monitor, control and survey its EEZ.

Total allowable catch (TAC) limits and vessel catch limits

The Prawn fishery management plan (legal notice no. 20) gives the director authority to specify the annual total allowable catch for shallow water prawns based on evaluation of stock assessment and monitoring data. Foreign vessels have TAC limits as provided for by the Fisheries Act 1991. They have to state the tonnage of the allowable catch in the foreign fishing craft license. The institutional capacity of Kenya is however limited to conduct MSC of vessel catch limits for foreign fishing vessels.

Comanagement

Comanagement is a partnership that harnesses the knowledge and capacities of those who have a shared interest in the sustainability of a fishery towards promoting a common end. Comanagement can involve all the principal fisheries stakeholders. In fisheries comanagement, there are several stakeholders, which fall in the following categories: fisherfolk, private sector, civil society, public sector and development partners. The fisherfolk participate in comanagement through their grass root organizations (the BMU; Figure 23). Both rights and responsibilities of stakeholders with respect to the fishery are considerably expanded. The roles of the BMUs are to:

(a) Maintain and keep a register of all boat owners and their fishing equipment, fishers and BMU members operating from the beach.

(b) Decide on local markings for identification of fishing gears and outboard engines by licensed fishers.

(c) Participate in vetting of boat owners and fishers for licensing and, in collaboration with government officials, ensure licenses are granted to those registered with the BMU.

(d) Propose by-laws for endorsement and enforce them.

(e) Identify fish breeding areas on the basis of indigenous knowledge and identify and enforce no fishing in prohibited fishing zones.

(f) Undertake Monitoring, Control and Surveillance in collaboration with the relevant authorities.

(g) Assist in the collection of data for Frame Surveys, catch monitoring and socio-economic investigations, using agreed formats.

(h) Inspect and record visiting boats and give permission to land where appropriate.

(i) Improve sanitation and hygiene at landing sites.

(j) Network with other BMUs to ensure marketing and fair pricing of fish and fish products.

(k) BMU committee should be part of the development organ in their areas of jurisdiction.

(l) Preparation of annual workplans, budgets and financial reports and Formulate funding proposals.

(m) Prepare development plans and solicit for funding.

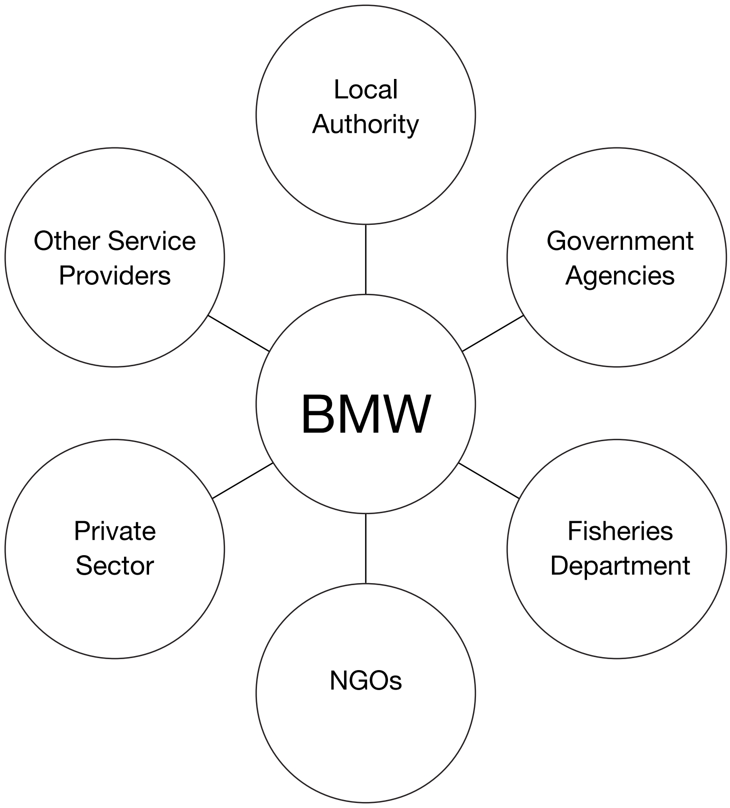


Figure 23. Schematic representation of interactions in fisheries comanagement.
BMU: Beach Management Units.

9.1. Enforcement and compliance issues

Under section 46 of the Fisheries Management and Development Bill, 2011, use of certain fishing gears and methods is prohibited. Under section 47, the Bill also prohibits damage, destruction to and interference with fishing gear and vessel.

The Fisheries Management and Development Bill, 2011 allows for the establishment of a Monitoring, Control and Surveillance Unit within the Fisheries Service that will oversee fisheries and fishing activities in Kenyan waters. It also gives the Director-General the responsibility of planning fisheries management and taking fisheries management measures to limit fishing and fishing related activities. The Director-General, for the purpose of MCS, may also establish and operate vessel monitoring systems (VMS) while the fishing vessel is in the national waters or, in respect of a Kenya fishing vessel, in areas beyond national jurisdiction. Fishing vessels, both local and foreign are required to have licenses in order to operate, except those individuals fishing for non-commercial subsistence.

Compliance and enforcement problems

Along the Kenyan coast, despite the regulations, there have been cases of high fishing effort in near shore fish habitats and use of destructive fishing gears (Mangi and Roberts, 2006) leading to overfishing. Compliance problems are mainly due to:

i. Insufficient awareness and training on fisheries issues
ii. Weak fisher organisations
iii. Insufficient background knowledge about the fishing communities which is essential in fisheries management and development planning
iv. Insufficient application of technical advice to fisheries management
v. Lack of sustained enforcement of fisheries regulations
vi. Difficulties in discouraging overfishing and disposing of acquired illegal gears
vii. Weak stakeholders' participation in fisheries management and enforcement
viii. Lack of participatory monitoring and evaluation of fisheries management and surveillance systems
ix. Insufficient support to alternative income generating activities to fishing
x. Proliferation of migrant fishers especially foreigners
xi. Resource use conflicts amongst stakeholders
xii. Inadequate ownership to the comanagement concept in the coast.
xiii. Inadequate capacity to conduct MCS.

Migrant fishery

Fisher migration is a common feature in the East African coast and occurs both within Kenyan waters and from neighboring countries (WIOMSA, 2011; Crona and Rosendo, 2011; Fulanda *et al.*, 2009). The drivers for migration are many but motivated mainly by improved livelihoods through better earnings, savings and increased catches. Fisher migration ranges from circular, seasonal migration to more long-term settlement by migrants though their policy implications have not been given enough attention (Crona and Rosendo, 2011). Fishers migration often occurs during the Northeast monsoon. Migrant fishermen are associated with use of destructive fishing gears and non-compliance to fisheries rules and regulations. On the other hand, migrant fishers assist in introducing new fishing technologies to fishermen and in effect transfer of fishing knowledge and skills.

References

Abunge, C. 2011. Managing finite marine resources the Kenyan way. East African Wildlife Society magazine, 03: 46-47.

Burczynski, J. 1976. Echo survey along the East African coast from Mombasa to Laurenzo Marques by RV *Professor Mesyatsev* in January−February 1976. FAO Fisheries Travel Report & Aide Memoire (1162) Suppl. 1. 28 pp.

Burhanuddin, S.M.; Hutomo, M.; Martosewojo, S. & Djamali, A. 1974 Some biological aspects of lemuru, *Sardinella sirm* (Walbaum), around Panggang Island. *Oseanol. Indones.* (2):17-25. (in Bahasa, Indonesia).

Church, J.E. & Obura, D.O. 2004. Management recommendations for the Kiunga Marine National Reserve, based on coral reef and fisheries catch surveys, 1998 – 2003. CORDIO/WWF KMNR. 57 pp.

Collette, B.B. & Nauen, C.E. 1983. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. FAO Fishery Synopses, 125 (2): 137 pp.

Collette, B.B. 1986. Scombridae (including Thunnidae, Scomberomoridae, Gasterochismatidae and Sardidae). *In*: P.J. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese, eds. *Fishes of the north-eastern Atlantic and the Mediterranean, Volume 2*. Paris, Unesco. p. 981−997.

Collette, B.B. 1995. Coryphaenidae. Dorados. *In*: W. Fischer, F. Krupp, W. Schneider, C. Sommer, K.E. Carpenter & V. Niem, eds. *Guia FAO para Identification de Especies para lo Fines de la Pesca. Pacifico Centro-Oriental*. 3 Vols. Rome, FAO.

Collette, B.B. 2001. Scombridae. Tunas (also, albacore, bonitos, mackerels, seerfishes, and wahoo). *In*: K.E. Carpenter & V. Niem, eds. FAO species identification guide for fishery purposes. *The living marine resources of the Western Central Pacific. Vol. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles.* Rome, FAO. p. 3721−3756.

Conand, F. 1991. Biology and phenology of Amblygaster sirm (Clupeidae) in New Caledonia, a sardine of the coral environment. *Bulletin of Marine Science*, 48(1): 137−149.

Crona, B. & Rosendo, S. 2011. Outside the law? Analyzing policy gaps in addressing fishers' migration in East Africa. *Marine Policy* 35(2011)379–388.

De Sousa, T. 1988: Summary of fisheries and resources information for Kenya. Kenya Marine Fisheries Research Institute, Mombasa, Kenya. *In* Proceedings of Workshop on the Assessment of the Fishery Resources in the Southwest Indian Ocean, Albion, Mauritius, September 1987. FAO/UNDP: RAF/79/065/WP/41/88/E: 21–43.

FAO. 1999. The State of World Fisheries and Aquaculture, 1998. ISBN-92-5-104-187-3.

FAO. 1981: Surface current movements of Kenya offshore waters observed during the survey period 1879 to 1981. Work Report No. 4 of the Offshore Trawling Survey Project. KEN/74/023.

FAO. 1990. Assistance to the Government of Kenya in the preparation of a fisheries sector development plan. Rome, FAO. 83 pp, appendices.

Fisheries Department. 2004. Marine Fisheries Frame survey report, 2004. Mombasa, Kenya. Ministry of Fisheries Development. 43 pp.

Fisheries Department. 2008. Frame survey report, 2008. Mombasa, Kenya. Ministry of Fisheries Development. 143 pp.

Fisheries Department. 2006. Marine Fisheries Frame survey report, 2006. Mombasa, Kenya. Ministry of Fisheries Development. 48 pp.

Fondo, E.N. 2004. Assessment of the Kenyan marine fisheries from selected fishing areas. United Nation 5 University Fisheries Training Program, Final Project 2004.

Froese, R. & Pauly, D., eds. 2011. FishBase. World Wide Web electronic publication. www.fishbase.org.

Fulanda, B.; Munga, C.; Ohtomi, J.; Osore, M. & Mugo, R. 2009. The structure and evolution of the coastal migrant fishery of Kenya. *Ocean & Coastal Management*, 52(9):459–66.

Fulanda, B.; Ohtomi, J.; Mueni, E. & Kimani, E. 2011. Fishery trends, resource-use and management system in the Ungwana Bay fishery, Kenya. Ocean & Coastal Management 54:401–414.

Glaesel, H. 1997. Fishers, parks and power: the socio-environmental dimensions of marine resource decline and protection on the Kenya Coast. University of Wisconsin, Madison (Ph.D. Thesis).

Habib. 2003. Kenya fisheries sector report and rationalization of fisheries department and its activities.

Harrison, P. & Laiser, J. 2009. Livelihoods on the south coast: a socio economic background for the development of community conservation areas within Shimoni Vanga, Kenya. Kilimanyika/ EAWLS/ FFI. 82 pp.

Hicks, C.C.; McClanahan, T.R.; Cinner, J.E. & Hills, J.M. 2009. Trade-offs in values assigned to ecological goods and services associated with different coral reef management strategies. *Ecology and Society* (14) 10.

IUCN. 2004. Managing marine protected areas: a toolkit for the western Indian Ocean. IUCN Eastern Africa Regional Programme. Nairobi, Kenya. xii+172 pp.

Iversen, S.A. 1984. Kenyan marine fish resources in waters deeper than 10 m investigated by RV *Dr Fridtjof Nansen*. *In*: Proceedings of the NORAD-KENYA Seminar to Review the Marine Stocks and Fisheries in Kenya. Mombasa, Kenya, 13-15 March, 1984. p. 33–60

Kamau, E.C.; Wamukota & Muthiga, N. 2009. Promotion and management of marine fisheries in Kenya. *In*: G. Winter, ed. 2009. Towards sustainable fisheries law. A comparative analysis. Gland, Switzerland. IUCN. xiv + 340 pp.

Kaunda-Arara, B. & Rose, G.A. 2004. Effects of marine reef national parks on fishery CPUE in coastal Kenya. *Biological Conservation* 118: 1–13.

Kimani, E.N.; Mwatha, G.K.; Wakwabi, E.O.; Ntiba, J.M. & Okoth, B.K. 1996. Fishes of a shallow tropical mangrove estuary, Gazi, Kenya. *Mar. Freshwater Res.* 47: 857–868.

Kenya Marine and Fisheries Research Institute. 2002. Current status of trawl fishery of Malindi–Ungwana Bay. Report by Kenya Marine and Fisheries Research Institute, Mombasa, Kenya. 97 pp.

Kuiter, R.H. & Tonozuka, T. 2001. *Pictorial guide to Indonesian reef fishes. Part 3. Jawfishes – Sunfishes, Opistognathidae – Molidae.* Australia, Zoonetics. p. 623–893.

Lucas, V.; Wardi, A.; Doorunamand, K.; Raboanarijadna, H.Z.; Bach, P.; Pianet, R.; Sigana, D.; Matola, H.; Palha de Sousa, B. & Groeneveld, J.C. 2010. Regional data gap-analysis for Component 4 (pelagic fishes) for SWIOFP. Unpublished Report 284, Oceanographic Research Institute, Durban, South Africa and SWIOFP Regional Management Unit, KMFRI, Mombasa, Kenya.

Maigret, J. & Ly, B. 1986. *Les poissons de mer de Mauritanie. Science Nat.*, Compiègne. 213 pp.

Maina, G.W.; Osuka, K.O. & Samoilys, M. 2011a. Opportunities and challenges of community-based marine protected areas in Kenya. *In*: D.O. Obura & M.A. Samoilys, eds. CORDIO Status Report. CORDIO East Africa. Available at www.cordioea.org

Maina, G.W. & Samoilys, M.A. 2010. An assessment of the state of the lobster fishery in the Kiunga Marine National Reserve, Kenya. CORDIO East Africa/UNDP SGP Report. 28 pp. + appendix.

Maina, G.W.; Samoilys. M.A.; Alidina, H.; Osuka, K. (In press). Targeted fishing of the shoemaker spinefoot rabbitfish, *Siganus sutor*, on potential spawning aggregations in southern Kenya. Chapter 3. *In*: J. Robinson, & M.A. Samoilys, eds. Reef fish spawning aggregations in the western Indian Ocean: research for management (in press). WIOMSA/SIDA/SFA/CORDIO. WIOMSA Book Series.

Maina, G.W.; Wekesa, P.N.; Osuka, K. & Mueni, E.M. 2010. Proceedings from the lobster fishery stakeholders' consultative, feedback and working group meetings held in Lamu on 15–17 May 2010 and in Mombasa on 18–19 May 2010. 53 pp + appendix.

Maina, G.W.; Obura D.; Alidina, H. & Munywoki, B. 2008. Increasing catch in an overexploited reef fishery − Diani-Chale, Kenya, from 1998 to 2006. *In*: D.O. Obura; J. Tamelander & O. Linden, eds. Ten years after bleaching – facing the consequences of climate change in the Indian Ocean. Coastal Oceans Research and Development in the Indian Ocean (CORDIO) Status Report. Mombasa, Kenya. CORDIO/Sida-SAREC. p. 309−320. Available at: http//:www.cordioea.org.

Mangi, S. & Roberts, C. 2006. Quantifying the environmental impacts of artisanal fishing gear on Kenya's coral reef ecosystems. *Marine Pollution Bulletin* 52:1646–1660.

Mbuga, J.S. 1984. Fishing gears of the Kenya marine waters. Proceedings of the NORAD-Kenya seminar to review the marine fish stocks and fisheries in Kenya, 13−15 March, 1984 Mombasa. NORAD, Bergen.

McClanahan, T.R. & Mangi, S. 2001. The effect of a closed area and beach seine exclusion on coral reef fish catches. *Fisheries Management and Ecology* 8, 107–121.

McClanahan, T.R. & Mangi, S.C. 2004. Gear-based management of a tropical artisanal fishery based on species selectivity and capture size. *Fisheries Management and Ecology* 11: 52–60.

McClanahan, T.R. 1988. Seasonality in East Africa's coastal waters. *Marine Ecological Progress Series*. 44: 191–199. Inter-Research F.R. Germany.

Mcclanahan, T.R.; Glaesel, H.; Rubens, J. & Kiambo, R. 1997. The effects of traditional fisheries management on fisheries yields and the coral-reef ecosystems of southern Kenya. *Environmental Conservation* 24, 105−120.

McClanahan, T.; Mwaguni, S. & Muthiga, N. 2005. Management of the Kenyan coast. *Ocean and Coastal Management* 48: 901−931.

McPherson, G.R. 1985. Northern line fishery for mackerels still important. *Aust. Fish*. 44(8):12−14.

Mueni E.M.; Maina, G.W.; Wekesa, P.N. & Samoilys, M. 2009. Proceedings of the first working group meetings on the lobster fishery management plan for Lamu Archipelago. September 2009. 31pp + appendix.

Munga, C.N.; Mohamed, M.O.; Obura, D.O.; Vanreusel, A. & Dahdouh-Guebas, F. 2010b. Resource users' perceptions on continued existence of the Mombasa Marine Park and Reserve. *Kenya. J. Mar. Sci*. Vol. 9 (2). 213−225.

Munga, C.; Ndegwa, S.; Fulanda, B.; Manyala, J.; Kimani, E.; Ohtomi, J. & Vanreusel, A. 2012. Bottom shrimp trawling impacts on species distribution and fishery dynamics; Ungwana Bay fishery Kenya before and after the 2006 trawl ban. *Fisheries Science*. Doi: 10.1007/s12562-011-0458-0.

Munga, C.N.; Kimani, E.N.; Odongo, D.; Mututa, W.; Ndegwa, S. & Mzee, S. 2010a. Biological and socio-economic assessment of ring net fishing off Kipini part of the Malindi-Ungwana bay, Kenya. Draft 1 Report. 34pp.

Murage D; Yusuf, H.; Lamprey, R.; Juma, R. & Liggit, B. 2010. Conservation and management of the Kenyan coastal and marine resources, 45 pp.

Murua, H. & Saborido-Rey, F. 2003. Female reproductive strategies of marine fish species of the North Atlantic. *Northwest Atl. Fish. Sci*. 33:23–31.

Mwikya, S.M. 2005. Kenya's marine fishery development potential under an economic partnership agreement (EPA) with the EU. A technical paper prepared for: EU – KEPLOTRADE project, Ministry of Trade and Industry, Nairobi, Kenya. 50pp.

Myers, R.F. 1991. *Micronesian reef fishes. Second Ed*. Barrigada, Guam. Coral Graphics, 298 pp.

Ndegwa, S. 2011. Kenyan sports fishing sailfish catches. Indian Ocean Tuna Commission. IOTC–2011–WPB09–09. Recieved 28th June 2011. Ninth Working Party on Billfish, Seychelles, 4–8 July 2011.

Ndegwa, S. & Sigana, D. 2010. National Report of Kenya (2010). Indian Ocean Tuna Commission. IOTC-2010-SC-Inf06. 10pp.

Nhwani, L.B. 1980. A gillnetting survey of an inshore fish stock off Mombasa coast. *University Science Journal*, 6 (1 & 2): 29−59.

Nikol'skii, G.V. 1954 Special ichthyology. (Rev. 1961). Jerusalem. Israel Program for Scientific Translations. 358 pp. J.I. Lengy and Z. Krauthamer, translators.

Nzioka, R.M. 1981. A review of past work done on pelagic resources of East African coastal waters. *In*: Proceedings of the Workshop of the Kenya Marine & Fisheries Research Institute on Aquatic Resources of Kenya July 13–19, 1981. Kenya Marine & Fisheries Research Institute and Kenya National Academy for Advancement of Arts and Sciences, Kenya. p. 46−55.

Nzioka, R.M. 1984. The evaluation of marine fisheries resources in Kenya. *In*: S.A. Iversen & S. Myklvoll, eds. The Proceedings of the NORAD-Kenya seminar to review the marine fish stocks and fisheries in Kenya, Mombasa, Kenya, 13–15 March, 1984. Kenya Marine & Fisheries Research Institute, Mombasa, Norwegian Agency for International Development, Institute of Marine Research, Bergen, Norway, 1984. p. 27–32.

Obura, D. 2005. Resilience and climate change: lessons from coral reefs and bleaching in the Western Indian Ocean. *Estuarine Coastal and Shelf Science* 63: 353–372.

Obura, D. 2001. Participatory monitoring of shallow tropical marine fisheries by artisanal fishers in Diani, Kenya. *Bulletin of Marine Science* 69: 777−791.

Odero, N. 1984. Marine fisheries development in Kenya. *In*: S.A. Iversen & S. Myklerou, eds. NORAD-Kenya seminar to review marine fish and stocks in Kenya, Mombasa: Kenya Marine and Fisheries Research Institute. p. 11−14.

Oduor, B.W. 1984. Status of fish catches and landings in Kenya. The proceedings of the NORAD-Kenya Seminar to review the marine fish stocks and fisheries in Kenya. 13–15 March, 1984 Mombasa. NORAD, Bergen.

Okemwa C.; Munga, E.; Fondo, E.; Kimani, S.; Agembe, C.; Aura, B.; Orembo, D.; Odongo, J.; Gonda & Anam, R. 2009b. Artisanal gear selectivity impacts on species composition and size variation at the south coast of Kenya: Msambweni – Vanga. KMFRI, Mombasa, unpublished report. 12 pp.

Okemwa, G.M.; Maina, G.W.; Munga, C.N.; Mueni, E. & Barabara. Managing exploitation of small and medium pelagic fisheries: a case study of the ringnet fishery in Kenya (in prep).

Okwemwa, G.; Kimani, E.; Fondo, E.; Agembe, S.; Munga C. & Aura, C. 2009a. Status of artisanal fisheries at the Kenyan coast: 2001–2008. KMFRI, Mombasa. Unpublished report. 19 pp.

Randall, J.E. 2005. *Reef and shore fishes of the South Pacific. New Caledonia to Tahiti and the Pitcairn Islands*. Honolulu, Hawaii. University of Hawaii Press. 720 pp.

Robinson, J.; Samoilys, M. & Kimani, P. 2008. Reef fish spawning aggregations in the Western Indian Ocean: current knowledge and implications for management. *In*: D.O. Obura, J. Tamelander & O. Linden, eds. Ten years after bleaching – facing the consequences of climate change in the Indian Ocean. Coastal Oceans Research and Development, Indian Ocean (CORDIO) Status Report 2007. Mombasa, Kenya. CORDIO/Sida-SAREC. p. 263−276.

Rubens, J. 1996. An analysis of the benefits and costs of marine reserve regulations at Diani, Kenya. MSc dissertation. Department of Marine Science and Coastal Management, University of Newcastle, UK.

Samoilys, M.; Macharia, D.; Kanyange, W.; Maina, G.W.; Robinson, J. Dynamics of spawning aggregations of *Siganus sutor* in southern Kenya. *In*: J. Robinson and M.A. Samoilys eds. *Reef fish spawning aggregations in the Western Indian Ocean: research for management.* WIOMSA Book Series. WIOMSA/SIDA/SFA/CORDIO (in press).

Samoilys, M.; Osuka, K.; Maina, G.W. & Obura, D.O. Effects of artisanal fishing gears along the Kenyan coast (in prep.).

Smith-Vaniz, W.F. 1986 Carangidae. *In*: P.J. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese, eds. *Fishes of the north-eastern Atlantic and the Mediterranean*. UNESCO, Paris. vol. 2. p. 815-844

Samoilys, M.A.; Church, J.; Kaunda-Arara, B.; Kamukuru, A. & Jiddawi, N. 2006. Preliminary findings on spawning aggregations of reef fishes in East Africa. *In*: Proceedings of the 10th International Coral Reef Symp, Okinawa: 404−415.

Samoilys, M.A., Maina, G.W. and Osuka, K. 2011a. Artisanal fishing gears of the Kenyan coast. Mombasa: CORDIO/USAID.

Spear, T.T. 1978. The Kaya complex: a history of the Mijikenda peoples of Kenya coast to 1900. Nairobi, Kenya. Kenya Literature Bureau. 172 pp.

Tarbit, J. 1976. Demersal fisheries research: terminal report 1974−76. EAMFRO annual report 1976. 28 pp.

Tuda, P.; Nyaga, W.G.; Maina, W.; Wanyonyi, I. & Obura, D. 2008. Estimating total fishing effort over tidal to annual periods in the Diani-Chale-Gazi reef fishery in Kenya. *In*: D.O. Obura, J. Tamelander & O. Linden, eds. Ten years after bleaching – facing the consequences of climate change in the Indian Ocean. Coastal Oceans Research and Development in the Indian Ocean (CORDIO) Status Report 2008. Mombasa, Kenya. CORDIAO/Sida-SAREC.

Tunje, J.G. 2002. Reef fisheries in Kilifi and Lamu districts: fishing practices, awareness of resource degradation and traditional ways of conservation among artisanal fishers. Moi University, Eldoret (M.Sc.thesis).

Uenagi, S. & Wares, P.G. 1975. Synopsis of biological data on striped marlin, *Tetrapturus audax* (Philippi), 1887. *In*: Proceedings of International Billfish Symposium, Kailua-Kona, Hawaii, 9−12 August, 1972, Part 3, Species Synopses. Edited by R. S. Shomura and F. Williams. US Department of Commerce, NOAA Technical Report NMFS SSRF No. 675.

Venema, S.C. 1984. Review of marine resource surveys in Kenyan waters. Proceedings of the NORAD–Kenya Seminar to Review the Marine Fish Stocks and Fisheries in Kenya. Mombasa, Kenya, 13-15 March 1984: 61−82.

Versleijen, N. 2001. An empty sufuria: the effects of a marine national park on the livelihood strategies and income diversification of fishermen households at the Kenya coast. Wageningen University and Research Centre (MA thesis).

Wakwabi, E.O. 1981. Sardine fishery in Kenya. *In*: Proceedings of the Workshop of the Kenya Marine and Fisheries Research Institute on Aquatic Resources of Kenya July 13–19, 1981. Kenya Marine & Fisheries Research Institute and Kenya National Academy for Advancement of Arts and Sciences. p. 109−116.

Wakwabi, E.R.; Abila, O & Mbithi, M.L. 2003. Kenya fish subsector: fish sector development strategy for Kenya. Consultancy report for the International Trade Centre/United Nations Conference on Trade And Development. World Trade Organization Joint Integrated Technical Assistance Program to Least Developed and Other African Countries. Kenya Department of Fisheries/Association of Fish Processors and Exporters of Kenya. Nairobi.

Williams, F. & Newell, S.B. 1958. Fishes of the family Carangidae in British East African waters. Annals & Magazine of Natural History, 16 (Thirteen Series No. 6): 369−430.

Williams, F. & Newell, S.B. 1957. Notes on the biology of the dorade or dolphin fish (Coryphaena hippurus). *East African Agricultural Journal of Kenya, Tanganyika, Uganda and Zanzibar*, 23 (2): 113-118.

Williams, F. & Newell, S.B. 1965. Further notes on the biology of East African pelagic fishes of the families Carangidae and Sphyraenidae. *East African Agricultural & Forestry Journal*, 31 (2): 141-168.

Williams, F. 1956. Preliminary survey of the pelagic fishes of East Africa. Colonial Office Fishery Publication, 8. HMSO, London.

Williams, F. 1958. A preliminary report on deep water fishing off the North Kenya coast. *East Africa Agriculture and Forestry Journal*, 24: 61-63.

Williams, F. 1962. The scombrid fishes of East Africa. Symposium on Scombrid Fishes Part 1. Marine Biological Association of India: 107−164.

Williams, F. 1965. Further notes on the biology of East African pelagic fishes of the families Carangidae and Sphryaenidae. *East African Agriculture & Forestry Journal*, 31: 141-168.

Williams, F. 1967. Longline fishing for tuna off the coast of East Africa 1958−1960. *Indian Journal of Fisheries*, 10: 223−390.

Williams, F. & Newell, S.B. 1959a. Black marlin in British East African waters. *Nature*, 184: 78.

Williams, F. & Newell, S.B. 1959b. Marlin in British East African waters. *Nature*, 183: 762-763.

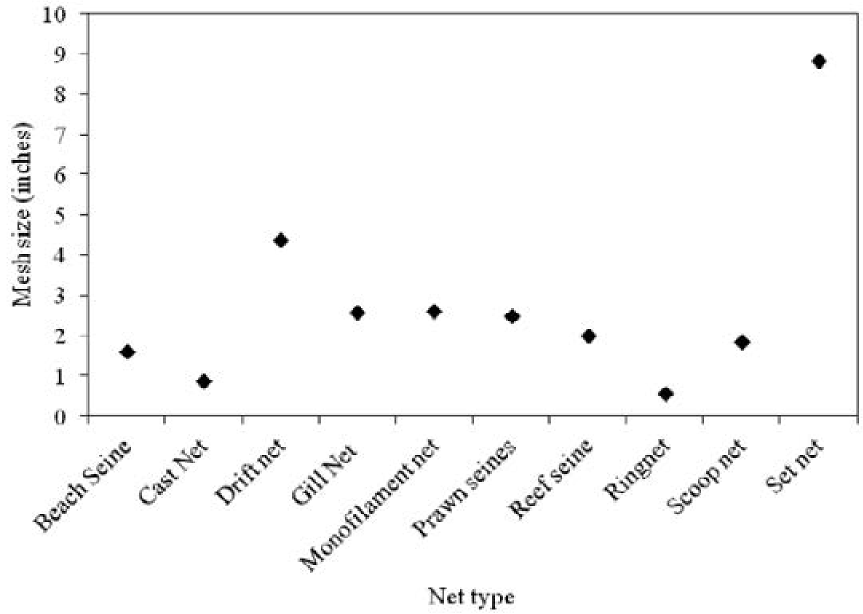
Williams, F. & Newell, S.B. 1960. On Scomberomorus linelatus (c.v.) 1831, from British East African waters (Pisces, Scombridae). Annals & Magazine of Natural History, 3 (Thirteen Series, No. 27): 183−192.

Williams, F. and Newell, S.B. 1964. The scombroid fishes of East Africa. *In*: Proceedings of the Symposium on Scombroid Fishes. Marine Biological Association of India, Mandapam Camp, India. p. 107−164.

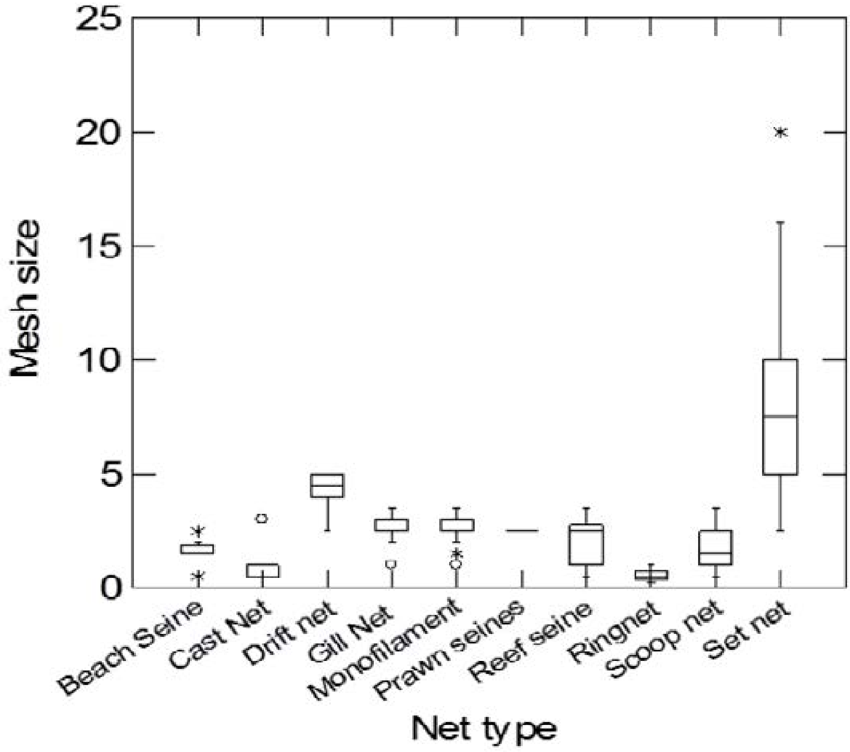
WIOMSA. 2011. Migrant fishers and fishing in the Western Indian Ocean: Socioeconomic dynamics and implications for management. Final Report of Commissioned Research Project MASMA/CR/2008/02.

Appendix 1. Mesh size of different fishing nets used along the Kenya's coast.

Average mesh size:



Box plot of mesh size:



The "gillnet" category consists of nets used to target reef fishes such as parrot fish, rabbit fish and emperors.

Appendix 2. Fisheries facilities available along the Kenyan coast by county.

Facilities	Years	Kwale	Mombasa	Kilifi	Tana River	Lamu	Total
Cold rooms (working)	2004	0	1	1	0	0	2
	2006	0	1	0	0	0	1
	2008	0	1	1	0	1	3
Cold rooms (non working)	2004	0	1	1	0	1	3
	2006	1	0	0	0	0	1
	2008	0	0	0	0	0	0
Pontoon/jetty	2004	2	2	5	0	6	15
	2006	4	3	3	1	1	12
	2008	2	4	7	0	8	21
Fish stores	2004	0	1	2	0	0	3
	2006	1	2	2	1	1	7
	2008	0	1	2	0	0	3
Landing sites	2004	35	23	26	4	22	110
	2006	31	28	31	3	22	115
	2008	38	29	49	4	21	141
Landing sites with BMUs	2004	19	3	14	2	9	47
	2006	19	16	25	3	7	70
	2008	38	29	49	4	21	141
Landing sites with BMU office	2008	2	2	1	0	0	
Net repair facilities	2004	10	13	19	3	12	57
	2006	15	9	23	3	0	50
	2008	21	17	4	3	9	54
Craft repair facilities	2004	12	12	15	2	13	54
	2006	15	10	19	2	0	46
	2008	17	15	8	2	14	56
Fish Smoking kilns	2008	2	0	2	1	0	5
Fish Drying racks	2008	1	0	1	1	0	4
Engine repair facilities	2008	3	2	3	0	2	10

Appendix 3. Number of ringnets in operation along the Kenyan coast as at January 2012 .
Data source: this study.

Area	Landing point	# nets	# fishermen / vessel	Boat type	Comments
Watamu	Watamu	2	38-40	Mashua	
Vanga	Vanga and Jasini	7	15-50	Mashua	Some operates at Jasini and in Tanzania
Kilifi	Kilifi central	2		Mashua	
Msambweni	Gazi	3	16-20	Mashua	
Shimoni	Bati/Mwazaro	2	15-28	Mashua	Tanzanian vessels

AN EAF BASELINE REPORT ON THE SMALL-SCALE FISHERIES SECTOR OF LIBERIA

D. Wisseh Kay, Paul Larry George, Glasgow Togba

1. Introduction

Liberia is located on the west coast of Africa (Figure 1). It lies along the Atlantic Ocean, with a coastline of 560 kilometers (350 miles) between Ivory Coast to the east and Sierra Leone to the west. It has a total land area of 11 369 km^2 and a population of 3.5 million of people.

Figure 1. Map of Liberia.

The Country has three main ecological regions: (1) Mangrove swamps and beaches along the coast; (2) wooded hills and semi-deciduous shrub lands along the immediate interior; and (3) the dense tropical forests and plateaus in the interior. Forty percent of the West Africa's rainforest is in Liberia.

Liberia has a tropical climate typical of the rest of West Africa with a principal rainy season from April to September and a dry season from October to March. Notwithstanding, in recent times, there is a slight climatic change, which is under study. The country annual rainfall decreases from 4 000 mm or more along the coast to 2 000 mm or slightly less along the northern border (with the exception of Mount Nimba along the coast where rainfall reaches 3 100 mm). Monrovia is the station with the highest rainfall (4 638 mm over 16 years observation), followed by Tappita and Suakoko in the north-central region, receiving around 1 900 mm.

The population of Liberia is estimated at 3.5 million with growth rate of 2.1 percent (2009 estimates). Liberia is divided into fifteen (15) subpolitical regions or counties, which form the basis of the decentralized structure of local government.

Fishery as a sector is a key in the agriculture framework of Liberia and in the national economy. In 2002 the fishing industry of Liberia has produced approximately 7 000 tonnes per year of fish/fishery products which constitute about 12 percent of the Agriculture Gross Domestic Product (GDP) and 3.2 percent of the national GDP. Unfortunately, this percentage is half of agriculture GDP obtained annually prior to the war of 1990. Fisheries also play a key role in the livelihood of the coastal population, and directly employs about 33 000 people using about 3 500 small vessels (canoes) in the artisanal and semi-industrial fisheries sectors.

Over 80 percent of the population in Liberia directly depends on fish as animal protein thereby creating an urgent need to improve fish production, preservation and distribution taking into consideration the ecosystem approach to fisheries.

Actually, as a result of the 14-years civil war, the legal fisheries instruments and institutions were often reduced to a symbolic presence. Human resources and enforcement capacity are almost non-existent. For over a decade after the war, there has been no government policy on fisheries and line institutions and staff were not able to guarantee resource conservation.

The coastline of Liberia has nine (9) coastal counties (Grand Cape Mount, Bomi, Montserrado, Margibi, Grand Bassa, Rivercess, Sinoe, Grand Kru and Maryland counties). These coastal counties are subdivided into three (3) fishing regions (Figure 2):

- Region I: Grand Cape Mount, Bomi and Montserrado County;
- Region II: Margibi, Grand Bassa and Rivercess County;
- Region III: Sinoe, Grand Kru and Maryland County.

Figure 2. Liberia coastline regional demarcation.
Source: Kebe *et al.* (2009).

The government of Liberia, knowing fully the vast potential of the fisheries sector, conducted in 2006 a comprehensive assessment through FAO assistance with the objective to assess its performance and potential after which an effective strategy for fisheries development was developed to contribute to achieving national priority objectives of food security, employment and investment.

During January and February 2008, a National Livelihood Survey of the Small Scale Fisheries was conducted along the Liberian coast covering 22 fishing communities using the participatory diagnosis of the fishing community to analyze the livelihoods of fisher folks. This analysis included an assessment of the Policies, Institutions and Processes (PIP) at the Macro (national) and Meso (district) levels.

The analysis identified some major issues as follows:

- Coexistence of various National and foreign migrants fishing communities that has positive and negative impacts on the livelihoods of people;
- High vulnerability of the fishing communities. Five major factors of vulnerability were identified:
    1. Seasonality of fishing activity;
    2. Safety at sea (lack of protective gears);
    3. Conflict at sea with industrial fishing;
    4. Economic shocks (limited or no saving capacity); and
    5. Health problems (inadequate health facilities).
- Weak capital assets particularly natural, physical, financial and human resources. Social capital can be considered as strong in some cases and it is possible to build on them to improve the other assets and reduce vulnerability.
- Political and institutional environment not favorable for a sustainable improvement of the livelihoods of the people.

At the end of the survey analysis, two key issues were identified as the way forward in improving the livelihood of Liberian fisher folks on the basis of strength and opportunities for policies and institutions:

- Human and social capital of the fisher folks (meaning organizational development of the fishing communities); and
- Political and Institutional environment (meaning an adjustment of policies and institutions that will impart the livelihood of fishing communities).

The present document provides an overview of the fisheries sector, the management measures used in the absence of the ecosystem approach to fisheries, the fishers interaction with the marine environment, level of exploitation on the fish stocks and the stocks assessment by *RV Dr Fridtjof Nansen*. The report also builds on the EAF- Nansen Project “Improving Artisanal fisheries Management” for Liberia and Sierra Leone Kick-off meeting, held on July 27 – 28, 2010 at the Bureau of National Fisheries, Monrovia where the need for and usefulness of the project was discussed and put into effect.

2. Overview of the fishery and resources exploited

Fishing is an art that is as old as the existence of man. It has started when man began to search for food. Hunting was one of the means of finding food. Fishing which is part of hunting becomes a major activity for man’s existence.

Traditional or indigenous fishers have operated along the Liberian coast and inland waters for centuries mainly on a subsistence level. Fishers were catching fish to feed their families and the excess catches were bartered for other essential commodities. The first attempt to commercialize fishing in Liberia was in 1848 when the then President Joseph Jenkins Roberts, converted his Yacht into a fishing boat. This venture was followed by another as fishing trawler. The first fishing trawler to operate in the Liberian territorial waters was called “Woerman” owned by a German Company between 1938 and 1939. Fishing was a daily activity and catches were sold immediately fresh to avoid post harvest losses because of lack of preservation and storage facilities. Considering the success of the fishing boat “Woerman” and realizing the importance of fisheries in national socio-economic development, the Government of Liberia requested FAO and United States of America, in 1952 to assist develop Liberian fisheries sector. As a result, experts were sent from FAO and USA to assess the fisheries potential of the country. A month of exploratory fishing was carried out which resulted to establishing a Medium Striving Fishing Industry in the country.

The Liberia Fisheries Sector comprises three main components:

- Marine fishery subsector, which includes the industrial and the artisanal activities;
- Inland fishery subsector, which is mainly artisanal (small scale fishing activities); and
- Aquaculture fishery subsector, which involves fish farming in inland, fresh water or marine waters.

Marine fishery subsector

The Marine fishery subsector of Liberia is usually categorized into three (3) components; artisanal (small-scale), semi-industrial (inshore), and industrial (the advanced offshore sector, well mechanized and deep-sea). Of these three subsectors, the artisanal fishery lands the highest catch in terms of quantity produced even though small-scale fishing methods are used. It accounts for about 70 – 75 percent of the national marine fish production and of the fishery gross domestic product (GDP).

The catches of the artisanal fishers are landed on a daily basis. The fishers of this component are not involved in illegal exportation or transshipment out at sea. As a result, all the catches (productions) are landed directly. The argument is not that the industrial fishery component does not have potential to produce as equal the artisanal fishery, but the industrial vessels are involved in illegal, unreported and unregulated fishing activities, exportation and transshipments as well as poaching. As a result, they do not declare all the production in order not to pay required taxes (revenues). Moreover, these vessels land weekly, monthly, or quarterly and fish is transshipped illegally.

Artisanal fishery

The artisanal fisheries are known to be a strategic sector in terms employment provided along the Liberian waters. During the registration process 2 762 canoes owners has been identified in Liberia. The Liberian citizens constitute the main component of the canoes owners (2 157) while the foreign owners is relatively considerable (605). Liberian male canoe owners constitute 98 percent and females 2 percent (Figure 3). For the foreigners/migrants, the male canoe owners constitute 99.3 percent and females 0.7 percent. Therefore, this situation shows the low level of involvement of the women in the development of the artisanal fishing fleet operating in Liberia.

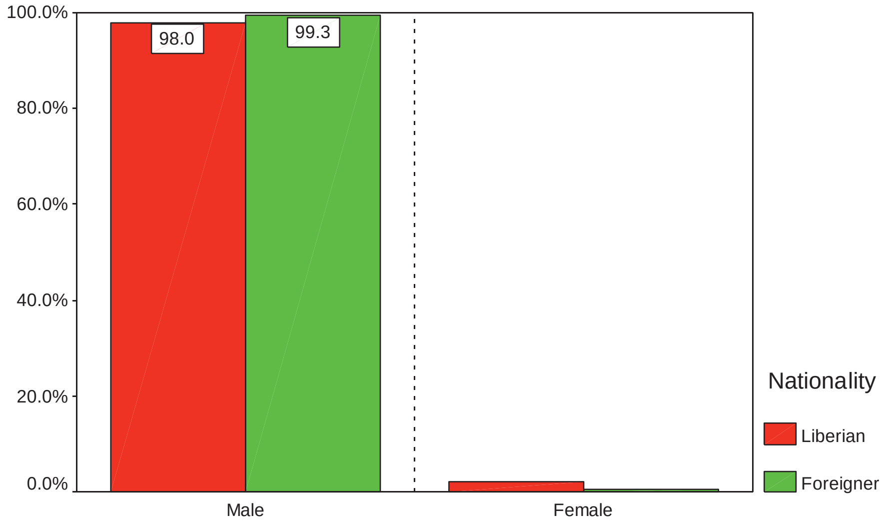


Figure 3. Percentage of owners by sex and nationality.
Source: Djiga Thiao report on fisheries vessels/canoes registration data collection 2010.

The population of the canoe owners in Liberia is constituted by individuals generally around 40 years old. The general average age is 39.9 years with a median of 38.0 years. However, the variability of the distribution of the owners' age is rather high. Indeed the inter-quartile ranges are respectively 15.0 years for the male and 13 years for the female. Moreover, in the specific case of the male owners, there are some individuals outside of the inter-quartile range. In particular the youngest owner is a boy of 6 years old while the oldest one is a man who reaches 101 years.

Several gear types are used in the artisanal fishery component (Table 1). These include seine nets, ring nets, long (trap) line, cast net, set net and hooks and lines. These gear types are operated from dugout wooden, and or dugout-built canoes.

Based on the 2007 fisheries frame survey, there are over 3 000 canoes and more than 11 032 fishers operating actively from 111 fish landing sites along the 560-kilometer coastline (Tables 1 and 2). About 14 percent of these canoes are motorized or powered by outboard or inboard motors with engine power ranged from 8 – 40 (Hp) (Figures 4 and 5). Most of these power run canoes are found in the semi-industrial subsector of Liberia.

Table 1. Number of fishing crew by gear type and nationality.
Source: Canoe registration data report 2010

Gear type	Liberian crew	Foreign crew	Total crew
Set net	2 939	1 976	4 915
Hook and line	2 073	21	2 094
Ring net	949	1 020	1 969
Long (trap) line	1 306	17	1 323
Other gear	519	212	731
Total	**7 786**	**3 246**	**11 032**

Table 2. Number and percentage of canoes by county.
Source: Djiga Thiao report on fisheries vessels/canoes registration data collection

County	Liberia		Ghana		Ivory Coast		Total	
	No.	%	No.	%	No.	%	No.	%
Grand Cape Mount	239	8.0	40	15.4	—	—	279	8.6
Bomi	39	1.3	26	10.0	—	—	65	2.0
Montserrado	546	18.3	89	34.4	—	—	635	19.5
Margibi	111	3.7	5	1.9	—	—	116	3.6
Grand Bassa	667	22.3	67	25.9	2	25.0	736	22.6
Rivercess	301	10.1	1	0.4	—	—	302	9.3
Sinoe	473	15.8	2	0.8	—	—	475	14.6
Grand Kru	345	11.5	2	0.8	2	25.0	349	10.7
Maryland	269	9.0	27	10.4	4	50.0	300	9.2
Total	**2 990**	**100.0**	**259**	**100.0**	**8**	**100.0**	**3 257**	**100.0**

Figure 4. Upper left: artisanal fisherman landing in Marshall beach. Upper right: artisanal fishermen on fishing expedition in West Point. Lower: Fanti artisanal fishing canoe (semi-industrial) from West Point beach on its way to fishing.

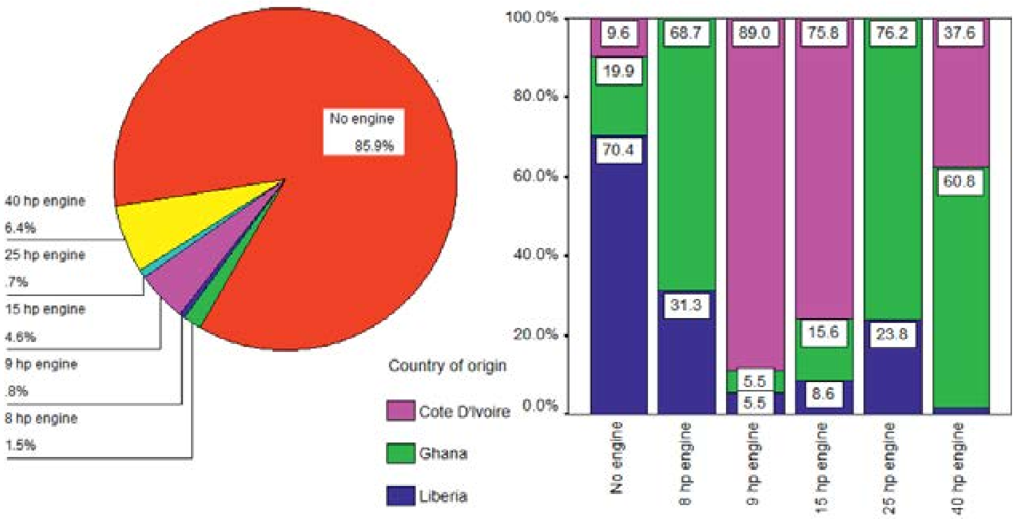


Figure 5. Use of engines by category of horsepower and country of origin.
Source: Djiga Thiao report on fisheries vessels/canoes registration data collection 2010.

Inland fishery subsector

Liberia has six major rivers that flow from the Fouta Djallon mountain of Guinea. Four of these rivers (Lofa, St. Paul, St. John and Cestos) are within the country, while Mano River forms the border of Liberia with Sierra Leone and Cavalla runs along the southern border with Ivory Coast. Beside these major rivers, Liberia has other rivers that are about 1 800 km long or above. Nearly all of these rivers are shallow, rocky and not easily navigable. There are also coastal lagoons and lakes. These water bodies are diversified with valuable fish species. They are major sources of fish resources that the livelihoods of rural dwellers depend.

Though the value of fish in monetary term and production is not known, inland fisheries are important subsistent activities to the rural dwellers using traditional fishing methods and gears (nets, baskets, traps, cutlass, hooks and lines and closed water to dry). Almost every girl above the age of 15 in the rural villages is trained to catch fish in the rivers and creeks, most especially during the dry seasons. Equally so some are trained traditionally to mend net, plait basket and water traps that are used for fishing.

Notwithstanding, due to limited manpower at the Bureau of National fisheries of the Ministry of Agriculture, that has the statutory responsibilities to develop, manage, regulate the Liberian territorial waters, no substantial data has been collected to ascertain the level of production and the taxonomy of the resources exploited.

2.1. The fishing gears and areas fished

Fishers of the marine sector use canoes or vessels with different types of gears. These gears vary based on ones' target species. Most of the fishing gears used in the artisanal sector are hooks and lines, gill nets, ring net, beach seine net, and long line with hooks (Table 1). Fishers visit fishing grounds based on the location of the target species. The artisanal canoes in this sector ranged from 7 ft (ca. 2 m) to 65 ft (ca. 20 m) length according to statistics and data collected. The revised fishery regulation provides that, for purpose of maintaining sustainable yield of the fisheries, no fishing net or trawl-net with a cod-end smaller than 3 inches (or 77 mm) can be used for finfish and 64 mm stretched cod-end mesh size for shrimps.

2.2. Resources exploited

The artisanal fishery subsector exploits both pelagic and demersal fish resources. The marine fisheries in Liberia are affected by a seasonal upwelling that occurs in the Liberian coastal waters. In the course of the upwelling period (December to February and July to September) there is an increase in abundance and production of most marine fishes. Consequently these seasons are characterized with high fisheries production.

The fish resources can be classified as:

- Small pelagic species: Clupeidae (Poorjor, Gbapleh, Sardinellas) and Engraulididae (Anchovies);
- Large pelagic species: Scombroidei (*Auxis thazard*, *Euthynnus alletteratus*, *Scomber japonicus* and other tuna-like-fishes);
- Demersal species: Sparidae (*Dentex* spp.), Lutjanidae, Mullidae, Pomadasydae, Serranidae, Polynidae, Panaedae (crawfish), etc.
- Other commercially exploited fish species: Sciaenidae (*Pseudotholithus elongathus*, *P. senegalensis*, *P. typus*), Polynemidae (galeodis), Sparidae (*Dentex angolensis*, *D. congoensis*), Balistidae and Penaeid shrimps.

Small pelagic resources

The biomass of small pelagics in the Liberian waters fluctuates most of the time. Biomass estimated by surveys in the Gulf of Guinea was 25 000 and 37 000 tonnes in 2006 and 2007, respectively. The biomass of large pelagics was 127 000 and 16 000 tonnes in the same period (Table 5). The lack of adequate surveillance system created a serious room for over-exploitation degradation, illegal fishing by using wrong mesh sizes, harvesting of juvenile fishes as well as poaching. As a result of these illegal activities, it is believed that the small pelagic is gradually depleting. There is a need to reduce the pressure on these fish resources in order to allow them to recover.

Large pelagic resources

The large pelagics are the main commercial resources exploited mostly for international markets. These include: yellowfin tuna (*Thunnus albacares*) Skipjack tuna (*Katsuwonnus pelamis*) and bigeye tuna (*Thunnus obesus*). Other tuna-like species found in the Liberia coastal waters are *Auxis thazard, Euthynnus alletteratus* and *Scomber japonicus*. Unfortunately, there is no single register tuna vessel in Liberia but yet these species are taken away from Liberia. Other large pelagics include *Campogramma glaycos, Caranx crysos, C. hippos* and *Caranx senegallus.*

Demersal fish resources

Table 3 shows the biomass of the main demersal groups estimated by surveys conducted in 2006 and 2007 on the Liberian continental shelf. Of the total biomass Sparids represented 47.4 percent, Sciaenids 29.9 percent, Lutjanids 4.7 percent and Haemulids 1.4 percent. Notwithstanding, catches of demersal resources landed in the last decade was about 98 086 tonnes.

Table 3. Biomass estimates (tonnes) of the main demersal groups on Liberian continental shelf (**Source:** *RV Dr Fridtjof Nansen* 2007 survey report for Liberia).

Species family	Biomass (tonnes)
Sparidae	7 800
Haemulidae	190
Sciaenidae	4 600
Lutjanidae	710
Serranidae	—
Total	**13 300**

Shrimps resources

Liberia has shrimps resources comparable to other countries in the subregion. But these shrimp species are not targeted by the artisanal fishery subsector. The fleets that engaged in shrimp's fishery are the industrial vessels. Prior to 1980, it was estimated that the Mesurrado Group of Company (an industrial fishing company) exported 720 tonnes of shrimps annually to Europe and America.

2.3. Number of fishers and land-based workers by sector

Statistics from surveys have shown that there are 11 154 land-based fishermen earning directly or indirectly income from the artisanal fishery subsector while there are 3 630 people involved in the industrial fishery subsector.

In the artisanal fishery subsector about 3 718 of the total fishermen are full-time fishers while 7 436 are part-time workers. There are 21 600 fish mongers and processors that are directly or indirectly involved in the sector; considering an average of two mongers and several processors per canoe (Source: 2010 Data collection survey BNF/WARFP).

2.4. Interactions with other fisheries

Conflicts at sea

The artisanal fishery subsector experience conflicts at sea with the industrial fishery subsector as well as with other sectors. Conflicts always happened either over the claiming of fishing exclusive zones, stealing and or destruction of gears. This normally happens between the indigenous fishermen and the migrant fishermen (Togolese, Ghanaians and Senegalese). The industrial fishing vessels habitually encroach on the six nautical miles exclusive fishing zones of the artisanal fishery subsector. In the process, these vessels destroy artisanal fishing nets and the livelihood of fishers. These encroachments cause economic losses for the small-scale fishers (loss of fishing gears, revenue earnings). It also reduces the level catch landings of fish for the domestic markets.

There are also conflict between the migrant's fishermen and the indigenous fishermen. The indigenous claim their capacities and method of fishing have low fishing capacity compared to the migrant fishers; therefore they should not fish in the same areas. Another factor is stealing of fish caught in set-nets as well as the stealing of fishing materials at sea.

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

The Bureau of National Fisheries, as a fishery institution, has not carried out any biological work on any of the main commercial species after the war. Fortunately, through intervention of Guinea Current Large Marine Ecosystem (GCLME), Liberia participated of fisheries stock assessment acoustic surveys conducted in 2006 and 2007, at which time some biological work was done on some selected species. Stomach contents of these species were collected and sent to the University of Angola and the University of Ghana to be analyzed. At present, the result of the analyses is still pending. Notwithstanding the FAO project on "Food Security through Commercialization Agriculture (FSCA)" is establishing and equipping a fish laboratory at the Bureau of National Fisheries for biological work. It is anticipated that by 2012 the laboratory will add value to the work.

3.2. Geographical distribution and biomass of the fish species

Apart from a narrow coastal strip, Liberia consists of several of rivers, lakes, lagoons, and streams. There are six main rivers (Cavalla, Cestos, Lofa, Mano, St John and St. Paul) that flow across the country from the Fouta Djallon Mountains of Guinea (Table 4). These rivers have high fish production potential.

Table 4. Geographical data of the main rivers

River	Source	Total length (km)	Drainage area (km^2)	Country traversed	Major tributary	Discharged to
Cavalla	Nimba Mountain, Guinea	700	22 400	Guinea, Cote d'Ívoire, & Liberia	Duobe & Hana	Atlantic Ocean, Cote d'Ivoire 4°20'N; 7°30'W
Cestos	Near Mt. Nimba	380	—	Cote d'Ivoire, & Liberia	Noun	Atlantic Ocean 5°27'N; 9°35'W
Lofa	Near Macenta, Guinea (Fouta Djallon Mountain	350	—	Liberia & Guinea	—	Atlantic Ocean 6°34'N; 11°4'W
Mano	Near Macenta	425	17 900	Guinea, Sierra Leone & Liberia	Meli	Atlantic ocean 7°57'N; 11°36'W
St. John	Mani Tributary, near Lofa	365	—	Liberia & Guinea	Mani, Gbin, & Zor creek	Atlantic Ocean 5°55'N; 10°4'W
St. Paul	Nianda tributary	430	—	Liberia & Guinea	Nianda	Atlantic Ocean 6°22'N; 10°48'W

The sea surface salinity of Liberia is more typical of a coastal narrow shelf tropical situation, with salinities ranging between 34.8 and 35.2, decreasing even further to 34.2 in areas with river outlets.

Survey carried out by *RV Dr Fridtjof Nansen* in 2007 in the Gulf of Guinea region estimated a total biomass of pelagic fish of 64 000 tonnes, with 31 000 tonnes of *Sardinella aurita* (Round bonny), 17 000 of *Sardinella maderensis* (Flat bonny) and 16 000 of Carangids and other species (Table 5). The length distribution of Sardinellas in Liberia were as follows:

- *Sardinella aurita* ranged from 9cm to 25cm (64 percent);
- *Sardinella maderensis* ranged from 5cm to 25cm (36 percent)

Table 6 shows the estimated biomass of demersal resources in the 2007 demersal survey. Figure 6 shows the tracks of the pelagic and demersal surveys off Liberia.

Table 5. Review of the acoustic biomass estimates (tonnes) of pelagic resources in the 2006 and 2007 acoustic surveys.

Group	Species Family	2006	2007
Pelagic 1	Sardinella & Anchovies	25 000	37 000
Pelagic 2	Carangids, Scombrids, barracuda & Hailtail	127 000	16 000
Total		**152 000**	**53 000**

Table 6. Biomass and catch rates (kg/hr) of the main demersal groups estimated by the survey in 2007.

Species\family	Catch rates (kg/hr)	Biomass estimate
Sparidae	47.4	7 800
Haemulidae	1.4	190
Sciaenidae	29.9	4 600
Lutjanidae	4.7	710
Serranidae	—	0
Brachydeterus auritus	—	8 400
Sharks	—	1 070
Rays	—	1 950
Cephalopods	—	680

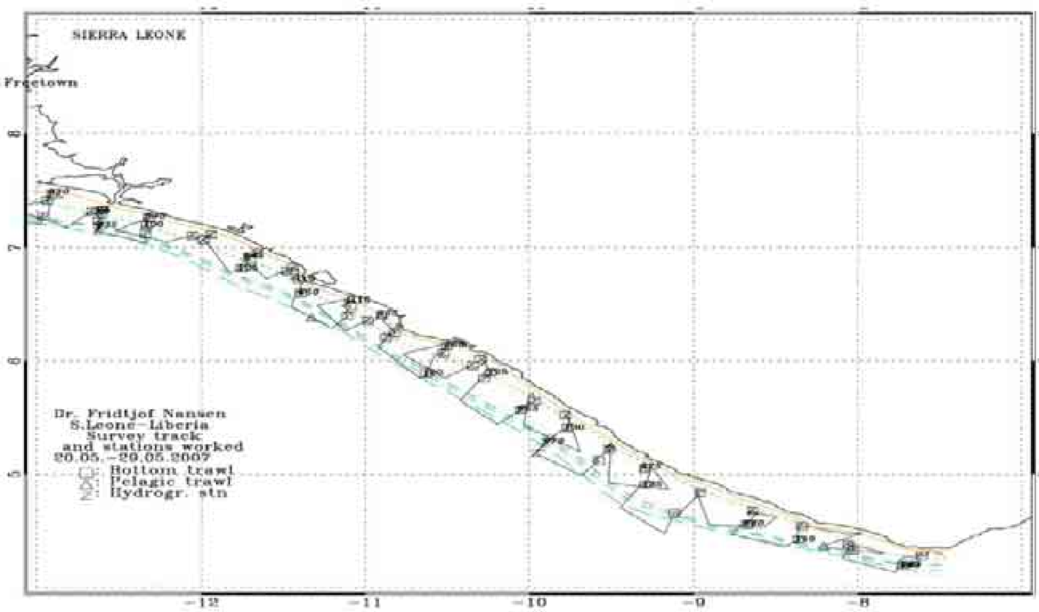


Figure 6. *RV Dr Fridtjof Nansen* 2007 Marine Fish Stock Assessment Survey reports within the Gulf of Guinea region.

3.3 Status of the stocks

Tables 7 and 8 shows the trends in landing of pelagic and demersal species in Liberia from 2003 to 2007. There are no formal assessments of the status of the stocks of these species in Liberian waters.

Table 7. Total pelagic species landed locally from 2003 to 2007 (landings in tonnes).

Species	2003	2004	2005	2006	2007	Total
Bonny ***Sardinella spp***.	1350	1355	386	660	1599	5,350
Barracuda ***Sphyraena spp.***	200	343	196	223	356	1,318
Bigeye tuna ***Thunnus obesus***	140	369	119	140	377	1,145
Flying fish ***Dactylopterus volitan***	20	490	112	1	246	869
Cavalla/Carangidae	280	490	339	370	289	1,768

Table 8. Total demersal species landed locally from 2003 to 2007 (landings in tonnes).

Species	2003	2004	2005	2006	2007	Total
Diawo ***Makaira indica***	110	490	123	15	143	881
Butternose ***Galeoides decadactylus***	190	573	138	206	464	1,571
Cassava fish ***Pseudotolithus elongatus***	130	535	107	390	381	1,543
Cassava fish/ ***Pseudotolithus senegalensis***	90	490	95	479	201	1,355
Grunter ***Pomadasys jubelini***	180	490	62	85	188	1,005
Deepwater shrimp ***Parapenaeus spp.***	210	490	218	21	40	979
Grouper ***Lutjanus johnii***	140	369	119	140	377	1,145
Grouper ***Lutjanus monostigma***	20	10	12	179	167	388

3.4. Direct interactions with the ecosystem

Fishing fleet in Liberia has evolved over seven decades and is known to be the most vibrant of the sectors. In recent years the production trend seems to be shifting downward as the landings decrease from 10 485 tonnes (1999) to 8 285 tonnes (2006), and the number of registered vessels reduced from 40 (2006) to 36 (2008). The underlying factors vary and can be viewed from different perspectives; but the direct interaction with the ecosystem resulting from the fishing fleet activities cannot be overemphasized. In addition to the fishing activities impact on the sea bottom, other direct interactions like sea pollution as a result of hazardous wastes, petrochemical wastes, oil spills, human wastes and other land-based pollutions need to be considered. Some of the direct interactions with the ecosystems are not limited to the understated.

Discards and ghost fishing

Every fishing craft focuses on target species but notwithstanding in the process other species are accidentally caught which are considered bycatch. In most cases, the bycatch has little or no significant value and therefore discarded back into the marine environment. The use of monofilament fishing gear, which is common among artisanal fishermen in Liberia, poses great threat to the ecosystem. Most often such fishing gears are commonly abandoned at sea and are less visible to the marine species and as such can cause the entanglement of these species. This act is considered ghost fishing.

Environmental impacts

Other pollution besides those caused by the fishers themselves may result from hazardous wastes including petrochemical wastes. Currently there is an ongoing oil exploration in Liberian waters by Anadarko Liberia Company (ALC) via the National oil companies. The direct dumping of debris (plastic bags, food containers, gear, twine materials, etc) in the marine environment and other human wastes can also impact the environment.

Overfishing

Excessive fishing is resulting in the decline of catches, as mentioned earlier. Fishing with dynamite and poisons are also major activities impacting the marine ecosystem of Liberia.

Types of fishing gears used

Most fishermen use inadequate fishing gears for target species causing impacts on the environment (e.g. bottom habitats) and the capture of juvenile fish.

Dredging

The dredging of the port by dredger vessel creates pollution sometime. Some of these dredge vessels dump the dredged materials into the seabed thus creating pollution of the marine environment.

3.5. Traditional knowledge about the fishery and the resources exploited

Traditional knowledge of fishery is understood to be the customs or norms or indigenous fishing practices handed down from generation to generation in fisheries operations.

Statistics have shown over the years that 85 percent of fishers in the artisanal fishery subsector are indigenous people. As a result, their fishing practices or activities are mainly traditional. Notwithstanding there exist among them some migrant fishermen that have introduced some western methods of fishing.

The traditional fishing activities are characterized as labor intensive. Most times, these fishers fished about 3 -5 nautical miles offshore without the use of compass, GPS or any other device that provide directions at sea. Moreover, the method of fishing is species selective (hooks and lines). The use of fishing net in this sector is most recent and was introduced by the migrant fishermen.

The types of boats used by indigenous fishermen are traditional dugout wooden boat ranged in length from 6 to 12 feet. Canoes with length ranging from 12 – 65 feet are owned and used by the migrant fishers. The method of preparing and the use of small dugout canoes were introduced in Liberia by the Kru tribe, thereby creating a trade mark on the canoe as “Kru canoe” no matter which tribe uses it.

Categories of artisanal fishing canoes

The traditional fishing canoes are divided into three categories:

- Small Kru canoe: This type of canoe ranged from 6 feet to 12 feet in length; width is about 1.5ft to 2ft and depth is 1.5ft. It takes a maximum of two persons crew members with the fishing accessories (hooks and lines). But normally such canoe takes only one crew member.

- Medium size Kru canoe is widely used by the indigenous and the migrant fishermen. It ranges from about 12 feet to 24 feet in length; width is about 3 to 3.5 ft and has the crew capacity of about four to six persons. The gear type used in this canoe is mainly monofilament gills net (Figure 6).

- Larger size canoe is not normally called Kru canoe because the method of preparing it was introduced by the migrant fishermen, mainly the Fanti (hence they are called “Fanti Canoe”). This canoe has a base of dugout but is built with planks thereby making it to be larger. It lengths ranged from 24 ft to 65 ft, width 4 to 6 feet and depth is about 4 feet. It has the crew capacity of 9 to 16 persons per fishing trip. Fanti canoes are powered by engines that range from 12hp to 45hp.

Figure 7. Artisanal fish landing site in Maryland County (see pile of monofilament nets).

Traditional sailing methods

The traditional canoes that carry one or two persons is operated by man power (paddles), cleverly made out of wood, with the help of sail sometimes made out of empty rice bag tied between two poles place at the head of the canoes. The medium and large canoes are powered by engines.

System of depth measurements

The traditional method of measuring sea depth (fathom) by the fishers is the use of anchor rope. When they reach a fishing area, a rope calibrated by fathom is sent to the bottom of the sea and measured to determine the depth of that area. Sometime the rope is measured by hand chest measurement (1 fathom = 6 feet or 2 yards).

Traditional navigational skills

Traditional fishermen do not have instruments or equipments or devices which direct them to go on sea and come back. However, they used traditional skills to go and come back. Sometime they used the sunrise and sunset or a natural or physical object, altitude usually mountains or some buildings, towers that are visible at long distances.

Resources exploited

The fishing methods and gear types (hooks and lines) used by most of the traditional fishermen is species selective. As a result, their catches are mostly valuable demersal and pelagic species. The main commercial species exploited by the traditional fishermen in the artisanal fisheries are listed in Table 9.

Table 9. Commercially exploited species of the artisanal fishery.

Demersal species	Pelagic species	Others species
Barracuda	Sardinella/bonny	Crabs
Groupers	Penten	Lobsters
Stingers	Poorjo	Inkfish
Sharks	Cavalla	Shrimps
Napleh	Flying fish	
Snappers	Sand cavalla	
Grunts	Bonga	
Croakers	Gbapleh/Illisha	
Diawo		
Cassava fish		
Catfish		

4. Annual catches

Catch data are collected from fisheries enumerators assigned at fish landing sites on the coast while the industrial trawlers catch data is collected by fisheries observers on board vessels and fishing pier. The catch landed from both sectors is collected from full enumeration. If a vessel does not have observer on board, the catch data is collected by the enumerator assigned at the pier immediately upon arrival at the fishing pier. The fish product landed in Liberia is usually packaged into 20kg cartoons or bags before landing except the loose species, shrimps or crabs. Table 10 presents the catch data by species from 1997 to 2007.

Table 10. Landings (tonnes) per species of the industrial and artisanal fisheries in Liberia.

Common name	Scientific name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Barracuda	*Sphyraena spp.*	0	67	343	174	196	200	200	343	196	223	355
Bear bear fish	*Pentanemus quinquarius*	155	138	118	92	102	110	110	118	217	79	62
Black bass/ seabream	*Spondyliosoma cantharus*					10	10	10	12	37	24	4
Black grouper	*Lutjanus johnii*	2	40	21	20	14	25	30	15	26	128	73
Bluefin tuna	*Thunnus obesus*	185	310	369	227	166	170	140	369	119	139	376
Bongar/bonnita	*Ethmalosa fimbriata*	17	33	123	37	123	120	120	123	23	87	101
Bonny (sardinella)	*Sardinella melanura*	485	620	1112	887	1358	1350	1350	1355	386	659	1 599
Butter nose	*Galeoides decadactylus*	236	248	573	181	183	190	190	573	138	206	463

Common name	Scientific name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cassava fish (longneck)	*Pseudotolithus elongatus.*	282	233	535	127	110	70	130	535	107	390	380
Cassava fish (shortneck)	*Pseudotolithus senegalensis.*	266	200	490	200	100	150	90	490	95	479	201
Catfish	*Ariidae*	0	4	31	21	210	210	200	490	394	137	187
Cavalla	*Carangidae*	30	178	394	235	271	280	280	490	339	369	288
Crab	*Brachyura (marine crabs nei)*	35	38	32	27	122	125	120	490	8	170	50
Deepwater rose shrimp	*Parapenaeus longirostris*	8	13	50	5	7	10	10	490	218	20	39
Diawoo	*Makaira indica*	122	59	37	187	131	130	110	490	123	14	142
Flying fish	*Dactylopterus volitans*	8	10	0	38	19	20	20	490	112	1	246
Forbor	*Coryphaenidae*	31	20	48	45	22	25	25	490	2	0	147
Gar fish	*Belonidae*	0	54	90	30	31	35	35	490	175	5	
Gbapleh	*Ilisha africana*	26	63	242	110	198	200	200	490	24	0	181
Greasy/sword fish	*Xiphias gladius*	543	21	39	42	34	35	30	490	85	93	71
Grunter	*Pomadasys jubelini*	99	85	216	102	180	180	180	490	62	84	188
Guitar fish	*Rhinobatidae*	0	54	175	16	0	0	0	490	50	130	23
Gbatoe												29
Hammerhead shark	*Sphymidae*			127	152					802	179	332
Horsepallet												21
Horsemackerel												99
Ink fisk	*Sepiidae/Sepiolidae*	0	12	8	14	29	30	30	8	535	14	60
Jacob fish	*Brotula barbata*	10	66	48	52	0	40	40	48	57	26	69
Jurel											130	66
Lobster	*Palinurus spp.*	8	26	4	41	36	40	40	4	39	123	22
Mackerel	*Scomber japenicus*	8	45	218	238	34	40	40	218	48	128	933
Mixed fish	*Osteichthyes (marine fishes nei)*	385	974	936	588	671	680	650	351	128	418	1 743
Mullet	*Mugilidae*	22	18	63	85	0	40	40	63	118	24	99
Napleh fish	*Istiophoridae*	71	781	513	683	163	165	135	513	8	61	574
Octopus	*Octopodidae*	2	61	23	16	41	45	40	23	490	1	

Common name	Scientific name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Penten	*Hemiramphidae*	0	77	85	96	97	100	100	85	63	16	198
Pike fish	*Sphyraena spp.*										321	806
Porgy	*Drepane africana*	0	70	256	94	104	110	110	256	573	128	150
Porjo	*Clupeoidei*	147	383	386	318	208	210	210	386	216	473	599
Red grouper	*Lutjanus monostigma.*	3	70	50	5	30	20	10	11	12	179	167
Rock	*Epinephelus*										64	145
Salmon fish	*Scombroidei*	0	3	2	14	8	10	10	2	343	4	45
Sand cavalla	*Decaplerus ronchus*	7	111	435	135	134	140	140	435	369	70	192
Sardine						242						4
Sea bat	*Mobulidae*	0	342	802	931	106	110	100	802	435	30	477
Sharks	*Elasmobranchii*	386	210	186	116	169	512	520	520	256	453	503
Shrimp	*Natantia*	73	100	252	20	24	30	30		31	46	41
Silver fish	*Trichiuridae*	10	9	33	34	169	160	160	33	201	69	207
Small mixed fish										33	353	1 026
Snake fish	*Congridae*	117	85	128	49	76	80	80	128	92	43	193
Snapper	*Lutjanus spp.*	17	27	339	132	201	210	200	339	420	1 245	1 259
Sole fish	*Soleidae*	150	149	217	129	206	210	200	217	60	65	344
Stinger	*Rajiformes*	38	50	119	103	29	30	30	119	29	72	152
Tempound	*Albula vulpes*	0	21	104	27	6	10	10	104	252	104	13
Trigger fish	*Balistidae*	5	2	0	0	0	0	0	0	4	0	0
Washboard	*Echeneidae*	0	3	1	12	0	0	0	1	513	0	91
Wonton												5
Yellowfin tuna	*Thunnus albacares*	340	108	112	201	175	175	145	112	32	38	289
Total		**4 329**	**6 291**	**10 485**	**7 088**	**6 545**	**6 842**	**6 650**	**14 591**	**9 095**	**8 285**	**16 154**

5. Importance of the fishery in the national economy

Fishery is an important sector of the Liberian economy. It provides an inexpensive and affordable source of protein to human diet, employment opportunities, generates foreign earnings and enhances food security.

Scientific knowledge has shown that fish is rich in protein and it is a sustainable means of acquiring better health standard. Most Liberians can easily afford fish as it is relatively cheap compared to meat or other sources of protein. As a result of unemployment rate of 85 percent in 2005, the majority of the youths, especially those living in the coastal areas, see this sector as a source of livelihood therefore devotes time in it. About 18 000 fishermen, processors and mongers are engaged in fisheries activities. Fisheries products are imported into and exported out of the country and earnings from both local and international trade of fish provide income to the economy.

Fisheries contribution to the economy was confirmed by the Food and Agriculture Organization (FAO) of the United Nations. During the National Agriculture Fair in Liberia held in December 2008, Liberia received “The Ceres Medal Award” from the FAO in recognition of its commitment to promote peace, food security, health and education as a means of achieving a Liberia free of hunger and poverty, as enshrined in the Poverty Reduction Strategy of Liberia (PRS) (FAO n.d).

Fisheries production, trade and labor

According to BNF 2006 statistical report, approximately 7 000 tonnes of fish are landed in 10 coastal artisanal landing sites. The average catch of a canoe per annum was 2.2 tonnes in 2004 and 1.16 tonnes in 2005. The reduction in volume of production in 2005 as compared to 2004 was due to the method of fishing employed by the industrial trawlers (double trawling/pair trawling) when they returned after the civil crisis. These trawling methods were very detrimental to the sector and were subsequently banned.

The major species exploited were sardinellas (S. aurita and S. maderensis), barracuda, croakers, sharks and ilisha Africana, among others. These species constitute some of the commercially valuable species in the local market. These species represented 83 percent and 59 percent of local fish supplied in 2004 and 2005, respectively. The Industrial fishery subsector comprised of large-scale trawlers contributed to about 41 percent of the total landings from 1997 to 2007.

The vessel market price (wholesale) of some of these major commercial fish species are shown in Table 11.

Table 11. Fishing vessel market prices per cartoon/bag (20 kg) of the main species.

Name of species	Price (local) USD$/20kg	Remarks
Stinger	8	
Yama (mixed species)	9	
Mix (Korea)	18	Small sizes
Mix (Selected)	23	Big sizes
Butter Nose	23	
Snappers	18	
Red Fish	15	
Sole Fish (small)	23	
Sole Fish (arge)	25	
Cassava Fish (small)	24	
Cassava Fish (large)	26	
Grunter	26	
Snake Fish	10	
Pipe Fish	20	
Cat Fish	8	
Jacob	15	
Porgy	23	
Loose (mixed)	1.20	
Bonnie	10	
Ink	26	
Octopus	5	
Lobster	26	
Shrimps	200	
Kappa	20	

Products and markets

Most Liberian firms seeking to operate in the export sector do not have capacity to meet international standards and other measures of quality applied in export markets. The performance of the Bureau of Standards in Liberia has been severely undermined by the 14 years civil war. There exist no alternative standard institution.

Liberian exporters suffer a competitive disadvantage. At the same time, government's capacity to assure the quality of export or import products especially foodstuffs and others is wholly comprised. This mean also that preshipment inspection services are not credible. The need to rebuild the standardization, Quality assurance, Accreditation and Metrology (SQAM) infrastructure in Liberia, is clearly a priority.

6. Fisheries management plan and objectives

The fisheries sector of Liberia has currently no management plans. But there are plans through the assistance of some national and international institutions to draft the fisheries management plan. In fact, the EAF-Nansen Project as well as the West Africa Regional Fisheries project under the sponsorship of the World Bank is currently strategizing, pulling out resources in preparing the fisheries management plan of Liberia. Sooner or later a consultant will be hired to draft a fisheries management plan.

The management of fisheries and aquaculture in Liberia is under the responsibility of the Ministry of Agriculture (MOA) through the Bureau of National Fisheries (BNF). The role of the BNF is to formulate guidelines, rules and regulations and implement fisheries policy to govern national fisheries and aquaculture for its planning, development and management (Kebe *et al.*, 2009). After two decades of instability and civil war, the institutional environment of fisheries management has become very unfavorable. However since the peace accords of 2004 and the subsequent stabilization of the country, the Liberian institutions are slowly starting to work again.

Significant efforts were undertaken since 2005 to re-habilitate the BNF but its capacity remains very limited. Indeed there is lack of fisheries research capacity which leads to weak governance and management of the fisheries. It is also important to mention that there is a weak coordination between governmental institutions which tends to limit the development of the fisheries sector (Kebe *et al.*, 2009).

A comprehensive assessment of the marine fisheries subsector provides the strategic framework for a fisheries Action plan, which translates these strategies into action.

The major objectives of the fisheries action plan are:

- Provide an overview of the past and present status of the fisheries subsector;
- Indicate the major bottlenecks for development of the subsector;
- Outline short/medium and long term actions for improvement of the subsector

7. Legal framework

The Natural Resources Laws of 1956 (revised in 1961 and 1973) are still in force in Liberia up to present. In 1972, FAO assisted the Government of Liberia to revise the Natural Resources Laws of 1956 but Presidential approval was not obtained up to the time of the military coup d'etat in 1980. In March 1999, draft fisheries legislation was prepared but was never finalized and approved by Government.

Fisheries Legislation

The Government of Liberia was assisted through the technical support of the World Bank under the West Africa Regional Fisheries Project of Liberia. New Fisheries regulations were developed, passed on 1 September 2010 and published on the 26 November 2010. The new fisheries legislations have an international character and dimension incorporating relevant provisions of the Code of Conduct for Responsible Fisheries and other international agreements, conventions and protocols addressing fisheries, natural resources and environmental issues. The new fisheries legislation is strengthening the maritime and fisheries laws and regulations and at the same time strengthening national capacity for MCS to control and regulate fishing and effectively curb and eventually eliminating poaching and other forms of IUU fishing within the EEZ of Liberia.

Fisheries Law

The Fisheries Law of Liberia enactment was formulated in 2007 and pending legislative enactment. It encompasses the Public Health Act, and the Subsidiary Legislation of Fisheries Products Regulations. The overriding principle of the regulations enshrined in the fisheries law is that these regulations are subject throughout to the provision that Liberia's exports of fishery products will comply with the food safety, quality and marketing requirements of the importing state.

8. Institutional and administrative frameworks for fisheries management

Institutional framework

The diagram in Figure 7 shows the institutional framework for fisheries management in Liberia. There is some collaboration with regards of planning, monitoring, capacity building, regulating and to further the implementation of the key principles of the ecosystem approach to fisheries management.

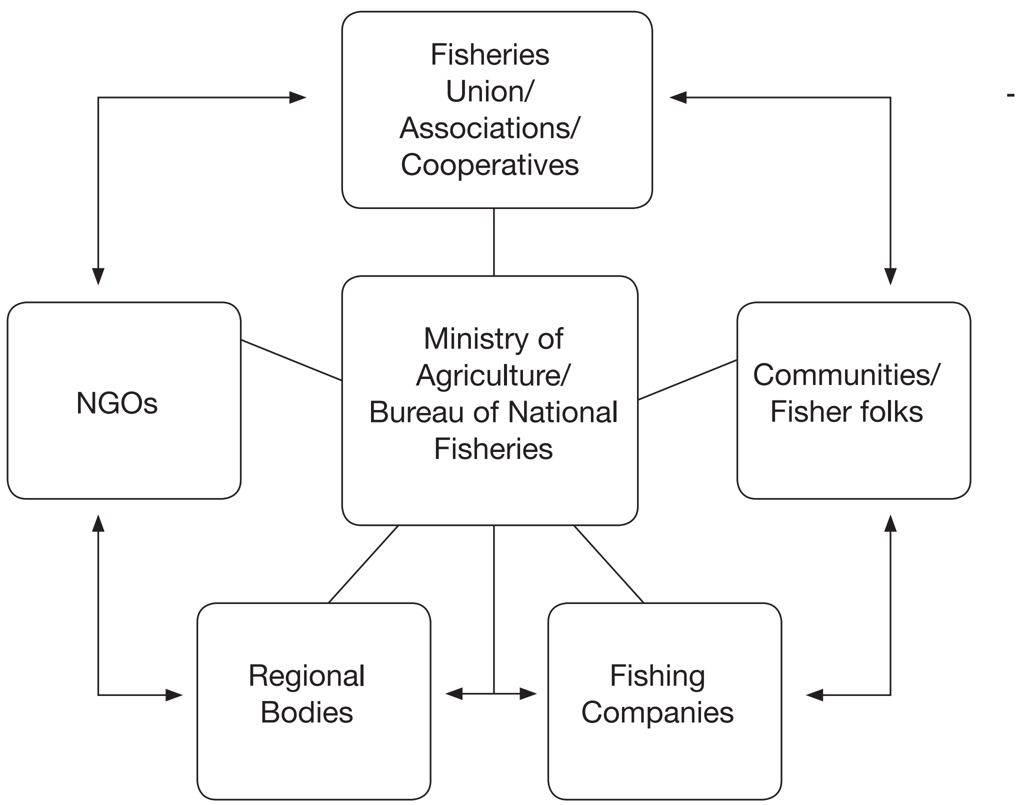
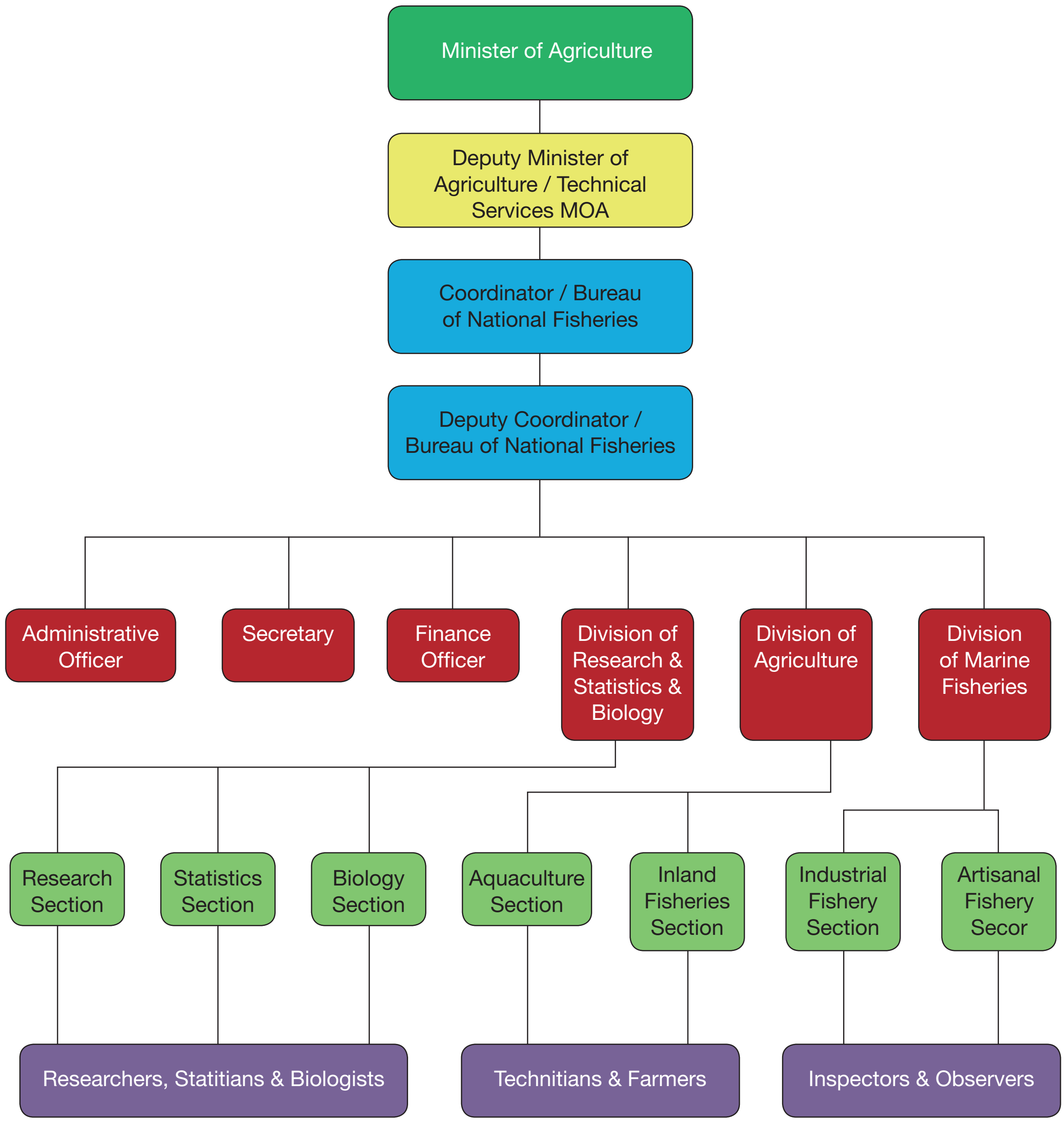


Figure 8. Institutional framework of the fisheries sector in Liberia.

Administrative framework



Linkages of other projects or organizations

EAF-NANSEN PROJECT

The EAF-Nansen Project offers an opportunity to coastal countries in subSaharan Africa, working in partnership with the project, to receive technical support from FAO for the development of national and regional frameworks for the implementation of Ecosystem Approach to Marine Fisheries management and to acquire additional knowledge on the ecosystem for their use in planning and monitoring. The project contributes to building the capacity of national fisheries management administration in ecological risk assessment methods to identify critical management issues.

This project is aimed at "Strengthening the knowledge base for and implementing an Ecosystem Approach to marine fisheries in developing countries".

Community science project of Liberia

The Community Science Project of Liberia is a Pilot Project that has the following objectives:

- To build capacity of West African artisanal fisher communities;
- To monitor and better manage their local coastal and inshore marine resources;
- To support an ongoing policy shift in fisheries management in West Africa to a "rights based" approach. This policy shift assigns rights over exploitation of inshore marine resources to fisher communities, largely devolving responsibility for the health and sustainability of those resources to those communities.
- To build strong and informed community groups with improved capacity to manage local coastal and fisheries resources effectively and to advocate for this both locally and nationally.
- The program trains volunteer groups in fishing communities to use a set of basic science procedures to systematically gather and interpret data and information on the status and health of Liberian fisheries.

West Africa Regional Fisheries Project Liberia (WARFP)

In order to address the specific issues of the West African fisheries, the West Africa Regional Fisheries Program (WARFP) was formulated as a support to fisheries management. The implementation of this program in Liberia has begun since April 2010. It aims to strengthen the capacity of Liberia to govern and manage targeted fisheries, reduce illegal fishing and increase local value added to fish products. The targeted fisheries mainly include coastal demersal fish, coastal shrimp and cephalopods.

The WARFP in Liberia is financed through a USD12 million grant under IDA/World Bank (USD 9.0 million) and GEF (USD 3.0 million) disbursed over an initial first phase of 5 years with a possibility of an extension for another five years. This program is to be implemented through four main components. More specifically, the registration of the fishing vessels and canoes is a particular aspect of the Component 2, which is financed by IDA/World Bank. This component aims to reduce the illegal fishing activities threatening the sustainable management of the marine fish resources and the wealth they can generate. This general objective will be achieved through the improvement of the fisheries MCS system of Liberia.

The Liberia Artisanal Fishermen Association (LAFA)

The Liberia Artisanal fishermen Association Inc. was established in December 2009 with the aim to unite all fishers in Liberia in order to have a common-front on fisheries development and to advocate on behalf of its members within the borders of the Republic of Liberia. It is an Umbrella fisheries organization in Liberia.

It has a membership of about 33 000 fishers including fishermen, fish mongers, fish processors, boat builders, fish farmers, fish preservers, fish marketers, etc; within 120 fishing communities.

The objectives of the Liberia Artisanal Fishermen Association are:

- To support government efforts in enhancing a productive base National Fisheries;
- To provide opportunity for fishers to be self-employed;
- To encourage grassroots fishing communities to organize as cooperatives;
- To promote fishers capacity building;
- To create micro-credit opportunity for fishing communities and individual members;
- To provide fishing and agricultural inputs to fishers at the subsidized rate;
- To ensure the enforcement of fisheries Laws and Regulations by relevant agencies;

9. Management measures and tools currently in use and status of implementation

The management measures currently used in the fishery sector of Liberia taking into consideration the substantive management tools are:

Spatial restriction

Vulnerability has characterized the Liberian territorial waters since the 1980’s up to 2010. Perhaps, the future intervention of national or international donor may reduce the vulnerability sector. The marine fishery sector, which has been the source of fish production, has not been protected, monitored adequately through regular surveillance. The 14 years civil war has devastated the fabric of Liberian society, destroyed institutions and instruments. Human resources and enforcement capacity were almost non-existent. There has not been fisheries policy for more than a decade and the line institutions and staffs are not able to guarantee resources conservation.

Geographically, there are fish nurseries, spawning grounds within the marine waters of Liberia. But these areas (marine protected areas, nursery areas, no-take zone, marine reserved areas and spawning areas) are yet to be identified and protected because of the weak monitoring system couple with the lack of defined fisheries policy. Notwithstanding, there are some interventions currently in place, a fisheries policy has been drafted and rules and regulations have been revised and published.

Temporal restriction

The coastal fisheries communities of Liberia are vulnerable to poverty. Some of the main factors that make them very vulnerable are as follows:

- Seasonality of fishing activities and absence of safety at sea. The period from January – May and October – December are considered good fishing seasons. During this time the ocean is calmed and sea breeze is relatively quiet. The average total production/catch of the artisanal fisher's is estimated at 3 tonnes per week per fisherman. The period of mid-May – mid-October is absolutely bad fishing season at which time the sea is very rough, damaging fishing canoes and to some extent causing the death of fishermen at sea due to lack of safety equipments.

- The artisanal fisheries operate on a daily basis with the exception of Sunday. Even in some cases, some can go on Sunday to discharge their set nets. About 99 percent of these fishermen do not have preservation facilities on board their canoes as a result cannot stay at sea for more than a day. The number of fishing hours for the artisanal fishermen is twelve hours per day.

Gear restriction

According to BNF fishery guideline, Rules and Regulations of 1976:

"3.3.1 No person for the purpose of maintaining a sustainable yield of the fisheries, shall fish with trawl-net with a cod-end smaller than 3 inches or 77mm except trawlers fishing exclusively for shrimps and bait fish.

3.3.2. Gill-net and or Beach seine net intended to be used for fishing in Liberia shall not be less than 3 inches or 77 mm cod-end mesh size. The wing of such gill net or beach seine net shall not be less than 3.5 inches mesh size.

3.3.3. No person shall buy or sell or have in possession, or expose for sale, manufacture for sale, to fishermen any netting (webbing) with mesh size less than 2.5 inches or 64mm stretch mesh".

Vessel/canoe size restriction

"3.4.1 No fishing vessel as well as Sport fishing vessel other than canoe shall fishing within six (6) nautical miles of the IEZ or within the In-Shore fishing zone (IFZ) (1976 fishery Regulations)".

Vessel/canoe age

As it relates to vessel/canoe age, this requirement is not much a focus but it is required that the vessel/canoe be sea worthy and meet all sanitary conditions.

Participatory restriction

All registered Artisanal fishing canoes are eligible to fishing within inshore exclusive zone. But each category of canoe has a limit or exclusive right in its territorial zone based on it capacity and size. The six (6) nautical miles zone is exclusive of the artisanal fishery while the industrial fishery operates beyond this distance.

Catch restriction

Total allowable catch (TAC) limit

There is no Total allowable catch (TAC) limit in place at the time of writing this document. Notwithstanding, fisheries regulations forbid the killing of endangered species such like sea turtles, dolphins and whales. Shark fishing is not yet restricted in Liberia.

Vessel catch limit

Under the Liberian fisheries rules and regulations of 1976, fishing vessels/canoes are not limited in term of catches landed, except for those species considered endangered and other species from illegal fishing activities.

Rights/ Incentives

Under the 1976 fisheries regulations rights and incentives were not granted to any fisher folks or canoe or entity. The New revised fisheries regulations intend to address the issues. However, currently all registered vessels/canoes have the right to fish within their respective exclusive fishing zones.

Individual effort quotas

Individual effort quota is yet to be put in placed. These are issues that the revised fisheries regulation will be addressing.

Individual fishing quotas

No individual shall operate a fishing canoe, trawler or any sport fishing craft within the territorial waters of Liberia without meeting the requirement as stated under fisheries guidelines/rules and regulations.

Territorial use rights

Territorial restriction is one of the main management measures fully in place. The six (6) nautical miles zone is exclusively for the artisanal and semi- industrial fisheries sectors (small-scale fisheries zone).

Stock use rights

The fish stock is to be harvested in a responsible manner. All fishermen have the rights to fish responsibly within the Liberian Marine waters, respecting the areas reserved, protected, no-take zones and restricted areas.

Acknowledgement

Recognizing the fact that some knowledgeable, experienced fisheries experts have contributed immensely for the production of this document, I wish to acknowledge D. Wisseh Kay, Head of Research and Statistics, Bureau of National Fisheries and Focal Point EAF-Nansen Project Liberia, Paul Larry George, Head of Fisheries section, United Seamen Union and Glasgow Togba, Head of Marine Fisheries, Bureau of National Fisheries for spending time sharing their meaningful contributions with us. The time they spent with us and effort made during the process was very much appreciated.

References and sources of information

Bureau of National Fisheries Statistics Division reports 2003–2007

Kebe, Jern, Kay, Collins & Kerkula. 2009. Livelihoods analysis of coastal fisheries communities in Liberia (This survey was sponsored by FAO under project "FIDP/C1043).

RV *Dr Fridtjof Nansen* Fish Stocks Assessment Survey reports 2006 & 2007 sponsored by GCLME in the Gulf of Guinea region.

Personal interviews with artisanal fishers and NTG members.

AN EAF BASELINE REPORT FOR THE FISHERIES OF SHALLOW WATER DEMERSAL FISH SPECIES OF THE SAYA DE MALHA AND NAZARETH BANKS OF MAURITIUS

Munesh Munbodh

1. Introduction

Mauritius has an exclusive economic zone of around 1.9 million km^2, which includes coral reefs, seagrass beds, rough and sandy areas, submerged oceanic banks and oceanic waters.

The exploitation of the fisheries resources of Mauritius provides an important source of fish to the population, employment to fishermen and other workers in the fishing industry and savings in foreign exchange. Besides export of fish and fish products is a valuable source of foreign exchange to the country being valued at MUR (Mauritian Rupee) 8.1 billion (USD 270 million) in the year 2010.

The fishing industry provides employment to about 12 000 persons in fishing, fish processing, marketing of fish and fish products and ancillary activities linked to it. Its contribution to national GDP in 2010 was 1.3 percent and its share of national exports amounted to 14.7 percent. Fish production was 7 800 tonnes valued at MUR 1.2 billion whilst per capita fish consumption was 22 kg in 2010.

Exploitation of the demersal fishery resources on the Saya de Malha and Nazareth Banks has been carried out for more than five decades on a regular basis. The fishery targets the *Lethrinus mahsena*, commonly known as the “dame berri”, which constitutes about 90 percent of the catch. Fish production from these banks has over the years supplied the local market with a valuable source of frozen fish. The number of fishing vessels and fishermen employed in the fishery has fluctuated with peaks in the 1990’s when resources were being heavily fished and even overexploited. About 550 fishermen, crew and other workers are employed in the industry and the value of fish landed in 2010 was MUR 145 million.

Several studies have been carried out on the fishing resources of the Saya de Malha and Nazareth Banks from as far back as the 1950s. The fishery was developed from the l960s onwards. The fish is long-lived and slow growing and can easily be overexploited if the necessary precautions are not taken to control fishing effort. Data available have been analysed and assessments carried out to determine the MSY of the stocks. The information has helped to apply management measures to ensure that fish stocks are exploited sustainably. The measures included a licensing system for all fishing vessels fishing on the banks as from 1992 and a system for allocation of quota as from 1994.

Data for the last ten years show that the stocks have been moderately fished at about two thirds of the total MSY of both banks. However, exploitation has remained at these levels due to other problems faced by the fishing companies. These circumstances helped to keep a hold on increasing capacity in the fishery.

The effectiveness of current management measures has been considered including the biological, social, economic and ecological aspects. Compliance in the fishery has been satisfactory except for a few cases of illegal fishing by foreign fishing vessels. Moreover, the distances of the banks from Mauritius make surveillance costly.

The demersal fishery resources on the Saya de Malha and Nazareth Banks amount to about 20 to 30 percent of local fish production and continue to play an important social and economic role in the fisheries sector. Hence development of a Fisheries Management Plan for the resources needs to be pursued further.

The national and regional forum for stakeholder consultations include the Bank Fisheries Management Committee, the Bank Fisheries Management Plan National Task Force, the Bank Fishing Operators Association, the Maritime Transport and Port Employees Union, the SWIOFP, SWIOFC and SIOFA, among others.

A validation workshop on the draft baseline report was held on 14 March, 2012, followed by an Ecological Risk Assessment (ERA) workshop on 15 and 16 March, 2012. Comments and suggestions made on the draft baseline report during the validation workshop have been included in the final baseline report and issues identified during the ERA workshop as having high risks are highlighted.

The Saya de Malha and Nazareth Banks

The Saya de Malha Bank was named by Portuguese sailors 500 years ago on finding a shallow area covered with seagrasses in the middle of the ocean whilst navigating from the Cape of Good Hope and India. The Saya de Malha Bank is the largest submerged bank in the world. It is found in a region of the Indian Ocean with very low productivity. The Saya de Malha and Nazareth Banks are part of the Mascarene Plateau (Figure 1). This plateau was formed by volcanic activity from the Reunion hot spot between 20 and 40 million years ago (Fisher *et al.*, 1967).

Figure 1. Map of Saya de Malha and Nazareth Banks (Fisher *et al.*, 1967).

The Nazareth and Saya de Malha Banks are situated 650 and 1 050 km respectively from Mauritius. The Saya de Malha Bank covers an area of 42 116 km^2 within the 75 m isobaths and comprises two parts, the larger South Bank (37 151 km^2) and the smaller North Bank (4 965 km^2). The Nazareth Bank covers an area of 22 814 km^2 inside the 75 m isobaths. The Saya de Malha and Nazareth Banks are composed of a basaltic basal rock overlain by 2.3 km and 1.6 km of limestone respectively. They could have been low lying islands as recently as 18 000 to 6 000 years ago when sea levels were up to 130 m lower during the recent ice age. Depths along the rim of the Saya de Malha Bank range from 17 to 29 m with shallower areas of 7 to 8 m reported in two sites. The Saya de Malha Bank is an area of high productivity compared to the surrounding nutrient-poor ocean. The banks form a barrier to the westward-flowing South Equatorial Current and cause upwelling and enhanced chlorophyll and secondary productivity supporting diverse fish communities on the banks, productivity being highest along the eastern edges of the banks (Goreau, 2005; Smythe-Wright *et al*., 2005).

Seagrasses cover 80 – 90 percent of the bottom on the Saya de Malha Bank with corals covering around 10 – 20 percent and sandy areas being less than 5 percent. Corals and coral communities are scattered across the seagrass beds with Porites and clumps of Heliopora and Millepora. Acropora are few. Seagrass species include *Thalassodendron ciliatum, Halophia decipiens* and *Enhalus acoroides* (Goreau, 2005).

Mauritius and the Seychelles jointly have an extended continental shelf of 396 000 km^2 on the Saya de Malha Bank. Part of the Saya de Malha Bank falls within the Exclusive Economic Zone (EEZ) of Mauritius.

2. Overview of the fishery and resources exploited

Historical overview

Fishing started on the St. Brandon Islands to the south of the Nazareth Bank in 1927 by the Raphael Fishing Co Ltd on a commercial basis when salted fish was sent to Mauritius by the company. The vessel “La Perle 1” was the first fishing vessel to operate on the banks around St. Brandon in 1939 (Couacaud in Samboo, l989). The fishery resources survey of the Nazareth and Saya de Malha Banks carried out by Wheeler and Ommaney using “Motor Fisheries Research Vessel No 1” in 1948-1949 (Wheeler and Ommaney, 1953) led to a better knowledge of the fishing potential of these banks (Ardill, 1979). Trawl surveys were also carried out by the FAO/UNDP chartered vessel “Professor Mesyatsev” in 1976 and 1977 (FAO/IOFC/IOP, 1979) for assessing the fishery resources on the banks as part of a wider Western Indian Ocean project.

Production of frozen fish, mainly of *Lethrinus mahsena*, commonly known as the “dame berri”, started from the Nazareth Bank in the 1950s with the operation of a single vessel for a short time and was further developed in the 1960s with the operation of additional vessels. Frozen fish production increased to 3 279 tonnes in 1974 but gradually declined in the late 1970’s to 1 232 tonnes in 1980 and the number of “mother” vessels decreased from seven to only three vessels by 1979 due, among others, to inexperienced management and labour problems (Wilkstrom and Kroepelien, 1979).

This situation led to the chartering of South Korean vessels by fishing companies for fishing on the banks and supplying the local market from 1977 until 1984. There was a regain of Mauritian participation in the banks fishery from 1984 with incentives provided by the government, such as, concessionary harbour dues for fishing vessels, reduced duties on items used in freezing fish and fuel and concessionary loans. The number of local fishing vessels thus increased to a peak of 17 in 1993 and gradually decreased to 5 in 2012 due to high costs of maintenance and certification of fishing vessels and lack of sufficient local active fishermen for fishing campaigns. Fish production likewise increased from a peak of 4 758 tonnes in 1994 and decreased to 1 630 tonnes in 2010.

Issues

Local fishing companies started to resort to fishermen from Madagascar as from 1994 in view of the lack of reliable local fishermen to fish on the banks. Bank fishing companies also face other problems related to acquisition of seaworthiness certificates, the high cost of fuel, ageing of the fishing fleet, conveyance of mogas and the reported indiscipline of fishermen leading to shortening of fishing campaigns. On the other hand fishermen claim that foreign fishermen are being employed to their disadvantage, living conditions on fishing vessels need to be improved and fishing campaigns shortened.

Local fishing companies started to resort to flagging their vessels in foreign countries, such as Madagascar and Comoros, as they found such arrangements to their advantage because they did not need to have the vessels surveyed in Mauritius and they could employ foreign fishermen.

New policy

Companies having vessels flagged in Mauritius sought a longer-term policy on the employment of foreign fishers whom they had been allowed so far to recruit on an *ad hoc* basis.

Hence in 2006 government approved a policy which set down clearly the conditions under which foreign fishers can be employed and payment of a “contributory fee” by all vessels flagged in foreign countries equivalent to 7 percent of the landed value of the catch and payment of proportional “contributory fees” for those Mauritian vessels which employ less than 70 percent of local fishermen per fishing trip in order to encourage employment of local fishers. The policy also spelt out the conditions for registration of fishermen and the allocation of catch quotas to foreign fishing vessels.

EAF perspective

Over the years the relatively low price of the frozen fish from the Saya de Malha and Nazareth Banks made it accessible to all the segments of the population including the lower income groups and it has become an indispensable food item on the market.

In view of the importance of the Saya de Malha and Nazareth Banks fishery resources, both as a source of fish to the local market and employment, its long-term sustainability is of high importance to the local economy. Fish stock assessments have been carried out with the availability of time series data and fish production can be compared to stock estimates. However, management measures such as licensing of fishing vessels and catch quota need to be integrated into a well-defined fishery management plan so as to manage the fishery resources sustainably in the context of the EAF. Important challenges include taking on board the various factors influencing the fishing industry and the participation of all stakeholders in the management of the fisheries resources.

2.1. Fishing gear used and areas fished

Fishing gear used and fishing operations

Fishing trials carried out between 1970 and 1973 using gear such as bottom longlines, gillnets and basket traps did not prove effective (Ardill, 1979). Handlines remained the only effective method of fishing and has thus changed very little since the start of fishing on the banks i.e. fishing continues to be carried out by handlines from 6 to 7 m dories. These dories are carried to the fishing grounds on board the “mother” fishing vessel where they are put at sea with three fishermen on board of each dory (Figure 2). The length of the mother vessels has ranged from 35 to 55 m Length Overall (LOA) in the last ten years and they can carry from 15 up to 22 dories. The fishing campaigns lasts for 45 to 60 days and each vessel makes on average of three trips per year. The fishermen have to buy their fishing equipment on board the vessel.

Figure 2. Upper left: “mother“ fishing vessel with dories. Upper right: dory set at sea from “mother” vessel for fishing trip (courtesy Sealord Fishing Co Ltd). Lower left: hauling of catch aboard “mother” vessel from dory (courtesy Sealord Fishing Co Ltd). Lower right: *Lethrinus mahsena*, “dame berri”.

The fishermen use nylon lines with about four hooks at the end and fish in depths varying from 18 to 60 m in areas where corals and seagrasses are present. Fishing is usually carried out in pairs of two boats fishing in the vicinity of each other for safety purposes. The dories are powered by 8 hp engines and fish within sight of the mother vessel and drift while fishing. Each dory is equipped with a radio for communications to the mother vessel. The dories make two fishing trips per day from 5:30 am to 12:00 pm and 13:00 pm to 18:00 pm or later respectively. Fish caught is gilled, gutted and cleaned in the dory by the fishermen before reaching the mother vessel and hauled aboard the latter at the end of each fishing trip (Figure 2). The fish is blast-frozen on board the fishing vessel and stored in cold rooms. The bait used for fishing is the “dame berri”, *Lethrinus mahsena,* and shark meat from sharks caught on the spot. As fishes less than 30 cm are not accepted, part of small “dame berri” caught is either released or dead or dying ones hooked in the throat are used as bait. Part of the undersize fish is also retained as catch. Areas where toxic fishes are found are avoided. The “mother” vessel changes locations every night by about 8 to 15 km as catch rates tend to decrease in the areas fished.

Over the years more fishing operations have been carried out during the summer months from September to the end of May of the following year although a few trips are also carried out in the winter months from June to August on vessels employing mostly foreign fishermen. The fishing year is thus from the 1 September to 31 August of the following year. It is also known that the fishing vessels spend less time on the Nazareth Bank as compared to the Saya de Malha Bank due to better weather conditions prevailing on the latter bank generally.

The transport of mogas on board the mother vessels for powering the dories is recognized as being unsafe for the fishing vessels. The alternative of using diesel-powered engines has met with resistance from fishermen as they are about twice as heavy as those propelled by mogas, difficult to handle and lack power to engage in heavy seas according to fishermen.

In order to find other fishing methods, trials were made using collapsible traps for fishing on the St Brandon Bank and the west of the Nazareth Bank in 2010, by the research vessel "Dr. Fridjof Nansen". Following encouraging results obtained through further experimentation using the research vessel "Sphyrna" of the Ministry of Fisheries in 2011 near the Albatross Island to the north of St Brandon, traps have been handed over to a few companies to continue fishing with them and gain experience with this new mode of fishing. Use of traps directly from the fishing vessel is expected to decrease reliance on the utilization of dories and mogas and will be safer for the fishing vessels in the industry. Furthermore as the traps are collapsible, more traps could be carried on board the fishing vessels or boats.

Semi-industrial chilled fish fishing boats have started to fish in the shallow waters of the Saya de Malha and Nazareth Banks as from 2003. Their sizes range from 13 to 23.9 m LOA and they also use handlines for fishing.

Areas fished

The areas of the banks that are fished are found on parts of the North Bank and the northern, northeastern and eastern rim of the South Bank of the Saya de Malha Bank (Figure 3) and the eastern rim of the Nazareth Bank (Figure 4). MRAG (1996) estimated the fishable areas of the Saya de Malha Bank to be 30 percent and that from the Nazareth Bank to be 38 percent. The actual fishing areas for 2011 are shown in Figures 3 and 4. The fishing area for the Saya de Malha Bank is 27 percent of its total area (30 percent for the South Bank and 52 percent for the North Bank) and for the Nazareth Bank it is 31 percent of its area.

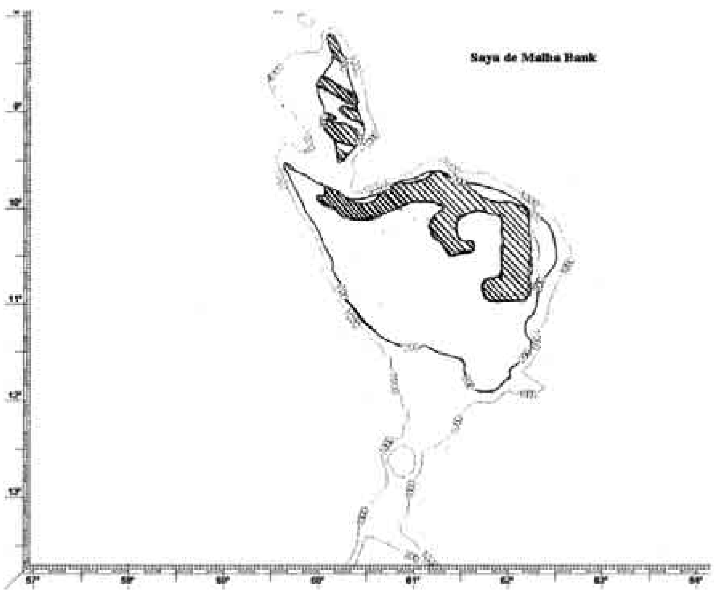


Figure 3. Fishing areas on the Saya de Malha Bank (shaded).

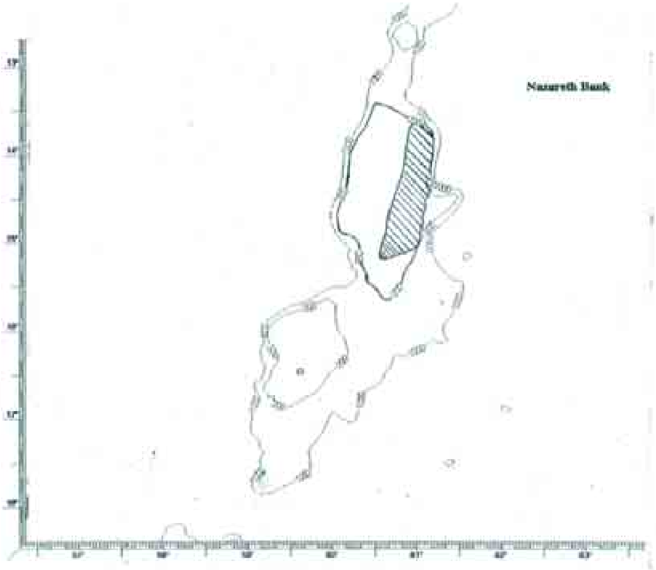


Figure 4. Fishing area on the Nazareth Bank (shaded).

2.2. Resources exploited

The shallow water demersal fish species constitute the fishery resources exploited. The "dame berri" *Lethrinus mahsena* (Figure 2) makes up to about 90 percent of the catch. The other part of the catch is composed mostly of serranids, lutjanids and other lethrinids (mainly *Plectropomus maculatus*, *Aprion virescens*, *Variola louti*, *V. albimarginata*, *Lethrinus rubrioperculatus and L. elongatus*) with smaller quantities of tuna. Table 1 gives a breakdown of fish caught by species for the last 5 years.

Table 1. Breakdown of Fish Catch by Species on the Banks
Source: Albion Fisheries Research Centre (AFRC).

Year	Lethrinids (%)	Snapper/Grouper (%)	Tuna/others (%)
2011	91	9	0
2010	92	8	0
2009	87	13	0
2008	91	8	1
2007	84	16	0

2.3. Number of fishers and land-based workers by sector

The number of fishermen involved in the fishery varies according to the number of active fishing vessels. In the past any person with fishing experience, especially in the artisanal fishery, wishing to fish on the banks was recruited as a fisherman by the fishing companies, depending on employment opportunities available. Subsequently bank fishermen were registered and issued a Continuous Record Book (CRB) in order to have a reliable list of fishermen from which companies could recruit fishermen. Registration of the banks fishermen started in July 1994 and 660 bank fishermen and 88 frigo-boys were registered. Frigo-boys are workers involved in freezing the catch aboard the fishing vessels.

Training sessions for banks fishermen were organized at the Sea Training School of the Ministry of Shipping. Training of the fishermen was carried out especially to get them acquainted with the safety aspects on board the fishing vessels and when they are out fishing in the dories. Only those who followed the training course were issued the CRB. However, it was noted with time that the number of registered fishers kept on increasing but fishing companies claimed they could not recruit regular fishers even though the official list contained a sufficient number of fishers. Many fishers on the list appeared to have employment in other sectors of the economy and were not available for fishing campaigns.

Following prolonged discussions chaired by officers of the Ministry of Fisheries with the fishermen union and the fishing companies, conditions for keeping a fisher on the “Active List” of fishers were revised and attached to the CRB and a new CRB issued in 2007. Active fishers are those who have done at least two fishing trips on bank fishing vessels or fished for a cumulative period of 100 days on semi-industrial fishing boats from 1 September to 31 August of the following year. The total number of active fishermen engaged on mother fishing vessels was 111 in 2011 according to the new criteria. In addition, there are about 200 fishermen engaged in the chilled fish fishery who fish on the Saya de Malha and Nazareth Banks part-time as they also fish on the slope fishery resources of the banks.

There is a need to register the fishermen fishing on semi-industrial fishing boats as the conditions for their registration are already spelt out in the CRB, the more so, that it is known that some fishermen who work on the mother vessels are also employed on the semi-industrial fishing boats.

Land-based workers related to the banks fishery are those working in the cold rooms on shore and in the processing, distribution and marketing of banks frozen and chilled fish. The number of such workers is estimated to be around 200. In view of the difficulty of getting such information from the enterprises the Ministry of Fisheries should in the future collect it in a systematic way.

2.4. Interactions with other fisheries

The shallow water fishery resources of the Saya de Malha and Nazareth Banks are exploited in isolated areas very far from the coast of Mauritius. No other fishery takes place in these areas except for the deepwater slope fishery which target mainly snappers and groupers such as *Polysteganus baissaci*, *Epinephelus morrhua*, *Etelis carbunculus*, *E. coruscans* and *Pristipomoides filamentosus.* The shallow water fishery targets the lethrinids but about 10 percent of the catch is mainly made up of snappers and groupers and lesser amounts of tunas and other species. This can amount to almost 200 to 350 tonnes of snappers, groupers and other lethrinids (mainly *Plectropomus maculatus, Aprion virescens, Variola louti, V. albimarginata, Lethrinus rubrioperculatus and L. elongatus*) and tuna. As the species of snappers and groupers caught in the shallow water fishery differ from those of the slope fishery there is no direct interaction between these fisheries.

On the other hand, in view of the fact that the *Caranx* species occurring on these banks are declared toxic, it is reported that fishing in areas with higher populations of these species are avoided and according to operators their numbers are increasing and affecting the stocks of lethrinids. To what exent this is founded cannot be gauged with precision due to lack of data on the carangid populations and as fishing for these fishes was prohibited as from 1996. However, estimates of the stocks of *L. mahsena* do not indicate any great change in their MSYs on the banks since 1989. This shows that the presence of the carangids may not be playing any significant role on the populations of *L. mahsena* as the latter is not the sole prey of carangids.

Species other than the lethrinids, snappers and groupers that are caught can be considered as bycatch. Whilst some fishermen report that undersize *L. mahsena* is caught in very small numbers other fishermen report that the numbers of undersize fish caught are quite large and some of them are thrown back to the sea. Some undersize fish is used as bait. No detailed information is available on the discards and it would be advisable to collect such information through observer programs.

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

The major species comprised in the shallow water fishery of the Saya de Malha and Nazareth Banks is the “dame berri”, *Lethrinus mahsena* (Figure 2). It makes up to about 90 percent of the fish catch and is a very well appreciated fish by the population in Mauritius.

Its colour is yellowish grey becoming lighter on the ventral side. Its head is purplish grey with about ten vertical light greenish blue stripes on the body. The species found around Mauritius has a red blotch on the nape whilst there is no such mark on the one fished on the banks. It is found in reef areas and adjacent sandy and sea grass areas. *L. mahsena* feeds mainly on echinoderms, crustaceans and fishes, mollusks, sponges, polychaetes, and other worms are consumed in lower quantities (Carpenter and Allen, 1989). It can reach a maximum length of 65 cm. The fish is known to be long-lived and slow-growing. Fecundity ranges from 26 700 to 166 200 eggs per mature female.

Wheeler and Ommaney (1953), Lebeau and Cueff (1975 and 1976) and Bertrand (1986) have studied the *L. mahsena* from the Saya de Malha and Nazareth Banks. According to Bertrand *et al* (1986) the fish is a protogynic hermaphrodite based on research carried out on the Saya de Malha Bank stock. Thus there are few females longer than 35 cm (fork length) or 8 years old and few males which are less than 20 cm (less than 3 years). Sex reversal is estimated to take place from 5 to 6 years mean age, which is some 2 to 3 years after the earliest onset of sexual maturity in the fish at 18 to 20 cm (age 3 years). Bertrand (1986) also suggested the existence of a single spawning season between October and November on the north of the Saya de Malha Bank and from January to February further south.

Soondron *et al.* (1999) have studied the reproduction of *L. mahsena* on the banks and estimated the length at first maturity, Lm_{50}, to be 19.8 cm and found that the spawning season was during the summer months with a peak in December.

3.2. Geographical distribution of the species

L. mahsena is widely distributed in the Western Indian Ocean on the Saya de Malha and Nazareth Banks and also found around Mauritius, Rodrigues, St Brandon, Agalega and in the Chagos Archipelago.

3.3. Status of the stock

The stocks of *L. mahsena* on the Saya de Malha and Nazareth Banks were estimated by Sanders (1989) and their Maximum Sustainable Yield (MSY) found to be 2 887 and 1 280 tonnes respectively using a methodology largely based on the Thompson and Bell model. The total MSY was 4 167 tonnes. Based on these figures it is observed that the stocks on these banks were heavily and even over-exploited from 1993 to 1995 when catches from the Saya de Malha Bank ranged from 2 682 to 3 173 tonnes and catches from the Nazareth Bank ranged from 1 252 to 1 720 tonnes from 1993 to 1997 (Table 2).

Estimation of the stocks by Soondron *et al.* (2005) gave the MSY to be 2 350 tonnes for the Saya de Malha Bank and 1 800 tonnes for the Nazareth Bank using the Shaeffer’s model, i.e., a total of 4 150 tonnes for both banks.

Stock assessment carried out by Degambur and Solmundsson (2005) estimated the MSY of *L. mahsena* on the Saya de Malha Bank to be 2 351 tonnes and the MSY for the Nazareth Bank to be 1 623 tonnes using surplus production dynamic biomass models and length frequency data. The amount of fish caught on the Saya de Malha Bank ranged from 771 tonnes to 1 845 tonnes in the period 2006 to 2010 whilst the quantity caught from the Nazareth Bank ranged from 281 to 855 tonnes during the same period. It is, therefore, deduced that the fishery has been moderately exploited from 2006 to 2010 and the stocks of *L. mahsena* on the banks are in good condition.

3.4. Interaction with the Ecosystem

The shallow water fishery resources of the Saya de Malha and Nazareth Banks are exploited by handlines. Some interaction is reported to take place with respect to damage to corals by dropping and entangled iron weights, weights lost during fishing operations and anchoring of fishing vessels during fishing operations.

As the banks are far from any populated land, which can discharge waste materials in or near them, there is no possibility of land-based pollution or coastal development affecting them. On the other hand, they are known to harbour rich seagrass beds and coral colonies, which are witness to their vitality. Being situated in a region of the Indian Ocean with quite low productivity nutrient levels in the water could be very low but enough to sustain coral and seagrass growth (Goreau, 2005).

3.5. Traditional knowledge of the fishery and resources exploited

The banks are very far from any populated land and the fishery and resources exploited were unknown to people until perhaps the Portuguese sailors navigated over the banks about 500 years ago. Even then the banks remained unexploited until the early twentieth century when a Mauritian company started to operate a fishery on the St Brandon Islands to the South of the Nazareth Bank. Hence, knowledge gained about the fishery on the Saya de Malha and Nazareth Banks by fishermen and crew of fishing vessels in the last 80 years constitute the traditional knowledge about the fishery and resources exploited. Fishermen who have fished on the banks for a long time accumulate some traditional knowledge with respect to the fishing grounds and use this to maximize their catches.

Fishermen who have long experience report that they fish in deeper waters during summer and move to shallower areas covered with seagrass beds during winter where larger fish come to feed. They have also noticed that they fish better when there are sharks present but they are now observing that there are lower numbers of sharks as foreign fishing vessels are targeting sharks and decreasing their populations.

4. Annual catches

Catches of “mother” vessels and semi-industrial fishing boats, catch per fisherman day (CPFD) and total effort (fisherman days) for the Saya de Malha and Nazareth Banks shallow water fishery for the period 1990 to 2010 are given in Table 2. The semi-industrial chilled fish fishing boats started operating in the shallow waters of the banks as from 2003.

Table 2. Catch (tonnes), Catch per Fishermen Day (CPFD) and total effort (fishermen days) from the banks fishery for the period 1990-2010
Source: AFRC.

	Saya de Malha		Nazareth		Total Effort (fishermen days)	Chilled Saya de Malha	Chilled Nazareth	Total Catch
	Catch	CPFD	Catch	CPFD		Catch	Catch	
1990	1 410	73.0	914	78.0	30 965	0	0	2 324
1991	1 782	71.4	793	77.1	30 014	0	0	2 575
1992	2 825	86.6	980	76.2	53 883	0	0	3 805
1993	3 173	89.1	1 358	72.5	66 487	0	0	4 531
1994	3 167	77.2	1 591	65.7	69 612	0	0	4 758
1995	2 682	57.8	1 609	60.2	73 134	0	0	4 291
1996	2 283	57.4	1 253	52.5	63 354	0	0	3 536
1997	1 798	71.8	1 720	66.1	51 047	0	0	3 518
1998	2 054	76.9	1 086	81.4	40 396	0	0	3 140
1999	2 107	70.1	1 121	76.2	44 785	0	0	3 228
2000	2 099	77.8	1 080	90.5	38 926	0	0	3 179
2001	1 283	71.0	1 366	84.2	24 113	0	0	2 649
2002	2 090	83.3	918	93.3	34 920	0	0	3 016
2003	2 354	80.1	468	72.9	35 797	1.0	1.2	2 824
2004	1 686	71.0	855	84.2	33 883	7.2	25.9	2 574
2005	1 028	81.2	578	75.2	20 338	54.1	32.2	1 692
2006	1 645	70.8	777	80.7	32 860	78.4	49.3	2 550
2007	1 481	76.1	506	95.2	24 735	16.7	97.9	2 102

As shown in Table 2 and Figure 5 the total catch from the banks peaked in 1994 at 4 758 tonnes and thereafter gradually decreased to 3 179 tonnes in 2000 and to 1 630 tonnes in 2010. The total catch trend also follows the same trend as the total effort indicating a very close relationship between the two as shown in Figure 5. Total effort reached a peak of 73 134 fisherman days in 1994, decreased to 38 926 fisherman days in 2000 and then to 16 645 fisherman days in 2010.

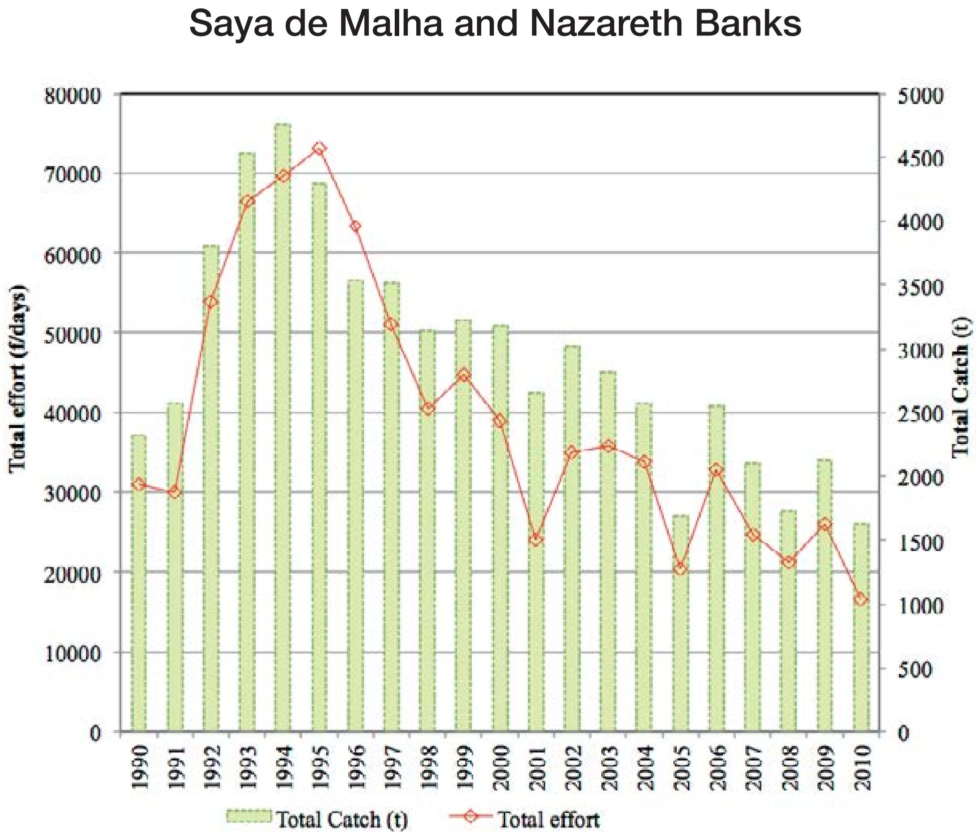


Figure 5. Total catch (tonnes) and total effort (fishermen days) from the Saya de Malha and Nazareth Banks (1990 to 2010).

The CPFD for the Saya de Malha Bank, which was at its lowest at 57.4 kg/fishermen days in 1996, increased to 83.3kg in 2002 and fluctuated between 71kg to 81.2kg for the period 2003 to 2010 as shown in Table 2 and Figure 6. The CPFD for the Nazareth Bank was lowest at 52.5kg/fishermen days in 1996 and highest at 95.2kg in 2007 and at 91.5kg in 2010 as shown in Table 2 and Figure 7.

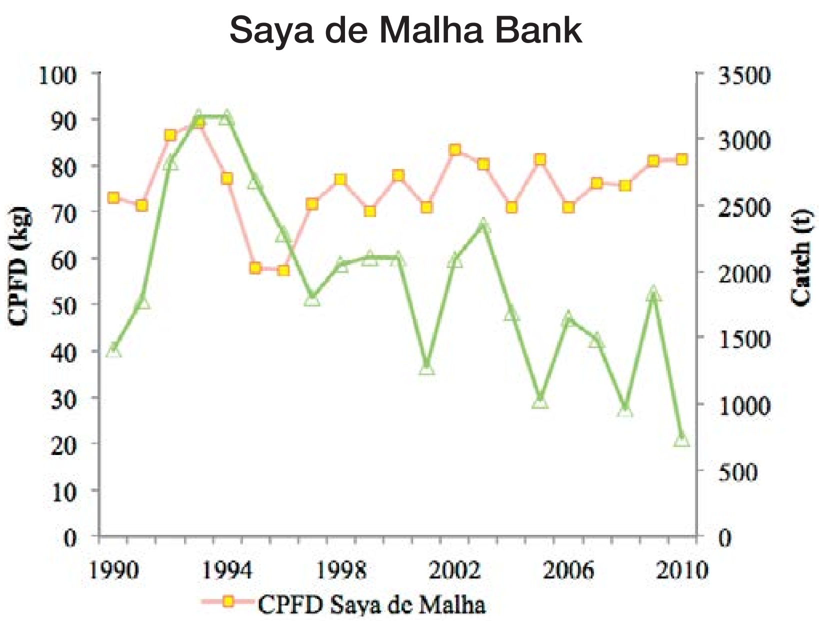


Figure 6. Trends in Catch (tonnes) and CPFD (kg/fishermen days) for the Saya de Malha Bank.

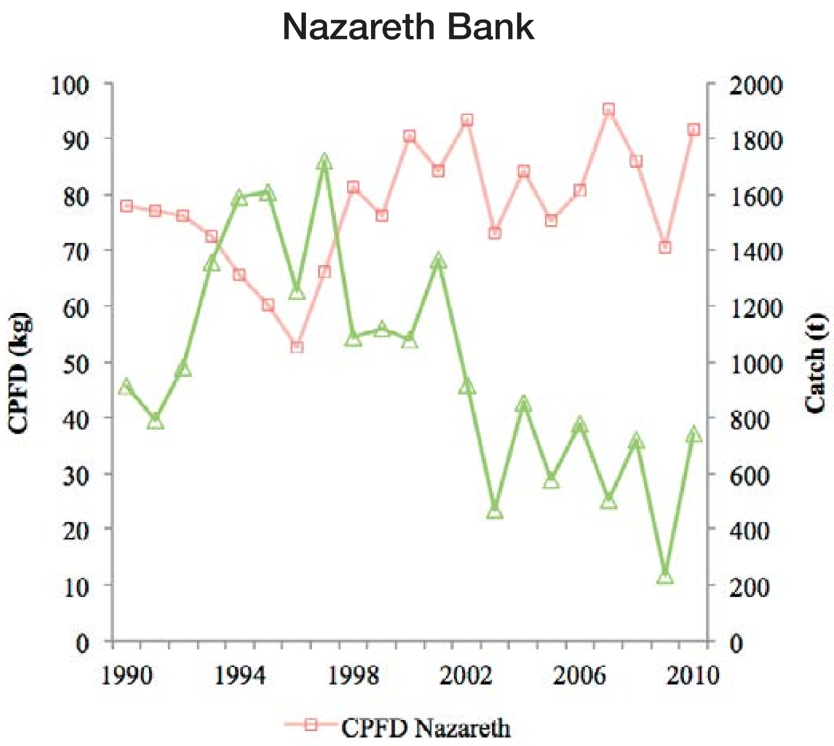


Figure 7. Trends in Catch (tonnes) and CPFD (kg/fishermen days) for the Nazareth Bank.

The total catch of the semi-industrial chilled fish fishing boats is quite erratic with peaks in 2006 and 2007 and highest in 2010 at 161.2 tonnes with a low production of 37 tonnes in 2008.

5. Importance of the fishery in the national economy

Fisheries are an important sector of the national economy. Fisheries comprise the following subsectors: the artisanal, semi-industrial, banks and the industrial fisheries and fish farming. It is an important source of food for the population and provides employment to around 12 000 people in fishing, fish processing, marketing of fish and fish products and ancillary activities linked to the fishing industry. Although the contribution of fisheries to Mauritius's GDP in 2010 was 1.3 percent, its share of national exports was 14.7 percent. Exports of fish and fish products amounted to MUR 8.1 billion (USD 270 million) while local fish production was valued at MUR 1.2 billion in 2010. Revenue from fishing vessels calling in the port was MUR 6 billion (USD 200 million). Foreign fishing license fees amounted to MUR 51 million. Fish production in 2010 was 7 800 tonnes and fish imports came to a total of around 20 000 tonnes. Per capita fish consumption was 22 kg in 2010.

There are three main fish processing plants, producing canned tuna products, loins and frozen fish products for export mainly to the EU and US markets and other smaller establishments using imported raw materials for processing for the local market. The Seafood Hub comprises all the activities related to fishing, fish processing, export of fish and fish products and ancillary services provided to fishing vessels.

[1] "La Perle" is the common market name for *L. mahsena*.

5.1. Value of the catches

The value of the catches from the Saya de Malha and Nazareth Banks for the period 2006 to 2010 is given in Table 3 together with the ex-vessel prices per kg. The ex-vessel price of frozen banks fish increased from MUR 62/kg to MUR 82/kg from 2006 to 2008 and remained at MUR 82/kg until 2011. The ex-vessel price of chilled fish increased from MUR 140.00 to MUR 160.00 from 2006 to 2010. The value of the catches has fluctuated from MUR 145 to 179 million during this period or 12 percent of the total value of local fish production in 2010. The share of chilled fish from the banks has increased from 5 percent to 9 percent of the total catch and the value increased from 11 percent to 17 percent from 2006 to 2010.

Table 3. Value of catches from the shallow water fishery of the Saya de Malha and Nazareth Banks
Source: AFRC.

Year	Annual catch (tonnes)			Price (MUR/kg)		Value
	Frozen	Chilled	Total	Frozen	Chilled	MUR (Million)
2006	2 422	129	2 551	62	140	168
2007	1 986	116	2 102	65	140	145
2008	1 688	47	1 735	82	160	146
2009	2 072	54	2 126	82	160	179
2010	1 478	152	1 630	82	160	145

According to the present remuneration orders in force (GN No. 130 of 2005), the rates of payment to be made to bank fishermen during fishing campaigns for the catch per day per dory of three fishermen are as follows:

- Up to 5 tonnes: MUR 7.40 per kg
- Up to 7 tonnes: MUR 10.30 per kg
- Up to 9 tonnes: MUR 12.61 per kg
- Over 9 tonnes: MUR 14.83 per kg

A frigo-worker gets MUR 203.66 per day. The seagoing allowance stands at MUR 110.54 per day for all fishermen. Whilst operators report that banks fishermen get an average salary of MUR 50 000 per fishing trip of 45 days, the fishermen claim that they can get only around MUR 25 000 per trip. On the other hand if it is assumed that one fisherman catches 75 kg per day, his income for 40 days fishing could come to MUR 37 780 00. For three trips in a year the salary is MUR 113 490. Seagoing allowance for 135 days would come to MUR 14 923. The annual income for a fisherman who does three trips would amount to a total of MUR 128 413 or an average of MUR 10 701 per month.

A spot market verification of frozen fish retail prices on 16 March 2012, showed that prices of fish per kg were as follows:

- Whole frozen "La Perle[1]" fish: MUR 150 (small) to MUR 170 (large)
- Whole "La Perle" in plastic bag: MUR 159 (packed individually)
- Whole "La Perle" scaled in plastic bag: MUR 200
- Sliced and scaled "La Perle" in packs: MUR 249

5.2. Imported fish from Indonesia

- Whole "capitaine" in plastic bag: MUR 225
- Whole "cateau" in plastic bag: MUR 187

From the above, it is seen that the ex-vessel value of frozen *L. mahsena* increases by 83 to 100 percent for the fish retailed whole whilst for whole fish in plastic bags the increase is 93 percent, for scaled fish the increase is 143 percent and for sliced and scaled it is 200 percent. Prices of other similar imported fishes, e.g. "capitaine" (a lethrinid) and "cateau" (parrot fish) are given for comparison.

Comparing the ex-vessel price of the fish to the rate of pay of the fisherman it is seen that the fisherman gets about 15 percent of the value of the fish assuming he gets paid MUR 12.61 per kg. The added value for retailing and processing fish ranges from 83 to 200 percent of the ex-vessel price of the fish.

5.3. Products and Markets

Four types of fishing operations exist in Mauritius: artisanal (lagoon and off- lagoon), semi-industrial banks fisheries (producing chilled fish mainly), banks fisheries (producing frozen fish from the banks and salted fish from St Brandon) and the industrial fisheries (import of raw materials, processing and export of value-added products).

Artisanal fishery

Fish produced in the artisanal sector is sold fresh with very little control over temperature, the fish being transported in the boats to shore and sold at ambient temperatures. Moreover, in cases where the fish caught is meant to be exported the fish is kept in ice and the cold chain maintained throughout. Fish from the artisanal sector is sold either directly by fishers at fish landing stations or through fishmongers and cooperatives at sales points in villages and in markets in towns. Part of the catch is also sold by hawkers both in villages and towns.

A training program is carried out by the Fisheries Training and Extension Centre (FITEC) to train fishmongers in handling fresh fish. Fishmongers are not issued permits to sell fish unless they have followed the course.

Semi-industrial chilled fish fishery

Semi-industrial chilled fish fishing boats fishing on the banks carry ice for chilling the catch which when brought to port is transported chilled in refrigerated vehicles to retail points in supermarkets and shops equipped with chilled cabinets.

Fish from the banks

All frozen fish produced from the banks is landed in Port Louis by fishing vessels. Officers inspect the logbook for quantities of fish on board. The cold room of the vessel is checked by officers of the Ministry of Fisheries and Ministry of Health and Quality of Life. A landing permit is then issued and the landing of fish monitored by officers of the Ministry of Fisheries to prohibit landing of any toxic fish. Frozen fish from the banks is transported in trucks (open or refrigerated) to whole sale cold rooms for storage at -18^{0}C until sold. Distribution of frozen fish to sales points throughout the island is carried out by vehicles equipped with refrigerated holds at a temperature of -18^{0}C. Retailing of frozen fish is done through shops and supermarkets equipped with freezer chests and cold storage facilities.

About 20 percent of the catch from the shallow water banks fishery is scaled and part of it filleted (with skin on) on board the fishing vessel whilst the fish is still fresh. Fish that cannot be filleted on board due to time constraints are sliced when landed at the cold storage premises. About 50 percent of the remaining fish is packed individually or in small units and the rest sold in bulk.

Industrial fisheries

The industrial fisheries sector is well equipped to handle and transport frozen fish to processing plants and quality standards are adhered to. Inspection of fish establishments is regularly carried out by the Competent Authority to see to it that all norms are being strictly followed.

A seafood hub One-Stop-Shop has been set up in the port area to provide prompt administrative services for the landing and clearing of all frozen fish meant for processing, value addition and export.

6. Fisheries management plan and objectives

A management plan for the shallow water demersal fish species of the Saya de Malha and Nazareth Banks has not yet been developed. A seminar was held at the Albion Fisheries Research Centre (AFRC) of the Ministry of Fisheries on 18 and 19 January 2012 and its outcome was a project to develop a Fishery Management Plan for the above banks based on EAF principles. The project will rely on appropriate stakeholder consultative processes to develop the plan and it is proposed to be executed by the EAF National Task Group under the supervision of the Ministry of Fisheries.

Objectives for the fishery in the absence of a management plan

Over the years the Saya de Malha and Nazareth Banks shallow water demersal fishery resources have been exploited with the objectives of providing a source of fish to the population and provision of employment to fishermen who would otherwise not find employment in other sectors of the economy without losing sight of the sustainable exploitation of the resources. Besides the supply of frozen fish from the banks continue to be an important substitute to imported frozen fish and results in foreign exchange savings for Mauritius.

7. Legal framework

7.1. The Fisheries and Marine Resources Act 2007

The Fisheries and Marine Resources Act (FMRA) 2007 provides the legal framework for the operation and management of fisheries in Mauritius. The FMRA makes provision for the management, conservation, protection of fisheries and marine resources and protection of the marine ecosystems.

The FMRA concerns all aspects of marine fisheries and fish farming. It comprises different parts as follows:

- Part I: Preliminary
- Part II: Management of Fisheries and Administration
- Part III: Fish Farming
- Part IV: Control of Fishing Activities
- Part V: Import, Export and Manufacturing
- Part VI: Licensing
- Part VII: Obligations relating to Fishing Boats and Fishing Vessels
- Part VIII: Enforcement
- Part IX: Offences and Penalties
- Part X: Miscellaneous

The following sections are, in particular, pertinent to managing the fishery resources on the Saya de Malha and Nazareth Banks:

Section (2) of Part I (Preliminary) defines "Mauritian fishing boats and vessels" and the "owner" of a vessel;

Section 6 of the FMRA provides for keeping a record of fishing boats and fishing vessels with the relevant details such as the name, registration, Lloyds/IMO registration number, international radio call sign, length, engine power and net and gross registered tonnage;

Section 11 provides for the registration of fishermen and the issue of a Fisherman Continuous Record Book to a bank fisherman;

Section 12 provides for prohibited fishing methods such as use of poisonous substances, explosives and landing, possession or selling of fish caught illegally;

Section 16 provides for the protection of fish and further stipulates that fishing undersized fish is prohibited. Marine turtles and marine mammals are also protected under this section;

Section 17 prohibits the landing, sale or possession of toxic fish, fish products unfit for human consumption, marine turtles and their eggs and marine mammals or any crab or lobster in the berried state;

Section 27 provides that no person shall import into Mauritius or construct a fishing boat or fishing vessel without the approval of the Permanent Secretary;

Section 36 provides for the licensing of all fishing boats and vessels fishing in the maritime zones and the high seas. Licenses will not be issued to fishing vessels having a history of non-compliance with international fishery conservation and management measures unless the ownership of the vessel has changed and the new owner satisfies conditions that the previous owner has no legal or financial interest in the control of the fishing vessel;

Section 37 provides for imposing conditions in the license whilst Section 38 defines the validity period of the license not to exceed one year;

Section 39 prohibits transshipment of fish at sea unless with prior approval of the Permanent Secretary when such transshipment is necessary or in accordance with appropriate management measures;

Section 40 provides for the proper marking of fishing boats and vessels and those to which no international call sign has been allocated;

Section 41 provides for the reporting of fishing activities in a fishing logbook as approved by the Permanent Secretary;

Sections 42, 43, 44 and 45 provide for the registration of Mauritian fishing boats (less than 24 m in length as those above 24 m are registered with the Ministry responsible for shipping);

Section 51 provides for the procedures to be followed for the arrival of a fishing boat or vessel into port and the submission of the fishing logbook and other information on the catch on board and;

Sections 52, 53 and 54 provide for the conditions for the storage of the fishing gear, entry and exit in the maritime zones and entry into port of a foreign fishing boat or vessel. Penalties for offences range from MUR 50 000 to MUR 1 000 000 or more depending on the amount of the license fee paid for a period of 30 days.

7.2. Fisheries Regulations

The following regulations, in particular, relate to the banks fishery:

(i) Fisheries and Marine Resources (Toxic fish) Regulations 2004 (GN No.193 of 2004);

(ii) Fisheries and Marine Resources (Vessel Monitoring System) Regulations 2005 (GN No.87 of 2005);

(iii) Fisheries and Marine Resources (Prohibition of Removal of Coral and Sea-shell) Regulations 2006 (GN No.95 of 2006);

(iv) Fisheries and Marine Resources (Undersized Fish) Regulations 2006 (GN No.54 of 2006);

(v) Contributory Scheme for Bank Fishermen Regulations 2006 (GN No.104 of 2006)

(vi) Fisheries and Marine Resources (Prohibition of the use of Hooks of Small Size) Regulations 2011 (GN No.128 of 2011); and

7.3. The Maritime Zones Act 2005

The Maritime Zones Act provides for the United Nations Convention on the Law of the Sea to have force of law in Mauritius. It defines the maritime zones as including the internal waters, historic waters, archipelagic waters, territorial sea, the contiguous zone, the exclusive economic zone, maritime cultural zone and the continental shelf. It also provides for the jurisdiction of Mauritius in the EEZ and the continental shelf and its rights to explore, exploit, conserve and manage the natural resources whether living or non-living of the EEZ and jurisdiction to carry out marine scientific research and protection and preservation of the marine environment therein.

7.4. The National Coast Guard Act 1988

The National Coast Guard Act provides for the enforcement of any law relating to the protection of the maritime zones and prevention and suppression of any illegal activity therein by the National Coast Guard. It can thus take action against any illegal fishing activity in Mauritian waters.

7.5. The Merchant Shipping Act 2007

The Merchant Shipping Act provides, among others, for the registration of ships (above 24 m LOA), the safety of navigation and the welfare of seamen.

Regulations made under this Act cater for the survey and certification of seaworthiness of fishing vessels and the safety of the dories used by such vessels for fishing purposes.

The Merchant Shipping Act (Safety of Fishing Vessels) Regulations (2000) provides for survey, inspections and certification of fishing vessels whilst the Bank Fishing Dories Regulations (2000) regulates the construction of dories and the equipment to be carried on board dories for safety purposes.

7.6. Banks Fishermen and Frigo-workers (Remuneration Order) Regulations 1997

These regulations provide for the rates at which fishermen are paid based on the catch per dory per day, allowances to frigo-workers, “patron pecheurs”, pay intervals to a named representative of a fisherman onshore, the conditions obtaining in the contract of employment, issue of pay-slips, articles sold on fishing vessels, repatriation in case of illness, meals, sick leave allowance, work on public holidays, end of year bonus and insurance of fishermen and death grants to the surviving spouse of fishermen or the person incurring funeral expenses.

The regulations were amended in 2005 through GN No. 130 to revise rates of payment to the fishermen and frigo-boys.

7.7. The Environment Protection Act 2002

The Environment Protection Act (EPA) provides for the protection and management of the environmental assets of Mauritius so that their capacity to sustain the society and its development remains unimpaired and to foster harmony between quality of life, environmental protection and sustainable development for the present and future generations; more specifically to provide for the legal framework and the mechanism to protect the natural environment, to plan for environmental management and to coordinate the inter-relations of environmental issues, and to ensure the proper implementation of governmental policies and enforcement provisions necessary for the protection of human health and the environment of Mauritius.

As designated in the EPA, the Ministry of Fisheries has responsibility for the subject of fisheries and marine resources.

8. Institutional and administrative frameworks for fisheries management

The Ministry of Fisheries

The Ministry of Fisheries is the institution for the management and administration of fisheries and marine living resources in Mauritius.

The head of the Ministry of Fisheries is the Minister and the Permanent Secretary is responsible for the administration of the Ministry whilst the Director of Fisheries (DOF), is the chief technical officer of the Ministry.

The Minister and Permanent Secretary are empowered to take action on the relevant sections of the FMRA. They rely on the advice of the DOF, Principal Assistant Secretary, the Assistant Secretary and other administrative staff for the day-to-day management and administration of fisheries. The staff of the Services and Divisions falling under the purview of the DOF provides him with the necessary support in his daily work.

The Fisheries Technical Services

The Director of Fisheries has three services under him namely: Fisheries Policy, Planning and Management Service (FPPMS), Fisheries Research, Development, Management and Training Service (FRDMTS), and Marine Ecosystem, Conservation and Aquaculture Research Service (MECARS). The FPPMS consists of the Licensing/Import/Export Division, the Fisheries Planning Division, the Monitoring, Control and Surveillance Division and the Fisheries Protection Service. The FRDMTS has the Fisheries Management Division and the Fisheries Research, Development and Training Division under its sphere of responsibility. The MECARS has the Marine Conservation Division, Aquaculture Division and Laboratories Division under its purview. The activities of the FPPMS and the FRDMTS have particular relevance to management of the banks fishery resources.

In addition the Competent Authority for fish inspection and certification falls under the purview of the Ministry of Fisheries.

The activities of the Ministry consist of, among others, formulation of policy and its implementation, planning, design and monitoring of projects, budget preparation and monitoring, law enforcement and fisheries monitoring, control and surveillance, licensing of fishing vessels, control of import and export of fish and fish products, collection of fisheries statistics, fisheries research, resource surveys, fisheries management, marine protected area management, assessment of EIA reports, marine ecosystem monitoring, fish fingerling production, aquaculture research, fish stock enhancement, training of fishermen, planning and maintenance of fish aggregating devices and provision of necessary support for the development of seafood hub activities through inspection and certification of fish establishments and fish and fish products for export.

The above activities are carried out through the Ministry's headquarters in Port Louis, the Albion Fisheries Research Centre at Albion, the Fisheries Training and Extension Centre at Pointe aux Sables, the One Stop Shop in Port Louis harbour and through the fisheries posts around the island.

Albion Fisheries Research Centre (AFRC)

The Albion Fisheries Research Centre was built in 1982 and subsequently expanded in 1987 and 1995. It provides the necessary facilities for fisheries, marine ecosystems and aquaculture research. It also houses the Fishery Monitoring Centre (FMC).

Fisheries Training and Extension Centre (FITEC)

The FITEC was constructed in 2004 and has facilities for the training of fishermen and carries out outer-lagoon fisheries development especially through the placing and maintenance of fish aggregating devices.

Fisheries Protection Service

The Fisheries Protection Service has as main task the enforcement of the fisheries legislation in Mauritius and operates from 15 Fisheries Posts located around the coast. It is equipped with vehicles for land-based patrols and patrol boats for surveillance in the sea and its range of action is in the lagoon and outer-reef areas.

One-Stop-Shop Service

The One-Stop-Shop Service which was set up in 2004 comprises the services of concerned ministries and organizations regarding the arrival and departure of fishing vessels and landing and export of fish and fish products, the Competent Authority and the Port State Control Unit.

One-Stop- Shop

The One-Stop-Shop is situated in Port Louis harbour. It comprises officers of the FPPMS responsible for port state control and of the Fisheries Protection Service and officers of the Customs Department, the Veterinary Services Division of the Ministry of Agro-Industry and Food Security, the Ministry of Health and Quality of Life and Passport and Immigration Office of the Police Department.

Competent Authority

The officers of the Veterinary Services posted at the One-Stop-Shop constitute the Competent Authority. They are responsible for the inspection and certification of fish establishments and fish and fish products for export.

Port State Control Unit

The Port State Control Unit implements measures relating to monitoring, control and surveillance of fishing vessels and other measures in the NPOA-IUU.

The National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing NPOA-IUU (2010)

The NPOA-IUU describes the implementation of measures to prevent, deter and eliminate IUU fishing and action taken accordingly. It addresses, among others, the following:

a) all State responsibilities;

b) flag State responsibilities including registration of vessels fishing boats and vessels, records of fishing boats and vessels and authorization to fish;

c) coastal states responsibilities;

d) port state measures with emphasis on advance notification of vessels, denial of access, cooperation with other States and RFMOs and port inspection;

e) trade related measures such as catch documentation, transparency of markets and information dissemination;

f) conformity with measures taken by Regional Fisheries Management Organizations which include party compliance and non-party compliance;

g) special requirements of developing States; and

h) several supporting action to enhance measures taken by Mauritius to combat IUU fishing.

The Ministry of Fisheries implements the NPOA-IUU through application of the relevant sections of the FMRA.

Fisheries Master Plan for Mauritius (FMPM)

A "Fisheries Master Plan for Mauritius, Rodrigues and the Outer Islands" has been produced in May 2011. The key strategies of the FMPM are to:

a) implement management to achieve sustainable domestic fish resources in accordance with Ecological Sustainable Development (ESD) principles and including, where appropriate, ecosystem based fisheries management;

b) support private sector growth at all stages of the value chain, including fish production, value adding and in supporting industries;

c) ensure safe, adequate and good quality seafood for domestic consumption;

d) reduce the medium-long term risk exposure of Mauritius's seafood export sector;

e) transition to a more participatory, comanagement approach to fisheries management and development that (i) involves all key stakeholders and (ii) recognises the private sector benefits that accrue from exploitation of Mauritian fisheries resources in funding services to support management;

f) support Mauritius's international obligations in fisheries and marine resource management.

It covers a 10-year strategic planning period (2011-2020) and includes a 5-year Action Plan for implementation of specific activities in support of the Master Plan. Twenty-two (22) projects are listed to be implemented over a ten-year period a few of which such as the one to "Increase the capacity of national vessels to operate in Mauritian and other waters" will have direct bearings on the banks fishery.

In view of the socio-economic implications of implementing the plan, a multi-sectoral committee has been set up to study all the recommendations and assess their implications, determine their degree of applicability and the resources needed for their implementation and come up with an implementation schedule.

Fishermen Welfare Fund Act 2000

The objects of the Fishermen Welfare Fund (FWF) are to:

a) advance and promote the welfare of fishermen and their families;

b) manage and optimize the financial and other resources of the fund to further the social and economic welfare of fishermen;

c) develop schemes and projects for the welfare of fishermen;

d) set up schemes including schemes in respect of loan or other financial assistance to the benefit of fishermen;

e) do all such things as appear to be necessary and conducive to the promotion of the welfare of fishermen in general.

The FWF functions under a Board with representatives from the Prime Minister's Office, the ministries responsible for Finance and Rodrigues, two fishermen from fishermen's organizations, one representative each of bank fishermen and the fishing industry.

The Fund provides the following assistance to registered fishermen:

- sickness allowance;
- interim assistance to fishers' family in distress;
- repairs of accidentally damaged boats and outboard motors;
- contributory scheme for bank fishermen and;
- award scholarships to children of fishers at secondary, tertiary and vocational levels.

Under this Act, regulations cited as the "Contributory Scheme for Bank Fishermen Regulations 2006" (GN No.104 of 2006) were passed in order to provide financial assistance to bank fishermen during the winter months of June, July and August when fishing vessels do not normally go on fishing campaigns. The scheme provided for a contribution of MUR 2 000.00 by each fisherman to the Fishermen Welfare Fund. In return each fisherman gets a financial assistance of MUR 6 000.00 for that period from the FWF with bank fishing operators each contributing a sum of MUR 2 000.00 per fisherman employed to the scheme.

The FWF operates with an annual budget of MUR 3.5 million.

Fishermen Investment Trust (FIT) Act 2006

The objects of the Fishermen Investment Trust are to invest in fishing activities, fish processing, fish marketing and such other activities related to the fishing industry as approved by the Board. The Board consists of a Chairperson, three representatives of artisanal, bank and semi-industrial fishermen from Mauritius and Rodrigues, representatives of the Ministries responsible for fisheries, finance and shipping and a representative from the Outer Islands Development Corporation and three persons having experience in administrative, economic, financial or commercial matters or matters relating to the fishing industry.

Since its coming into operation, the FIT has embarked in the construction of three boats for outer-lagoon fishing. The Mauritius Export Association (MEXA) has, moreover, already donated a boat to the FIT for operation by fishers. The FIT has been allocated with two 'barachois' (marine fish farms), which need to be revitalized.

The FIT has also been allocated a fishing quota of 1 000 tonnes on the Nazareth Bank and around St Brandon.

Fish Auction Market

The construction of a Fish Auction Market (FAM) has been completed at Les Salines in the port area to facilitate the marketing of fish and it is expected to come into operation shortly.

8.1. National and regional forums for discussions on fisheries management

The Ministry of Fisheries uses various platforms for discussions on issues and problems related to the fishing industry. In fact, apart from the formal mechanisms which are mentioned below there is constant contact with the stakeholders to sort out day-to-day issues besides having regular meetings to thrash out problems that crop up and necessitate immediate action.

Consultative Committees

The FMRA provides for the setting up of Consultative Committees by the Minister for discussions and advice on matters of general policy relating to fisheries, marine resources, aquaculture and marine conservation and for inquiring into matters relating to fisheries and marine resources. The Consultative Committee shall consist of the Minister as Chairperson and such other persons as he may appoint.

Artisanal Fishery Consultative Committee

A Consultative Committee for the artisanal fishery has been set up and meets about three times per year to discuss issues pertaining to problems of artisanal fishers. It is chaired by the Minister of Fisheries and comprises representatives of other ministries concerned with coastal development such as that for environment, tourism, local government and fishermen organizations.

Bank Fisheries Management Consultative Committee

In 2011, a Bank Fisheries Management Consultative Committee has been set up under the chair of the Director of the Board of Investment (BOI) to address issues relating to the banks fishery. The members of the Committee are officers of the Ministry of Fisheries, the representatives of bank fishing companies, the National Coast Guard, the Fishermen Investment Trust and the Maritime Transport and Ports Employees Union. Some of the issues raised are lengthy procedures for departure, clearance, unloading of fishing vessels and bunkering, employment of foreign fishermen and purchase of bait for fishing campaigns. Actions have been taken to improve administrative procedures in this regard.

Bank Fisheries Management Plan National Task Force

A Bank Fishery Management Plan National Task Group has been set up in January 2012. It comprises representatives of the Ministry of Fisheries, Ministry of Environment, Tourism Authority, Beach Authority, Mauritius Oceanography Institute, National Coast Guard, National Parks and Conservation Services, Bank Fishing Operation Association, Artisanal Fishermen, Mauritius Marine Conservation Society and Conservation Mauritius. The National Task Group has already started to meet and will give the necessary support for the development of the Bank Fisheries Management Plan.

The Bank Fishing Operators Association (BFOA)

The Bank Fishing Operators Association regroups companies fishing on the banks and is an important stakeholder of the industry. It comes up with issues that affect the operators and acts as a useful interface with the Ministry of Fisheries in dealing with the industry.

The Maritime Transport and Ports Employees Union

The Maritime Transport and Ports Employees Union include bank fishermen as its members and defend their interests especially concerning employment and living conditions on board fishing vessels.

Regional Fisheries Surveillance Project

The Regional Fisheries Surveillance Project – Plan Régional de Surveillance des Pêches (PRSP), to combat IUU fishing in the South West of the Indian Ocean operates under the Indian Ocean Commission (IOC). The members of the IOC are Mauritius, Madagascar, Comoros, Reunion/France and Seychelles.

The project was initiated in August 2007. It comprises:

- joint surveillance missions in the EEZ of countries of the IOC to detect IUU fishing through aerial and maritime surveillance.
- use of radar satellites to locate vessels in a large area.
- training of fisheries inspectors.

Thirty (30) joint fisheries surveillance missions have been carried out in the EEZ of IOC Member States to-date. During all these missions a number of fishing vessels have been inspected and several have been contravened due to irregularities.

South West Indian Ocean Fisheries Project (SWIOFP)

The South West Indian Ocean Fisheries Project (SWIOFP) is a multinational research project which aims to improve the understanding and management of marine resources in the Southwest Indian Ocean. It involves nine countries, including Comoros, France, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa and Tanzania.

The project has been organized into six components namely:

Component 1: data gap analysis, data archiving and information technology.

Component 2: Assessment and sustainable utilization of crustaceans.

Component 3: Assessment and sustainable utilization of demersal fishers (excluding crustaceans)

Component 4: Assessment and sustainable utilization of pelagic fish.

Component 5: Mainstreaming biodiversity in national and regional fisheries management. Mauritius is the lead country for Component 5.

Component 6: Strengthening regional and national fisheries management.

The SWIOFP organizes regular meetings to assess progress on the different components of the Project, preparation of annual budgets and work plans and give guidance to component leaders on project implementation. Mauritius participates actively in the SWIOFP.

South West Indian Ocean Fisheries Commission (SWIOFC)

SWIOFC was established in 2004 by Resolution 1/127 of the FAO Council under Article VI 1 of the FAO Constitution. Its Rules of Procedures were adopted by the Commission at its First session in 2005. The main objectives of the Commission is to promote the sustainable utilization of the living marine resources of the South West Indian Ocean region, by the proper management and development of the living marine resources, without prejudice to the sovereign rights of coastal States and to address common problems of fisheries management and development. The Commission has due regard for and promotes the application of the provisions of the FAO Code of Conduct on Responsible Fisheries, including the precautionary approach and the ecosystem approach to fisheries management.

The functions and responsibilities of the Commission are to:

a) contribute to improved governance through institutional arrangements that encourage cooperation amongst members;

b) help fishery managers in the development and implementation of fishery management systems that take due account of environmental, social and economic concerns;

c) keep under review the state of the fishery resources in the area and the industries based on them;

d) promote, encourage and coordinate research related to the living marine resources in the area and draw up programmes required for this purpose, and to organize such research as may be necessary;

e) promote the collection, exchange, dissemination and analysis or study of statistical, biological, environmental and socio-economic data and other marine fishery information;

f) provide a sound scientific basis to assist Members in taking fisheries management decisions;

g) provide advice on management measures to member governments and competent fisheries organizations;

h) provide advice and promote cooperation on monitoring, control and surveillance, including joint activities, especially as regards issues of a regional or subregional nature;

i) encourage recommend and coordinate training in the areas of interest of the Commission;

j) promote and encourage the utilization of the most appropriate fishing craft, gear, fishing techniques and post harvesting technologies.

The SWIOFC meets every two years to discuss fisheries management issues and take appropriate decisions to improve fisheries governance in the region. These meetings are normally preceded by scientific committee meetings, which pave the way for the meetings of the Commission.

Southern African Development Community (SADC)

Provided for in Article 5 of the SADC Treaty, the SADC objectives are, among others, to:

- achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the peoples of Southern Africa and support the socially disadvantaged through regional integration.
- promote self-sustaining development on the basis of collective self-reliance, and the inter-dependence of Member States;
- achieve complementarity between national and regional strategies and programmes.
- promote and maximize productive employment and utilization of resources of the region.
- achieve sustainable utilization of natural resources and effective protection of the environment.

Mauritius has signed the SADC Protocol on Fisheries. This is a comprehensive legal instrument covering among others, harmonization of legislation, law enforcement, management of shared stocks, access agreements, high seas fishing, artisanal fisheries, aquaculture, protection of the aquatic environment, human resources development, trade and investment and information exchange in and among the members of SADC for the benefits of their populations. Mauritius participates actively in the activities of SADC with regard to the fisheries sector especially through action taken under the Protocol on Fisheries.

Southern Indian Ocean Fisheries Agreement (SIOFA)

The Southern Indian Ocean Fisheries Agreement aims at the long-term sustainable use and conservation of fishery resources other than tuna in areas that fall outside national jurisdictions. Action under the SIOFA include regular studies on the fish stocks and the impact of fishing on the environment, implementing joint management and conservation measures, establishing rules for fishing in the SIOFA area, provision of reports on fishing operations and inspection of fishing vessels in ports of parties for compliance purposes.

Mauritius has signed the SIOFA and looks forward to its coming into operation soon.

Indian Ocean - South-East Asian Marine Turtle Memorandum of Understanding (IOSEA)

The Indian Ocean - South-East Asian (IOSEA) Marine Turtle Memorandum of Understanding (MoU) is a non-binding intergovernmental agreement that aims to protect, conserve, and recover marine turtles and their habitats in the Indian Ocean and South-East Asia region.

The agreement falls under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (Article IV, para. 4).

Six marine turtles are protected under IOSEA:

1. Flatback turtle (*Natator depressus*)
2. Green turtle (*Chelonia mydas*)
3. Hawksbill turtle (*Eretmochelys imbricata*)
4. Leatherback turtle (*Dermochelys coriacea*)
5. Loggerhead turtle (*Caretta caretta*)
6. Olive ridley turtle *(Lepidochelys olivacea*)

There are over 30 signatory states to the MOU including Mauritius.

9. Management measures and tools currently in use and status of implementation

Primary Management Tools

The Fisheries and Marine Resources Act (FMRA), provides for the necessary legal framework for fisheries and marine living resources management in Mauritius. It makes provision, *inter alia*, for registration of fishermen, collection of fisheries information, setting up of marine protected areas (fishing reserves and marine parks and reserves) and fish farming; prohibition of fishing by use of poisonous substances, spears or explosives; close periods for net fishing and fishing of oysters; prohibition of fishing of undersized fish, crabs or lobsters in the berried state, turtles and marine mammals; prohibition of sale of toxic fish and fish products unfit for human consumption; import of fish and fish products and import of fishing vessels, licensing of nets and fishing implements. Provisions are also made for licensing of local and foreign boats and vessels, use of position fixing equipment on board boats and vessels and use of photographic evidence in court cases. A local boat or vessel needs a fishing license to fish within Mauritian waters or on the continental shelf, in any fishery on the high seas and in the fishing zone of a foreign state.

The Fisheries Protection Service and the National Coast Guard (the latter particularly in the offshore area) enforce provisions of the FMRA.

Development of management measures

Management of the fishery resources of the Saya de Malha and Nazareth banks has been of interest to Mauritius for a long time and systematic collection of statistics on the fishery began in 1977. A "Seminar on the Management of the Banks Handline Fishery" was held at the AFRC in October 1989 with the objectives of presenting information on the fishery, calculating the maximum sustainable yields of the banks and making proposals for allocating quota to bank fishing companies (FAO/SWIOP, 1989).

Initial management measures were taken in 1992 with the licensing of fishing vessels with a view to limiting entry in the fishery which was then being heavily exploited by 15 vessels with a total catch of 3 805 tonnes. The total catch from the banks increased further in the following years reaching a peak of 4 758 tonnes in 1994. As now the resources were being overexploited government had to resort to an additional measure with the allocation of catch quota as from 1994 based on the past performance of the fishing vessels. No new fishing vessel was allowed to join the fishery so as to stop increasing fishing capacity. Since the total allowable catch (TAC) was above the total MSY of both banks the TAC was decreased by 5 percent each year until 1999 when the total MSY of both banks was reached. The quota was allocated on a per vessel basis but this system of allocation was changed in 1995 and quota allocated by company. This rendered the operation of the fishing vessels more flexible as the company could decide internally how best to regulate the catch of its vessels. Quotas were not allocated by species as around 90 percent of the fish catch is composed of *L. mahsena*. Quotas were also not allocated by bank in view of the difficulty (fishing vessels operating on both banks during any fishing campaign) in implementing such a measure and the fact that the fishing vessels fished less on the Nazareth than on the Saya de Malha Bank in practice. Companies were also allowed to re-allocate their quotas to other companies subject to approval of the Ministry of Fisheries. These measures continue to be applied in the fishery to the present.

As the semi-industrial chilled fish fishery developed, fishing boats were allowed to fish on the shallow water fishery resources of the Saya de Malha and Nazareth Banks from 2003. The boats were subsequently issued fishing quotas for this purpose.

Current practice

Current management measures are based on those already taken as described above and they are given below and in Table 4:

a) licensing of all fishing boats and vessels;

b) limited entry in the fishery;

c) quota allocation to companies proportional to the past performance of fishing vessels;

d) a policy with regard to foreign-flagged fishing vessels and employment of foreign fishermen;

e) new criteria defining active fishermen;

f) allocation of quota to semi-industrial fishing boats; and

g) all fishing boats and vessels report to the FMC through the VMS.

Other management measures being applied in the banks fishery concern all the conditions attached to the license, the prohibition of landing of fishes which are toxic due to their potential for ciguatera, minimum sizes for catching fish, registration of banks fishermen and reporting through the VMS.

Table 4. Management Measures/Primary Management Tools currently being used in the Fishery/Sector

Type of Management Tool	Comments
Gear size restrictions	Hooks with gap size of less than 5mm prohibited. Basket trap: mesh size not less than 4 cm. Restriction on use of trawls.
Size/Age restrictions	Minimum size of L. mahsena defined by regulations to be 30 cm.
Participatory restrictions	
• Licenses	For fishing on Saya de Malha and Nazareth Banks, St Brandon and outer smaller banks since 1992.
• Limited entry	For fishing on Saya de Malha and Nazareth Banks, St Brandon and smaller banks.
Catch restrictions	
• Total allowable catch (TAC) limits	In Saya de Malha and Nazareth Banks fishery since 1994 onwards.
• Vessel catch limits	In case company owns only one vessel or boat.
• Individual vessel quotas	In case company owns only one vessel or boat.
Rights- / incentive-adjusting regulations	
• Individual transferable quotas	Allowed subject to approval of the Ministry of Fisheries.
• Group fishing rights (including community development quotas)	Reserved quota of 1000 tonnes for the Fishermen Investment Trust in the Nazareth Bank and St Brandon fisheries.

The licence includes conditions relating, among others, to reporting requirements, filling of fishing logbooks and submission of information on fishing activities.

G.N. No. of 193 of 2004 lists down the toxic fishes whose landing is prohibited and includes, *inter alia*, the yellow-tailed croissant, *Variola louti*, the vieille babonne, *Plectropomus maculatus*, the vieille loutre, *Epinephelus fuscogutatus*, the bourgeois, *Lutjanus sebae*, the vara vara, *L. bohar* and the carangids.

G.N No. 54 of 2006 lists down the minimum sizes of fish that can be caught in Mauritius e.g. for the "dame berri", *L. mahsena*, it is 30 cm and this regulation applies to the banks fish as well.

Registration of bank fishers is carried out as per Section (4) (b) and (c) of the FMRA. Such legislation was first introduced in the FMRA 1998 so as to give legal effect to the Continuous Record Book issued to bank fishers.

The VMS Regulations (2005) require all boats and vessels licensed to fish to be equipped with a satellite tracking device and describe the procedures for providing real time position data to the Fishery Monitoring Centre of the Ministry of Fisheries situated at the Albion Fisheries Research Centre.

From the above table it is seen that there are, as yet, no marine protected areas, no nursery area closures, no no-take zones or other temporary area closures in the fishing grounds and no defined number of days for fishing or defined fishing season in the banks fishery. However, there are gear size and gear type restrictions. In addition, both a licensing and quota systems are in place and there is provision for group fishing rights for the FIT in the banks fishery.

9.1. Effectiveness of the current management measures

In the FAO Technical Guidelines for Responsible Fisheries on "Fisheries Management" fisheries management is taken as:

"The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives."

It is admitted that fisheries management entails a complex process and wide-embracing set of tasks aimed at ensuring optimal benefits for the local users, state or region from the sustainable utilization of the living aquatic resources to which they have access.

Fisheries management has to take into account the policies and objectives for each fishery or stock to be managed, its biological characteristics, its nature, impact on other fisheries and its economic and social contribution to national or local needs and goals.

From information provided in the Table 4 it is observed that a number of management measures are applied in the fisheries sector. In the banks fishery a licensing system for fishing vessels together with limited entry and a catch quota system are in place. In addition fishermen are registered, their conditions of work are spelt out in regulations and incentives (e.g. loan facilities) and other support provided to fishing companies for their operations.

Biological Aspects

Biological success requires that a fishery is not exploited to such an extent that its productive capacity for the long term is jeopardized. In order to take decisions which will allow a fishery to be exploited sustainably information on the stock needs to be available. Assessments of the stock will give the basis for evolving management measures. The banks fishery has been subject to such exercises in the past.

Sanders (1989) carried out assessments of the stocks of *L. mahsena* on the Saya de Malha and Nazareth Banks which gave estimates of the MSY for the Saya de Malha Bank to be 2 887 tonnes and that for the Nazareth Bank to be 1 280 tonnes. The total MSY for both banks was thus 4 167 tonnes.

Potential yields of the two banks have also been calculated from catch per unit area data (Mees, 1992). He estimated the productivity of demersal hand line caught species in the shallow waters around Seychelles (north of Saya de Malha) at 168 kg per km^2 per year. Assuming the fishable area for Saya de Malha bank to be 12 500 km^2 and the productivity to be similar to that of the Seychelles, he estimated the potential yield for Saya de Malha as 2 100 tonnes and that for the Nazareth bank as 1 680 tonnes (Mees, 1992), i.e., a total of 3 780 tonnes for both banks.

With a view to control the fishing effort on the banks, fishing vessels were licensed as from 1992 and catch quotas introduced in 1994. These measures resulted in gradually reducing the total catch from the banks from 4 758 tonnes in 1994, which was above the total MSY of both banks, to around 3 000 tonnes by 2000 well within the estimated MSY for both banks.

Estimation of the stocks by Soondron *et al.* (2005) gave the MSY to be 2 350 tonnes for the Saya de Malha Bank and 1 800 tonnes for the Nazareth Bank using the Shaeffer's model, i.e., a total of 4 150 tonnes for both banks.

Stock assessment carried out by Degambur and Solmundsson (2005) from catch and effort data from 1989 to 2004 resulted in an estimated MSY of 2 351 and 1 623 tonnes for the Saya de Malha and Nazareth Banks respectively for *L. mahsena* i.e. a total of 3 974 tonnes for both banks which is not far from what Sanders (1989) obtained. Total catch from the banks has remained below 2 500 tonnes since 2006 to 2010 and thus below their combined MSYs.

Taking the MSY of the banks separately the catch from the Saya de Malha Bank has not exceeded the estimate of Degambur and Solmundsson (2005) since 1994 except in 2003 when it was about equal to the MSY. As for the Nazareth Bank, the MSY of 1 280 tonnes was exceeded from 1993 to 1997 but the catch remained below it from then on until 2010.

The management measures have been, to a large extent, able to restrict fishing capacity and fishing effort in the fishery and led to the recuperation of the stocks although other factors could have helped also. This is reflected in the catch per fishermen day (CPFD) which has remained between 70.8 to 83.3 kg for the Saya de Malha Bank from 2001 to 2010 compared to 57.4 kg in 1996, which was after four years of heavy exploitation or over-exploitation of the banks. The same trend is observed for the CPFD of the Nazareth Bank which ranged from 70.6 to 95.2kg from 2001 to 2010 compared to 52.5kg in 1996.

Data from 2007 to 2011 indicate that the percentage of fish less than 300 mm is showing a tendency to decrease from 12.43 percent to 6.27 percent of the catch whilst the mean length of fish caught has witnessed an increase from 336 mm to 354 mm in the same period (AFRC, 2012). This reflects a fishery which, at the moment, is in satisfactory condition.

Degambur and Solmundsson (2005) makes mention that at the 1992 FAO Technical Consultation on High Seas Fishing, the non-precautionary nature of traditional MSY reference points was highlighted and emphasis was placed on the need for a more precautionary management strategy with new reference points (FAO, 1992). At the 1996 FAO Technical Consultation on the Precautionary Approach to Capture Fisheries, an annual catch of two thirds of the MSY was suggested for conservation of higher levels of biomass, aiming at reducing the risk of over-fishing (FAO, 1996). Degambur and Solmundsson (2005) were of opinion that the setting of catch levels at the average yields for both banks in the years 1995-2004 seemed to be a feasible option from a precautionary point of view. In fact catch levels remained at or below two thirds of the total MSY for the banks from 1998 to 2010.

In 2010 the Ministry of Fisheries set the TAC for the banks at 3 780 tonnes, i.e. at 90 percent of the total MSY of around 4 200 tonnes. Pitcher (1986) proposed a TAC rule based on the level of exploitation of a fishery, e.g. the TAC for a lightly exploited fishery over say a period of 10 years may be set at 90 percent of the MSY while a heavily fished or over-exploited one may have a TAC set at below 25 percent of the MSY.

MRAG (1996) carried out a spatial analysis of the catch data on the two banks and concluded that there was sporadic over-exploitation at certain locations on the Saya de Malha Bank. It is quite obvious that more fishing pressure would be exerted in areas where fish are abundant. Thus we need to address this concern in the management plan.

This brings us to another issue which needs consideration, that is, the spatial distribution of the fishing grounds of Saya de Malha North, Saya de Malha South and the Nazareth Bank and whether the stocks of *L. mahsena* found on these banks are a unit stock or different stocks. Genetic studies are proposed to be carried out in this respect under the SWIOFP. Research in this direction would show whether allocation of TACs would have to done on a more refined area basis in the future.

Social Aspects

There are three main social aspects of the fishery resources of the Saya de Malha and Nazareth banks i.e. the supply of the local market with frozen fish which is especially affordable for the lower income groups, the employment of fishermen, crew on fishing vessels and other workers on land ant the safety aspects of fishing operations.

The fishery has been able to supply an average of 2 000 tonnes of frozen fish per year to the population which is about 7 percent of total fish supply or about 40 percent of the amount of frozen fish consumed in Mauritius in 2010.

There are 111 active local fishermen employed in the fishery together with about 200 foreign fishermen employed both on local and Mauritian-owned foreign flagged vessels. Besides there are about 200 fishermen and crew employed on the semi-industrial chilled fish fishing boats who fish part-time in the fishery.

In addition about 200 workers are engaged in land-based fish storage, processing, distribution and marketing activities not including those involved in vessel repairs and supplying provisions and the crew of the fishing vessels. The total number of workers involved in the fishery comes to around 511 and possibly about 550 if the crew, those doing vessel repairs and supplying provisions are taken into account. The fishery is hence an important provider of employment to the population.

The safety aspects of fishing operations are covered by regulations concerning the safety and certification of fishing vessels and the safety of the dories used by the fishermen once on the fishing grounds. In addition, verifications are carried out before the departure of fishing vessels to see to it that they have the relevant equipment such as radios for communications with the mother vessel from the dories and lifejackets for the number of fishermen on board.

Despite the safety measures in place the lost of three fishermen in 2004 near St Brandon whilst fishing in a dory and the lost of another 16 fishermen and crew during a cyclone on two semi-industrial chilled fish fishing boats in 2007 are deeply regretted. Another fisherman was lost overboard from the mother vessel in 2008. Additional measures concerning the safety aspects such as the range of fishing boats and their operations during the cyclonic period have been taken following these tragic incidents.

Economic Aspects

In 2010 a total catch of 1 630 tonnes was landed having a value of MUR 145 million and there is potential for increasing these benefits even if the catch quota is kept at about two thirds of the total MSY of the banks at about 2 700 tonnes.

However, over the years bank fishing companies have claimed that they are either breaking even or operating at a lost due to high costs of inputs such as fuel, harbour dues, repairs of fishing vessels and the difficulties they face in having their vessels certified for navigation and problems associated with availability of reliable fishermen. A few companies have even sold their fishing vessels to other investors and left the fishery. A few new companies have joined the fishery but they operate their vessels under foreign flags and employ foreign fishermen. The age of the five fishing vessels, which are active in 2012, range from 22 to 34 years. Such vessels would require more frequent maintenance to stay in good condition.

Fishing companies also claim that there is illegal fishing on the banks, which reduces the catch per fisherman day, and their vessels have to stay longer at sea to fill up their holds. Hence it appears the industry is operating under conditions that can affect its viability and the above issues need to be addressed through discussions with all stakeholders. A study could be carried out to determine the maximum economic yield of the banks fishery to provide information for managing the fishery more efficiently.

There are, however, loan facilities available at the DBM up to a ceiling of MUR 50 million for the purchase of fully equipped fishing vessels for fishing on the banks and loans for the repairs, upgrading or renovation of existing fishing vessels. In addition the import of species of fish (“capitaine”, “sacrechien” and “butterfish”), which can compete with those fished on the banks, is controlled since 2004 so as to facilitate marketing of the banks frozen fish.

Ecological Aspects

The Saya de Malha and Nazareth Banks demersal fishery targets mainly the *L. mahsena*, which forms 90 percent of the catch and the rest of the catch being snappers and groupers mostly. Management of the fisheries for the latter species on the banks would have to take into account their catch from this fishery. Apart from this the shallow water fishery does not interact with other fisheries especially as it takes place in quite remote areas. MRAG (1996) observed that discards of undesirable fish is insignificant as the fishery is well targeted and almost mono-specific. This is the situation even now.

It is mentioned in this report that the length of the fish at first maturity is 19.8 cm, which is well below the length of 30 cm declared as undersize. It is believed that this measure is protecting the fish as fishermen target fish of length higher than 30 cm although the percentage of fish less than 30 cm in the catch has averaged about 12.3 percent in the last five years. Although some of the undersize fish are not discarded and brought back as part of the catch it is reported that some undersize fish are also discarded.

Although fishing by handlines would appear to be having minimal impacts on the ecosystem it is reported by fishermen that some corals are broken whilst hauling entangled lines. If the lines are pulled out of water with the corals still entangled, the corals are broken to free the fishing lines. The iron weights attached to the lines (about one kg each) can probably break corals in their descent. Iron weights are also lost and left on the bottom. The anchoring of the mother vessel takes place two times per day and corals are probably damaged during these operations.

9.2. Enforcement and compliance issues

Compliance and enforcement of the relevant provisions of the fisheries legislation are carried out mainly through the Fishery Monitoring Centre (FMC), the Port State Control Unit in Port Louis harbour and sea and air patrols carried out by the National Coast Guard (NCG). As the fishery resources exploited are far away on the banks the fishing vessels use only one point of departure and arrival i.e. from and to the Port Louis harbour. Surveillance on such distant banks is quite costly and the NCG strives to operate in the most effective way from information it receives about fishing activities.

There is a need to embark observers on board of bank fishing vessels. In this context, SWIOFP has set up an observer program to monitor the fishing activities and collect relevant data on the fishery. Several officers of the Ministry of Fisheries have been trained in this regard.

VMS and Safety Conditions

All licensed fishery vessels leaving the port need to have on board a transponder in working order and able to transmit position data through the VMS to the FMC and comply with safety regulations and conditions for boats and vessels.

Port State Control

The Port State Control Unit monitors all departures and arrivals of fishing vessels and landings of fish catch by fishing vessels according to the FAO Port State Measures and the NPOA-IUU. Arriving vessels have to submit in advance (two days prior to reaching port) information relating to the date and time of arrival of the vessel. The fish catch on board is checked against entries made in the fishing logbook and any discrepancy is investigated by officers of the Monitoring, Control and Surveillance Division together with officers of the Fisheries Protection Service.

One case of noncompliance was noted during inspections of fishing vessels fishing on the Saya de Malha and Nazareth Banks during port state control (see below).

Fisheries Surveillance

The National Coast Guard is provided with a VMS terminal to monitor the position and fishing activities of licensed fishing vessels. It carries out regular air and sea patrols using VMS and other information for onsite monitoring of the vessels; 800 hours of air and 1450 hours of sea patrol were carried out in 2011.

Fishing license conditions stipulate that fishing boats and vessels have to report any sighting of illegal fishing by other vessels.

Control of the fishing vessels by the patrol vessels operating under the regional surveillance project of the IOC has revealed some minor compliance problems with those fishing on the banks.

Cases of Illegal Fishing

i) A foreign fishing boat was arrested in 2002 for illegal fishing near St Brandon and the master of the boat charged accordingly. The master was fined one million rupees for the offence in 2003.

ii) Following inspection of the fishing logbooks another foreign vessel was found to have fished in an area where it was not authorized to fish in 2009. The master of the vessel was charged a fine of eight million rupees after the case was compounded.

iii) Another foreign fishing vessel was arrested in June 2011 on suspicion of carrying out illegal fishing on the Nazareth Bank. The vessel was taken to Port Louis and the master was detained and the crew members released. The vessel was a trawler and had about 2 tonnes of demersal fish on board. Court proceedings against the master of the vessel are ongoing.

10. Ecological Risk Assessment

An Ecological Risk Assessment Workshop was held from 14 to 16 March, 2012, at Domaine Les Pailles, Mauritius, in the context of the Development of a Fisheries Management Plan for the Shallow Water Demersal Fishery Resources of the Saya de Malha and Nazareth banks. An exercise was carried out to calculate the risk associated with the ecological well-being and social and economic well-being components of EAF.

Concerning the Ecological Well-Being component high risks are associated with fishing in the peak spawning season, lack of information on spawning/nursery grounds in view of identification of possible closed areas and lack of information on migration, larval dispersal and identification of unit stocks amongst banks for management purposes for the targeted species.

For non-targeted species high risks are associated with lack of information on population, numbers and species of turtles and sharks caught in view of their conservation status.

Concerning the ecosystem high risks are associated with anchoring by mother-vessels at least twice daily leading to damage of the seabed substrate, damage to corals by iron weights during fishing line hauling and use of anti-fouling agents containing tributyltin (TBT) on fishing vessels. Loss of iron weights from fishing lines constituted a medium risk to the environment.

With regard to human-well-being, high risks are associated with low salaries paid to fishermen as compared to the total value of the catch, long working hours, poor working conditions and purchase of fishing equipment by fishermen. Besides non-compliance of the contract agreement by fishing operators and fishers and low attraction of young fishers into the fishery pose high risks to fishing operations. The ageing fishing fleet, high costs of maintenance of fishing vessels and inadequate cold chain also pose high risks to the industry.

For the local dependent community high risks are associated with shortage of fish on the local market, the high price of fish, reliance on imported fish and the threat of consuming toxic fish.

Further details on the Ecological Risk Assessment (ERA) will be available in the workshop report.

11. The way forward

The shallow water demersal fishery resources on the Saya de Malha and Nazareth Banks provide an excellent source of frozen fish for the local market. The fishery resources provide employment to fishers and crew on fishing vessels and workers on land and in the processing distribution and marketing of fish. Fish production from the banks contributes to foreign exchange savings and import substitution. Management of the fishery resources in the last 20 years through licensing, limited entry and quota allocation has to a large extent contributed to its sustainability. Fish production has mostly been below the total MSY of both banks and the TACs imposed since the fishery has been subject to quota allocation. The resources are thus in good condition and it is the opportune time to embark on the development of a Management Plan for the fishery based on EAF principles with the participation of all stakeholders. Existing management measures need to be integrated in a well defined fisheries management plan (FMP).

The ERA carried out in March 2012, has, in addition, highlighted a number of issues with their respective risk levels for the fishery and these need to be addressed during the development of the FMP. There is need to institute an observer program to collect more precise information on a number of issues raised with regard to the ecological impacts of fishing so as to reinforce EAF.

Moreover, the industry faces other problems not directly connected to the resources such as fishing vessel surveys and certification, ageing of the fleet, high costs of repairs and maintenance and lack of regular active fishers.

Consultative processes with all stakeholders will certainly be necessary to have a common approach on issues and problems in the sector. Fisheries governance should be able to take on board biological, ecological, economic and social goals for the benefit of one and all. As a large part of the Saya de Malha Bank falls outside the Mauritian EEZ all factors related to the jurisdiction of Mauritius on the bank should be taken into consideration so as to have an effective FMP. The SIOFA could be the vehicle for the international recognition of the measures put in place and the FMP for the sustainable management of the fishery resources of the bank.

Acknowledgements

I wish to thank Mr. R. Payet, Executive Secretary of the SWIOFP, Dr. K. Koranteng, EAF-Nansen Project Coordinator and Dr. G. Bianchi, Senior Fishery Resources Officer of the FAO, Mr A.C. Moosuddee, Permanent Secretary of the Ministry of Fisheries, Mr D. Mauree, Director of Fisheries and the staff of the Ministry of Fisheries for the collaboration and support provided to me for the preparation of this report. The collaboration of Messrs Hemraj and Rajesh Ghina of Sealord Fishing Co. Ltd. are also appreciated together with other persons from the private sector and fishermen in providing useful information for the report.

References

Anon. Annual Reports of the Ministry of Fisheries, 1995 to 2009.

Ardill, J.D. 1979. Country statement on the marine fisheries in Mauritius. In: Report of the FAO/IOP Workshop on the Fishery Resources of the Western Indian Ocean South of the Equator. Mahé, Seychelles, 23 October – 4 November 1978. p. 54−62.

Bertrand, J. 1986. *Données concernant la reproduction de Lethrinus mahsena sur les bancs de Saya de Malha* (O.I). Cybium 10 (1) 15−29.

Bertrand, J. et al. 1986. *Rapport du groupe de travail pour une évaluation des ressources en capitaine/dame berri des bancs de Saya de Malha.* Publication IFREMER, 40 pp.

Bertrand, J. et al. 1986. *Pour une évaluation des ressources en capitaine/dame berri (Lethrinus mahsena) des bancs de Saya de Malha. Rapport du Groupe de Travail.* IFREMER/Albion Fisheries Research Centre (Mauritius), 23−25 juillet, 1985. 39 pp.

Carpenter, K.E. & Allen, G.R. 1989. FAO species catalogue, Emperor fishes and large-eyed breams of the world (family Lethrinidae). An annotated and illustrated catalogue of lethrinid species known to date. *FAO Fish. Synop*., 125: 118 p. Rome, FAO.

Degambur, D. & Solmundsson, J. 2005. Stock assessment of the offshore Mauritian banks using dynamic biomass models and analysis of length frequency of the sky emperor, *Lethrinus mahsena*. Final project, UNU. 56 pp.

FAO. 1992. Papers presented at the Technical Consultation on High Sea Fishing. Rome, 7–15 September, 1992. FAO Fisheries Report. No. 484, Suppl. Rome, FAO. 77 pp.

FAO. 1996. Precautionary approach to capture fisheries and species introductions. FAO Technical Guidelines for Responsible Fisheries. No. 2. Rome, FAO. 54 pp.

FAO/IOFC/IOP. 1979. Report of the Workshop on the Fishery Resources of the Western Indian Ocean South of the Equator. Mahe, Seychelles, 23 October to 4 November, 1978. 101 pp.

FAO/SWIOFP. 1989. Proceedings of the seminar on the Management of the Banks Handline Fishery. Albion, Mauritius. 99 pp.

Fisher, R.L.; Johnson, G.L. & Heezen, B.C. 1967. Mascarene Plateau, Western Indian Ocean. *Geological Society of America Bulletin* 78: 1247−1266.

Goreau, T. 2005. Saya de Malha Expedition. 107 pp.

Lebeau, A. & Cueff, J.C. 1976. *Biologie et peche des Lethrinides sur les haut fonds de Saya de Malha. Trav. et documents ORSTOM* 47:333−348.

Mees, C.C. 1992. Seychelles demersal fishery − an analysis of data relating to four key demersal species: *Pristipomoides filamentosus, Lutjanus sebae, Aprion virescens, Epinephelus chlorostigma*. SFA/R&D/019. Victoria, Seychelles. Seychelles Fishing Authority. 43 pp.

MRAG Ltd. 1996. The Mauritian banks fishery: a review and spatial analysis. Technical report for the management of multi-species tropical fisheries. Overseas Development Administration, Fish Management Science Programme Project R5484.

Pitcher, Tony J. 1986. *The behavior of teleost fishes*. John Hopkins University Press, 554 pp.

Samboo, C.R. 1989. A re-appraisal of the Banks fishery. *In*: Proceedings of the Seminar on the Management of the Banks Handline Fishery. SWIOFP Document RAF 87008. P. 10–26.

Sanders, M.J. 1989. An assessment of exploitation levels in the Banks handline fishery and a management plan to improve the fishery performance. *In*: SWIOFP/MAFNR. Proceedings of the Seminar on the Management of the Banks Handline Fishery. FAO/UNDP: RAF/87/008/WP/52/89/E: 42–53.

Smythe-Wright, D.; Boswell, S.M.; Lucas, C.H.; New, A.L. & Varney, M.S. 2005. Halocarbon and dimethyl sulphide studies around the Mascarene Plateau. *Phil. Trans.R. Soc*., 363: 169–185.

Soondron, S.; Venkatasamy, A. & Mamode, S.A. 1999. Some results on the sexual maturity of Lethrinus mahsena from the Saya de Malha bank, AFRC. *In*: Proceedings of the Annual Meeting of Agricultural Scientists, Mauritius. 150 pp.

Soondron,S.; Venkatasami, A. & Ramkissoon, S. 2005. Estimation of the maximum sustainable yields (MSY) for the demersal fish stocks on the Saya de Malha and Nazareth Banks. Presented at the National Ocean Science Forum, Mauritius Oceanography Institute, 2005.

Wheeler, J.F. & Ommanney, F.D. 1953. Report on the Mauritius-Seychelles fisheries survey 1948–49. Fishery Publication Vol.1 No.3. Her Majesty's Stationary Office, London. 148 pp.

Wijkstrom, U.N. & Kroepelien, T. 1979. Revitalisation of the Mauritian Bank fishery: an appraisal. FAO/IOP/TECH/39/35. 56pp.

AN EAF BASELINE REPORT OF THE LINEFISH FISHERIES IN MOZAMBIQUE

Rui J Mutombene, Lucinda Mangue, Estela Mausse, Hadija Mussagy, Mateus Filipe, Rudy van der Elst

1. Introduction

The configuration of the extensive Mozambique coastline provides its population with excellent access to the sea and its marine resources, thereby creating opportunities for development and diversification of its fisheries, extending from subsistence catches to small and medium-scale companies. Among these, one of most prominent fishing activities is the marine linefishery, defined as a form of fishing in which the basic components of fishing gear consist of hook and line.

The linefishery in Mozambique operates along the entire coastline and is developed in all the recognised sectors of Mozambique fisheries: Industrial, Semi-Industrial, Recreational, Sport and Artisanal and Subsistence. The harvest comprises mainly fish of high commercial value, thereby contributing to the country's economic development. Moreover, the high level off accessibility to quality linefish considerably enhances food security in many coastal regions.

The wide range of practitioners in this fishery, declining catch catches (CPUE), reduced average daily income, the large number of vessels operating, the decrease in the average size of the species coupled with the expansion of semi-industrial fleet to new areas (north of the Save River) as well as the introduction/improvement of fishing gear to catch deep water demersal fishes are the main motivations that have led to the need for developing a management plan for this fishery.

In this context, the Ministry of Fisheries, represented by its relevant institutions, and with technical assistance from FAO, the South-Western Indian Ocean Fisheries Project (SWIOFP) and the Oceanographic Research Institute (ORI), began the process of preparing a management plan for the resources accessible to the marine line fishery taking into account the objectives enshrined in the Fisheries Master Plan, the Action Plan for the Reduction of Absolute Poverty (PARPA), the fisheries legislation in force, the FAO Code of Conduct for Responsible Fisheries and the Ecosystem Approach to Fisheries Management (EAF). Thus, it is expected that the management plan to be approved will establish a participatory and adaptive system enabling the sustainable exploitation of resources accessible to the marine linefishery in Mozambique.

The dynamics of this fishery, which has resulted in increased fishing effort due to market demand and other factors, suggests the need for a better management strategy reflecting a deeper and more holistic approach that should contribute to better economic gains but also taking into account the sustainability of this fishery. We believe that a specific linefishery management plan is the most appropriate solution at this time to better reflect the challenges and opportunities presented by this fishery.

The present report constitutes the initial phase necessary for the achievement of the management plan for the line fisheries in Mozambique. The information contained in the document seeks to reflect the current situation of the linefisheries in Mozambique, in its various forms, including among other things, information on resources available to these fisheries, the issues associated with exploration and resource management as well as the legislation in place.

2. Overview of the fishery and resources exploited

2.1. Fishing gear used and areas fished

Each of the main fisheries subsectors in Mozambique has a line fishing component, ranging from inshore subsistence to large industrial vessels. The various subsectors are briefly described below.

Subsistence line fishing

This takes place with handline and other traditional gear and the catch is primarily for personal consumption or trade within the fishers' own community. Those involved are not part of the formal economy, inevitably poor and generally inadequately represented in management structures. Linefishing may take place from the shore or with the use of small traditional canoes. While some species may be preferred, this sector is largely opportunistic with limited species targeting. Few of these fishers are licensed or registered. This sector includes those described as artisanal shore Type 1 in Table 1.

Artisanal linefishing

A large number of people harvest linefish as part of small-scale fisheries. These operations are largely confined to the near-coastal zone, mostly boat-based and use either sail or engine power. The artisanal catch is important for local and district food security which are primarily traded on proximal markets. Most artisanal fishers are formally licensed. Although this sector is of local economic significance, few artisanal fishers are part of the formal economy. The range of this fishery is the entire coast. However, increasingly new technology is entering this sector, such that engine-powered vessels of up to 10 m can operate as artisanal, yet be exempt from management regulations that are imposed on semi-industrial fisheries.

Semi-industrial linefishing

This sector represents a significant component of Mozambique fisheries. The operations are boat based, often with sizeable crew and extensive sea going capacity and facilities. Most carry ice and may remain at sea for periods of up to 7 to 12 days. Legally this sector is defined as being motorised vessels from 10 to 20 m in length. All are formally licensed and the vessels operate from one of several harbours, where catches are normally monitored by the National Institute for Fisheries Research (IIP) , either through on-board observers or via port sampling on return from fishing trips. The range of operations is considerable, enabling this sector to move in response to fishing trends and seasonality. There are two management zones, such that a vessel is only authorized to operate in one of them (region south of 21°S or region north of 21°S). Based on the fleet activities one can infer that effectively the semi-industrial fleet is split into a northern zone (essentially Sofala Bank) and a southern zone (effectively from south of 24°S to Ponta d'Ouro) (Figure 1). Very low activity of this sector has to date been recorded north of 17°S. Although a wide variety of species is taken, certain species are targeted in response to market demands.

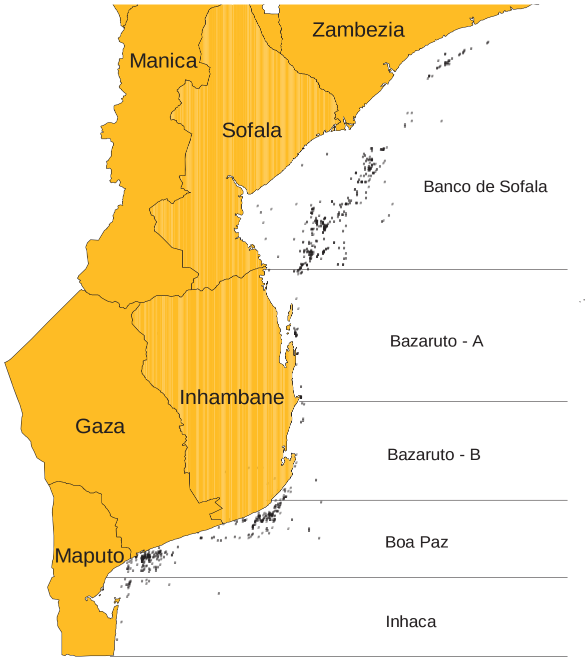


Figure 1. Main zones of semi-industrial fleet operations in Mozambique waters.

Industrial linefishing

Linefishing is also conducted from larger industrial vessels, defined as being longer than 20m and fitted with freezer capacity. Much of the catch is destined for export. This fishery is strongly target-driven in response to market demands for certain species and size of fish. The range of these vessels potentially includes the entire Mozambique coast but historically they confine their operations to the Southern 21°S region. However, since 2011 the two industrial linefishing vessels were licensed to operate only in the Northern 21°S zone.

Recreational and sport linefishing

Fishing as a recreational pursuit is increasingly common and in some developed countries this reaches very significant proportions – often larger than the commercial sector. In Mozambique there are four components to this subsector: domestic recreation, sport fishing, spear fishing and tourist fishing.

In domestic recreational fishing there is a growing but undocumented number of people who fish as a leisure activity and to supplement domestic food. These fishers invariable originate from an urban setting although they may well do their fishing in more remote areas. While some species may be preferred, most linefish will represent a desirable catch, especially if the specimen is large. The driving objective for this sector is the recreational aspect of fishing.

A second sector, which is more formally organised, is the sport or gamefish sector. These fishers belong to a club that normally sets standards for fisher ethics, organises tournaments and may contribute to conservation initiatives. Most fish from sea going craft that make daily trips from a port base. This sector prefers to target pelagic or gamefish species such as those from the Scombridae, Carangidae and Istiophoridae. Although no accurate data exist, it is believed there are at least 50 of these vessels in operation in Mozambique.

A further sector is that of recreational spearfishing. This involves individuals who dive without scuba gear but use spearguns to target selected species of linefish. Although numbers are believed to be low, this is a popular activity in some areas. In some cases spearfishing may also be undertaken for subsistence, by fishers who use more primitive gear and who target fish for food and not necessarily for trophy purposes.

Tourist fishing is another significant recreational subsector. Here, foreign visitors, mostly from South Africa, are attracted to Mozambique waters to harvest linefish. This can be an economically valuable fishery as it supports tourist ventures, but it has also resulted in significant problems when over-zealous tourists make excessive catches which are exported back to their home countries.

A growing recreational activity is that of charter boat fishing. Here, the owner of a boat rents space on the boat for visitors to go fishing. This is especially popular in association with resorts, both for diving and fishing. In most cases the target species are gamefish, but many cases are known where the charters also target reef fish species. The extent of these operations in Mozambique is not known but they represent a significant activity and an industry in many countries, including South Africa. While this activity offers positive opportunities, it is in fact a commercial operation that needs to be specifically managed.

Table 1 shows the characteristics of the fishing gears used by the different sectors that target directly on linefish. The main fishing gear used is the handline and the rod and line. This consists of monofilament lines with one or more hooks attached. These hooks are of variable size and baited with pieces of squid or fish such as Indian mackerel (carapau), magumba and other small species. Each gear is operated manually by one fisher, either as handline or using a geared reel to recover the line.

Table 1. Summarized description of the gears used in Mozambican linefishery sectors currently operational.

Sector	Type	Vessel	Crew	Gear	Comment
Artisanal	Shore	N/A	N/A	Handline	
	Type 1	Canoe < 3m (paddle)	1-2	Handline/trap	
	Type 2	Boat 3-8m (paddle/ sail)	2-3	Handline/trap	
	Type 3	Boat 5-10m (outboard)	3	Handline/trap	
	Skiboat	5-8m	3-6	Rod + line	Iced catch (1 day trip)
Recreational	Shore	N/A	N/A	Rod + line	
	Skiboat – sport	5-8m	2-6	Rod + line	Pelagic catch only
	Skiboat -spear	5-8m	2-6	spear	
Semi-industrial	Port-based	10-20m	10-15	Rod + line/ handline	Iced catch
Industrial	Port-based	>20m	10-30	Rod + line / handline	Frozen catch; quota controlled

Between 1997 and 2001 an experimental trap fishery targeting demersal reef fish operated in the southern region. This fishery licensed two vessels authorized to operate at depths greater than 100m. The gear was comprised of large steel traps, baited and attached to a long line. Each long line carried 50 traps and the larger the two vessels operated with 4 longlines (200 traps). While it was authorized to operate at 100m depths to target deeper water demersal species, studies carried by IIP showed that the gear was often set shallower, from 50m to 180m, thus potentially also taking the shallow water species that sustain the other sectors. Accordingly, this fishery was closed.

2.2. Resources exploited

Mozambique has a rich ichthyofauna and more than 302 species of fish have been described from linefishery catches (Fischer *et al.*, 1990). From this total, 169 species are considered to be of significant value to the linefishery and hence constitute a part of the linefish definition (Appendix I). The majority of species are of Indo-Pacific distribution and are found throughout the West Indian Ocean (WIO) region. Significantly, fish populations in the southern third of the country have a high incidence of endemism, especially amongst the seabream family (Sparidae).

The fish can broadly be divided into two groups: (1) those that are mostly reef and bottom associated and (2) those that are largely open water pelagic or gamefish species. Some of the most significant linefish families and species numbers are tabulated in Table 2.

Table 2. Broad division of major linefish species recorded from Mozambique waters, including those considered to be key species for line fishing and endemic species
Sources. Fischer *et al.*, 1990; Smith and Heemstra, 1986

Demersal Family	Number species			Pelagic Family	Number species		
	Total	Key	Endemic		Total	Key	Endemic
Sparidae	26	18	10	Carangidae	44	28	0
Lutjanidae	25	14	0	Scombridae	10	10	0
Haemulidae	17	17	0	Istiophoridae	4	3	0
Serranidae	53	23	2	Sphyraenidae	2	2	0
Lethrinidae	16	11	1	Coryphaenidae	1	1	0
Sciaenidae	4	4	1	Selachi (sharks)	23	19	1
Batoidea	14	14	1				
Nemipteridae	7	0	0				
Scaridae	3	3	1				
Total	**175**	**104**	**16**	Total	84	63	**1**

There is considerable variability in the life history amongst these linefish species. As a result, some species are significantly more vulnerable than others. Some features that add to the species' vulnerability are shown in Table 3. Thus, species with limited distribution ranges, slow growth and complex life cycles are more likely to require management protection than those which are wide ranging and fast growing. Generally, the demersal reef and offshore bank species are the more vulnerable while the pelagic gamefish species have greater resilience to exploitation.

Table 3. Examples of features that increase linefish species' vulnerability

Feature	Examples (English name, ***Portuguese name)***
Limited geographic range	Captain Fine rockcod, *Garoupa bordo branco*
Confined to limited habitats	Parrot fishes, *Papagaios*
Slow growth	Sharks, *Tubarões*
Endemism	Slinger, *Marreco*
Old at first maturity	Brindle bass, *Garoupa lanceolada*
Low fecundity	All sharks, *Tubarões*
Complex reproductive strategy	Rockcods, *Garoupas*

The semi-industrial and industrial linefisheries are generally oriented to harvest demersal fishes (although the pelagic component is also taken) and operate over reefs or rocky bottom areas. The extinct industrial trap fishery was allowed to operate at deeps greater than 100m having deep water demersal species as target (mainly cachucho, *Polysteganus coeruleopunctatus*); but shallow demersal species such as marreco and robalo were recorded as bycatch in this fishery with significant proportions.

The recreational (domestic and tourism) linefishing sector harvests the pelagic and demersal component but the later with some restriction in terms of number of individuals that may legally be taken per day.

For artisanal linefishing there is no specific target, the catch depending on local availability of the resources. In general, due the limitations in terms of capacity of the boats the operations are confined to the inshore coastal areas, harvesting coastal resources mainly within 3 nautical miles coastal waters. However, as more artisanal vessels become engine-powered and approach 10 m length, this sector may justify re-classification in order to avoid the uncontrolled expansion of effort in the linefishery.

Demersal resources

Generally the type of demersal resource exploited varies for the different zones (south, central and north) and are associated in part with the characteristics of these areas.

The south region (21º -26.3º S) is characterized by various (some endemic) rocky bottom species and the most dominant are the Sparidae marreco (*Chrysoblephuspuniceus*), robalo (*Cheimeriusnufar*), cachucho (*Polysteganus coeruleopunctatus*) and garoupas (Serranidae). The emperors (Lethrinidae) are widespread along the entire coast and mostly found associated with reef areas but also with coastal habitats such as corals and seagrass beds. Some species of this group includes ladrão relâmpago (*Lethrinus nebulosus*), ladrão masena (*Lethrinus mahsena*), ladrão de lantejoulas (*Lethrinus lentjan*), ladrão machado (*Lethrinus crocineus*) and São Pedro (*Lethrinu sharak*).

The central coast (16º - 21º S) has a wide continental shelf which comprises the sand and muddy bottoms of the Sofala Bank area (but also applicable to other sandy and muddy areas of Maputo Bay and Limpopo river delta in the southern coast.) The most prominent species are peixe-pedra (*Pomadasys kaakan*) and gonguri (*Pomadasys maculatum*), both from the Haemulidae family, bagre (*Arius dussumieri*) from the Ariidae and corvinas such as corvine dentuça (*Otolithes ruber*) and corvina real (*Argyrosomos japonicus*), both from the Sciaenidae.

The northern coast (10º - 16º S) has a narrow continental shelf comprising small islands, hard rock and coral bottom areas. The most prominent demersal group, apart from the Lethrinidae, are the Lutjanidae or snappers such as pargo de manchas (*Lutjanus bohar*), pargo vermelhão (*Lutjanus sanguineus*), pargo dentuço *(Pristipomoides typus*), pargorosa (*Pristipomoides filamentosus*), pargo de cauda comprida (*Etelis coruscans*) and pargorubi (*Etelis carbunculus*). In this region the rockcods are also common.

Pelagic resources

The pelagic component of linefish resources occurs along the entire coast. The most prominent species are the Scombridae, particularly peixe-serra (*Scomberomorus commerson*), and the Carangidae with emphasis on xeréu narigudo (*Carangoides chrysophrys*), xeréu malabarista (*Carangoides malabaricus*), *Caranx sexfasciatus* and *Caranx ignobilis*. The gamefish albacora (*Thunnus albacares*), merma (*Euthynnus affinis*), cavala gigante (*Acanthocybium solandri*) are very common in sport fishing catches, together with the other pelagic species listed above.

2.3. Number of fishers and land-based workers by sector

A striking feature of the linefish fishery is its high manpower and thus employment demand. This contributes to human well-being but conversely this also creates sensitive situations with fluctuations in fish abundance and the status of the resource: what follows gives some insight into the scale of employment levels.

Artisanal Sector

In terms of numbers of participants, the total number of workers involved in the marine artisanal fishery activity is around 350 000 including fishermen without a vessel, boat crews and support land-based workers (IDPPE, 2009[1]). Of this number, it is estimated that about 97 000 are fishermen who are permanent crew, engaged in all types of marine fishing. However, the number of fishermen and support staff involved in the actual exploitation of linefish is not clearly defined.

According to data of 2007 from the Census of Artisanal Fisheries (IDPPE, 2009) the number of fishing units that use hand line in the maritime areas is round 9 200 artisanal boats (Table 4). Crossing these data with an estimated number of four crew per unit (boats), we estimated that the number of fishermen engaged in artisanal linefishing operations as permanent crew is around 37 000.

According to the data from the Census 2009, the number of fisherman operating hand line without boats (subsistence line-fisherman) is around 19 400 (Table 4).

[1]New survey data available in 2013.

Table 4. Number of artisanal fishing units (boats) and fishers without boats using hand line by coastal province

Province	Artisanal linefish boats	Subsistence linefishers without boats
Cabo-Delgado	2115	2765
Nampula	3404	6089
Zambézia	1030	4144
Sofala	1797	1235
Inhambane	577	2493
Maputo	291	2626
Total	9214	19352

Semi-industrial/ Industrial and Recreational Sectors

Using the numbers of boat licenses issued (Table 5 and Figure 2), and assuming semi-industrial and industrial crew sizes are around 15 and 25 respectively, the total number of fishers in these two sectors is around 600 and 50 fishers respectively. In the past the industrial fisheries included trap and mid-water trawl which potentially also caught linefish when operational (Table 5) and thus also employed fishermen.

The number of the land based workers in the semi-industrial and industrial sector is not available for this report but these normally have a formal job contract, different to fishermen where there is generally no formal job agreement with the company or vessel owner.

For the recreational sector the number of participants is around 2500 (based on individual fisherman licences), although this is likely to be an underestimate (Table 5).

Table 5. Number of boat licenses per fisheries sector
Source: ADNAP; 1996-2000 figures were reported in Van der Elst *et al*., (2003).
Note that for the recreational sector the numbers correspond to individual fisherman licences, not boats, and only commenced in 2004.

	Semi-industrial (line fishing licenses per port)						Industrial			Recreational
	Beira	Quelimane	Angoche	Cabo Delgado	Maputo	Inhambane	Line	Trap	Mid-water trawl	
1996	2				20	3	0	0	10	
1997	1				24	9	3	2		
1998	1				21	16	3	1		
1999	2				22	10	4	1	3	

	Semi-industrial (line fishing licenses per port)						Industrial			Recreational
	Beira	Quelimane	Angoche	Cabo Delgado	Maputo	Inhambane	Line	Trap	Mid-water trawl	
2001	2				7		4	1	11	
2002	2				12	6	4	0	7	
2003	2				9	2	4	0	2	
2004	3				10	5	3	0	1	
2005	2			3	11	5	3	0	0	1143
2006	7		1	4	11	6	3	0	0	1329
2007	8				11	5	2	0	0	1476
2008	15	3	1	5	13	4	2	0	0	2525
2009	11	2		2	15	6	2	0	0	2413
2010	9	4		2	11	6	2	0	0	2412

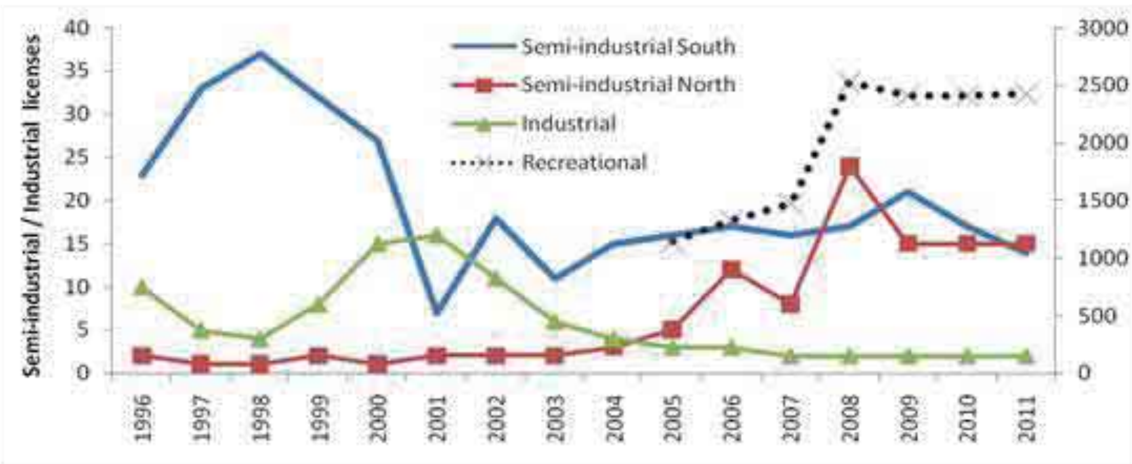


Figure 2. Annual number of linefish licences per fishing sector issued by ADNAP.

2.4. Interactions with other fisheries

The present document focuses on fisheries of different sectors that have in common the use of hook and line to harvest fish: the artisanal linefishing, the semi-industrial linefishing, the industrial linefishing, the recreational and sport linefishing. However, there are other fishing techniques that harvest linefish directly or as bycatch. In the artisanal sector linefish are taken in large quantities also by beach seine and trawl nets. Other fishing techniques such as artisanal traps and longlines target linefish species directly but they are in relatively low proportion when compared to the main gear types of handline, trawls and seine nets.

In the semi-industrial and industrial sectors linefish resources are also taken by shrimp trawling as bycatch. However, this is not always discarded and the retained part of this bycatch provides for a very interesting relationship between these trawler vessels and the artisanal sector. The artisanal operators collect the bycatch directly from the large vessels thus minimizing wasteful discards.

In the past the industrial sector also included trap and mid-water trawl fisheries which caught demersal and pelagic linefish respectively.

In general all these fisheries (the hook and line fisheries and others that use other fishing techniques) interact directly and/or indirectly with each other, by harvesting at a minor or major scale the linefish resources. The level of interaction is expanded in the following chapter, as part of the description of species-specific status of exploitation.

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

This section describes the key biological features of the main linefish species caught in Mozambique. The information is collated from IIP research records, as well as Fischer *et al.* (1990), Smith and Heemstra, (1991), van der Elst (1988), Mann (2000) and FishBase (Froese and Pauly, 2013).

Marreco (Chrysoblephus puniceus)

<u>Biology</u>

Carnivorous, feeding mainly on molluscs, crustaceans and echinoderms and in some cases on polychaetes and small fishes. Protogynous hermaphrodite.

<u>Distribution</u>

Marreco is a subtropical fish, endemic to the southern region of the Indian Ocean between Southern Mozambique (21°S) and KwaZulu-Natal in South Africa. A demersal species of coastal waters in depths ranging from 10 to 80 m (common at depths lesser than 50m). Rock bottom and reef associated.

<u>Exploitation and stock status</u>

Species of commercial value in Mozambique (Lichucha 2001). Taken with hook and line by artisanal, semi-industrial and industrial sectors. Exploited to some extent by recreational fishing. Historically, marreco dominated the catches of the semi-industrial linefishery in southern Mozambique (Lichucha, 2001). Bycatch in the industrial trap linefishery (1997-2001) (Torres *et al.*, 2011). In terms of specific management measures no more than four fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. Actually considered to be overexploited (Fennessy *et al*, 2012).

Robalo (Cheimerius nufar)

<u>Biology</u>

Carnivorous fish. No specific information on diet.

<u>Distribution</u>

Subtropical species (24°N - 34°S) of the Indo-Pacific region. In the southern Indian Ocean the species is found from southern Mozambique to KwaZulu-Natal. Demersal in coastal waters at depths ranging from 40 to 100 m. Rock bottom and reef associated.

Exploitation and stock status

A species of high commercial value and second most important in the catches of the semi-industrial fleet from the southern region. Exploited by hook and line by artisanal, semi-industrial and industrial sectors. Bycatch in experimental trap fishery (1997-2001) (Torres *et al.,* 2011). It is assumed to be taken by recreational fishing.

In terms of specific management measures no more than four fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. Considered to be overexploited.

Cachucho (Polysteganus coeruleopunctatus)

Biology (see Torres, 2008)

Carnivore fish. No specific information on diet.

Distribution

Tropical species (31°N - 28°S) distributed from Red sea to the KwaZulu-Natal coast (Smith and Heemstra, 1991). Occurs along the entire Mozambique coast. A deep-water demersal species found at depths greater than 100m but most common between 80-150m over rock bottom and near reefs.

Exploitation and stock status

A valuable commercial species constituting one of the demersal species of major contribution to the semi-industrial and industrial linefisheries in the southern region and on the Sofala Bank. A significant target species in the experimental trap fishery in southern Mozambique (1997-2001).

In terms of specific management measures no more than four fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. Considered optimally exploited.

Garoupa de bordo branco (Epinephelus albomarginatus)

Biology

Feeds mainly on benthic invertebrates, also on fishes and squids. Protogynous hermaphrodite. The species can attain a maximum length of 90cm.

Distribution

Subtropical, endemic to the southern Indian ocean from Sofala Bank in central Mozambique to East London, South Africa. Demersal in coastal water from 10 to 100m over rock and reefs.

Exploitation and stock status

A species of high commercial value in Mozambique taken by hook and line by the artisanal, semi-industrial and industrial sectors. Taken also by the recreational linefishing. Bycatch in experimental trap fishery (1997-2001) (Torres *et al.*, 2011).This species constitutes the most commonly caught grouper in commercial line fishing in the southern region.

In terms of specific management measures no more than four fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. Classified as vulnerable in the IUCN red list. The information available is inadequate to assess the stock status but taking into consideration the species' high level of vulnerability and the reduction of mean size and catches, it is considered to be overexploited.

Ladrão relâmpago (Lethrinus nebulosus)

Biology

Feeds mainly on molluscs, crustaceans and echinoderms and less commonly on polychaetes and small fishes. Protogynous hermaphrodite.

Distribution

Tropical (36°N - 32°S) Indo–West Pacific. A demersal species of coastal waters at depths ranging from 5 to 60m and inhabiting coral reefs, coralline lagoons, seagrass beds, mangrove swamps and coastal sand and rock areas. Adults solitary or in small schools; juveniles form large schools in shallow, sheltered sandy areas, also harbours where there is seagrass, algae or sponge habitats at various depths. In Mozambique the species occurs along the entire coastline, although recent study has indicated local stocks (together with KwaZulu-Natal) to be geographically isolated from other stocks of this species (Gouws, 2012).

Exploitation and stock status

A species of commercial value in Mozambique, taken with hook and line by artisanal, semi-industrial and industrial sectors. In the artisanal sector it is also taken by gillnets and beach seine. Jointly, with other emperor species, they form one of the most dominant demersal group exploited mainly by the artisanal sector. Exploited in some places by recreational fisheries. In terms of specific management measures no more than four fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. The information available is inadequate to assess the stock status which remains unknown. However, the isolated stock in Mozambique and northern KwaZulu-Natal presents a need for vigilance and precautionary management.

Ladrão masena (Lethrinus mahsena and Lethrinus sanguineus)

Biology

Feeds mainly on molluscs, crustaceans and echinoderms and to a lesser extent on polychaetes and small fishes. Protogynous hermaphrodite.

Distribution

Tropical species (28°N - 25°S) of the west Indian Ocean; reef-associated at depth ranging from 2 - 100 m. Also found over reef-adjacent sandy and seagrass areas. In Mozambique these species are predominantly harvested in the northern region.

Exploitation and stock status

Species of commercial value in Mozambique. Taken with hook and line by artisanal, semi-industrial and industrial sectors. In the artisanal sector it is also taken by gillnets and beach seine. Jointly with other emperors they form one of the most dominant demersal group exploited mainly by the artisanal sector.

In terms of specific management measures no more than ten fish per fisher day of either species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. The information available is inadequate to assess the stock status which remains unknown.

Pargo de manchas (Lutjanus bohar)

Biology

An aggressive predator that feeds mainly on fishes but also takes shrimps, crabs, amphipods, gastropods and tunicates. Solitary but occasionally forms groups.

Distribution

Tropical species (31°N - 33°S) of the Indo-Pacific region. More common around oceanic islands than in continental areas. Demersal and reef associated species at depths between 5 and 180 m, but most common between 10-70m. In Mozambique the species is frequently found in the northern region including the São Lazaro Bank.

Exploitation and stock status

In terms of specific management measures no more than ten fish per fisher day of either species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. The stock status is unknown.

Pargo dentução (Pristipomoides typus)

Biology

Feeds mainly on fishes and benthic invertebrates. Frequently form schools.

Distribution

Demersal and reef associated species ranging in depth from 40m to more than 200m on continental shelf and slopes. In Mozambique the species is found in the Sofala Bank area mainly at depths greater than 100m.

Exploitation and stock status

A species of high commercial value in Mozambique. Exploited by the industrial and semi-industrial linefishing fleet when they operate at depths of 200m. In terms of specific management measures no more than ten fish per fisher day of either species may be taken by recreational fishing. There are no specific restrictions for the commercial sector.

The stock status is unknown but taking into account that the linefishery does not exploit all deep areas of this species' range it is assumed that the stocks are not presently threatened.

Pargo rosa (Pristipomoides filamentosus)

Biology

Feeds on small fish, shrimp, amphipods, sea squirts and salps. Undertakes vertical migration so that during the night it moves to the upper parts of their habitat for feeding.

Distribution

Tropical (35°N - 26°S) of the Indo-Pacific region. Benthic-pelagic at depths between 40 and 400 m; more common between 180-270m. Normally reef associated over the continental shelf and slope. In Mozambique the species occurs along the entire coast but is more abundant in the north.

Exploitation and stock status

A species of high commercial value in Mozambique. Exploited by the industrial and semi-industrial linefishing fleet and occasionally also taken by the artisanal sector using hook and line. In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. The stock status is unknown but taking into account that the linefishery does not exploit all deep areas of this species' range, it is assumed that the stocks are not presently threatened.

Pargo rubi (Etelis carbunculos)

Biology

Feeds on fishes and larger invertebrates such as squids, shrimps and crabs. Also ingests components of the plankton.

Distribution

Tropical (34°N - 25°S) of the Indo-Pacific region. Benthic-pelagic in relatively deep waters between 90 and 400 m but most common between 200-350m. In Mozambique the species is captured from Quissico northwards.

Exploitation and stock status

A species of high commercial value in Mozambique. Exploited by the industrial and semi-industrial linefishing fleet when operating to 200m depths. In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. The stock status is unknown but taking into account that the linefishery does not exploit all deep areas of this species' range, it is assumed that the stocks are not presently threatened.

Pargo de cauda comprida (Etelis coruscans)

Biology

Carnivore species feeding on fishes, squids and crustaceans.

Distribution

Tropical (35°N - 27°S) of the Indo-Pacific region. Benthic-pelagic in relatively deep waters between 90 and 400 m. In Mozambique the species occur along the entire coast but is mostly harvested in the Northern region.

Exploitation and stock status

A species of high commercial value in Mozambique. Exploited by the industrial and semi-industrial linefishing fleet when operating to 200m depths, especially associated with rock bottom and reefs on the shelf and slopes. In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. The stock status is unknown but taking into account that the linefishery does not exploit all deep areas of this species' range, it is assumed that the stocks are not presently threatened and in good condition.

Corvina real (Argyrosomus japonicus)

Biology

Maximum length of 150cm. Feeds on fishes, cuttlefish, squid, crabs and shrimps, often in turbid water.

Distribution

A temperate species found from Mozambique to False Bay and several other localities in the Indo-Pacific. It tolerates waters of 13°C - 24°C is found between 21°N - 39°S and normally occurs close to the bottom. Inhabits coastal and estuarine areas to depths of 150 m.

Exploitation and stock status

This commercial species is harvested by artisanal, semi-industrial and industrial linefisheries while it is also taken by the artisanal sector using gillnets, beach seine and collected from industrial shrimp trawler bycatch. In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. This species is severely overfished in South Africa and as it is likely to be the same stock as in Mozambique its status is of concern.

Corvina dentuça (Otolithes ruber)

Biology

Maximum length is about 90cm and size at first maturity is 22cm. Feeds on fishes, shrimps and other invertebrates.

Distribution

Tropical Indo-Pacific: 26°C - 29°C, between 34°N - 35°S. Common in East Africa, including in Madagascar. Demersal in coastal and estuarine waters to 40m depths.

Exploitation and stock status

Commercial species harvested by artisanal and semi-industrial linefishing. It is mainly taken by the artisanal linefishing sector where it is also harvested using gillnets and beach seine. Also retained as bycatch in industrial shrimp trawl fisheries. In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. The stock status is unknown.

Peixe pedra (Pomadasys kaakan)

Biology

Feeds on crustaceans and fishes. Maximum length 80cm but is common less than 50cm. Prefers turbid waters in sand or muddy areas or estuarine environments. Reproduction takes place at the mouth of rivers during winter in large where they may form large schools.

Distribution

Tropical (32°S-32°N) Indo-West Pacific. Demersal in coastal waters to depths of 75 m.

Exploitation and stock status

Exploited mainly by artisanal fishers using hand lines, gillnetting and beach seine. Significant bycatch of industrial shrimp trawl fishery. In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. The stock status is unknown.

Gonguri (Pomadasys maculatum)

Biology

Feeds on fish and crustaceans. Length can reach 45 cm, usually 20-15cm.

Distribution

Tropical, Indo-west Pacific. In coastal waters 20-110m, reef associated and enters estuaries.

Exploitation and stock status

Harvested mainly in the artisanal sector by hook and line and beach seine. In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. The stock status is unknown.

Bagre (Arius dussumieri)

Biology

Feeds on invertebrates and small fishes.

Distribution

Tropical, Indo-west Pacific: Mozambique and Madagascar to Sri Lanka. Found along the coast where it may enter the lower parts of rivers. A demersal species of coastal waters at depths less than 50m.

Exploitation and stock status

Exploited by artisanal sector using handline, gillnets and beach seine**.** In terms of specific management measures no more than ten fish per fisher day of this species may be taken by recreational fishing. There are no specific restrictions for the commercial sector. The stock status is unknown.

Serra (Scomberomorus commerson)

Biology

Known to undertake lengthy long-shore migrations, but permanent resident populations also seem to exist. Found in small schools feed primarily on small fishes like anchovies, clupeids, carangids, also squids and penaeid shrimps. Usually hunts solitary and often swim in shallow water along coastal slopes. Eggs and larvae are pelagic. Attains 220cm of maximum length, generally 60-90cm). Length at first maturity is 85.0 cm.

Distribution

Indo-West Pacific. Epipeplagic between 15 and 200m. Distributed from near the edge of continental shelf to shallow coastal waters. Also found along drop-offs and in shallow or gently sloping reef and lagoon waters.

Exploitation and stock status

Exploited with hook and line by all sectors that harvest linefish. There are no specific management measures. The stock status is unknown.

Xeréu narigudo (Carangoides chrysophrys)

Biology

A predator of shrimps, small fishes and crabs that can attain 60cm. Usually found in small groups.

Distribution

Widespread tropical, Indo-Pacific in shallow coastal bays, sometimes in slightly turbid water to depth of 60m. Juveniles occur in inshore areas, including estuaries.

Exploitation and stock status

Harvested with hook and line in all sectors that exploit linefish. In the artisanal sector the species is also taken by beach seine. There are no specific management measures for the species. The stock status is unknown.

Albacora (Thunnus albacares)

Biology

An oceanic species occurring above and below the thermoclines. Pelagic in open water, and rarely seen near reefs. They shoal primarily by size, either in monospecific or multi-species groups. Larger fish frequently shoal with dolphins, also associated with floating debris and other objects. The species can attain a maximum length of 200cm. Feed on fishes, crustaceans and squids. It is sensitive to low concentrations of oxygen and therefore is not usually caught below 250 m in the tropics. Peak spawning occurs during the summer, in batches. Eggs and larvae are pelagic.

Distribution

Worldwide in tropical and subtropical seas (15°C - 31°C). Highly migratory pelagic species.

Exploitation and stock status

Intensely exploited by foreign fisheries operating under agreement in Mozambique waters. Also taken by artisanal and recreational sectors, including during fishing tournaments. No specific management measures in place. It is considered as a near threatened (NT) species in the IUCN red list and considered to be fully exploited by IOTC.

Merma (Euthynnus affinis)

Biology

May form schools by size, sometimes with other scombrid species, comprising from 100 to over 5 000 individuals. A highly opportunistic predator feeding indiscriminately on small fishes, especially on clupeids and atherinids and also on squids, crustaceans and zooplankton. Attains 100 cm maximum length but more common from 50 – 60cm.

Distribution

Indo-West Pacific: in warm waters including oceanic islands and archipelagos. Highly migratory pelagic species. Occurs in open waters but always remains close to the coast. The young may enter bays and rarely the larger harbours.

Exploitation and stock status

Exploited by artisanal fisheries and also recreational sector during fishing tournaments. There are no specific management measures. The stock status is unknown.

3.2. Status of stocks

A recent stock assessment of linefish resources was undertaken by IIP (Fennessy *et al.*, 2012). The assessment was mainly focussed on catches and species targeted by the semi-industrial and industrial sectors operating in the region south of 21^{o}S (effectively south of 24^{o}S as only limited fishing occurs between 21^{o}S and 24^{o}S). Equivalent data from the Sofala Bank region north of 21^{o}S was also processed but in more limited scope. A preliminary assessment of the recreational sector was also performed with limited data available.

In general the study concluded that the linefish resources are under a high level of exploitation with a recorded increase in effort of 50 percent in the period from 2008 to 2010.

In the southern region the overall trend in the cpue in the semi-industrial linefishery has been declining since the 1990s (Figure 3). In fact, cpue has declined to less than 200 kg/boat day - slightly less than 30 percent of the peak of almost 700 kg/boat day recorded in 1991.

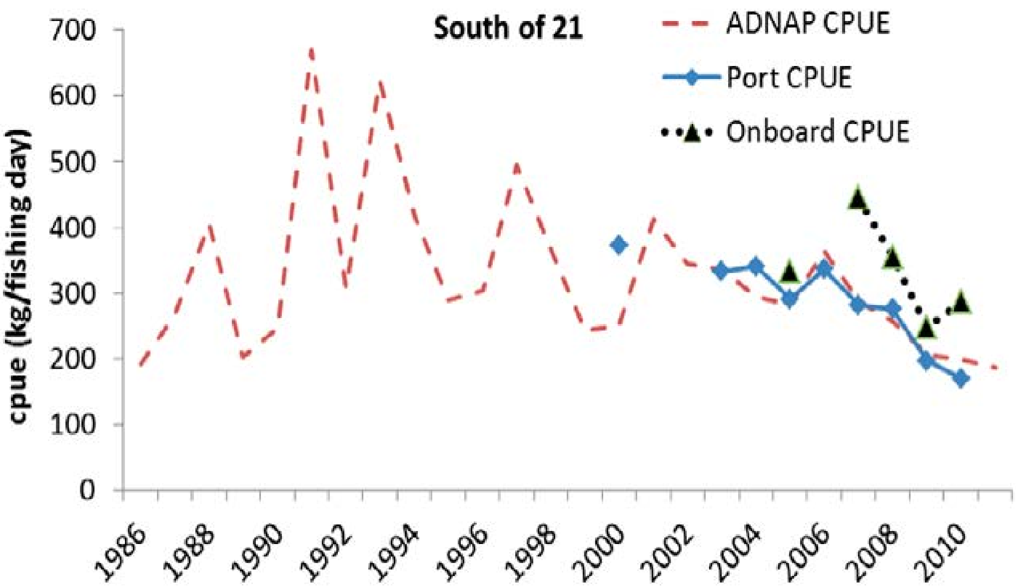


Figure 3. CPUE of the semi-industrial line fishery south of 21°S from three sources. **Sources.** port sampling, on board observer sampling and ADNAP data. Port CPUEs are not available for 2001-2002 and 2011; observer CPUEs are not available for 2006 and 2011. ADNAP data are the reports of total catch (all species combined) and effort (fishing days) of each boat per trip.

Catches of 700 kg/day on individual boats are occasionally made these days (recorded by on board observers), but these are exceptional. van der Elst *et al.* (2003) estimated that landings could have been under-reported by up to 60 percent. If this is the case, this would imply that the catch rate has declined by even more than 70 percent, suggesting a serious sustainability issue in the line fishery south of 21°S. The industry representatives agreed that catch rates in this region have declined, to the extent that the fishery is marginally viable. Furthermore, there is a significant declining trend in the size of the main target species of marreco and robalo.

The northern region experienced a progressive increase in fishing effort since about the year 2000 at a time when the southern stock demonstrated signals of depletion. There is information that semi-industrial vessels were already linefishing in northern region in 1996, but there are no catch and effort records; thus it should not be assumed that the northern area was unexploited at that time.

The results of the last linefish assessment (Fennessy *et al.*, 2012) showed that the linefishery in the central region (Sofala Bank area) had developed quickly, with a 4-fold increase in effort since 2004 and a further 66 percent increase from 2010 to 2011. Despite this increase, the catch rates appear to have remained relatively stable (300 to 400kg/boat day) but with a declining trend towards the end of this period (Figure 4).

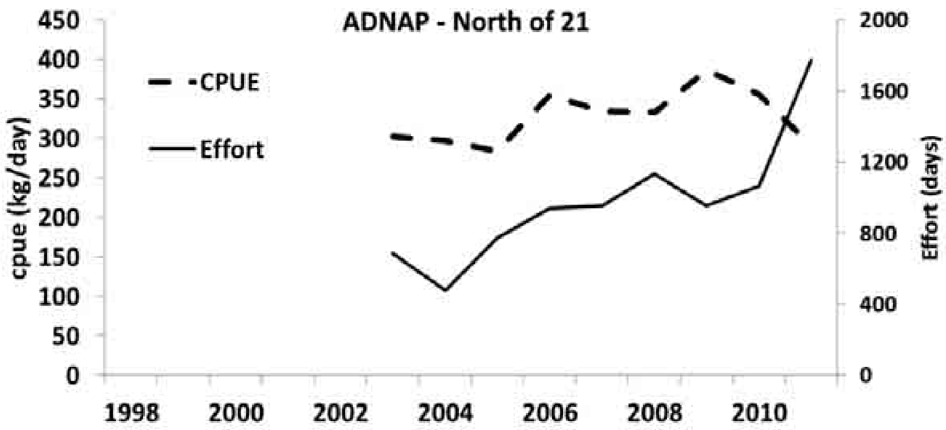


Figure 4. CPUE and effort from the semi-industrial and industrial linefish fleets for the central area north of 21°S (Sofala Bank area), as provided by ADNAP.

The linefish assessment includes a preliminary assessments of recreational linefishing which concluded that recreational boat catches are probably substantial, possibly up to ¼ of semi-industrial and industrial catches. There also appears to be considerable overlap in species composition between the different sectors (Tables 6 and 7). With the rapid expansion of tourist accommodation along much of the Mozambique coast, the demand for recreational fishing opportunities has grown, and the demand for fresh fish at these resorts has thus also grown (Fennessy *et al*., 2012).

Table 6. Number and weight of fishes landed during pelagic game fishing competitions monitored by IIP from 2005-2010, mainly from Maputo and Inhambane.

	No.	% no.	Weight (kg)	% wt.
King mackerel (serra)	1445	39.3	10740	39.7
Tunas	1021	27.7	6479	24.0
Kingfish (Carangidae)	258	7.0	1920	7.1
Dolphinfish (Dorado)	262	7.1	1942	7.2
Other	694	18.9	5959	22
Total	3 680	100.0	27 040	100.0

Table 7. Number and weight of fishes reported caught during 430 recreational fishing outings from 2008-2010, almost entirely from Maputo. Red fish and encarnado includes marreco, robalo and lutjanids.

	No.	% no.	Weight (tonnes)	% wt.
Tunas	677	17.0	3.1	22.0
Other	513	13.0	2.8	20.0
King mackerel (serra)	397	10.0	1.9	14.0
Red fish	926	23.0	1.8	13.0
Kingfish	235	6.0	1.6	11.0
Encarnado (red snapper)	470	12.0	0.9	6.0
Groupers	342	9.0	0.8	6.0
Emperors	322	8.0	0.7	5.0
Snappers	138	3.0	0.5	3.0
Total	4 020	100.0	14.1	100.0

Although the recent assessment has not focused on the artisanal sector (due to the great complexity of this sector), it is known that considering the large number of fishermen involved in this sector, it probably exploits the largest fraction of coastal resources accessible to line fishing and is therefore the sector with the greatest impact on coastal resources. Figure 5 shows the variation of the mean cpue of the artisanal linefishing boats. The cpue of artisanal fisheries in the south (Maputo and Inhambane) show a downward trend over the time series. For the northern area (which includes the coastal provinces of Sofala, Zambezia, Nampula and Cabo Delgado) the cpue showed an increasing trend up until 2008 and a decline in recent years. This picture resembles to some extent that observed for the semi-industrial sector, which also shows a sharp decrease in the indices of abundance in the south in recent decade suggesting over-exploitation of coastal fish stocks available to the linefishery.

Figure 5. Variation of mean cpue (kg/boat*day) for active artisanal boats in the south (sul), north (north) and overall (geral).

3.3. Direct interactions with the ecosystem

While the physical act of linefishing has several impacts on the marine ecosystem, these are considered relatively minor when compared to net fisheries. Linefishing activities can impact reefs and sea grass beds by anchoring. Some ghost fishing may occur as result of losing (discarding) lines with hooks. Waste disposal such as plastic, fishing line, food, discards and fuel all disturb the ecosystem wellbeing, especially on coral reefs.

Targeting of spawner aggregations is harmful and not sustainable while removal of top predators or other target groups may upset the environmental balance. For example finning may be on the increase and yet the role of sharks in the ecosystem is not understood by the fishermen.

Estuarine nurseries are under threat and some estuarine species seem depleted as result of use of non-selective gears and high pressure on these coastal habitats.

4. Annual catches

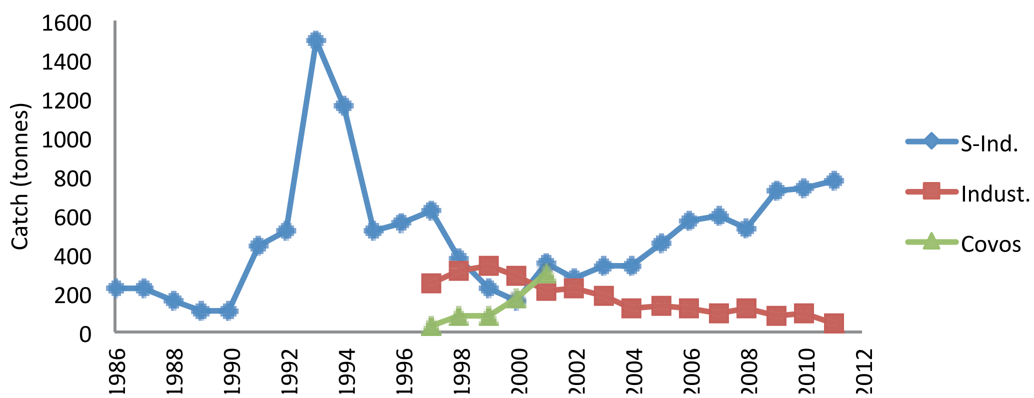
Semi-industrial and industrial sectors

The semi-industrial linefishery started in the 1980s with two semi-industrial vessels from Maputo harbour and expanded rapidly when the civil war ended, reaching a peak in 1998 with 30 vessels operational

(Figure 6). Very high catches were recorded in 1993 and 1994 as result of this rapid increase in effort. Subsequently the catches were progressively lower until around 2000. During this period fishing effort was confined in the southern region between Ponta Závora (24° 30'S) and Ponta de Ouro (26° 52'S) which was considered the preferred linefishing zone due the existence of species of high commercial value (*C. puniceus*, *C. nufar* and groupers) in close proximity to the main markets at Maputo.

With the reduction in catches of main shallow-water target species the sector promoted diversification of the linefishery by introducing vessels of larger capacity and other fishing techniques to target valuable deep-water demersal fishes. This resulted in the introduction of five industrial linefish vessels in 1997, two of them experimental using traps. At the end of 1997 one of the trap vessels ceased its fishing activity so that just one vessel has remained in this fishery. The trap fishery was licensed to operate at depths greater than 100 m initially with a total of 50 traps per vessel and was especially introduced to trap under-exploited species like *P. coeruleopunctatus* (cachucho). However, it proved difficult to manage the expansion and operations of this fleet and progressively the catches of this vessel were overlapping with those from semi-industrial shallow species. The number of traps used also progressively increased to a peak of 300 traps per day in 2001 (Torres *et al.*, 2011). There was also a risk of ghost fishing with lost traps. Trap fishery catches rose to reach more than half of the combined catches of semi-industrial and industrial line fishing vessels (Figure 6) before the management authorities decided to terminate this experimental fishery in 2002 (Torres and Jakobsen, 2007).

From 2000 onwards, "economic" overfishing of target species in the southern region forced the fleet to expand its fishing area towards the Sofala Bank. This movement resulted in a partial switch of effort to other species such as *Pristipomoides spp* and included some pelagics such as King mackerel (*S. commerson* or serra). This expansion to the north of 21° S was more prominent after 2004. Indeed, the increase of the total production of semi-industrial and industrial linefishery was catalysed by this expansion of the fishing areas and also by a general increase of fishing effort. This has resulted in a stable level of mean cpue when considering the entire fleet. Notwithstanding, the cpue levels for the Sofala Bank fleet were greater than those of the southern region, which demonstrated clear trends of declining of CPUE (Figure 7). In the southern region the species composition was dominated by serra, sparids (cachucho, marreco and robalo) and groupers. On the Sofala Bank area the catches included cachucho, and the snappers *Pristipomoides spp.* and *Etelis spp*.



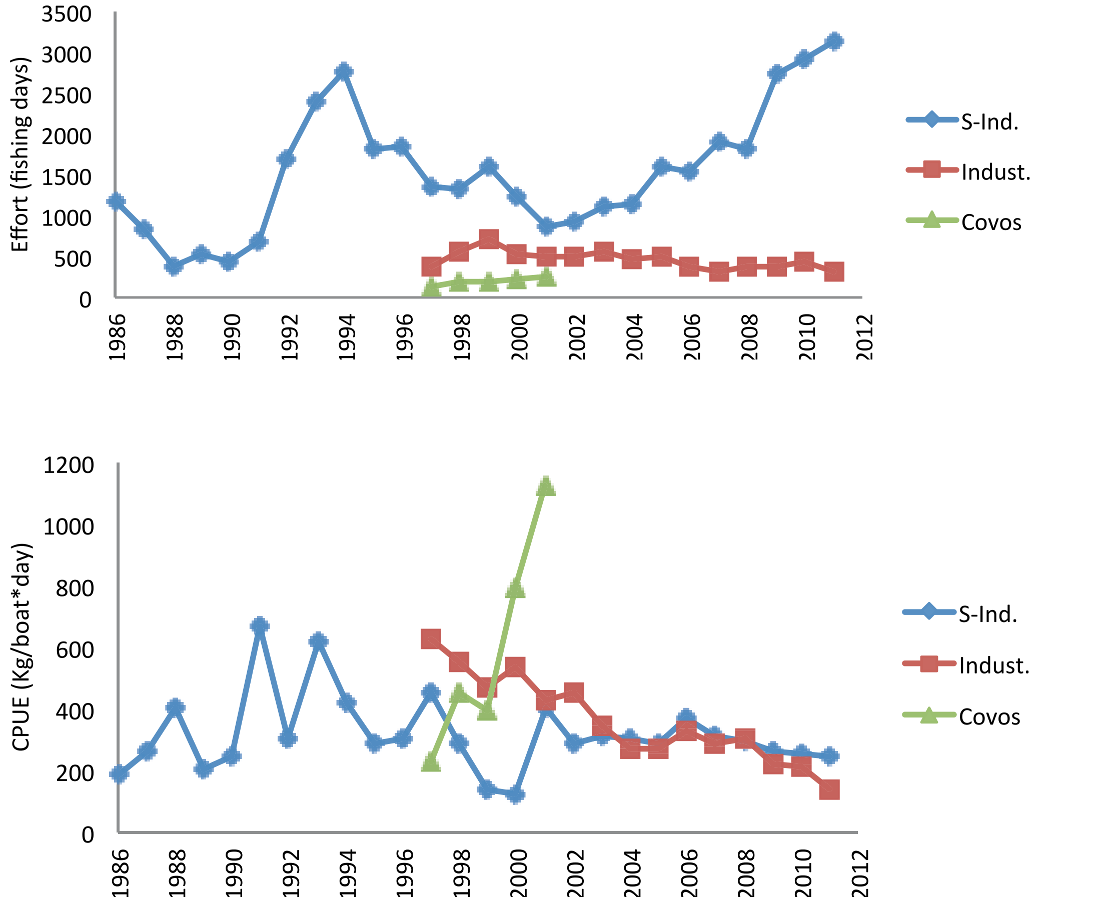
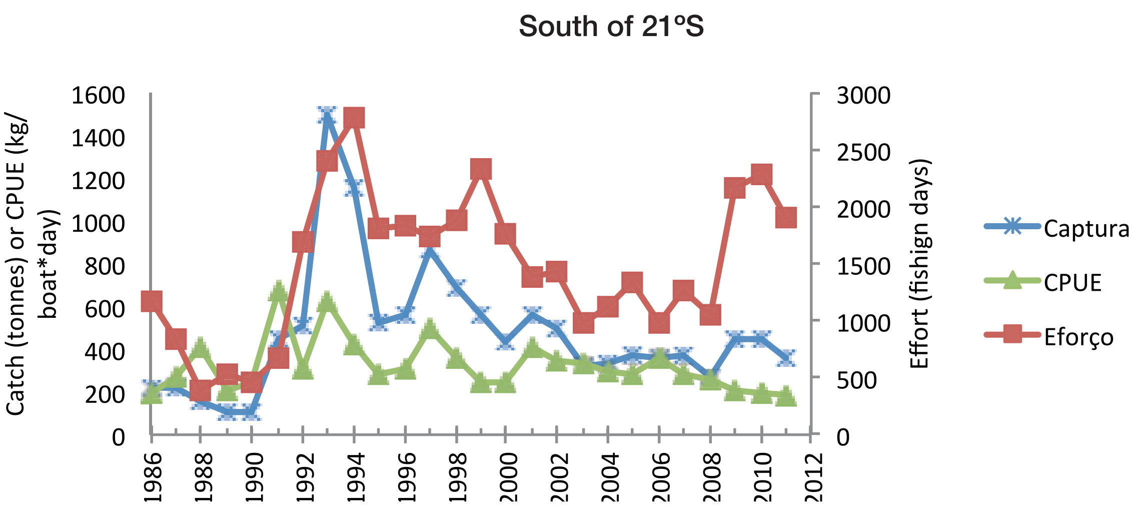


Figure 6. Variation of the annual catches (tonnes), effort (fishing days) and cpue (kg/boat.days) for semi-industrial and industrial linefishery and experimental industrial trap fishery (covos).



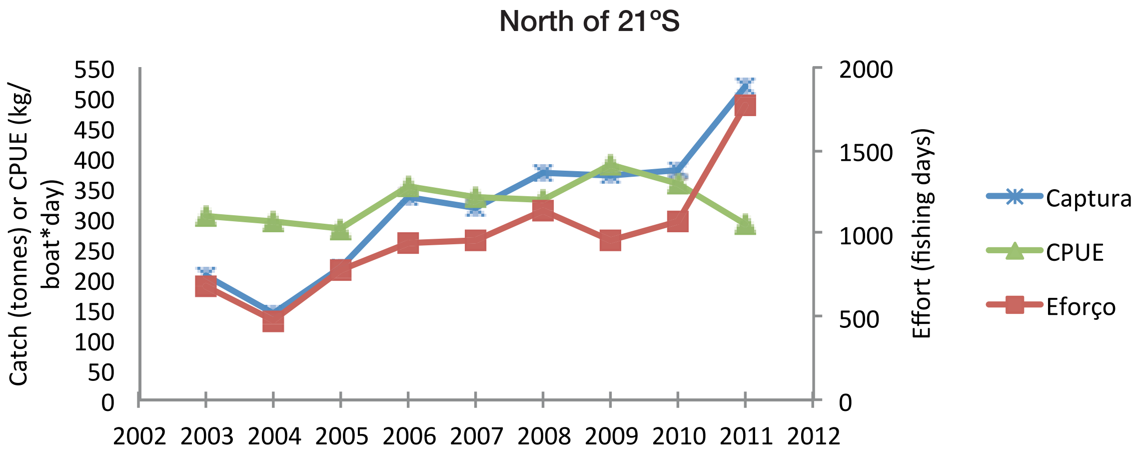


Figure 7. Catch (tonnes), effort (fishing days) and cpue (kg/boat days) for the semi-industrial fleet in management areas south of 21°S and north 21°S.

Recreational sector

Levels of recreational fishing were relatively low during the colonial era but increased greatly in recent decades as a result of increased tourism in the country. Most practitioners are foreigners, except in Maputo city where most practitioners are nationals (IIP, 2011). The peak of catches and effort (except in Maputo city) correspond to the holiday periods, especially in April and December (IIP, 2011). Currently, the activity extends up along the coast but is still concentrated in the southern region, especially from Ponta do Ouro to all of the Inhambane Province's coast. Although permits are required this fishery is essentially open access and continues to expand. Historically effort focussed on gamefish and it is believed that the trend in catches will increase as a consequence of the continued expansion of tourism.

Artisanal linefishing

For the artisanal sector the catch and effort data has been intensely monitored by IIP since 1997 by means of observers at landing sites. This was designated as the National system of statistics for the artisanal sector. The level of coverage of the system of monitoring of artisanal fishery is growing gradually and covers all coastal provinces.

The information on total catches and effort of the artisanal marine line fishery are displayed in Figure 8. The same information was split into two regions in Figure 9: the Southern region which includes the Provinces of Maputo and Inhambane and the Northern region including Sofala, Zambézia, Nampula and Cabo Delgado Provinces.

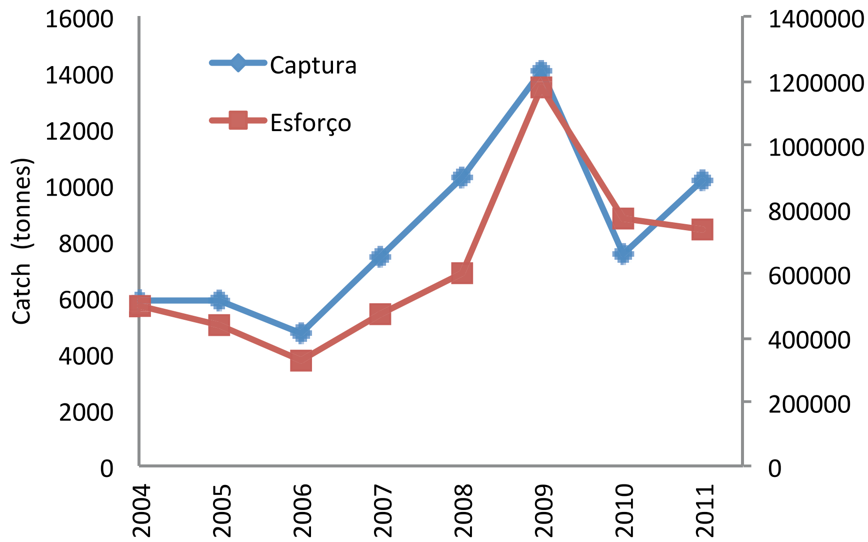
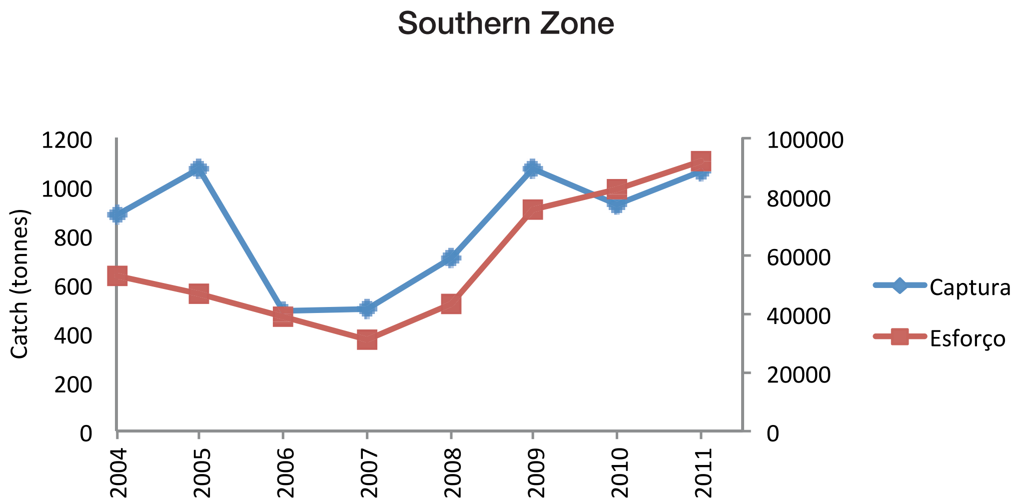


Figure 8. Variation of the annual catches (tonnes) and effort (number of active boats) of the artisanal linefish fleet operating in the Mozambican coastal zone.



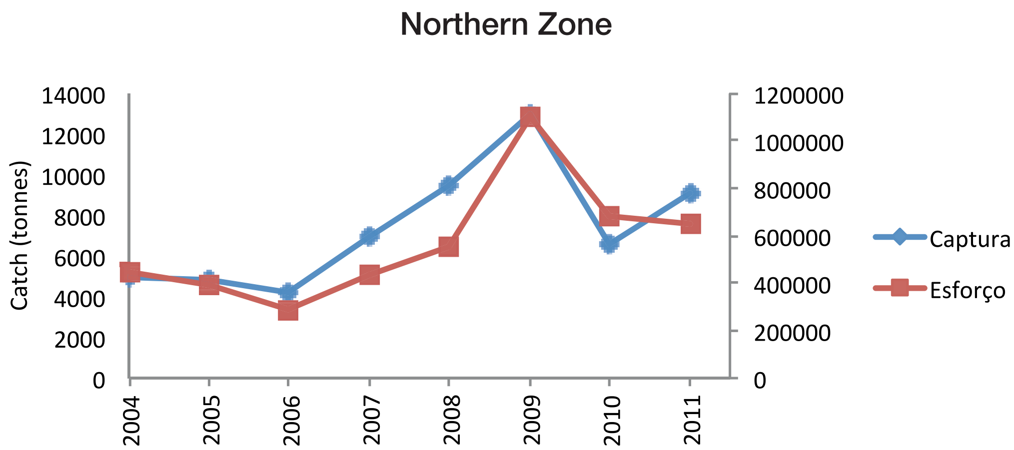


Figure 9. Variation of the annual catches (tonnes), effort (number of active boats) and cpue (kg/boat.days) of the artisanal linefish fleet operating in Southern (Maputo e Inhambane) and Northern (Sofala, Zambézia, Nampula e Cabo Delgado) regions of Mozambique.

5. Importance of the fishery in the national economy

The linefishery contributes to the economic and social development of the country. The contribution or importance of each sector was presented in section 2. However, all sectors contribute to the supply of seafood to one or other segment of the population, thereby increasing the overall per capita consumption of fish protein and promoting equity in access to food security.

5.1. Value of the catches

The average market price of the principal linefish species sold fresh in the main artisanal fishing centres varies according to the region (Table 8).

Table 8. Average market prices of the principal linefish species by regions (1USD = 28 Mozambican Metical (MZN)).

Species	Price per Kg (MZN)			
	North	Central	South	Average price
Marreco ***(Chrysoblephus puniceus)***	—	—	140	140
Robalo ***(Cheimerius nufar)***	—	—	140	140
Cachucho (Polysteganus coeruleopunctatus)	—	—	140	140
Garoupa de bordo branco ***(Epinephelus albomarginatus)***	37	127	217	127
Ladrãorelâmpago ***(Letrinus nebulosus)***	80		95	87
Ladrãomasena ***(Lethrinus mahsena and Lethrinus sanguineus)***	—	—	—	—
Pargo de manchas ***(Lutjanus bohar)***	57		60	58
Pargodentução ***(Pristipomoides typus)***	—	—	—	—
Pargorosa ***(Pristipomoides filamentosus)***	—	—	—	—

Species	Price per Kg (MZN)			
	North	Central	South	Average price
Pargo de cauda comprida ***(Etelis coruscans)***	—	—	—	—
Corvina real ***(Argyrosomus japonicus)***	—	75	187	131
Corvinadentuça ***(Otolithes ruber)***	—	75	187	131
Peixepedra (Pomadasys kaakan)	105	80	238	141
Gonguri or peixe pedra ***(Pomadasys maculatum)***	105	80	238	141
Bagre ***(Arius dussumieri)***	—	31	63	47
Serra ***(Scomberomorus comerson)***	98		176	137
Xeréunarigudo ***(Carangoides chrysophrys)***	45	50	50	48
Albacora ***(Thunnus albacares)***	—	—	—	—
Merma ***(Euthynnus affinis)***	—	—	—	—

5.2. Products and markets

There is little value added to linefish products in Mozambique, except in relation to icing and occasional drying and smoking. The availability of ice or deep freeze facilities is modestly developed and enhances the operator's financial return from the linefish resource: in particular it assists in moving fish from higher catch areas in the north to higher value markets in the south. Smoking and drying of the catch is often confined to beach seine catches but may include linefish. This is especially true for remote rural areas lacking ice facilities.

Local markets are normally the first point of sale of linefish, often associated with some fishing infrastructures such as boat landing facilities. Such public fish markets are mainly concentrated in the urban areas next to people of the city. The semi-industrial linefish catch is often sold to hotels, restaurants and other tourist and visitor establishments. These sales may be direct or in the larger fish markets such as in Maputo. Part of the semi-industrial linefish is exported to South Africa while the products of the industrial linefishery are exported by air cargo to the Europe market – mainly Portugal.

6. Fisheries management plan and objectives

While there is presently no legislated plan specific to the linefishery, the broad vision and objectives as enshrined in the Fishery Master Plan (PDP 2012-2019) are applicable, including socio-economic and development objectives, as summarized below:

- Ensure improvement of food security and nutrition derived from fish for the population;
- Improvement of living conditions of artisanal fishing communities;
- Increased production of fisheries to assist the achievement of national economic and social development;
- Increase the net contribution of the fisheries sector to the balance of payments of the country;
- Ensure the sustainability of exploitation of resources and the preservation of the biodiversity of aquatic ecosystems.

7. Legal framework

The mother instrument that governs all fishing activities in Mozambique is the Fisheries Act (Law 3/90 of September 26), which is currently under review, and its respective regulations. Taking into account that we are assuming linefishery as a marine fishery, the main guiding document for thisis the General Regulations of the Sea Fisheries (REPMAR) 43/2003 approved by Decree of 10 December. Another guiding document is the Regulation of Recreational and Sport Fishing, 51 Decree 99 of August 31, which is also under review.

7.1. Regional and International Agreements and Obligations

Analysis of the various international and regional instruments (agreements, MoUs, etc.) about fisheries suggests that a significant proportion can be considered important reference in the perspective of the management of linefish fisheries as they provide a set of rules or principles with implications for how best this and other fisheries should be managed. Mozambique is signatory to a range of these international agreements, many of which are already adequately accommodated in Mozambique legislation. Below are summarized some instruments that are thought to be important reinforcements for fisheries management in Mozambique.

FAO Code of Conduct for Responsible Fisheries

Also known as "Fish Code", this instrument has the following goals:

- The protection and conservation of living aquatic resources, particularly the target species, species that are associated with these, and species that are caught accidentally (bycatch);
- Minimization and elimination of damage to the marine environment caused by fisheries;
- Research and data collection in order to improve the scientific and technical knowledge about fishing, including its interaction with the ecosystems.

There are ten widely accepted primary objectives:

1. Establish principles for responsible fishing;
2. Establish criteria and principles for the development of national policies for responsible conservation of fisheries resources and the management and development of fisheries;
3. Serve as an instrument model for states to develop their own legal and institutional frameworks related to fishing activity;
4. Provide guidance for the formulation and implementation of international instruments;
5. Promote cooperation related to fisheries;
6. Promote the contribution of fisheries to food security and quality;
7. Promote the protection of living aquatic resources and their habitats;
8. Promote trade in fish products in accordance with the relevant international rules;
9. Promote research on fisheries and associated ecosystems;
10. Provide standards of conduct for all persons involved in fishing.

[1]www.wiofish.org

United Nations Convention on the Law of the Sea

The most important international legal instrument dealing with the sea is the UN Convention on the Law of the Sea 1982 (UNCLOS), generally regarded as a "constitution" for the oceans. UNCLOS provides a broad legal framework for marine environmental cooperation and prescribes a general role for the states to protect and preserve the marine environment (UNCLOS, Article 192).

In the 1995 provision related to the Conservation and Management of fish stocks an agreement on Highly Migratory Fish Stocks was adopted to promote the effective enforcement, conservation and management measures of migratory fish. In particular, the Agreement on Fish Stocks calls on coastal states and states fishing on the high seas to:

- Adopt measures to ensure long term sustainability of highly migratory fish;
- Adopt measures for species belonging to the same ecosystem or associated with or dependent upon the target stocks;
- Protect biodiversity in the marine environment;
- Adopt plans that are necessary to ensure conservation of non-target or related and dependent species and their environment;
- Where stocks occur within the EEZs of two or more coastal states, states should seek to agree on measures necessary to coordinate and ensure the conservation and development of such stocks, with special attention to the highly migratory species.

UNCLOS also calls for strengthening of regional fisheries management organizations such as the South West Indian Ocean Fisheries Commission (SWIOFC). Developing countries deserve special assistance in terms of financing and establishing new, and strengthening of existing organizations or sub regional or regional fisheries management arrangements.

Convention on Biological Diversity (CBD)

This Convention was adopted in 1992, with the goal of providing a framework for the conservation of biological diversity, the sustainable use of its components and fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including through access to these resources. The Convention stipulates that State Parties shall, "as far as possible and as appropriate, establish a system of protected areas or areas where special measures need to be undertaken to conserve biological diversity". Mozambique has signed the Convention and it was subsequently ratified by the Parliament of the Government of Mozambique and published on August 24, 1994 (Bulletin Nr 34/94). It seeks to protect the richness of life, including genes, species and ecosystem. In the case of Mozambique, biodiversity is strategically important as it provides goods and services, including building materials, food, medicinal plants and water that can all alleviate poverty.

Jakarta Mandate on Marine and Coastal Biological Diversity

This Programme of Work (PoW) of the Convention of Biodiversity has its focus on marine and coastal diversity and promotes the implementation of the CBD in the marine environment, specifically to achieve significant reduction of the current rate of marine and coastal biodiversity loss nationally and regionally (initially by 2010). There are a number of relevant elements, namely:

- The promotion and improvement of the implementation of integrated marine and coastal area management;
- The conservation and sustainable use of marine and coastal living resources;
- The establishment and maintenance of marine and coastal protected areas;
- The prevention and minimization of the negative effects of mariculture on marine and coastal biodiversity and the enhancement of the benefits of mariculture based on native species;
- The prevention of the introduction of invasive alien species into the marine and coastal environment and the eradication of those that have already been introduced; and
- The assembly of a database of initiatives on elements of the PoW and the promotion of effective collaboration, cooperation and harmonization of initiatives with relevant conventions, organizations and agencies. Mozambique plays an active role in WIOFish[1], the regional fisheries information system that was initiated under the Jakarta Mandate.

In addressing the need to conserve and sustainably use marine and coastal living resources, the following are highlighted:

- Promoting the sustainable use of marine biodiversity beyond national jurisdiction;
- Ecosystem approaches to management;
- Research and monitoring activities aiming at covering knowledge and information gaps;
- Understanding of the pathways and causes of the introductions of invasive alien species.

FAO International Plans of Action (IPOAs)

International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks)

The IPOA-Sharks is to ensure the conservation and management of sharks and their long-term sustainable use. Under IPOA-Sharks all states involved in the targeted or incidental catch of sharks should develop a national Shark-plan aimed at the conservation and management of shark stocks. As part of this effort, and in order to review the need for and the measures contained in the Shark-plan, states should conduct regular assessments of the status of shark stocks that are subject to fishing. Sharing of the resulting data is of great importance for straddling, transboundary, highly migratory and high-seas shark stocks. Cooperation among states at subregional and regional levels is advocated, with the eventual elaboration of subregional or regional shark plans. IPOA-Sharks is directed at states that catch sharks in coastal waters and states that have vessels fishing for sharks in the high seas. For the purpose of IPOA-Sharks, the term “shark” is used to designate all species of sharks, skates, rays and chimaeras (Class Chondrichtyes).

International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated (IUU) fishing

There is global concern over illegal, uncontrolled and unreported fishing as a major contributor to fisheries declines. Linefishing is no different. While fishers that harvest linefish are legally bound to be licensed and thus be documented in the monitoring programme, there are also known to be operators that fish illegally or that do not record their activities. In some cases these may be foreign fishers that enter Mozambique waters illegally. Such fishing is likely to include high-value species such as tuna and sharks for their fins. This illegal, unrecorded and unreported fishing (IUU-fishing) requires special action. Mozambique has been involved in the development of a plan of action towards IUU fishing and this needs to be accommodated in the LMP. Such a plan is also dependent on effective implementation of monitoring, control and surveillance (MCS) activities.

Plan of Implementation of the WSSD – Sustainable development for Africa

This Plan is a follow on from the principles and the programme of action that emerged from the UNCED held in Rio de Janeiro in 1992.It has overarching objectives that are poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base of economic and social development. The Plan puts emphasis on socio-economic issues such as addressing the challenges posed by conflicts, insufficient investment, limited market access opportunities, unsustainable debt burdens, historically declining levels of official development assistance and the widespread impact of HIV and AIDS. A final priority for the African continent identified in the Plan is the establishment of regional or subregional partnerships among countries, such as the New Partnership for Africa's Development (NEPAD). Specific to coastal and marine environments, the Plan contains a number of provisions including the implementation of regional and international instruments – such as the UNCLOS Convention; the CBD; the promotion of sound fisheries practices; the development of integrated coastal and ocean management practices; and the advancement of scientific knowledge about marine and coastal ecosystems. States are explicitly encouraged to establish MPAs as means of ensuring the conservation of marine and coastal resources, including the establishment of representative networks by 2012. The UN Commission for Sustainable Development oversees the plan's implementation and revision.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Mozambique has ratified CITES, thereby ensuring that international trade in specimens of wild animals and plants do not threaten their survival. One aspect of CITES is to monitor and manage wild populations of endangered species. Transboundary areas should contain enforcement mechanisms to combat the cross-border trade in and around the cross-jurisdictional area. CITES has wide global acceptance and respect and is thus a potentially valuable tool for the conservation of protected species, including linefish species that are listed in the appendices of CITES, such as the sawfishes and other shark species.

Meanwhile, Mozambique ratified the Conservation of Nature and Natural Resources (IUCN) through Resolution 18/81 of 30 December in Annex 1. By ratifying the Convention, the country committed to take the necessary measures to ensure the conservation, use and development of soil, water, flora and fauna resources based on scientific principles taking into account the best interests of the people.

8. Institutional and administrative frameworks for fisheries management

The Presidential Decree 6/2000 of April 4 defines the objectives, functions and competences of the Ministry of Fisheries of Mozambique (MoF). The Ministry has the responsibility for ensuring proper management of fishery resources in the country and to define operational measures that affect the harvesting of marine fauna in order to increase its contribution to the development of the country. The Resolution 38/2010 of 22 December approves the statute of the Ministry of Fisheries. Several Articles of this Resolution addresses the role of the key bodies within the Ministry.

Article 9

National Directorate of Fishery Economics and Policy (DNEPP), which includes (i) coordinating the preparation and analysis of proposed policies, strategies and development plans for fisheries, (ii) provision of analysis of technical proposals for fisheries management plans, aquaculture activities, international instruments on fisheries and aquaculture, (iii) coordination of credit policies and incentives, and (iv) studies of macro-economic strategies including bio-economic and socio-economic models.

Article 10

The National Directorate for Fisheries Inspection (DNF) which ensures (i) the surveillance of fishing activities in the territorial waters of Mozambique, (ii) the inspection of fishing boats that require national ports, (iii) that Mozambican fishing boats licensed for the offshore and/or the waters of third countries follow existing laws, and (iv) guides and monitors the operation of the fishing community councils in relation to surveillance of fishing.

The Ministry has a number of autonomous fishery-related institutions, namely

- National Administration of Fisheries (ADNAP)
- National Institute for Fisheries Research (IIP)
- National Institute for the Development of Small Scale Fisheries (IDPPE)
- National Institute of Inspection of Fish (INIP)
- National Institute of Aquaculture Development (INAQUA).

The National Fisheries Administration (ADNAP) is an autonomous institution in accordance with Decree 4/2010 of 08th March. The Resolution 36/2010 of 22 December approves the statutes of the National Board of Fisheries. In accordance with Article 3:ADNAP sees to (i) the implementation of policies, strategies and management plans for fisheries, (ii) monitors the status of fisheries and their environmental impacts, (iii) adopt and implement management measures necessary for sustainable fisheries, (iv) ensures the functioning of fisheries management systems, and (v) promotes responsible fishing.

Decree 18/2005 of 24th June establishes the **National Institute of Inspection of Fish (INIP)** and approves its statute. Article 2 addresses the duties of INIP as being (i) the licensing of infrastructure for processing and storage of fishery products on fishing boats (ii) transport of subproducts and fish products, (iii) certification of fish products for export as well as products imported, and (iv) conducting laboratory analysis to establish the quality of fish products.

Decree 63/98 24th November established the **National Institute for Fisheries Research (IIP)**. Article 3 deals with the duties of the IIP which are defined as (i) conducting research on fisheries resources for their management, conservation and optimum exploitation, (ii) additional environmental studies for investigation of fishing resources, including oceanography and limnology (iii) testing of cultivation techniques for the commercial production of aquatic species, and (iv) dissemination of scientific information relevant to the fisheries sector.

Decree 62/98 of 24th November established the **National Institute for the Development of Small Scale Fisheries (IDPPE)**. Article 3, addresses the duties of IDPPE as to: (i) carry out studies for the establishment of policies, strategies, plans and programmes for the development of small-scale fisheries, (ii) conduct socio-economic and fish technology related to small-scale fisheries, (iii) promote and coordinate actions and projects of cooperation for the development small-scale fisheries, and (iv) to assist and implement capacity building of small-scale fishermen.

There are two other autonomous institutions of the Ministry of Fisheries namely:

- **The Fund for Fisheries Promotion and Development (FFP),** which is a financial institution with the task of managing funds for public investment, and provision of credit for fisheries development.

- **The School of Fisheries (EP)**, which provides training for primary and secondary levels in different fields of fisheries expertise.

Apart from government institutions, community and consultation forums have been created.

The Ministerial Diploma 49/2007 of 24th May approves the regulation-type for the functioning of the of **Fisheries Comanagement committees (GCC**). Article 1 defines the GCC as a consultative forum of local authority for Administration of the Fisheries. Article 2 provides that the powers of the GCC include setting closures periods, determination of appropriate fishing gear, protection of vulnerable species and the coastal and marine environment, fisheries legislation proposals, plans and development projects, exploratory and experimental fishing, fishing licenses and their fees, conflicts of fishing, fisheries monitoring, marketing of fish products, inspection of fishing and aquaculture. Article 3 states that the composition of GCC includes local authorities and representatives of fisheries management to advise the fishing community, operators of industrial fishing, fisheries research, fishing extension, fishing inspectorate, maritime authorities and traders in fishery products.

The Ministerial Diploma 47/2002 of 10th March approves the resolution of the operation of the **Fisheries Administration Commission (CAP).** According to Article 3, the CAP is composed of the National Fisheries Administration, National Fisheries Research Institute, National Institute for the Development of Small Scale Fisheries, National Directorate of Fishery Economics and Policy, Department of International Cooperation, Institute for Fisheries Inspectorate, Association of Industrial fisherman, Association of Semi-industrial fisherman and Association of artisanal fishermen. The CAP is a consultative forum of the Ministry of Fisheries for the management of fisheries and conservation of marine resources.

Number 1 of Article 19 of Decree 43/2003, of 10 December, endorsing the General Regulations of Maritime Fisheries, instructs the Fisheries Minister to authorize local associations called **Fishing Community Councils (CCP's)**, to develop their fisheries under instruction and authority of Provincial Fisheries Administrations.The CCP's comprise organized groups or individuals who are residents in the community where the CCP is located.

In addition to the administrative structures, the Ministry of Fisheries in Mozambique is structured at three levels or subsystems:

1. **The Political Subsystem** formed by the Ministry of Fisheries and its Provincial Delegations whose primary function is to set policy and industry priorities, coordinate and monitor the activities under their responsibility, thus ensuring the achievement of sectoral objectives set out in guiding national and sectoral instruments.

2. **The Subsystem of Fisheries Management** comprises the functions of research, administration and supervision. Briefly, each of these functions pursues its own objectives while competing for common purposes and goals:

- ✓ The fisheries research, taking into account the goals set for the fisheries, is concerned with assessing the state of exploitation of fisheries resources, making sure to maintain the levels of sustainability as well as the economic situation of the fisheries. The level of aquaculture should be developed through actions that determine the environmental impact of aquaculture ventures in order to take mitigating management measures, as well as to determine the species that indicate rapid growth;

- ✓ The fisheries administration defines the rules for access by operators to fish resources in the different fisheries that operate in the EEZ; and

- ✓ The inspectorate ensures that the fishing activities carried out by operators are performed in compliance with the access rules and established practices in the fisheries legislation. In terms of aquaculture, it is necessary to control the introduction of new species, which are poorly managed and could colonize water bodies, resulting in the disappearance of native species or the introduction of diseases. Inspection of the catch quality is a part of the supervisory work of the Fisheries Administration, focussed on the sanitary facilities of fisheries processing, fishing vessels and fishery products for export.

3. **Subsystem of Promotion and Development of the Fisheries Sector is charged with the responsibility to prom**ote the development of fisheries and is constituted by the IDPPE, INAQUA, the FFP and EP. Fisheries extension services are mainly oriented towards artisanal and small-scale aquaculture and also covers inland waters.

   The extension services geared towards small-scale aquaculture should developed mechanisms for coordination between the sector and Ministry of Agriculture (MINAG), in order to maximize the synergies of the network extension. The credit sector has as its function to define a credit strategy, which would harmonize the different forms of intervention in support of fishing communities, with special attention to be given to subsectors of Artisanal and Semi-industrial fisheries.

Additional institutions of relevance to linefish management

In addition to the institutions of the fisheries ministry, there are other ministries with an interest and role in the marine sphere and thus interact with the fisheries sector:

Ministry for Environmental Coordination (MICOA). The competence of this Ministry is to promote better coordination of all environmental sectors for proper planning and better use of natural resources of the country in a responsible way. This includes protection and management of the coastal zone.

Ministry of Tourism (MITUR). The competence of this Ministry is to guide the management of the national wildlife resources heritage in conservation areas such as national parks and reserves, the hunting areas, development of projects and exploration of ecotourism and community programmes for conservation and exploitation of forest and wildlife resources.

The Ministry of Trade, has among other responsibilities that of control over export of fish and fish products. **The Ministry of Transports** includes **the Maritime Administration** which is responsible for general supervision of shore and sea. **The Law of Forestry and Wildlife** establishes the principles and basic rules on the protection, conservation and sustainable use of forest and wildlife resources within an integrated management approach for the economic and social development of the country**. The Mozambican Navy** plays a role in the compliance of fishing regulations.

8.1. National and regional forums for discussions on fisheries management

National Forums

The Committee on Fisheries Administration (CAP)

The CAP is an advisory body to the Ministry of Fisheries advising on matters of interest and scope of the conservation of fisheries resources and fisheries management including:

- Total Allowable Catch (TAC);
- Fishing quotas;
- Maximum number of vessels to be licensed by fishery;
- Periods of closures;
- Areas with restrictions on fishing activity;
- Procedures for preparing and reviewing fisheries development plans;
- Other measures of fisheries management or conservation of the aquatic environment.

Fisheries Management Council (CGP)

The CGP is an advisory body of ADNAP, facilitating coordination between the various entities of the subsystem components of fisheries management. The Fisheries Management Council is coordinated by ADNAP and integrates representatives of some institutions of the sector particularly IIP, INIP, DNFP, IDPPE and Fishing Ports.

The operation of the Fisheries Management Council is set out in its rules of procedure approved by the Minister who oversees the area of fisheries.

Comanagement committees

At the local level, and in order to make the management process more inclusive and participatory, the management system provides for the establishment of boards of management participation, best known as Committees for Community Fishing (CCP's) (acting at the level of fishing communities) and comanagement committees (that encapsulate various sensitivities and act at the level of the district and province). These forums act as advisory bodies to the local fisheries management authority. These answer to matters of interest and the rational use of fishery resources, including aspects of conservation and marine and coastal biodiversity.

Regional Forums

The regional bodies of management of the fisheries congregate the coastal countries and the interested parts on the resource exploitation and management. The main regional bodies are the Southwest Indian Ocean Fisheries Commission (SWIOFC), the Indian Ocean Tuna Commission (IOTC) and the Southern African Development Community (SADC). All these bodies are represented in the FAO.

9. Management measures and tools currently in use and status of implementation

As Mozambique fisheries developed over time and as catch rates came under threat through high demand, so the Mozambique authorities have introduced management measures. This includes management measures for linefish fisheries, albeit on an *ad hoc* basis and not as part of an overall defined plan. Some of the linefish management measures include:

- Defining different linefishing sectors;
- Specifying certain daily bag limits for recreational fishers;
- Defining different management zones;
- Limiting the number of semi-industrial vessels operating in some zones: 25 for southern region;
- A quota system for the industrial fleet;
- Allocation of new linefishery entrants only to the north of 21° S region.

Other management measures by sectors are listed in Table 9. Despite the social and economic importance of the marine line fishery, the large number of its users and the diversity of its operations, these few management measures that are in place are not adequate to protect its future sustained viability.

Table 9. Existing rules and regulations to manage linefisheries in Mozambique.

Regulations	Sector	Current linefish regulations
Recreational and sport fishing regulation	Recreational and sport fishing	• Maximum number fish per fisher-day = 10 • Daily limit of Marreco (Chrysoblephus puniceus), Robalo (Cheimerius nufar), Cachucho (Polysteganus coeruleopunctatus) and all species of Serranidae family (Garoupa) is four of each per fisher-day. • Species fully protected: Brindle bass, Potato bass and Great white shark. • Maximum number of hooks used in surface fishing is three • All regulations apply to national and foreign fishers • A schedule of fines for certain transgressions exists • A schedule of license fees exists, variable according to type of fishing and different for foreigners compared to nationals. • Trophy fish (e.g. billfish) command a higher license fee • Fishing tournaments require authorization • Recreational and game fishers may not sell their catch • A cast net may be used but for personal live-bait purposes only • All catches must be available for research if asked by officials • Fishers may be asked to submit catch returns • Demersal fish capture is forbidden during fishing tournaments

Regulations	Sector	Current linefish regulations
REPMAR	Artisanal	• A schedule of license fees exists • Fishers may be asked to submit catch returns • In the Sofala Bank area the inshore 3 nm are reserved exclusively for artisanal fisheries.
REPMAR	Semi-Industrial	• Only accessible with a license • Number of semi-industrial boats in southern region (21°S) limited to 25 • May be required to provide access to catches for study • Must submit catch returns to DNAP • Must submit daily catch record to IIP
REPMAR	Industrial	• Only accessible with a license • May be required to provide access to catches for study • Limited by annual catch quota • Must submit catch returns to DNAP • Must submit daily catch records to IIP
Recreational and sport fishing regulation	Spear-fishing	• Similar rules as for hook and line anglers • No explosives and no scuba • No nocturnal spearfishing

Effectiveness[2] of the current management measures

While the management measures introduced to direct fishing effort to certain zones may have arrested the decline in cpue, it seems to have been inadequate to reverse that trend. In general, the pressure exerted on the linefish resources continues to be raised. There is precedence of the decrease in cpue being the most serious in the region south of parallel 21° S. Although the effort here is regulated in term of number of boats licensed, this has resulted in the number of fishing days increasing rapidly with a consequent higher level of fishing effort.

The measures to regulate recreational fishing activities have failed in some cases. There are conflicts between the commercial and recreational fishermen in relation to the use of fishing areas, which is associated with the decline of demersal fish stocks. Commercial fishermen claim that the low yields obtained are related to the enormous pressure being exerted by the recreational sector on the stocks and that they did not respect the rules that regulate their activity. They claim there is a lack of monitoring (control) by the authorities on recreational fishermen and the level of compliance by them is very weak.

[2]"Effectiveness" was analysed in terms of better status of the stocks (increasing cpue), decreasing conflicts, increasing value, level of compliance, etc. It is important to note that in the State of World Fisheries and Aquaculture (SOFIA) FAO defines fisheries governance as "the sum of the legal, social, economic and political arrangements used to manage fisheries".

The annual quota for the industrial linefish sector is never attained, probably attributable to lower resource levels set against on over-optimistic target. The fishermen claim that their incomes are too low to cover the operational cost of these larger vessels.

All fishing activity is subject to annual licensing but the level of compliance is variable. It is considered to be close to 100 percent for the semi- and industrial sectors but estimated to be less than 50 percent for the artisanal sector. The level of licensing of the recreational sector has not been assessed but it is recognized as deficient. Nevertheless, the trend in licensing has increased substantially in recent years, suggesting higher levels of compliance.

The level of reporting of catch information is satisfactory in the industrial and semi-industrial sector. The semi-industrial and industrial vessels are required to report their total catch (all species combined) and effort (fishing days) to ADNAP every 10 days. The IIP also collects catch/effort data, species composition and other biological data by means of observers at ports and at sea. However, the level of coverage of this by IIP in the northern region is very weak: below 20 percent. In the south there are satisfactory levels of coverage at ports. At sea, the level of coverage by observer is one trip per month on board of one semi-industrial linefish vessel.

For the artisanal sector the catch and effort, the catch composition and biological data has been intensely monitored by IIP since 1997 by means of observers at landing sites. The level of coverage of the system of monitoring of artisanal fishery is growing gradually and covers all coastal provinces.

The level of surveillance is not satisfactory. However, in recent years there have been advances in this field. In 2011, the National Directorate for Fisheries Inspection (DNF) was created with responsibly to ensure the surveillance of fishing activities in the territorial waters of Mozambique. DNF recently acquired a vessel for surveillance. Simultaneously, improved visualization of industrial and semi-industrial vessel operations is being planned through the vessel monitoring system (VMS).

10. Other comments relevant to current management of the fishery and the way forward for the introduction of EAF

The exercise that intends to introduce a component of the ecosystem approach in the management of the linefish fishery will require the involvement of all stakeholders, groups of users and management groups at all stages of the process of preparing the management plan for linefisheries in Mozambique.

Based on the information of this report for Mozambique linefisheries, it can be seen that this is an extremely complex fishery given the wide range of species exploited, the great diversity of habitats impacted, the great diversity of practitioners involved including various interests of the practitioners and other groups involved in conservation and management.

It is expected that this exercise will result in a management plan that is functional and gives a comprehensive framework for the different topics outlined in this document. Others that were not addressed but that are relevant will also be incorporated in the plan. Without prejudice to the functionality of the general plan, there will need to be specific management actions tailored according to the characteristics of the areas, the type of resources and stakeholders in the linefisheries. Only such an approach will provide the most appropriate and practical management steps taking into account the ecosystem approach to fisheries.

References

Fennessy, S. T.; Mutombene, R.; Simango, A.; Cuco, C. & van der Elst, R.P. 2012. *Relatório Interno de Investigação Pesqueira nº14* – Mozambique linefish assessment 2011. IIP, Maputo. 17 pp.

Fischer, W.; Sousa, I.; Silva, C.; Freitas, A.; Poutier, J.M.; Schneider, W.; Borges, T.C.; Feral J.P. & Massinga, A. 1990. *Guia de campo para identificação das espécies comerciais marinhas e de Águas Salobras de Moçambique. Roma*. 424 pp.

Froese, R. & Pauly, D., eds. 2013. FishBase. World Wide Web electronic publication. Available at: www.fishbase.org

Gouws, G. 2012. Genetic stock assessment of the blue emperor (*Lethrinus nebulosus*) in the South West Indian Ocean. SWIOFP report. Grahamstown, South Africa. South African Institute for Aquatic Biodiversity. 53 pp.

IDPPE, 2009. *Recenseamento da pesca artesanal 2007. Principais resultados.* Maputo, IDPPE. 83 pp.

IIP. 2011. *Boletim de divulgacao nº47 – relatorio do censo da pesca recreativa e desportiva no Sul de Mocambique (Maputo Cidade, Maputo Provincia, Gaza e Inhambane) Realizadoem 2007*. Maputo. 23 pp.

Lichucha, I.D. 2001. Management of the linefish resource in southern Mozambique: a case study for marreco (*Chrysoblephus puniceus*). University of Natal, South Africa (M.Sc. thesis). 99 pp.

Mann, B.Q. 2000. Southern African marine linefish status reports. Oceanographic Research Institute Special Publication No 7. Durban, South Africa. Oceanographic Research Institute. 252 pp.

Smith, M.M. & Heemstra, P.C. 1986. *Smiths' sea fishes*. Johannesburg, South Africa. Macmillan South Africa. 1047 pp.

Torres, R.G. & Jakobsen, T. 2007. Assessment of Mozambican linefishes. Maputo, *Instituto Nacional de Investigação Pesqueira.* 24 pp.

Torres, R.G. 2008. Biology and stock assessment of robalo, *Cheimerius nufar* (Valenciennes, 1830) in southern Mozambique. *Universidade A Politecnica*, Maputo (M.Sc. thesis). 64 pp.

Torres, R.G.; van der Elst, R.P.; Lichucha I.D. & Cuco, C.A. 2011. *Relatório interno de Investigação Pesqueira nº1* – the industrial trap fishery of southern Mozambique: results of experimental phase 1997–1999. Maputo, IIP. 26 pp.

Van der Elst, R.P. 1988. *A guide to the common sea fishes of southern Africa*. Cape Town, South Africa. Struik. 398 pp.

Van der Elst, R.P.; Lichucha, I.D.; Torres, R.G. & Fennessy, S.T. 2003. Linefish resource: annual report for the year 2000. *Boletim de Divulgação n. 38*. Maputo, *Instituto Nacional de Investigação Pesqueira*. 56pp.

Appendix I. Fish species known to be captured by hook and line in Mozambique waters (marked Line), including those considered of particular importance to the linefishery (marked N.B.). Species listed by IUCN Red List and CITES are given. Information partly derived from Fischer et al 1990, Smith & Heemstra 1986 and the ORI fish tagging project (Bullen & Mann, 2006), CITES and IUCN websites.

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
FAO	*Caesio varilineata*	Caesionidae	Lemon fusilier	1				Fuzileiro limão
210.001	*Alectis ciliaris*	Carangidae	Threadfin mirrorfish	1	1			Xaréu africano
210.002	*Alectis indicus*	Carangidae	Indian mirrorfish	1	1			Xaréu cabeçudo
210.003	*Alepes djedaba*	Carangidae	Shrimp scad	1				Xaréu camaroneiro
210.004	*Atule mate*	Carangidae	Yellowtail scad	1				Xaréu cauda amarela
210.005	*Carangoides armatus*	Carangidae	Longfin kingfish	1	1			Xaréu armado
210.006	*Carangoides caeruleopinnatus*	Carangidae	Coastal kingfish	1	1			Xaréu costeiro
210.007	*Carangoides chrysophrys*	Carangidae	Longnose kingfish	1	1			Xaréu narigudo
210.008	*Carangoides dinema*	Carangidae	Shadow kingfish	1				Xaréu crepúsculo
210.01	*Carangoides ferdau*	Carangidae	Blue kingfish	1	1			Xaréu azul
210.011	*Carangoides fulvoguttatus*	Carangidae	Yellowspotted kingfish	1	1			Xaréu cintilante
210.012	*Carangoides gymnostethus*	Carangidae	Bludger	1	1			Xaréu oliva
210.013	*Carangoides hedlandensis*	Carangidae	Bumpnose kingfish	1				Xaréu boxe
210.014	*Carangoides malabaricus*	Carangidae	Malabar kingfish	1				Xaréu malabárico
210.015	*Carangoides oblongus*	Carangidae	Coachwhip kingfish	1				Xaréu oblongo
210.016	*Carangoides plagiotaenia*	Carangidae	Barcheek kingfish	1				Xaréu maquilhado
210.017	*Caranx ignobilis*	Carangidae	Giant kingfish	1	1			Xaréu gigante
210.018	*Caranx lugubris*	Carangidae	Black kingfish	1	1			Xaréu preto
210.019	*Caranx melampygus*	Carangidae	Bluefin kingfish	1	1			Xaréu barbatana azul
210.02	*Caranx papuensis*	Carangidae	Brassy kingfish	1	1			Xaréu bronzeado
210.021	*Caranx sem*	Carangidae	Blacktip kingfish	1				Xaréu cocoli
210.022	*Caranx sexfasciatus*	Carangidae	Bigeye kingfish	1	1			Xaréu voraz
210.023	*Caranx tille*	Carangidae	Tille kingfish	1	1			Xaréu til
210.031	*Elagatis bipinnulata*	Carangidae	Rainbow runner	1	1			Salmão
210.032	*Gnathanodon speciosus*	Carangidae	Golden kingfish	1	1			Xaréu dourado
210.033	*Lichia amia*	Carangidae	Garrick	1	1			Xaréu palmeta
210.034	*Megalaspis cordyla*	Carangidae	Torpedo scad	1				Carapau torpedo
210.038	*Scomberoides commersonnianus*	Carangidae	Talang queenfish	1	1			Machope saltador
210.039	*Scomberoides lysan*	Carangidae	Doublespotted queenfish	1	1			Machope de areia
210.04	*Scomberoides tol*	Carangidae	Needlescaled queenfish	1	1			Machope comum
210.041	*Selar crumenophthalmus*	Carangidae	Bigeye scad	1				Carapau preto
210.043	*Seriola dumerili*	Carangidae	Greater yellowtail	1	1			Xaréu coronado
210.044	*Seriola lalandi*	Carangidae	Giant yellowtail	1	1			Xaréu rabo amareio
210.045	*Seriola rivoliana*	Carangidae	Longfin yellowtail	1	1			Xaréu rivoliana
210.046	*Seriolina nigrofasciata*	Carangidae	Dusky yellowtail	1	1			Xaréu nigrofasciata

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
210.047	*Trachinotus africanus*	Carangidae	Southern pompano	1	1			Pâmpano africano
210.048	*Trachinotus baillonii*	Carangidae	Smallspotted pompano	1	1			Pâmpano abotoado
210.049	*Trachinotus blochii*	Carangidae	Snubnose pompano	1	1			Pâmpano lunar
210.05	*Trachinotus botla*	Carangidae	Largespotted pompano	1	1			Pâmpano manchado
210.051	*Trachurus delagoa*	Carangidae	African maasbanker	1				Carapau africano
210.052	*Trachurus trachurus*	Carangidae	Maasbanker	1				Carapau do Atlântico
210.053	*Ulua mentalis*	Carangidae	Heavyjawed kingfish	1				Carapau peneiro
210.054	*Uraspis secunda*	Carangidae	Cottonmouth kingfish	1				Xaréu algodão
9.004	*Carcharhinus amboinensis*	Carcharhinidae	Java shark	1	1	DD		Marracho baleta
9.006	*Carcharhinus brevipinna*	Carcharhinidae	Spinner shark	1	1	LR		Marracho barbatana negra
9.007	*Carcharhinus falciformis*	Carcharhinidae	Silky shark	1	1	LR		Marracho sedoso
9.009	*Carcharhinus leucas*	Carcharhinidae	Bull shark	1	1	LR		Marracho touro
9.010	*Carcharhinus limbatus*	Carcharhinidae	Blacktip shark	1	1	LR		Marracho macuira
9.011	*Carcharhinus longimanus*	Carcharhinidae	Oceanic whitetip shark	1		VU	App II	Marracho oceánico
9.013	*Carcharhinus melanopterus*	Carcharhinidae	Blackfin reef shark	1	1	LR		Marracho tinteiro de coral
9.014	*Carcharhinus obscurus*	Carcharhinidae	Dusky shark	1	1	LR		Marracho areneiro
9.015	*Carcharhinus plumbeus*	Carcharhinidae	Sandbar shark	1	1	LR		Marracho de Milberto
9.016	*Carcharhinus sealei*	Carcharhinidae	Blackspot shark	1	1	NT		Marracho marcado
9.017	*Carcharhinus sorrah*	Carcharhinidae	Spot-tail shark	1	1			Marracho rabo manchado
9.018	*Carcharhinus wheeleri*	Carcharhinidae	Shortnose blacktail shark	1	1			Marracho enlutado
9.019	*Galeocerdo cuvier*	Carcharhinidae	Tiger shark	1	1	LR		Marracho tigre
9.029	*Negaprion acutidens*	Carcharhinidae	Lemon shark	1	1	VU		Limão foiçador
9.033	*Rhizoprionodon acutus*	Carcharhinidae	Milkshark	1	1	LC		Marracho branco
FAO	*Scoliodon laticaudus*	Carcharhinidae	Spadenose Shark	1				Marracho espadarte
9.035	*Triaenodon obesis*	Carcharhinidae	Blunthead shark	1	1	LR		Marracho de covas
215.003	*Chirodactylus brachydactylus*	Cheilodactylidae	Twotone fingerfin	1				Pintado bicolor
215.004	*Chirodactylus grandis*	Cheilodactylidae	Bank steenbras	1				Pintado de Natal
187.001	*Dichistius capensis*	Coracinidae	Galjoen	1				Galeào damba
187.002	*Dichistius multifasciatus*	Coracinidae	Banded galjoen	1	1			Galeào raiado
30.001	*Dasyatis brevicaudata*	Dasyatidae	Short-tail stingray	1	1			Uge caude-curta
30.002	*Dasyatis kuhlii*	Dasyatidae	Bluespotted stingray	1	1			Uge ponteado
30.004	*Dasyatis thetidis*	Dasyatidae	Thorntail stingray	1	1			Uge caude-espinhosa
30.009	*Himantura gerrardi*	Dasyatidae	Sharpnose stingray	1	1			Uge caude-espinhosa
30.010	*Himantura uarnak*	Dasyatidae	Honeycomb stingray	1	1			Burá alveolado
30.013	*Taeniura lymma*	Dasyatidae	Bluespotted ribbontailray	1	1	LR		Ratão pintalgado

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
30.014	*Taeniura melanospilos*	Dasyatidae	Round ribbontailray	1	1			Ratão cauda redonda
FAO	*Drepane punctata*	Drepanidae	Spotted sicklefish	1				Enxada manchada
192.004	*Tripterodon orbis*	Ephippidae	Spadefish	1	1			Peixe-galo
144.001	*Fistularia commersonii*	Fistulariidae	Smooth flutemouth	1				Corneta pintada
144.002	*Fistularia petimba*	Fistulariidae	Serrate flutemouth	1				Corneta colorida
247.008	*Thyrsites atun*	Gempylidae	Snoek	1				Escolar atum
247.009	*Thyrsitoides marleyi*	Gempylidae	Black snoek	1				Escolar gracioso
167.001	*Aulacocephalus temmincki*	Grammistidae	Goldribbon soapfish	1				Sabonete fita dourada
167.003	*Grammistes sexlineatus*	Grammistidae	Sixstripe soapfish	1				Sabonete raios-de-sol
179.001	*Diagramma pictum*	Haemulidae	Sailfin rubberlip	1	1			Pargo mulato
179.002	*Plectorhinchus chubbi*	Haemulidae	Dusky rubberlip	1	1			Pargo sombreado
179.003	*Plectorhinchus flavomaculatus*	Haemulidae	Lemonfish	1	1			Pargo limão
179.004	*Plectorhinchus gaterinus*	Haemulidae	Blackspotted rubberlip	1	1			Pargo galinha
179.005	*Plectorhinchus gibbosus*	Haemulidae	Harry hotlips	1	1			Pargo negro
FAO	*Plectorhinchus orientalis*	Haemulidae	Oriental sweetlips	1	1			Pargo oriental
179.006	*Plectorhinchus plagiodesmus*	Haemulidae	Barred rubberlip	1	1			Pargo raiado
179.007	*Plectorhinchus playfairi*	Haemulidae	Whitebarred rubberlip	1	1			Pargo raios de sol
179.008	*Plectorhinchus schotaf*	Haemulidae	Minstrel	1	1			Pargo trovador
179.009	*Plectorhinchus sordidus*	Haemulidae	Redlip rubberlip	1	1			Pargo sórdido
179.010	*Pomadasys commersonnii*	Haemulidae	Spotted grunter	1	1			Roncador
179.011	*Pomadasys furcatum*	Haemulidae	Grey grunter	1	1			Roncador de seis bandas
179.013	*Pomadasys kaakan*	Haemulidae	Javelin grunter	1	1			Peixe pedra
179.015	*Pomadasys maculatum*	Haemulidae	Saddle grunter	1	1			Gonguri
179.016	*Pomadasys multimaculatum*	Haemulidae	Cock grunter	1	1			Galo roncador
179.017	*Pomadasys olivaceum*	Haemulidae	Pinky / Olive grunt	1	1			Roncador oliva
179.019	*Pomadasys stridens*	Haemulidae	Lined piggy	1	1			Roncador striado
FAO	*Hemipristis elongatus*	Hemigaleidae	Snaggletooth shark	1				Tubarão doninha
2.002	*Hexanchus griseus*	Hexanchidae	Sixgill shark	1				Canhabota cinzenta
252.001	*Istiophorus platypterus*	Istiophoridae	Sailfish	1	1			Veleiro
252.002	*Makaira indica*	Istiophoridae	Black marlin	1	1			Espadim negro
252.003	*Makaira mazara*	Istiophoridae	Blue marlin	1	1			Espadim azul
164.001	*Kuhlia mugil*	Kuhliidae	Barred flagtail	1				Ronquinho bandeira
164.002	*Kuhlia rupestris*	Kuhliidae	Rock flagtail	1				Ronquinho campestre
189.001	*Kyphosus bigibbus*	Kyphosidae	Grey chub	1	1			Preguiçosa cinzenta
189.002	*Kyphosus cinerascens*	Kyphosidae	Blue chub	1	1			Preguiçosa azul
189.003	*Kyphosus vaigiensis*	Kyphosidae	Brassy chub	1	1			Preguiçosa bronzeada

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
FAO	*Neoscorpis lithophilus*	Kyphosidae	Stonebream	1	1			Preguiçosa de pedra
220.016	*Cheilinus undulatus*	Labridae	Humphead wrasse	1	1	EN	App-II	Bodião napoleão
14.001	*Carcharodon carcharias*	Lamnidae	Great white shark	1		VU	App-II	??
14.002	*Isurus oxyrinchus*	Lamnidae	Shortfin mako	1		LR		Anequin barbatana curta
35.1	*Latimeria chalumna*	Latimeriidae	Coelacanth	1	1	CR		Celecanto
185.001	*Gnathodentex aureolineatus*	Lethrinidae	Glowfish	1				Ladrão imperador
185.002	*Gymnocranius griseus*	Lethrinidae	Grey barenose	1	1			Ladrão cinzento
FAO	*Gymnocranius robinsoni*	Lethrinidae	Blu-lined large-eye bream	1	1			Ladrão tatuado
185.004	*Lethrinus concyliatus*	Lethrinidae	Redaxil emperor	1	1			Ladrão alcoólico
185.005	*Lethrinus crocineus*	Lethrinidae	Yellowfin emperor	1	1			Ladrão rabo amarelo
185.008	*Lethrinus erythropterus*	Lethrinidae	Mozambique emperor	1	1			Ladrão manchado
185.007	*Lethrinus harak*	Lethrinidae	Blackspot emperor	1				Ladrão moçambicano
185.01	*Lethrinus lentjan*	Lethrinidae	Redspot emperor	1	1			São Pedro
185.016	*Lethrinus mahsena*	Lethrinidae	Cutthroat emperor	1	1			Ladrão de lentejoulas
185.011	*Lethrinus mahsena*	Lethrinidae	Sky emperor	1	1			Lethrinus sanguineus
185.006	*Lethrinus microdon*	Lethrinidae	Longnose emperor	1	1			Lethrinus elongatus
185.013	*Lethrinus nebulosus*	Lethrinidae	Blue emperor	1	1			Ladrão relâmpago
185.014	*Lethrinus obsoletus*	Lethrinidae	Orange-striped emperor	1	1			Lethrinus ramak
185.015	*Lethrinus rubrioperculatus*	Lethrinidae	Spotcheek emperor	1				Ladrão maquilhado
185.017	*Lethrinus variegatus*	Lethrinidae	Variegated emperor	1				Ladrão moteado
185.018	*Lethrinus xanthochilus*	Lethrinidae	Yellowlip emperor	1				Ladrão de boca amarela
202.001	*Lobotes surinamensis*	Lobotidae	Tripletail	1				Furriel
181.001	*Aphareus furca*	Lutjanidae	Blue smalltooth job	1	1			Pargo de boca doce
181.002	*Aphareus rutilans*	Lutjanidae	Red smalltooth job	1	1			Pargo de boca vermelha
181.003	*Aprion virescens*	Lutjanidae	Green jobfish	1	1			Pargo verde
181.005	*Lutjanus argentimaculatus*	Lutjanidae	River snapper	1	1			Pargo de mangal
FAO	*Lutjanus bengalensis*	Lutjanidae	Bengal snapper	1				Pargo de Bengala
181.006	*Lutjanus bohar*	Lutjanidae	Twinspot snapper	1	1			Pargo de manchas
181.007	*Lutjanus ehrenbergii*	Lutjanidae	Blackspot snapper	1				Pargo carpa
181.008	*Lutjanus fulviflamma*	Lutjanidae	Dory snapper	1	1			Pargo tinteiro
181.009	*Lutjanus fulvus*	Lutjanidae	Yellow striped snapper	1	1			Pargo rabo negro
181.01	*Lutjanus gibbus*	Lutjanidae	Humpback snapper	1	1			Pargo curvado
FAO	*Lutjanus guilcheri*	Lutjanidae	Yellowfin red snapper	1				Pargo rabo amarelo
181.011	*Lutjanus kasmira*	Lutjanidae	Bluebanded snapper	1	1			Pargo de raios azuis

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
181.012	*Lutjanus lemniscatus*	Lutjanidae	Sweetlip snapper	1				Pargo de raios amarelos
181.013	*Lutjanus lutjanus*	Lutjanidae	Yellow snapper	1				Pargo de Madras
181.014	*Lutjanus monostigma*	Lutjanidae	Onespot snapper	1	1			Pargo de uma
181.015	*Lutjanus notatus*	Lutjanidae	Bluestriped snapper	1				Pargo dozenário
181.016	*Lutjanus rivulatus*	Lutjanidae	Speckled snapper	1	1			Pargo maori
181.017	*Lutjanus russelli*	Lutjanidae	Russell's snapper	1	1			Pargo Russell
181.018	*Lutjanus sanguineus*	Lutjanidae	Blood snapper	1	1			Pargo vermelhão
181.019	*Lutjanus sebae*	Lutjanidae	Emperor snapper	1	1			Pargo imperial
181.02	*Macolor niger*	Lutjanidae	Black beauty	1				Pargo branco e preto
181.021	*Paracaesio xanthura*	Lutjanidae	Yellowtail fusilier	1				Pargo azul
FAO	*Pinjalo pinjalo*	Lutjanidae	Pinjalo	1				Pargo rosado
181.023	*Pristipomoides multidens*	Lutjanidae	Striped jobfish	1				Pargo de cauda
181.024	*Pristipomoides zonatus*	Lutjanidae	Obliquebanded snapper	1				Pargo de bandas
197.004	*Malacanthus brevirostris*	Malacanthidae	Stripetail tilefish	1				Branquinho nariz curto
197.005	*Malacanthus latovittatus*	Malacanthidae	Sand tilefish	1				Branquinho azul
29.001	*Manta birostris*	Mobulidae	Manta	1	1	NT	App II	Jamanta gigante
29.002	*Mobula kuhlii*	Mobulidae	Devilray	1	1			Jamanta diabo
222.01	*Mugil cephalus*	Mugilidae	Flathead mullet	1	1			Tainha cabeça achatada
196.001	*Mulloides flavolineatus*	Mullidae	Yellowstripe goatfish	1				Salmonete de estria amarela
196.002	*Mulloides vanicolensis*	Mullidae	Flame goatfish	1				Salmonete de Vanicolo
196.003	*Parupeneus barberinus*	Mullidae	Dash-dot goatfish	1				Salmonete barberino
196.004	*Parupeneus bifasciatus*	Mullidae	Two-saddle goatfish	1				Salmonete de duas manchas
196.005	*Parupeneus cinnabarinus*	Mullidae	Redspot goatfish	1				Salmonete cinbar
196.006	*Parupeneus cyclostomus*	Mullidae	Goldsaddle goatfish	1				Salmonete dourado
196.007	*Parupeneus indicus*	Mullidae	Indian goatfish	1				Salmonete do Indico
28.001	*Aetobatus narinari*	Myliobatidae	Spotted eagleray	1	1	NT		Ratau ponteado
28.003	*Pteromylaeus bovinus*	Myliobatidae	Duckbill ray	1	1			Ratão bovino
186.001	*Nemipterus bipunctatus*	Nemipteridae	Butterfly bream	1				Nemipterus bleekeri
FAO	*Nemipterus japonicus*	Nemipteridae	Japanese threadfin bream	1				Baga japonês
FAO	*Nemipterus metopias*	Nemipteridae	Slender threadfin bream	1				Baga elegante
186.003	*Parascolopsis eriomma*	Nemipteridae	Shimmering spinecheek	1				Baga rosado
186.004	*Scolopsis bimaculatus*	Nemipteridae	Doubleblotch spinecheek	1				Sizi São Pedro
186.005	*Scolopsis ghanam*	Nemipteridae	Paleband spinecheek	1				Sizi da Arábia

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
186.006	*Scolopsis vosmeri*	Nemipteridae	Silverflash spinecheek	1				Sizi da cara branca
19.001	*Carcharius taurus*	Odontaspididae	Spotted ragged-tooth	1	1	VU		Tubarão de areia
206.001	*Oplegnathus conwayi*	Oplegnathidae	Cape knifejaw	1				Perico do Cabo
206.002	*Oplegnathus peaolopesi*	Oplegnathidae	Mozambique knifejaw	1				Perico de Moçambique
206.003	*Oplegnathus robinsoni*	Oplegnathidae	Natal knifejaw	1				Perico do Natal
FAO	*Platax orbicularis*	Platacidae	Batfish	1				Morcego
155.005	*Papilloculiceps longiceps*	Platycephalidae	Madagascar flathead	1				Sapateiro cirroso
60.001	*Plotosus lineatus*	Plotosidae	Striped eel-catfish	1				Patuna raiada
60.002	*Plotosus nkunga*	Plotosidae	Eel-catfish	1				Patuna picadoro
178.001	*Pomatomus saltatrix*	Pomatomidae	Elf	1				Anchova
174.002	*Priacanthus cruentatus*	Priacanthidae	Glass bigeye	1				Fura-vasos de rocha
174.003	*Priacanthus hamrur*	Priacanthidae	Cresent-tail bigeye	1				Fura-vasos espelhudo
22.001	*Pristis microdon*	Pristidae	Smalltooth sawfish	1	1	CR	App-I	Tubarão-serra dentuço
22.002	*Pristis pectinata*	Pristidae	Largetooth sawfish	1	1	CR	App-I	Tubarão-serra candu
22.003	*Pristis zijsron*	Pristidae	Largecomb sawfish	1	1	CR	App-I	Tubarão-serra africano
212.001	*Rachycentron canadum*	Rachycentridae	Prodigal son	1	1			Bacalhau
27.2	*Rhinobatos annulatus*	Rhinobatidae	Lesser guitarfish	1	1	LC		Peixes guitara
27.7	*Rhynchobatus djiddensis*	Rhinobatidae	Giant guitarfish	1	1	VU		Peixes guitara
221.004	*Bolbometopon muricatum*	Scaridae	Humphead parrotfish	1	1			Papagaio verde
221.011	*Scarus ghobban*	Scaridae	Bluebarred parrotfish	1	1			Papagaio de escamas amarelas
221.015	*Scarus rubroviolaceus*	Scaridae	Ember parrotfish	1	1			Papagaio de brasa
FAO	*Argyrosomus hololepiditus*	Sciaenidae	Southern meagre	1	1			Corvina real
199.002	*Argyrosomus thorpei*	Sciaenidae	Squaretail kob	1	1			Corvina sul-africana
199.007	*Otolithes ruber*	Sciaenidae	Snapper kob	1	1			Corvina dentuça
199.009	*Umbrina rhonchus*	Sciaenidae	Slender baardman	1	1			Macujana
249.001	*Acanthocybium solandri*	Scombridae	Wahoo	1	1			Cavala gigante
249.003	*Auxis thazard*	Scombridae	Bullet tuna	1	1			Judeu
249.006	*Gymnosarda unicolor*	Scombridae	Dogtooth tuna	1	1			Bonito dente-de-cão
249.007	*Katsuwonus pelamis*	Scombridae	Skipjack tuna	1	1			Gaiado
249.009	*Sarda orientalis*	Scombridae	Striped bonito	1	1			Sarda oriental
249.012	*Scomberomorus commerson*	Scombridae	King mackerel	1	1			Serra
249.013	*Scomberomorus plurilineatus*	Scombridae	Queen mackerel	1	1			Serra canadi
249.014	*Thunnus alalunga*	Scombridae	Albacore	1	1			Voador
249.15	*Thunnus albacares*	Scombridae	Yellowfin tuna	1	1	LR		Albacora
249.017	*Thunnus obesus*	Scombridae	Bigeye tuna	1	1	VU		Patudo
149.031	*Scorpaenopsis diabolus*	Scorpaenidae	False stonefish	1				Rascasso diabo
149.046	*Synanceia verrucosa*	Scorpaenidae	Stonefish	1				Lacrau

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
166.019	*Aethaloperca rogaa*	Serranidae	Redmouth rockcod	1				Garoupa roga
166.020	*Anyperodon leucogrammicus*	Serranidae	Slender rockcod	1				Garoupa elegante
166.021	*Cephalopholis argus*	Serranidae	Peacock rockcod	1	1			Garoupa pavão
166.022	*Cephalopholis aurantia*	Serranidae	Golden rockcod	1				Garoupa dourada
166.023	*Cephalopholis boenack*	Serranidae	Brownbarred rockcod	1				Garoupa chocolate
166.024	*Cephalopholis formosa*	Serranidae	Bluelined rockcod	1				Garoupa formosa
166.025	*Cephalopholis leopardus*	Serranidae	Leopard rockcod	1				Garoupa leopardo
166.026	*Cephalopholis miniata*	Serranidae	Coral/Bluespotted rockcod	1	1			Garoupa estrelada
166.028	*Cephalopholis sexmaculata*	Serranidae	Six-blotch rockcod	1				Garoupa de 6 manchas
166.029	*Cephalopholis sonnerati*	Serranidae	Tomato rockcod	1	1			Garoupa tomate
166.030	*Cephalopholis spiloparaea*	Serranidae	Strawberry rockcod	1				Garoupa marinheira
166.027	*Cephalopholis urodeta*	Serranidae	Duskyfin rockcod	1				Cephalopholis nigripinnis
166.031	*Cromileptes altivelis*	Serranidae	Humpback rockcod	1				Garoupa corcunda
166.032	*Dermatolepis striolatus*	Serranidae	Smooth rockcod	1				Garoupa lisa
166.033	*Epinephelus albomarginatus*	Serranidae	Captain fine rockcod	1	1	VU		Garoupa bordo bordo
166.034	*Epinephelus andersoni*	Serranidae	Catface rockcod	1	1	NT		Garoupa gato
166.035	*Epinephelus areolatus*	Serranidae	Squaretail rockcod	1				Garoupa areolada
166.036	*Epinephelus caeruleopunctatus*	Serranidae	Whitespotted rockcod	1				Garoupa manchas brancas
166.037	*Epinephelus chabaudi*	Serranidae	Moustache rockcod	1				Garoupa bigotuda
166.038	*Epinephelus chlorostigma*	Serranidae	Brownspotted rockcod	1	1			Garoupa pintada
166.039	*Epinephelus fasciatus*	Serranidae	Redbarred rockcod	1	1			Garoupa bandeireia
FAO	*Epinephelus faveatus*	Serranidae	Bigspot grouper	1				Garoupa alfombrada
166.041	*Epinephelus flavocaeruleus*	Serranidae	Yellowtail rockcod	1	1			Garoupa azul e amarela
166.042	*Epinephelus fuscoguttatus*	Serranidae	Blotchy rockcod	1	1			Garoupa manchada
166.043	*Epinephelus marginatus*	Serranidae	Yellowbelly rockcod	1	1	EN		Garoupa preta
166.044	*Epinephelus hexagonatus*	Serranidae	White Specked rockcod	1				Garoupa melifera
166.045	*Epinephelus lanceolatus*	Serranidae	Brindle bass	1	1	VU		Garoupa fajardo
166.046	*Epinephelus longispinus*	Serranidae	Streakyspot rockcod	1				Garoupa espigão
166.047	*Epinephelus magniscuttis*	Serranidae	Speckled rockcod	1				Garoupa bacalhau
166.048	*Epinephelus malabaricus*	Serranidae	Malabar rockcod	1	1	NT		Garoupa malabárica
166.049	*Epinephelus melanostigma*	Serranidae	One-blotched rockcod	1	1			Garoupa espaldar
166.050	*Epinephelus merra*	Serranidae	Honeycomb rockcod	1	1			Garoupa panaleira
166.052	*Epinephelus miliaris*	Serranidae	Netfin rockcod	1				Garoupa abelha
166.053	*Epinephelus morrhua*	Serranidae	Contour rockcod	1	1			Garoupa cometa
166.054	*Epinephelus multinotatus*	Serranidae	White-blotched rockcod	1	1			Garoupa de luas brancas

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
166.055	*Epinephelus ongus*	Serranidae	White-streaked rockcod	1				Garoupa floculada
166.056	*Epinephelus poecilonotus*	Serranidae	Dot dash rockcod	1				Garoupa ponto e linha
166.057	*Epinephelus posteli*	Serranidae	Tiger rockcod	1	1			Garoupa tigre
FAO	*Epinephelus praeopercularis*	Serranidae	Brokenline grouper	1				Garoupa pálida
166.059	*Epinephelus retouti*	Serranidae	Red-tipped rockcod	1				Garoupa ponteada
166.060	*Epinephelus rivulatus*	Serranidae	Halfmoon rockcod	1				Garoupa meia-lunada
166.063	*Epinephelus spilotoceps*	Serranidae	Foursaddle rockcod	1				Garoupa de quatro selas
166.064	*Epinephelus suillus*	Serranidae	Orangespotted rockcod	1				Garoupa alaranjada
166.065	*Epinephelus tauvina*	Serranidae	Greasy rockcod	1	1			Garoupa lutra
166.066	*Epinephelus tukula*	Serranidae	Potato bass	1	1			Garoupa batata
166.068	*Gracila albomarginata*	Serranidae	Red-edged rockcod	1				Garoupa de bordo
166.012	*Holanthias natalensis*	Serranidae	Gorgeous swallowtail	1				Garoupa
166.071	*Plectrpomus laevis*	Serranidae	Black-saddled leopardgrouper	1	1			Garoupa selada
FAO	*Plectrpomus leopardus*	Serranidae	Bluedotted coral-trout	1	1			Garoupa celestial
166.072	*Plectrpomus pessuliferus*	Serranidae	Leopardgrouper	1				Garoupa de coral
166.073	*Plectrpomus punctatus*	Serranidae	Marbled leopardgrouper	1	1			Garoupa vermiculada
166.074	*Variola albimarginata*	Serranidae	White-edged lyretail	1				Garoupa rabo branco
166.075	*Variola louti*	Serranidae	Swallowtail rockcod	1	1			Garoupa papagaio
198.001	*Sillago chondropus*	Sillaginidae	Clubfoot sillago	1				Prescadinha pateta
198.002	*Sillago maculata*	Sillaginidae	Blotchy sillago	1				Pescadinha trombeteira
198.003	*Sillago sihama*	Sillaginidae	Silver sillago	1				Prescadinha comum
183.001	*Acanthopagrus berda*	Sparidae	Perch	1	1			Sargo picnic
183.002	*Acanthopagrus bifasciatus*	Sparidae	Twobar seabream	1	1			Sargo de duas bandas
183.003	*Argyrops filamentosus*	Sparidae	Soldier bream	1	1			Pargo soldado
183.004	*Argyrops spinifer*	Sparidae	King soldierbream	1	1			Pargo real
183.005	*Argyrozona argyrozona*	Sparidae	Carpenter	1				Sargo carpinteiro
183.007	*Cheimerius nufar*	Sparidae	Santer	1	1			Robalo
183.008	*Chrysoblephus anglicus*	Sparidae	Englishman	1	1			Pargo de Natal
183.012	*Chrysoblephus lophus*	Sparidae	False englishman	1	1			Sargo falso
183.013	*Chrysoblephus puniceus*	Sparidae	Slinger	1	1			Marreco
183.014	*Crenidens crenidens*	Sparidae	Karanteen	1				Esparo
183.016	*Diplodus cervinus hottentotus*	Sparidae	Zebra	1	1			Sargo zebrado
183.017	*Diplodus sargus capensis*	Sparidae	Blacktail	1	1			Sargo do Cabo
183.021	*Lithognathus mormyrus*	Sparidae	Sand steenbras	1				Ferreira estriada
183.024	*Pachymetopon grande*	Sparidae	Bronze bream	1				Hotentote bronzeado

Smith's No	Species	Family	South African Name	Line?	N.B.	IUCN	CITES	Mozambique Name
183.027	*Polyamblyodon germanum*	Sparidae	German	1	1			Sargo alemão
183.028	*Polyamblyodon gibbosum*	Sparidae	Cristie	1	1			Sargo navalhada
183.029	*Polysteganus coeruleopunctatus*	Sparidae	Blue skin / Trawl soldier	1	1			Cachucho
183.031	*Polysteganus praeorbitalis*	Sparidae	Scotsman	1	1			Dentuço de Natal
183.032	*Polysteganus undulosus*	Sparidae	Seventy-four	1	1			Dentuço manchado
183.033	*Porcostoma dentata*	Sparidae	Dane	1	1			Romano denteado
183.034	*Pterogymnus laniarius*	Sparidae	Panga	1				Dourada panga
183.035	*Rhabdosargus globiceps*	Sparidae	White stumpnose	1				Dourada austral
183.037	*Rhabdosargus sarba*	Sparidae	Natal stumpnose	1	1			Dourada comum
183.038	*Rhabdosargus thorpei*	Sparidae	Bigeye stumpnose	1	1			Dourada de olho grande
183.039	*Sarpa salpa*	Sparidae	Strepie	1				Salema
183.04	*Sparodon durbanensis*	Sparidae	White musselcracker	1				Dourada quebradora
224.003	*Sphyraena barracuda*	Sphyraenidae	Great barracuda	1	1			Barracuda bicuda
224.007	*Sphyraena jello*	Sphyraenidae	Pickhandle barracuda	1	1			Barracuda serpentina
13.001	*Sphyrna lewini*	Sphyrnidae	Scalloped hammerhead	1	1	LR	App II	Tubarão martelo comum
13.002	*Sphyrna mokarran*	Sphyrnidae	Great hammerhead	1	1	DD	App II	Tubarão martelo gigante
13.003	*Sphyrna zygaena*	Sphyrnidae	Smooth hammerhead	1	1	LR	App II	Tubarão martelo liso
FAO	*Cyttopsis roseus*	Zeidae	Rosy dory	1				São Pedro rosado
138.003	*Zenopsis conchifer*	Zeidae	Buckler dory	1				São Pedro prateado
138.004	*Zeus capensis*	Zeidae	Cape dory	1				São Pedro do Cabo
138.005	*Zeus faber*	Zeidae	John dory	1				São Pedro comum
TOTALS				**302**	**179**	**39**	**10**	

AN EAF BASELINE REPORT OF THE INDUSTRIAL SHRIMP FISHERIES OF NIGERIA

P. O. Abohweyere, A. B. Williams, E. E. Edet

1. Introduction

Nigeria is located between 4°16'–52'N and 2°49'–14°37'E, and has a coastline of about 853 km bordering the Gulf of Guinea in the Atlantic Ocean. The coastline is composed of four distinct geomorphic zones, namely:

- The barrier bar lagoon with sandy coastal plains, which stretches about 200 km in the western sector;
- The medium to coarse sand grains with steep beach profiles, which stretch for about 75 km up to the Benin River mouth;
- The Niger Delta, which is the second largest in the world, is rimmed by barrier islands and extends for about 500 km from Benin River to the Imo River mouth;
- The Strand coast, which is characterized by the active mixing of river and sea waters analogous with tidal ranges. It extends from the Imo River mouth to the Cross River estuary covering a distance of about 85 km.

The continental shelf is relatively narrow, and widens progressively from 15 km off Lagos in the west to about 85 km off Calabar in the southeast. The relatively narrow continental shelf limits trawlable grounds and fish abundance. The area of the shelf is about 39 342 km² of which 10 976 km² (representing about 28 percent of the total) is trawlable (Tobor, 1990). The total area to the 200 m isobath, which is generally accepted as the outer edge of the continental shelf, is estimated at 41 000 km² (Domain, 1980). The region of the continental shelf between the shoreline and about 18 m contour line is almost exclusively fished by artisanal fishermen, but both the artisanal and industrial fishermen exploit the waters between the 18 m and 40 m depth. The 40 m contour line is a fairly reliable boundary of the thermocline, separating the upper from the lower oceanic currents (Scott, 1966) and limits the extent of the distribution of the demersal fish stocks.

There are 36 estuaries on the Nigerian coast (Amadi, 1990). Salinity in the bar built estuaries shows a gradual gradient as against the steep gradient of the river mouth and delta estuaries. In the Lagos area, salinity is about 34 up to 50 m depth, while in the southeastern coast, salinity is less than 30 due to the numerous rivers and fresh water run-offs.

Nigeria declared an Exclusive Economic Zone (EEZ) of 200 nm in 1978, though the deposition of the instrument for the declaration was made in 1986. The EEZ covers an estimated area of 210 900km² (World Resources, 1990).

Commercial shrimp trawling in Nigeria dates back to the mid-sixties soon after preliminary exploratory surveys (Scott, 1966; Raitt and Niven, 1969; Thomas, 1969) had demonstrated its tremendous potential.

Contribution of fisheries to agricultural GDP in 2007 was 4.0 percent, while it is 0.1 percent to the national GDP (FDF, 2008). Fish also contributes substantially and cost-effectively to national food (nutrition) security by supplying protein and other vital nutrients to the diets of about 150 million

Nigerian. The industrial component, with its huge capital outlay, exploits the coastal fishery resources and the market is both foreign and locally oriented. The sustainability of coastal and marine fisheries is dependent on maintaining the integrity and productivity of the coastal and marine environments on which these fisheries depend.

2. Overview of the fishery and resources exploited

2.1. Fishing gear used and areas fished

On the average, about 83 percent of the registered and operating fishing vessels in Nigeria between 1995 and 2007 were shrimp fishing vessels (FDF, 2008). The main fishing method employed in this fishery is trawling and the main gear used is the bottom trawl net with an average length of about 12 m and with minimum cod-end stretched mesh sizes of 44 mm as approved by law. Almost all the vessels operating in Nigeria are rigged with twin-trawl nets on both sides of the vessel with otter doors to ensure better opening of the nets while trawling. All the nets are also fitted with Turtle Excluder Devices (TEDs) and Bycatch Reduction Devices (BRDs) for the escape of sea turtles and juveniles of non-target species.

The Niger Delta area (from Benin River mouth eastward to Cross River estuary), which is nutrient fed river runoff, is known for its rich shrimp resources especially within the inshore waters (0 – 50 m depth). Shrimp season is mainly between May and September.

2.2. Resources exploited

Trawling is not a target-specific method of harvesting resources as it takes all living resources along its path and captures all species that the cod-end can retain. Therefore, all living demersal and benthic species, vertebrates and invertebrates in the path of the net are harvested.

The main target species are the penaeid shrimps (*Penaeus notialis*, *P. monodon*, *P. kerathurus*, *Parapenaeopsis atlantica* and *Parapenaeus longirostris*). The annual estimated potential yield for shrimp is between 3 500 – 4 020 tonnes (Bayagbona, 1979; Ajayi and Talabi, 1984). However, higher shrimp catches have been recorded since 1992 until 2007 when about 5 000 tonnes was recorded (FDF, 2008). Other important species being targeted are the royal spiny lobster (*Palinurius regius*) and the portunid crabs (*Portunus validus* and *Callinectes* spp.). These species are targeted for the export market.

Other resources that are non-target but retained for their economic values include the fin fishes (bony and cartilagenous), cephalopods (sepia, squids and octopuses) and other invertebrates such as sea-cucumbers.

2.3. Number of fishers and land-based workers by sector

Estimated employment of the fisheries primary sector is 8.23 million while the secondary sector is 18.27 million (FDF, 2008). In the industrial trawl fishery the number of people in direct and indirect employment are very few when compared to the artisanal fisheries. From unpublished FDF records in 2010, those that are direct fishers or crew going to sea are estimated to be about 1 589 while those that are land-based workers are 759 (Figure 1). The direct fishers include the captains and other crews on board vessels while the land-based workers are the administrative, financial and maintenance staff.

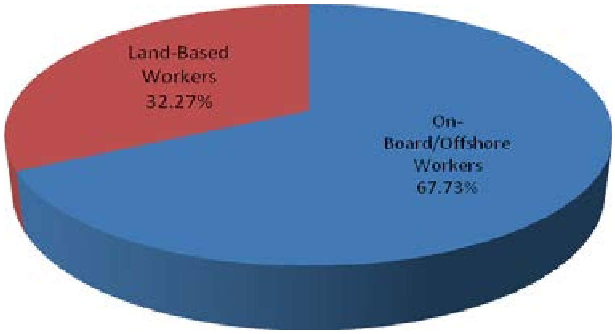


Figure 1. Percentage number of fishers to land-based workers in the industrial fisheries sector of Nigeria.

2.4. Interactions with other fisheries

There are two principal categories of capture fisheries in Nigeria; artisanal fisheries and industrial fisheries. The industrial fisheries are further subdivided into shrimp fishery and finfish fishery. All the various forms of fisheries are taking place at the same time and space. Although by regulation, the industrial fisheries are not supposed to interfere with artisanal fisheries, they target the same resources that straddle the 5 nm non-trawling zone limits specified for the artisanal fisheries. This causes conflict between industrial and artisanal fishers arising from destruction of their gears as the trawler operators encroach into the non-trawling zone.

The shrimp fishery targets the shrimps, other crustaceans and other bycatch species that are retained for their economic value. The shrimp trawl net cod-end (44 mm) is smaller than the fish trawl net cod-end (76 mm) and because it is not selective it catches all the fishes that are the primary target for the finfish fishery. Bycatch in the shrimp fishery affects other fisheries. Various species of finfish constitute about 70 percent of the total catch landed by shrimpers. Also included are cephalopods, crabs and gastropods. Large quantities of juveniles, which are not accounted for, are caught and sold to trash fish mongers at sea. These are consumed in coastal communities as food. This really affects the returns on the catch in the industrial finfish fishery and has resulted in the fishing companies licensing more of their vessels as shrimp trawlers. In 1987 a total of 161 vessels were registered for finfish fisheries while 82 were registered for shrimp trawling. In 2005, only 35 vessels were registered for finfish fisheries while a total of 203 vessels were registered for shrimp trawling (FDF, 2008).

The artisanal fisheries utilize the nearshore, estuaries and lagoon as their fishing area. These areas are known to be the breeding and nursery grounds for the target species in the industrial finfish and shrimp fisheries. The juveniles or the recruiting stages of the target species are continually harvested by the artisanal fishermen and these affects the recruitment into the fisheries. Of much importance is the Nkoto fishery that targets the small white shrimp (*Nematopalaemon hastatus*) as the primary target species. They use a net of about 10 mm mesh size for catching the shrimp and, in some areas (Osoroko in Lagos State), they practice a form of trawling (beam trawling) with outboard engines (Ambrose *et al.*, 2005).

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

The penaeid shrimps have similar life cycles as they have both estuarine and marine water life stages. They spawn offshore, between 10 m and 80 m depths, and the hatched nauplius (planktonic larvae) are carried by currents towards shore. During this migration they moult several times and arrive at shore as post larvae. The post-larvae migrate into the brackish waters (lagoons and estuaries) and settles down as demersal species (Abohweyere, 1993). They grow to juveniles and migrate back to sea until they reach the adult stage to repeat the cycle.

3.2. Geographical distribution of the species

The Nigerian coastal zone is blessed with extensive estuaries, lagoon systems and 853 km of coastline. The coastal waters are very rich in penaeid shrimp resources and other crustaceans that are the main target of the industrial shrimp industry. The entire Niger delta region is favourable habitat for the growth of the shrimps and serves as nursery area. Nutrients carried by river runoff (Niger-Benue, Imo, Akwa Iboe and Calabar rivers) increase the productivity of coastal waters. Figure 2 shows the morphological area of the Nigerian coast and some major estuarine systems that support the shrimp populations.

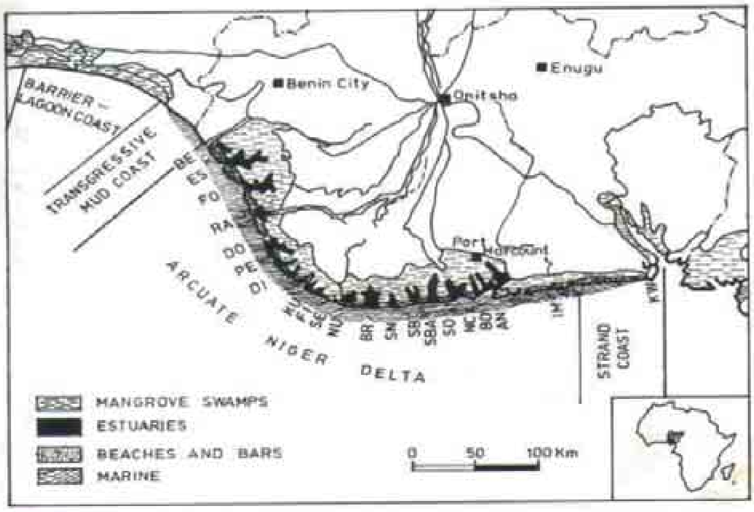


Figure 2. Morphology of Nigerian coastline

The penaeid shrimps are found from shore to about 100 m depth but different species occupy different depths, and this helps to avoid competition between species. The *P. atlantica*, *P. notialis* and the *P. monodon* are more common in the depths below 50 m while *P. longirostris* occurs at a depth beyond 50 m.

3.3. Status of the stocks

There is no information available on the status of the shrimp stocks.

3.4. Direct interactions with the ecosystem

The bottom trawl fishery is a non-selective method of catching fishes or shrimps. It catches all other organisms in its path with many of the species not wanted and discarded. The net is designed with heavy chain and/or rollers are attached to the foot-rope of the net to ensure that all species in the sediments are ‘chased out’ into the net. This action destroys critical habitats for other organisms, particularly the benthic organisms (benthos) many of which are sessile and are sediment specific. As the benthos is food for many demersal species, their destruction will affect other living components in the ecosystem. During the ‘chasing out’, there will be re-suspension of sediment particles (silt and clay particles) that will increase turbidity and reduce light for photosynthesis in shallow areas and may liberate other contaminants or pollutants that had been locked-up in the sediment. The silt and clay particles may clog the breathing organs (such as gills in fishes) of other organisms thereby causing asphyxiation.

Direct pollution caused by the fishery is in terms of malfunctioning sanitary system and lack of waste management system on the vessels. Human and food wastes, other wastewaters and solid wastes are dumped directly into water untreated, as there are no provisions for these on the vessels.

More than 20 percent of Nigerians live along the coast and most of the biggest cities in Nigeria such as Lagos and Port Harcourt are located on or near the coast. A significant amount of wastes being generated in these cities is still dumped directly into the sea, lagoons and estuaries. As of today, solid waste is a major problem in Nigeria waters and a major challenge to the fishing industry. In a fish survey carried out by Nigerian Institute for Oceanography and Marine Research (NIOMR) in May 2009 offshore Lagos, in a single haul (around Badagry) a total of 66 kg of solid waste was recovered and only about 20 kg of fish were sorted.

3.5. Traditional knowledge about the fishery and the resources exploited

The industrial shrimp fishery is a modern form of fisheries in Nigeria and was manned by experienced Indians that were partners with indigenous company owners. As a result of this, there is no known traditional knowledge indigenous to Nigeria. Most of the methods used for shrimp fishing are technology-based, such as the use of echo sounder or fish finder and the use of 'try-net' for sub sampling to have an idea of species composition after a school had been detected.

4. Annual catches

The industrial shrimp fishery started very early in the 1970s with resources being exploited offshore Lagos. In 1972 a shrimp resources survey carried out by the NIOMR showed that the shrimp resources are available off Niger Delta area and could support commercial exploitation. This led investors into fishing with many vessels being licensed for shrimp fishing, except for few years between 1981 and 1988, when more vessels were licensed to finfish fisheries (Figure 3).

The shrimp production data available from Federal Department of Fisheries (FDF) dated back to 1971 and up to 2007 (37 years), as shown in Figure 4. In 1971, total production value was 1 377 tonnes, while in 2007 it was 5 995 tonnes. The highest production recorded was in 1999 with a value of 15 249 tonnes. In 2010, total shrimp production was 4 643 tonnes (FDF, unpublished). Comparatively, as the production of finfish was going down that of shrimp was going up (Figure 4). This was the result of the reduction in the number of finfish vessels and the increase in number of shrimp vessels, as discussed above.

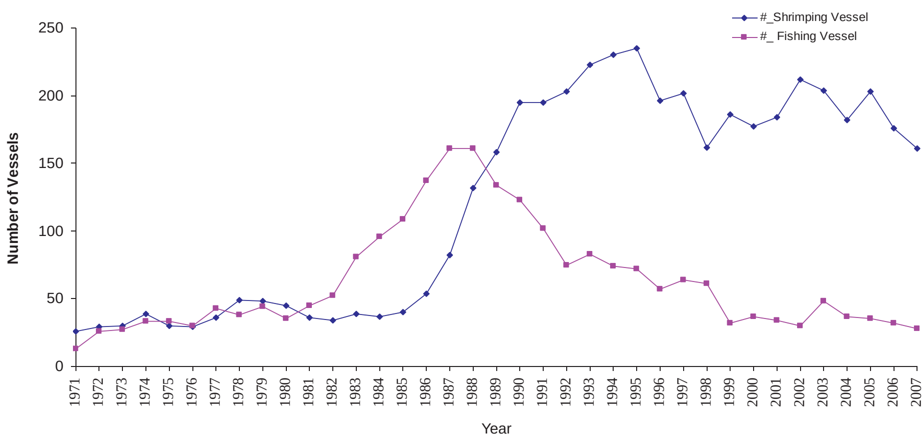


Figure 3. Number of vessels licensed for finfish and shrimp fishing in Nigeria from 1971 to 2007.

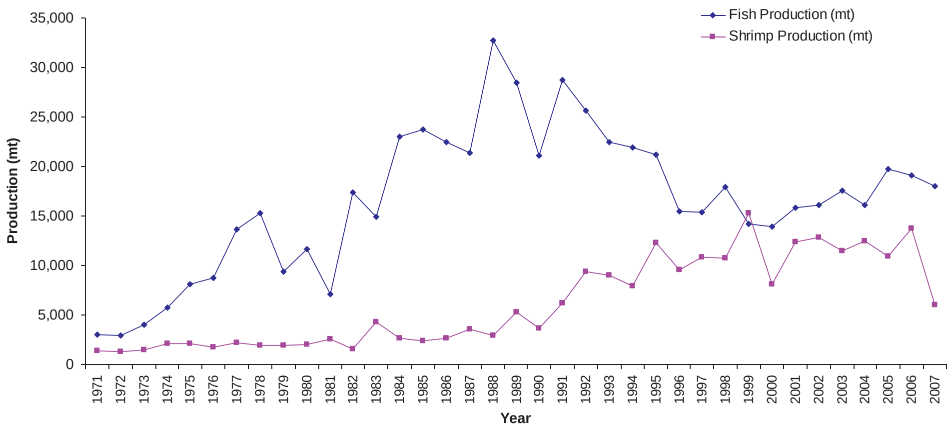


Figure 4. Fish and shrimp production (tonnes) in Nigeria from 1971 to 2007.

5. Importance of the fishery in the national economy

5.1. Value of the catches

The shrimp fishery from inception has been highly valued. In 1973, 1 359 tonnes were caught and exported, earning ₦[1] 4 million. Estimated export revenue from the 2 116 tonnes and 1 798 tonnes of shrimp landed in 1977 and 1978 were in the order of ₦ 5 - 6 million, at the whole-sale price of ₦ 3 000 per tonne. Over the last five years the revenue accruing to Nigeria from the shrimp fishery ranged from USD 15.4 million to USD 46.8 million (Table 1).

The industry experienced some crisis that accounted for the drop in the total catch from 2007 to 2009, with the lowest quantity landed in 2008. In 2010 there was an increase in landings. used to be the major species in the landings. However, since the introduction of by accident into the Gulf of Guinea, and its subsequent migration into the Nigerian coastal waters, the importance of the species in the landings has gradually increased, presently competing and sometimes surpassing the production. The percentage contribution of the various species landed from this fishery is shown in Figure 5. The value of catches for the different species on a monthly basis from March 2010 to February 2011 is presented in Table 2.

Table 1. Shrimp exports and value from 2006 to 2010. Source: Fisheries Statistics of Nigeria 2007 and Adapted From Federal Department of Fisheries Records 2010 / 2011

Year	Value (‘000 USD)	Export (tonnes)
2006	46 804.10	7 736
2007	38 311.32	5 137
2008	15 413.034	1 857
2009	20 664.792	2 490
2010	38 552.247	4 645

[1] 1 Nigerian Naira (₦) = 0.006 USD (2013).

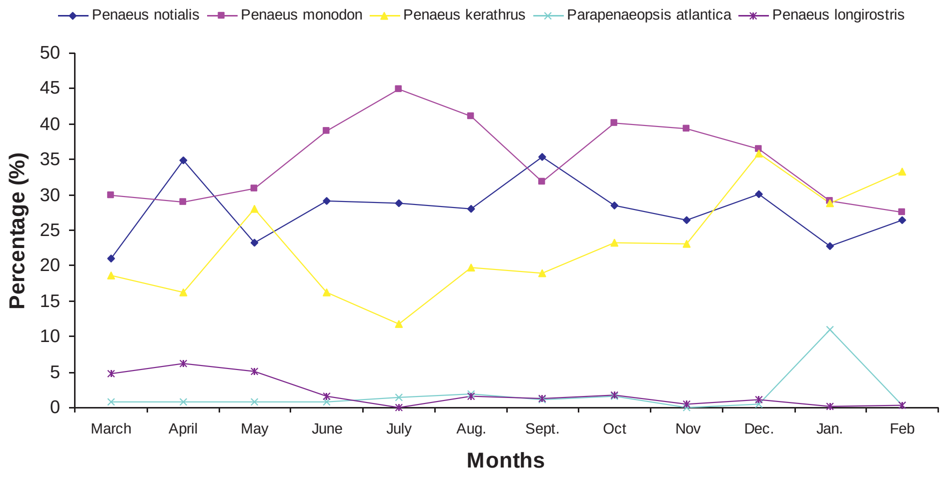


Figure 5. Percentage contribution of different shrimp species to landing from March 2010 to February 2011.

Table 2. Value ('000 USD) of the different shrimp species landed monthly from March 2010 to February 2011. Source: Adapted From Federal Department of Fisheries Records 2010/2011.

Species	*Penaeus notialis*	*Penaeus monodon*	*Penaeus kerathrus*	*Parapenaeopsis atlantica*	*Parapenaeus longirostris*
March	449	642	17	170	105
April	1 191	993	27	234	211
May	482	639	15	244	105
June	977	1 305	27	229	53
July	996	1 546	47	173	-
Aug	828	1 209	56	246	48
Sept	1 383	1 246	42	313	49
Oct	1 088	1 534	61	374	68
Nov	1 296	1 930	2	477	26
Dec	1 110	1 346	19	557	38
Jan	820	1 047	397	436	5
Feb	565	589	6	299	6

5.2. Products and markets

The product form of the inshore shrimp fishery is mainly frozen head-on and packaged in two kg cartoon. However a small percentage is peeled, deveined and headless. Head-on constituted 99.1 percent of the total product exported in 2010 while only 0.9 percent was peeled and deveined. The packaging is done on board ready for the export market. Shrimp fishery in Nigeria is export oriented.

Trade in Nigerian fish products has increased substantially over the past two decades and fish exports were valued at about USD 60 million per annum. Fish export to European and other overseas markets contributes significantly to the national economy. In a relatively short time, the fish processing and exporting industry has acquired access to tightly regulated markets by meeting international Hazard Analysis and Critical Control Point (HACCP) and Sanitary and Phyto-Sanitary (SPS) standards.

A total of USD 35.7 million accrued from 4 302 tonnes of shrimp between March 2010 and February 2011 exported to EU countries. The countries, quantity and value are presented in Table 3. More than half of the quantity exported was to the Netherlands, followed by Belgium, France and Spain.

Activities employed in value-addition include peeling, deveining and decapitation.

Table 3. Country, quantity and value of shrimp export from March 2010 to February 2011.
Source. Adapted From Federal Department of Fisheries Records 2010 / 2011.

Country	Quantity (tonnes)	Value ('000 USD)
Belgium	1 100	9 129
Netherlands	2 801	23 248
France	344	2 853
Spain	58	480
Total	4 302	35 710

6. Fisheries management plan and objectives

There is no management plan for the fishery.

The main objective is to achieve increased domestic fish production from all sources on a sustainable and renewable basis to the level of self sufficiency and fish export in the medium to long term.

7. Legal framework

The legal framework within which fishery is being operated in Nigeria currently is the Sea Fisheries Act Cap S.4 of 2004 and its related Regulations. An update and review exercise of the Act, with inputs from the relevant stakeholders, was conducted in May 2011.

8. Institutional and administrative frameworks for fisheries management

These include the following organizations:

- Federal Department of Fisheries in the Federal Ministry of Agriculture and Rural Development, which manages marine fisheries resources;
- Nigerian Institute for Oceanography and Marine Research, which conducts research in the marine environment of the country;
- Nigerian Maritime Administration and Safety Agency, which registers all fishing vessels under Nigerian flag;
- Nigerian Navy and Marine Police, which assist Monitoring Control and Surveillance Division of Federal Department of Fisheries in the enforcement of the provisions of the fisheries law and regulations.

There is also the National Council on Agriculture responsible for the harmonization of agriculture policy and the National Fisheries Development Committee that gives inputs into fisheries development plan.

8.1. National and regional forums for discussions on fisheries management

At the national level there is a bi-annual stakeholders forum that involves, the Federal department of Fisheries, Nigerian Institute for Oceanography & Marine Research, Nigeria Trawler Owners Association, Nigerian Navy, Nigeria Police (Marine), among other organizations. The discussion focuses on the challenges encountered by the industry such as piracy, cost of operation, input availability, compliance with fishing laws and regulation.

Regional fora includes Fishery Committee for the West Central Gulf of Guinea (FCWC), Fishery Committee for the Eastern Central Atlantic (CECAF), Aquaculture Development in African Countries Bordering the Atlantic Ocean (ATLAFCO), *Guinea Current Large Marine* Ecosystem (GCLME) and African Caribbean Pacific Fish II projects (ACP Fish2).

9. Management measures and tools currently in use and status of implementation

The management measures and tools in use for the shrimp fisheries include (Table 4):

- Sea Fishery Act No 71 Cap S4 of 2004 and the related regulations
- Inshore Shrimp fishing Licensing Regulation
- Offshore Licensing (Distant Water and EEZ Licensing Regulation)
- Fishing Regulations Specifying
    - i. Non-trawling zone of 0 – 5 nm from the coastline
    - ii. Trawl net cod-end mesh size restriction of 44 mm for shrimp fishing
    - iii. Vessel size restriction for inshore shrimp fishing operation (23.2 m LOA and 130 GRT)
    - iv. Turtle Excluder Devices (TEDs) and other Bycatch Reduction Devices (BRDs) Regulation of 2006.

The implementation of these measures includes, but not limited to:

- Routine inspection of all fishing vessels that land in all port or jetty in the country to ensure compliance with the provisions of the Sea Fisheries Act;
- Annual prelicensing inspection of fishing vessels to ensure compliance with the relevant provisions of the Sea Fisheries Act and Maritime Laws before renewal of annual fishing license;
- Regular workshops and meetings with all stakeholders in the subsector which provide platform for effective comanagement of the fisheries resources.

Table 4. Management measures and tools in use in the industrial shrimp fisheries of Nigeria.

Types of management tool/measures	Comments
Spatial (area) restrictions and closures	
Non-trawling Zone	0 - 5nm from the coast, effective 1992 as part of fisheries regulation. Compliance level is very low.
Gear restrictions	
Gear Size restrictions	Trawl net having cod-end mesh size of 44 mm (Fishing Regulation of 2004) and BRDs (Fishing Regulation of 2006) respectively. On-shore inspections at landing sites indicate very high compliance level.
Gear type Restriction	Same as above
Participatory restrictions	
Licenses	Licensing effective and compliance is total

9.1. Enforcement and compliance issues

Since the management tools do not include catch restrictions, compliance and enforcement problems does not apply with regard to catch against permitted exploitation. Compliance and enforcement problems as regards MCS are quite obvious. This is occasioned by very critical MCS implementation constraints, which include:

- Lack of surveillance boat(s). This is a very important facility for enforcement of the Sea Fisheries Act and its Regulations. The current total reliance on-shore monitoring and vessel inspection at landing sites does not ensure sufficient and effective monitoring and compliance with provisions of the Law and its Regulations;
- Lack of vehicles to service MCS Programmes nationwide;
- Lack of communication equipment, such as VMS and radio;
- Manpower shortage;
- Capacity building.

10. Other comments relevant to the management of the fishery and the way forward

The industrial shrimp fishery, including shrimp trawling, is being hampered by a number of challenges, which include:

- Series of sea armed robbery attacks on trawlers resulting in loss of equipment and human lives;
- High cost of fuel which represents about 80 percent of operational cost;
- Lack of dedicated central fishery terminal in Lagos where 99 percent of trawler operators are domiciled. This has led to reliance on private jetties with the attendant large leasing charges.

As a result of these challenges many trawler operators have withdrawn the fishery, as they could no longer contain the losses. Since the ultimate goal of EAF is improvement of human welfare, the above extraneous social challenges need to be addressed.

Other management constraints include lack of adequate manpower in the Monitoring Control and Surveillance Division, Federal Department of Fisheries, as well as funding.

References

Abohweyere, P.O. 1993. On the ecology and sustainability of penaeid shrimp (coastal) fishing in Nigeria. Coastline of West Africa. *In*: *Coastline of the world*. p. 1–14.

Ajayi, T.O. & Talabi, S.O. 1984. The potential and strategies for optimum utilization of the fisheries resources of Nigeria. NIOMR Technical Paper No. 18.

Amadi, A.A. 1990. A comparative ecology of estuaries in Nigeria. *Hydrobiologia*. 208: 27–38.

Ambrose, E.E; Solarin, B.B.; Isebor, C.E. & Williams, A.B. 2005. Assessment of fish bycatch species from coastal artisanal shrimp beam trawl fisheries in Nigeria. *Fisheries Research* 71: 125–132.

Bayagbona, E.O. 1979. Survey of shrimp resources of Nigeria. NIOMR occasional paper 24. 59 pp.

Domain, F. 1980. *Contribution á la connaissance de l'écologie des poissons démersaux du plateau continentale sénégalo-mauritanien. Les ressources démersales dans le contexte général du Golfe de Guinée. Thèse de Doctorat d'Etat es-Sciences Naturelles. Université Pierre et Marie Curie, Paris VI.*

Federal Department of Fisheries. 2008. Fisheries statistics of Nigeria. Fourth Edition.

Raitt, D. F. & Niven, D.R. 1969. Exploratory prawn trawling in the waters of the Niger Delta. *In*: Proceedings of the UNESCO Symposium on the Oceanography and Fisheries Resources of the Tropical Atlantic, Abidjan 1966. Paris, UNESCO. pp. 403–414.

Scott, J.S. 1966. Report on the fisheries of the Niger Delta special area. Port Harcourt, Niger Delta Development Board. 109 pp.

Thomas, D. 1969. Prawn fishing in Nigeria. *In*: Proceedings of the UNESCO Symposium on the Oceanography and Fisheries Resources of the Tropical Atlantic, Abidjan 1966. UNESCO, Paris. 415–417 pp.

Tobor, J.G. 1990. The fishing industry in Nigeria: status and potential for self-sufficiency in fish production. NIOMR Technical Paper No. 54. Lagos. 34 pp.

World Resources Institute. 1990. *World resources: a report by the World Resources Institute and the International Institute for Environment and Development.* New York, Basic Books.

AN EAF BASELINE REPORT FOR THE SEYCHELLES ARTISANAL AND RECREATIONAL FISHERIES TARGETING THE DEMERSAL FISH STOCKS BY HANDLINE, TRAPS, GILLNETS AND DROP LINES

Joel Nageon, Vincent Lucas, Warwick Sauer

1. Introduction

This chapter presents the EAF Baseline repot for the artisanal and recreational fisheries for demersal fish stocks in the Seychelles.

For the purposes of this report, the fishery is defined as those fishing activities that operate in reef areas targeting reef-associated teleost fish, including demersal species and some semi-pelagic species.

2. Overview of the fishery and resources exploited

2.1. Area fished, gear and the resources exploited

The Seychelles EEZ encompasses an area of 1 374 000 km^2 of which only 48 019 km^2 cover ocean depths of less than 200m, the remainder being over depths of 1000-1500 m. The main group of islands (approximately 32) is granitic and within 30 miles of the main Island of Mahé. The remaining are coralline and are more widely dispersed, with Aldabra lying over 500 miles west-south west of Mahé. There are two principal continental shelf or plateau areas: the Mahé Plateau and the Amirantes Plateau and these constitute the main fishing grounds for the artisanal fishery.

The artisanal fishery in Seychelles is characterized by 14 fishing sectors, with 7 main regions comprising of over 50 landing sites (Figure 1). Except for Port Victoria, the other landing sites have very limited and rudimentary shore based facilities. The artisanal fishing harbor in Port Victoria, recently rebuilt in 1998 with funding from the Japanese Government, was planned to cater for the growth in the local demersal handline fishing industry for over ten years but is already faced with the problems of congestions due to the ever increasing number of larger vessels. In 2011, the Victoria artisanal fishing port was extended and a new fishing port to be utilized both by the artisanal demersal fleet and the semi-industrial fishing fleet opened on Zone 6 of the Providence Industrial Estate. Two ice making facilities operated by private companies are in place but are occasionally faced with shortages. Besides Victoria, the Seychelles Fishing Authority owns three other ice-making facilities and another one is found on the island of Praslin. Facilities for repairs and maintenance of the demersal fleet are available either in Victoria or the Providence area.

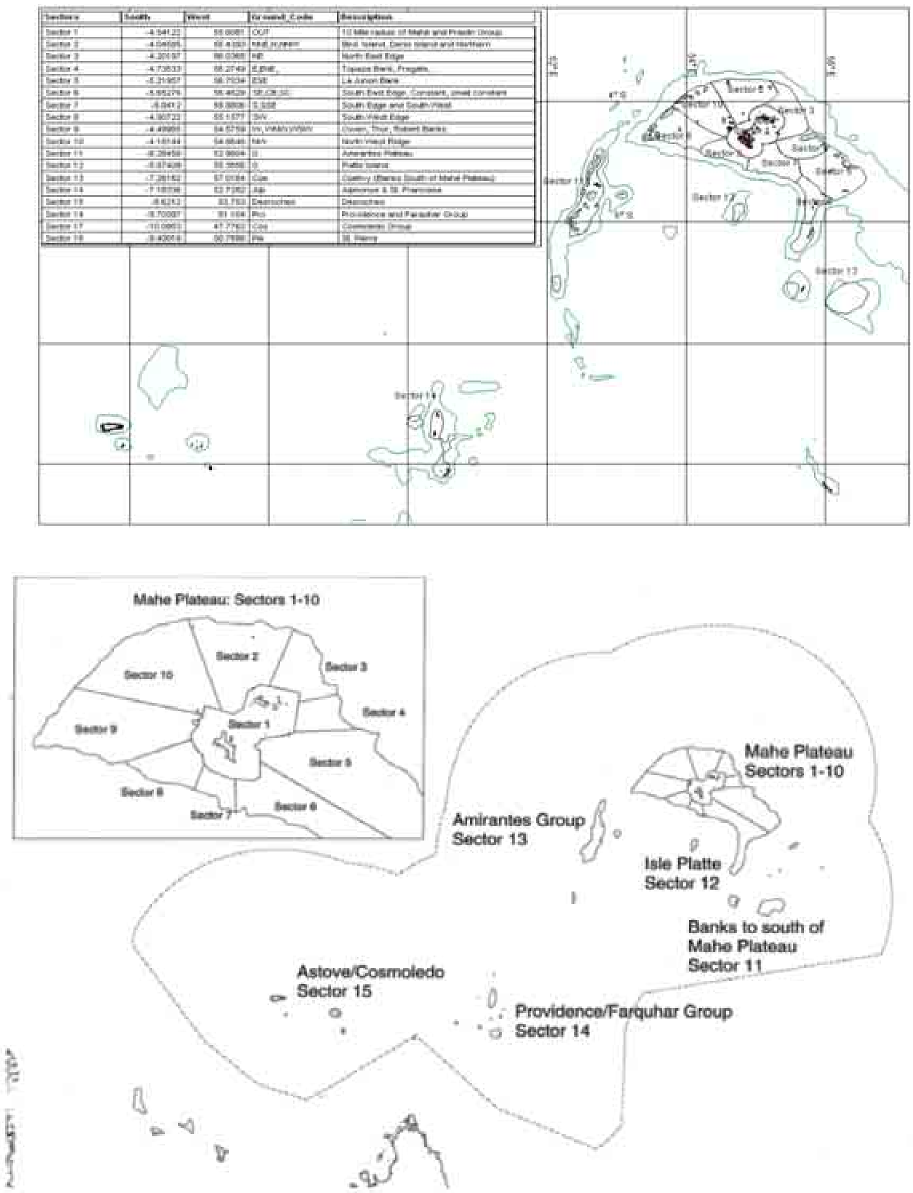


Figure 1. The Seychelles Exclusive Economic Zone, showing the Mahé Plateau and associated banks (after Lablache & Cararra, 1984a).

Seychelles is characterized by a series of continental shelves with a total surface area of almost 50 000 km^2. A wide range of marine habitats including shallow water fringing reefs, granitic reefs, banks, plateaus, shelves and drop-offs, atolls, lagoons, seamounts and pelagic habitats can be found within the Seychelles waters (Jennings, 1999). The Seychelles waters are relatively rich in fishing resources, demersal as well as pelagic (Sweenarain and Cayré, 1988).

Fishing grounds can be identified within three major regions; inshore reef and inshore waters, offshore fishing banks and outer islands. Both inshore regions relate to Fisheries Sector 1, whereas the offshore banks and outer islands are classified within Fisheries Sectors 2 – 15 (Figure 1).

The main fishing grounds (Mahé and the Amirantes Plateaux) are of steep sided plateau rising rapidly from around 1000m. The Mahé Plateau is encompassed by an incomplete shallow rim of around 10-20 m, which surrounds an area of about 50-65m^2 with subsurface granite and coral outcrops forming banks. The relative large area of the shallow banks and plateau in Seychelles provides the main fishing grounds for an important artisanal demersal fishery (Table 1).

Table 1. Total fishable areas (km²) of Seychelles banks and plateau at shallow (0-75m) and intermediate (75 -100m) depth strata and length (km) of the 100 ms depth contour (after Mees, 1998).

Location/Strata	Shallow strata (km2)		Intermediate strata	
	Total	Fishable	Length (km)	Area (km2)
Mahé Plateau				
Inshore	—	6 000	—	—
Offshore	—	6 500	—	—
Trawlable	—	14 000	—	—
Total	**41 338**	**26 500**	**998**	**374**
Outlying Islands, Plateaux and Banks				
Banks South of M.P, including Platte	2 199	1619.6	542.6	135
Amirantes Plateauinc. Desroches	3 999	2399.0	455.6	136
Alphonse	190	114.0	55.6	14
Providence/ Farquhar	1 621	927.7	549.5	132
Astove/ Cosmoledo	398	238.9	129.5	32
Total	8 407	5299	1 733	449
Grand total	**49 745**	**31 799**	**2 731**	**823**

The artisanal fisheries in Seychelles are characterized by a multispecies resource base, encompassing a diverse assemblage of demersal, reef-associated and pelagic fish species, plus a range of invertebrate groups such as lobsters, sea cucumbers and octopus (Robinson and Shroff, 2004). Practiced solely by Seychellois fishers, the artisanal fisheries comprise a variety of vessel and gear types. The traditional man powered wooden canoes ('pirogues') have been replaced by more powerful craft. Larger and more sea-worthy boats, mostly built of fiberglass have allowed fishermen to venture further out to sea and to exploit offshore banks and deep-water species (with more positive results for the fish stocks). The fleet is now dominated by small fiberglass boats ('Mini-Mahé') powered by outboard motors (> 15 hp) and partially decked whaler vessels ('Lekonomi' and 'Lavenir') powered by inboard motors (Mees, 1989). Most large artisanal fishing vessels are presently (since the late 90s and early 2000s) equipped with echo sounders and GPS which enables fishermen to locate fish schools easily and to reduce searching time. These two modern fishing equipment, in particular the GPS, has permitted a significant increase in the fishing power, allowing fishers to target high valued species (in particular red snappers and groupers) and have put considerable pressure on those demersal fish stocks.

The main gear types employed are hand lines, fish traps, drop lines, beach seines and gillnets. Other than a minimum mesh size of 40 mm for traps, and a ban on spear fishing and on the use of demersal trawl nets, there are no management measures relating to the fishery. The handline fishery using hooks and lines is by far the most important type of fishing technique, accounting for more than 73 percent of total fish landings. Handlines are used to target species like snappers, groupers, emperors and trevallies. Each fisher operates a single monofilament hand line containing 6 to 12 hooks per line and each hook is usually baited with a piece of pelagic fish (e.g. Indian mackerel or bonito).

In 1986, electric and hydraulic reels were introduced to facilitate hand line operations and to encourage fishers to venture further offshore. As mechanization of the hand line fishery has improved new hook and line fishing techniques such as drop lines (1994) and more recently bottom (horizontal long lines) longline (2011) have been introduced with some success.

Numbers and vessel types used in the handline fishery include:

- 210, 5-7 m open fiberglass vessels powered by 25-40 hp outboard engines. These boats were introduced in Seychelles in 1977. Account for 26 percent of the catch.
- 50, Lekonomi type vessels, which are 6.5 m to 8.0 m fiberglass vessels equipped with an icebox and a one to two cylinder inboard engine. Account for 25 percent of the catch.
- 61, whaler type vessels, which were traditional open decked clinker-constructed vessels 9-12 meters with inboard engines which are now mostly partially decked and built of fiberglass accommodating a crew of 6 to 7 persons. Most whaler type vessels are now equipped with iceboxes and doing trips of 3 to 6 days. Account for 35 percent of the catch.
- 19, Schooners which are wooden-hull decked vessels usually between 10 to 15 meters and equipped with a 3 to 4 cylinder diesel inboard engines and an icebox of 2500 to 3000kg capacity. Schooners do trips averaging 8 days on the edge of the Mahé and Amirantes Plateaux. Account for 10 percent of the catch.

The trap fishery accounts for 15 percent of total landings. Traditionally traps are fabricated out of bamboo; however metal meshare slowly becoming more common. Traps are used to reef fish species, some of which are not caught in the line fishery, including rabbitfishes (siganids), parrotfishes (scarids) or juvenile's groupers (serranids) and snappers (lutjanids). This fishery originally targeted mostly inshore species associated with reefs (and protected lagoons) and inshore shallow water banks. In the last 20 years however, the inshore trap fishery has moved further offshore, up to a distance of 30kms from the granitic islands. Of concern is the percentage of juvenile and immature fish, mostly taken as Bycatch, as a result of the relatively small size of the mesh (minimum width of 40 mm), in particular wide-bodied juvenile fish such as snappers and emperors. Another concern for sustainability is the heavy seasonal fishing pressure on spawning aggregations of some species.

Moreover, in the last 10 years, most larger hand line fishing vessels targeting demersal species at the edge of the Mahé Plateau and on the Amirantes Plateau, now carry one or two fishing traps (depending on space availability on board) so as to supplement their hand line catch and/or use the trap fish for bait and food for the crew. This practice can be qualified as very destructive, in view of the large amount of juvenile fish caught (mostly as Bycatch).

Beach seine and gillnets are used mainly to target small pelagic such as mackerels, sardines, decapterus and fusiliers.

Artisanal fisheries catches have remained fairly stable since comprehensive monitoring began in 1985, averaging 4568 tonne per annum. However over the period 2008 to 2010 catches dropped significantly by 45 percent. Piracy and the rising cost of fishing operations are factors which may have contributed to this decline in artisanal fisheries catches over the past 3 years.

Alongside the artisanal fishery exist the sport and the recreational fisheries. The sport fishery is a relatively small sector made up of licensed super ski boats primarily taking tourists out for big game fishing for species such as wahoo, dolphin fish, sailfish, tunas and marlins. The main gear type used is trolling, however, some handline fishing for demersal species are also conducted. Its contribution to the coastal livelihood is relatively unknown, as there are few data collected for this fishery, even though a logbook system was introduced.

Similarly, the monitoring of recreational fishery is virtually impossible since anyone can fish for leisure or as a hobby in the Seychelles. Fishing is considered as a fundamental right of every Seychellois citizen and therefore no license is required for recreational fishing. Moreover, because recreational fishermen are mostly active during the evenings and week-ends, the landings are not recorded in the Seychelles Fishing Authority (SFA) statistics, even if most of the catch is commercialized.

The artisanal fisheries predominantly target the semi-demersal *Caranx* spp. (trevally) and demersal resources such as *Lutjanus* spp. (snappers), Aprionvirescens spp. (green jobfish), *Epinephelus* spp. (groupers), and *Lethrinus* spp. (emperors). Pelagic species such as *Euthynnusaffinis* (bonito) and tuna found on the Mahé and Amirantes Plateaux are also targeted. The larger demersal hand line vessels also occasionally target the offshore banks in the southern island group.

Sharks are caught by both the artisanal and recreational fisheries. The implementation of the NPOA for sharks progressed relatively slowly since it was produced in April 2007. However over the last 2 years some progress has been made on some work programs. Funds have been secured by both NGO's and the Government (Seychelles Fishing Authority) to address many of the activities identified under the various work programs. The SEYSHA research project will address many of the gaps identified under research, regarding biology, ecology and behavior of coastal shark in the Seychelles. The tragic deaths of two tourists in August 2011, due to shark attacks, (the first in 50 years), have highlighted the lack of scientific information about the ecology and behavior of sharks in Seychelles. This research will improve our knowledge on the behavioural ecology of some coastal shark species in the Seychelles, and the knowledge will be used to assess existing spatial management (MPA) and make recommendations for improving management measures if necessary.

A new fishery, which is an adaptation of the drop line fishery, has recently been introduced in the last few months (SFA, personal communication) called the bottom drop line technique. This fishing technique, which in effect is a demersal long line, is presently being carried out by three vessels and targets the same species as the hand line fishery. Preliminary results would indicate that the catches, in particular for groupers, look promising. However for reason of sustainability the development of such fishing technique should be done in accordance with available fishery resources.

Catch composition (SFA data), excluding catches from the recreational sector, is given in Table 2 and percentage catch by different gear types in Table 3.

Table 2. Species composition of catches from the artisanal fishery recorded by the SFA from 2000 to 2010. Source: Artisanal Fisheries Statistic for 2010 (SFA Technical Report).

Species Group	Catches (tonne)										
English/Scientific names	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Trevally (*Caranx* spp.)	1 762	1290	2 040	1 289	1 175	1 100	756	783	1 227	538	675
Mackerel (*Rastrelliger* spp.)	469	264	346	221	461	683	254	386	377	307	203
Bonito (*Euthynnusaffinis*)	81	52	69	135	78	88	74	82	148	152	48
Rabbitfish (*Siganus* spp.)	174	90	203	255	317	241	279	215	191	226	255

Species Group	Catches (tonne)										
Red snapper (*Lutjanus* spp.)	415	595	490	444	710	987	1 027	1 237	1 051	606	561
Jobfish (*Aprionvirescens* spp.)	550	704	611	607	521	498	596	658	756	511	354
Groupers (*Epinephelus* spp.)	150	107	74	92	96	93	121	158	155	83	78
Emperors (*Lethrinus* spp.)	424	479	336	233	258	227	168	191	340	219	97
Others spp.	724	704	720	560	559	516	569	471	531	377	324
Total	**4 748**	**4 285**	**4 889**	**3 836**	**4 174**	**4 433**	**3 845**	**4 181**	**4 777**	**3 019**	**2 595**

Table 3. The percentage of artisanal catch by gear type. Source: Artisanal Fisheries Statistic for 2010 (SFA Technical Report).

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Gear type											
Harpoon (Octopus)	0.6	1.0	0.5	0.6	0.5	0.5	0.5	0.3	0.8	0.5	0.3
Handlines	75.8	81.6	80.8	78.9	70.8	71.6	76.4	78.7	80.2	74.0	72.1
Traps	8.5	7.0	8.9	11.1	11.8	7.4	9.6	6.5	6.3	10.0	11.9
Handlines & Traps	3.4	3.6	2.7	3.4	4.6	4.8	5.4	3.8	4.6	4.8	5.4
Gillnets	10.5	6.1	7.1	5.7	11.6	15.3	6.2	9.3	8.1	10.8	10.2
Beach Seine	1.2	0.6	0.0	0.2	0.3	0.3	1.3	0.0	0.0	0.0	0.0
Dropline	0.0	0.0	0.0	0.0	0.3	0.0	0.6	1.4	0.1	0.0	0.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.2. Number of fishers and land-based workers by sector

The estimated number of full-time fishers employed in the artisanal demersal fishing sector in 2007 amounted to approximately 1 050 plus an indeterminate number of part-time and recreational fishermen. Unfortunately, there is currently no reliable information on the total number of full-time commercial fishermen within the population. This is partly as a result of the lack of distinction between recreational and part-time fishermen and full time commercial fishermen. SFA has introduced a system to register all full-time fishermen but up to now the list has never been completed, mainly due to a lack of cooperation by full-time fishermen (Wakeford, 2000). It has been estimated that full-time demersal fishers represents 62 percent of total number of fishers in the artisanal fishery sector and accounting for 73 percent of total fish landings.

The number of persons employed in the land-based artisanal processing sector is approximately 200 (including around 25 part time workers). The two largest employers are ‘Oceana Fisheries’ and ‘Sea-harvest’ together with three other small processing plants.

The future development and employment potential in the artisanal demersal fishery can be considered to be moderate, with the best prospects being in value-added processing activities.

2.3. Routine data collection

SFA routinely collects and monitors data for the main fisheries. The artisanal fisheries have been monitored since 1985 through a catch and fishing effort survey (CAS, Catch Assessment survey). Fisheries technicians are rotated between fishing landing sites where they sample catches and record fishing effort, to which a number of raising factors are calculated and applied to obtain estimates of total catch per strata and boat / gear type category.

The system is composed of 4 boat type surveys plus data collected from the fish processing companies. The individual surveys within the system are in terms of boat type, gear type stratification, area stratification, species classification, outputs sampling procedure and daily record forms and the methods of estimation of catch and effort. Detailed information on these surveys is described in Mees (1990a).

The four surveys are:

(a) Small boats Survey

The main objective of the small boats survey is to collect catch, effort, and species composition data on the small boats fisheries. The boats types covered are (i) fishermen on foot, (ii) pirogues, (iii) outboards and (iv) whalers with traps. Catch and effort data is collected for 18 boat/gear type categories.

(b) Whaler Handline Survey

The main objective of the Whaler Handline Fishery survey is to obtain catch, effort species composition and economic data by vessel type. The gear types used are either handlines and or electric reels. Catch and effort data is collected for 31 species category and is designed to provide monthly estimates on a stratum basis.

(c) Schooner Fishery Survey

The objective of this survey is to obtain catch and effort species composition and economic data on the schooner fishery. Catch and effort data is collected for 30 species categories in addition to an ‘others’ category of unidentified species.

(d) The Sport Fishery Survey

The objective of this survey is to obtain catch and effort, species composition and economic data on the sport fishery. Even if a logbook system was put in place since the inception of the CAS, low returns have made it impossible to monitor this subsector.

In addition to the above data collection schemes based on catch and effort, the SFA also collects length/frequency and biometric data for the following commercially important species.

2.4. Natural, anthropogenic factors impacting the artisanal fishery

The biological productivity supporting fisheries varies spatially and temporally and is linked to environmental parameters which are influenced by global warming and climate variability. During the first half of 1998, the coral reefs of the inner granitic islands of the Seychelles were affected by the worst mass coral bleaching event in the Indo-Pacific region to date, caused by a mass of warm water spreading over the entire Indian Ocean. Coral mortality due to bleaching was on average 85 to 90 percent (SEYMEMP Final Report, 2004). The reefs were again impacted in 2002, 2003 and 2010 by other smaller scale bleaching events. Current trends suggest that raised sea water temperature events will reoccur with increasing frequency in the future and coral bleaching will undoubtedly be repeated.

Although the impacts of climate change on terrestrial and marine ecosystems have yet to be adequately assessed in Seychelles, the 1998 coral bleaching event clearly demonstrated its ability to cause major habitat perturbations, with potential to cause changes in fish diversity and abundance and severe socio-economic impacts. Habitat perturbation is also directly caused by human actions. In Seychelles there is an extreme scarcity of land for development purposes. As a consequence, major land reclamation works have been carried out since the early 1980s on Mahé and Praslin to provide much needed land for economic development but have also had significant impacts on the coral reefs and the productivity of the coastal zone (SEYMEMP Final Report, 2004). Land reclamation has resulted in loss of potential fishing grounds, hence fishing opportunities to many small scale fishers, particularly the artisanal trap fishermen.

The percentage share of tourism related activities (provisional figure for 2009) was 25.5 percent of GDP (NSB report, May 2010). Economically, the country is heavily dependent on tourism and fishing. Tourism grew substantially during the last decade. It achieved record numbers in terms of visitor arrivals in two successive years, 2006 and 2007, with 140 627 and 161 273 visitors respectively. From 2000 to 2006 visitor arrivals grew by 8 percent overall. Although visitor arrivals dropped by 1 percent in 2008 and 2009 due to the global economic crisis and the IMF economic reform programme, results were better than had been projected. During the period of January to December 2011, 194 476 visitors arrived. This was 11 percent above the 2010 level. In 2011, earnings from tourism were SCR[1] 2570 million compared to SCR 2451 million in 2010, representing an increase of 5percent.

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

Emperor Red snapper (Lutjanussebae)

<u>Biology</u>

The emperor red snapper (local name: Bourzwa) lives in a variety of habitats including rock and corals reefs and also over adjacent gravel patches. They are found in waters from 25 to 60 m deep. Juveniles are frequently commensally with sea urchins in inshore waters (when less the 20 cm) and moving to deeper waters as they grow larger. They form schools of similar-sized individuals or are solitary. *Lutjanussebae* is a large long-lived species attaining a maximum size of 116 cm fork length and a maximum age of 34 years. (Grandcourt, 2008). Commercially, it is a very important food species (usually marketed fresh or frozen) but in certain regions of the western Indian Ocean (Mauritius and Madagascar) large individuals are known to cause ciguatera poisoning. found on the Seychelles plateau generally spawns from October to May with the peak spawning period during March and April.

[1] 1 Seychellois Rupee (SCR) = 0.08 USD

Distribution

In Seychelles, it is caught almost exclusively on the Mahé Plateau and very rarely caught on the Amirantes Plateau. It is caught almost everywhere on the plateau within depths of 30 to 80 m but most commonly caught at a depth between 45 to 55 m.

Two-spot red snapper (Lutjanusbohar)

Biology

The two-spotted red snapper (local name: varavara) inhabits coral reefs, including sheltered lagoons and outer reefs. Usually found singly, often adjacent to steep outer reef slopes but occasionally found in groups. It feeds mainly on fishes, but also eats shrimps, crabs, amphipods and gastropods. It spawns throughout the year with peak spawning activity in March and in October/November (Wheeler and Omanney, 1953). Large specimen in oceanic areas in the Western Pacific and some parts of the western Indian Ocean (Mauritius, Reunion and Madagascar) can be ciguatoxic. The species is eaten fresh or salted (on outer islands). In Hong Kong it is sold on the live fish market.

Distribution

In the Seychelles it is commonly found around all the islands of the archipelago in particular around the coralline islands of the Southern Group. It is commonly caught on shallow water banks and coral outcrops at a depth ranging from 20 to 45 m but can be found up to a depth of 70 m (Smiths' Sea Fishes, 1988).

Humphead snapper (Lutjanuscoccineus)

Biology

The Humphead snapper (local name: Bordomar) inhabits corals and rocky reefs up to a depth of 100 m but prefers shallow offshore banks. It attains a maximum length of 80 cm and a maximum weight of 27 kg. It is very active at night, when it is mainly caught, feeding over sandy or ruble bottom. Its preferred depth is between 45 and 55 m. Adults develop a pronounced hump on the forehead and its preferred food includes shrimp and invertebrates. It spawns mainly from October to May with peak spawning period during March /April.

Distribution

In Seychelles it is found mostly on the Mahé Plateau but the South-West of the Plateau which is an area that contains fine grey muddy substrate, supports the major population of (Tarbit, 1980). This is also an area that supports minor quantities of penaeid shrimps.

Lyretail Grouper (Variolalouti)

Biology

The Lyretail Grouper (local name: Kwasan) usually occurs in clear-water areas at depths below 15 m, preferably between 20 to 50 m. And it prefers islands and offshore reefs rather than continental shores. It is a non-migratory species attaining a maximum length of 83 cm and weighing up to 12 kg. It feeds mainly on fishes but also on crabs and shrimps. Its flesh is very delicate and sought after. It cannot be openly sold in Mauritius or La Reunion (where it is subject to size restrictions) because of cases of ciguatera poisoning however, it is very popular in the Hong Kong live fish market.

Distribution

It is found on both the Mahé and Amirantes islands as well as the shallow offshore banks around all the coralline islands of the southern Group.

Brown spotted grouper (Epinepheluschlorostigma)

Distribution

Found on rocky and coralline banks of the Mahé and Amirantes plateaux as well as around most other coralline islands of the archipelago.

Blue and yellow grouper (Epinephelus flavocaeruleus)

Biology

The blue and yellow grouper (local name: Vyey plat) is yellow colored as a juvenile but this colour usually disappears in adults. The species can grow to a maximum length of 90 cm and weigh up to 15.0 kg. The species is believed to be a protogynous hermaphrodite with the peak spawning season in Seychelles during March/April. It is found in a depth range from 10 to 150 m (Smiths' Sea Fishes, 1994) with a preferred depth of 50-60 m.

Distribution

According to Tarbit (1980), although it is found on all areas of the Mahé plateau, its distribution is controlled by the substrate and it is more commonly found on the Southeast (Sectors 5 & 6) and Northeast of the Plateau (Sectors 3 & 4).

Green jobfish (Aprionvirescens)

Biology

The green jobfish (local name: Zobgri) is found from coastal reefs ecosystem to offshore banks up to a depth of 100 meters. Although this fish forms an important component of the demersal hand line fishery in Seychelles, it is considered to be bentho- pelagic (or semi-pelagic) being generally found swimming several meters from the sea bottom. The most common size for this species is around 60 cm (total length) attaining up to 102 cm at a maximum age in excess of 8-9 years. The species is known to breed during the period January to April/May with a peak spawning activity in January (Tarbit, 1980).

Distribution

Occurs on all fishing banks on the Mahé and Amirantes Plateaux and around the Southern Island Group.

Blue-spotted jobfish (Pristipomoides filamentosus)

Biology

The bluespotted job fish (local name: Zobzonn) occurs over rocky bottom generally at a depth range from 40-400m but most commonly found between 180 to 250 meters. At night, it migrates vertically to the upper part of the habitat to feed (where it is most commonly caught by hand lines).

Distribution

Commonly found in deeper waters at the edge of the Mahé and Amirantes Plateau and around all offshore banks generally at a depth exceeding 100 m.

Bludger trevally (Carangoidesgymnostethus)

Biology

The bludger (local name: karangbalo) is considered to be semi-pelagic. It is the most commonly caught fish by the hand line demersal fishery, accounting for almost 30 percent of the total artisanal landings. This fish is commonly found in mid-water several meters above the sea bed usually on shallow coral banks (at a depth range of 20-50 meters). It is usually found inshore (between 2 and 20 km from the granitic islands and travels in schools). Juveniles usually form large schools whereas the larger individuals are more solitary. It feeds on shrimp and small fish. The peak spawning season is generally in April and May when it comes closer inshore where it also usually caught in large numbers between May to September. The species is known to attain a maximum size of 94 cm for a recorded weight of 14.5 kg (Smiths' Sea Fishes, 1998).

Distribution

Occurs uniquely on the Mahé plateau where it is found mostly inshore and caught in large numbers during May to September. It is considered an excellent food fish when eaten fresh.

Spangled emperor (Lethrinusnebulosus)

Biology

The spangled emperor (local name: kaptennrouz) inhabits coral reefs, coralline lagoons, seagrass beds, mangrove swamps and coastal sand and rock areas. Adults are solitary or in small schools; juveniles form large schools in shallow, sheltered sandy areas, also found in seagrasses, algae or sponge habitats at depths ranging from 5 to 70 m. This species is a protogynous hermaphrodite and it has been suggested that in Seychelles there are two distinct spawning seasons; one extending from September to December and the other from March to May (Wheeler and Omanney, 1953). Recorded maximum total length for this species of emperor is 86 cm with weights attaining at least 4.4 kg.

Distribution

Found both on the Mahé and Amirantes plateau(in particular the latter) and the other southern island Group, in depths ranging from 3 to 70 m, with a preferred depth of 15 to 30 m. It is caught by traps as well as hand lines.

Sky emperor (Lethrinusmahsena)

Biology

The sky emperor (local name: madanm beri) is found over reef areas and adjacent sandy and seagrass habitats up to a depth of 100 m. It is a protogynous hermaphrodite and is commonly found at a total length of 40cm although it can attain a maximum length of 65 cm with a maximum reported age of 27 years (Smith' Sea Fishes, 1994).

Distribution

Found on all shallow banks on the Plateau areas and around the southern coralline islands and is known to be non-migratory. Its favoured depth is from 10 to 40 meters.

Bonito (Ethynnusaffinis)

Biology

The bonito (local name: bonit) is considered to be semi-pelagic it forms an important component of the artisanal demersal hand line fishery. Bonito is found in open waters but always remain close to the shoreline. The young may enter bays and harbours. It forms multi-species schools by size with other scombrid species comprising from 100 to over 5000 individuals.

Distribution

Found all over the Mahé Plateau mostly inshore.

3.2. Stock status

Table 4 provides the latest information on the catch trends and management measures for the fisheries resources targeted by the artisanal fishery.

Table 4. Stock status, trends and management measures for the fisheries resources targeted by the artisanal fishery. Source: Reproduced from SWIOFC Scientific Committee Report, Seychelles Status tables for 2010 and 2012.

Species/ Complexes/ Groups	Stock	Trans-boundary /Straddling/ EEZ	Catch 2010	Measure of abundance	Stock status (Note 12)	Annual Management plan (✓/×)	Management Measure(s)
Sharks inshore and offshore (Note 1)	Mahe Plateau, Amirantes, Outer Island	EEZ	20.7	–	D	×	Shark nets prohibited, NPOA being implemented
Slope water snappers f (Note 2)	Mahe Plateau	EEZ	7.31	–	R	×	None
Fish Multispecies (Note 3)	Demersal linefish stocks	EEZ	1044.4	CPUE declined past 3 years	F-O	×	None

Species/ Complexes/ Groups	Stock	Trans-boundary /Straddling/ EEZ	Catch 2010	Measure of abundance	Stock status (Note 12)	Annual Management plan (✓/×)	Management Measure(s)
(Note 4)	Mahe Plateau	EEZ	35.50	–	Unknown	×	None
(Note 5)	Mahe Plateau	EEZ	479.38	–	F-O	×	None
Note 6)	Mahe Plateau	EEZ	297.65	-	F	×	None
(Note 7)	Mahe Plateau	EEZ	28.19	-	F	×	None
Fish Multispecies (Note 8)	Semi-pelagic line fish stocks	EEZ	736.6	CPUE declined past 2 years	M	×	None
spp.	Semi-pelagic line fish stock	EEZ	613.58	-	-	×	None
spp.	Semi-pelagic line fish stock	EEZ	49.35	-	-	×	None
	Semi-pelagic line fish stock	T/S	37.56	-	-	×	None
Fish Multispecies (Note 9)	Semi-pelagic gillnet stocks	EEZ	265.2	CPUE variable, declined past 2 years	M	×	Gear/fishing time/area restrictions
	Semi-pelagic gillnet stock	EEZ	174.23	-	-	×	
Fish Multispecies (Note 10)	Inshore trap fish stocks	EEZ	308	CPUE weak declining trend	F-O	×	Minimum mesh size
(Note 11)	Inshore trap fish stock	EEZ	210.05	–	Unknown	×	Minimum mesh size

Notes in Table 4:

Note 1: Catch data includes rays and is considered as underestimated by a large extent given the practice of fining. The NPOA indicates that shark fisheries are substantially data deficient but that significant historical, anecdotal and fisheries-independent information suggests inshore populations continue to be severely depleted. Revised fuel rebate conditions concerning permissible level of catch and Bycatch of sharks in the semi-industrial fishery have led to a major reported decline in catches of offshore sharks. While many semi-industrial vessels are known to have switched to targeting swordfish and tuna, reduced catches recorded between 2009 and 2010 are indicative of high level of under reporting particularly from the offshore fishery.

Note 2: This fishery reported declines in effort in 2009 and 2010. Yield in the last 10 years significantly below MSY of 268 tonnes for Mahé Plateau (estimated from Mees, 1993)and continues to be lower - stocks were overfished in the early 1990s and considered to be recovering.

Note 3: Major declines in catch occurred across all species of the demersal line fishery between 2009 and 2011. The level of decline in catch was commensurate with a large decline in effort measured by men days. During those 3 years the fishery was affected by piracy as well as by economic reforms resulting in higher operation cost which may also have reduced effort. Analysis of VMS data indicates a slight spatial shift in the distribution of the fishing effort. Estimates of virgin biomass (1.4 t/km^2 = 17500 tonnes) and MSY (0.168 t/km^2 = 2100 tonnes) for Mahe Plateau inshore and offshore line (< 75m) grounds (12500 km^2) from Mees (1992). Yield of demersal guild (0.111 t/km^2) below MSY in 2009. Also, several demersal (indicators species) stocks are fully or overexploited.

Note 4: No recent assessments since 2005 study, so status unsure. However, high fishing pressure continues in the absence of management measures, so concerns over stock remain.

Note 5: Per recruit assessments (Grandcourt, 2008) indicate over-exploitation in recent years. Catches in 2007 was more than 4 times greater than revised MSY estimate (208 tonnes). Current catch level still above MSY level, hence stock requires urgent management measures.

Notes 6 and 7: Stock assessments conducted in 2007 for the period 2004-2006 revealed overfishing in some years (2004) against management indicators (L_{c50}/ L_{m50} in conjunction with F/M), while reduced catches in more recent years indicate that these had not been exceeded.

Note 8: This fishery was also subject to declines in effort in 2009 and 2010.

Note 9: In 2009, the main target species was potentially misidentified which may partially explain the large decline in catch. Highly variable yield with large seasonal/inter-annual variability in catch and effort. Stocks of the main target species have not been assessed, but the fishery has been considered as under-exploited as only inshore portion of stock is targeted.

Note 10: Catches below MSY (445 to 471 tonnes), derived from Schaefer models (Wakeford, 2000, BSFC report), in 2007. Fishery has been fully- to over-exploited in previous years and the primary target species is overexploited.

Note 11: Stock of (a primary target species) is over-exploited (reports to BSFC). Species-specific stock assessment difficult to estimate as siganid species are aggregated to family in the catch assessment survey.

Note 12: Status of stocks according to the following definitions: U – underexploited; M- moderately exploited; F – fully exploited; O: overexploited; D: depleted; R: recovering.

3.3. Ecosystem effects of anthropogenic factors

The east coast of the main island of Mahé has been subject to large extensive reclamation projects since the early 1970s. The reclaimed land has been utilized for the construction of the International airport, the expansion of Port Victoria and for industrial and housing developments on the east coast industrial estate. This has caused the destruction of important inshore ecosystem such as coral reefs, sea grass flats and mangrove forests, which were important fish habitats both for reproduction and growth, in particular for juveniles. Consequently, fish resources on the inshore coast of east Mahé have been considerably reduced and this has had a direct impact on capture fisheries with a considerable decline in coastal marine resources. For example, the coastal village of 'Pointe Larue' situated alongside the International Airport used to be an important fish landing site for at least a dozen fishing boats. Presently, the fishers have either been displaced to other fish landing sites or have discontinued all fishing activity, with the result that the growing population of the village now has to purchase their fish from other landing sites or from Victoria Market. Similar reclamations work have also been undertaken in more recent years on the second main island of Praslin, although on a lower scale. Habitat destructions particularly coral reefs and sea grass flats also occurred there. Furthermore in spite of the use of siltation screens trap fishers of Praslin claim that large coastal areas have been affected by reclamation works for considerable time after work has been completed and this has affected coral growth as well as the presence of many marine species in the area.

Tourism developments is another factor that has had a direct impact on the inshore marine ecosystem as land along the coast is very often requisitioned for tourism projects, whereby the developers are often prepared to pay high prices for prime coastal land or beach front property. In such cases, fishers are severely affected by such displacements as their fishing ground and access to the sea become seriously restricted. Examples of such tourism developments are at Port Launay and Beau Vallon on Mahé and Anse Possession on Praslin. Another impact of development in coastal areas is the damaged caused by the deposit of land-based sediments onto coral reefs ecosystem.

The use of destructive fishing methods are considered to be one of the major immediate threats to coral reef ecosystems in some countries. Very early in the development of the fishing industry in the Seychelles, destructive fishing practices were prohibited. Dynamite and cyanide fishing, practiced in other parts of the world, have never been an issue in the Seychelles and spear fishing using spear guns is also banned. The impact of demersal trawling trials in the late 70s and early 80s on the shallow banks at the rim of the Mahé Plateau may have seriously impacted this ecosystem and such practices are now illegal.

The main mode of destructive fishing practices in the artisanal fishing sector in the Seychelles is isolated to a few cases of fishermen using gill nets on coral reefs. However the level of such practice and its impact on the ecosystem has never been assessed.

In more recent years, there have been some concerns over the increasing use of steel mesh in traps rather than the traditional bamboo, as lost traps made of steel may continue to trap fish over a long period. However this ghost fishing has never been verified and it is doubtful that traps will continue to attract fish once the bait is depleted. Although steel traps are favoured because they are long-lasting and more resistant to shark attacks, there is the possibility that they have a greater potential for habitat damage than bamboo traps. Some fishermen claimed that compared to bamboo traps, which were seldom set on coral reefs for fear of damaging the traps, metal traps are being set directly onto coral reefs and are likely to be causing damages. Given that metal traps are increasingly being used for the targeting of reef fish species, it would be wise to monitor the use of such gear and access its impact on the coral reef ecosystem.

Other factors claimed to be having significant impact on the coral ecosystem are damages caused by boat anchoring on coral reef habitats (Beaver, 2004), as well damages caused by FAD's (Fish Aggregating Devices) intensely used by industrial purse seiners, as they are washed up on coral reefs particularly in the outer island region.

3.4. Traditional knowledge

Historically, Seychellois fishers have always considered the Mahé Plateau as their traditional fishing grounds where all the major demersal species can be caught, including the high-valued species like red snappers and groupers. The Mahé Plateau is still the main fishing ground for the artisanal demersal fleet, in particular from October to May (during the calmer seas of the North-west Monsoon). The Mahé plateau however, is a large body of open water and affords very limited shelter to the fishing fleet with only two islands (Denis and Bird Islands) bordering the Northern rim of the plateau, providing minimal shelter in rough weather.

Fishing effort has traditionally been concentrated on or at the edge of the Plateau, where the shallow coral banks are located. Fishers utilize their experience (this is now facilitated by using echo-sounders and/or GPS) to locate the good fishing grounds and once a good fishing spot is located (on the plateau) they either drop anchor or drop a marker buoy to demarcate the spot. In deeper waters (more than

70 meters), on the edges of the plateau or on offshore fishing banks, fishers allow their boats to drift up and down over the fishing ground utilizing engine power to return to their original fishing spot. When fishing on the Southeast sector of the Plateau (Sectors 5 & 6), which extends up to 180 km from Mahé (Constant Bank), fishing vessels sometimes travel in pairs for greater security.

From June to September, which corresponds to the rough seas of the South–east Monsoons, certain fishers concentrate their fishing effort on the Amirantes plateau, as the numerous coralline islands provide shelter at night for the fishing fleet. In effect, they venture on the edges and middle of the Plateau during the day and return to the shelter of the islands for the night. When fishing on the Amirantes, fishing effort concentrates on shallow water species, mainly emperors and groupers found at a depths ranging from 25 to 45 m.

A challenge faced by fishers when sailing directly south to the Amirantes is that they have to cross about 40 km of open oceanic waters (with depths exceeding 2000 m) where they cannot anchor should they experience an engine breakdown. This is the reason why only experienced fishers make this trip.

4. Annual catches and importance of the fishery in the national economy

The fishing industry in Seychelles is a major contributor to the economic development of the country. The economic importance is derived from its role as a source of employment, contribution to production, food security and income generation, trade and foreign exchange generation, government revenue and most importantly as a major source of animal protein.

Traditionally, fishing has occupied an important place in the lives of the Seychellois people. Seychelles has one of the highest per capita consumption of fish with most recent figures standing at about 57 kg per annum (FAO, 2005). The local supply of fish comes mainly from the artisanal subsector.

Artisanal fisheries catches have remained fairly stable since comprehensive monitoring began in 1985, averaging 4568 tonnes per annum. However over the period 2008 to 2010 catches dropped significantly by 45 percent. Piracy and the rising cost of fishing operations are factors that may have contributed to this decline in artisanal fisheries catches over the past 3 years.

It is estimated that the fishing sector including ancillary activities generates both directly and indirectly around 6 000 jobs, amounting to about 17 percent of total formal employment. In terms of income generation, for 2008 the National Statistic Bureau (NSB) estimated the “direct” contribution of fisheries activities to the total Gross Domestic Product (GDP). This new method of calculating GDP was applied to previous year’s data and it showed that since 2004, the percentage of fisheries contribution to the total GDP has been increasing from 6.4 percent of the total GDP at current market prices to 7.7 percent in 2008 (NSB report, May 2010). It is believed that should all fisheries related activities be taken into account, the annual true contribution to GDP would be between 15 and 20 percent.

Official figures from the Central Bank of Seychelles indicate that from 2008 to 2010 gross earnings from fisheries and fisheries related activities surpassed gross earnings from tourism. This further highlights the economic importance of the fisheries sector and its role in the development of the country.

Fisheries are often variable in their social and economic importance, between fisheries and on spatial and temporal scales. The economic viability and the social background of fisheries have an important impact on sustainable use and response to management. At present, socio-economic information is not well integrated in fisheries monitoring even though fisheries specific socio-economic surveys are conducted from time to time; for example for the studies by Mees (1990b) and by Wakeford (2000). Basic socio-economic parameters should be monitored and assessed routinely, both to identify management concerns and to determine management impacts. Moreover, expertise and practice at SFA tends to veer towards the economic aspects of fisheries, and social systems and dynamics are poorly understood or studied. A good and efficient fisheries socio-economic data management and dissemination are crucial not only for fisheries management purposes, but even more so in the monitoring of the performance of the sector.

Table 5 shows the production of fish and fish products from 2004 to 2010. Canned tuna accounted for approximately 88 percent of the total domestic production of fish and fish products and remained the most important product manufactured locally. The production of prawns stopped in 2009 with the closure of the Coetivy Prawn Farm.

Table 5. Total production of fish and fish products (tonnes) from 2004 to 2010.
*Seychelles flagged vessels.

	2004	2005	2006	2007	2008	2009	2010
Artisanal catch	4 177	4 583	3 849	4 189	4 777	3 019	2 595
Semi-Industrial catch	111	312	237	269	233	329	295
Canned tuna	36 109	40 606	40 222	31 569	28 709	30 824	30 338
Other processed tuna	585	334	218	276	-	-	-
Prawns	1 175	772	638	368	289	50	-
Smoked fish	16	15	25	29	31	28	30
Others	32	37	52	53	35	60	70
Sub Total	**42 205**	**46 659**	**45 241**	**36 753**	**34 074**	**34 311**	**33 328**
Purse seine catch*	82 600	87 534	79 340	49 938	56 382	68 339	75 787
Long liner catch*	9 998	14 359	8 374	8 462	6 795	8 323	6 659
Sub Total	**92 598**	**101 893**	**87 714**	**58 400**	**63 178**	**76 663**	**82 446**
Fish meal	-	-	-	6 899	6 873	5 168	7 863
Fish oil	-	-	-	731	537	826	915
Sub Total	-	-	-	7 630	7 410	5 994	8 778
Grand Total	**134 803**	**148 552**	**132 955**	**102 783**	**104 662**	**116 967**	**124 551**

5. Fisheries management plan and objectives

There is no specific Management Plan for the artisanal demersal hand line fishery or the recreational fishery. Some management measures however, have been introduced (mainly over the last 30 years) to monitor and control the development of the artisanal fishery.

Objectives for the fishery

With respect to artisanal and recreational fishery targeting mainly the demersal fish stocks, the general objectives of the Government of Seychelles are:

- As a primary goal, to ensure appropriate sustainable management of the resources such that all fishing is undertaken with due regard and concern for the stability of fish stocks and conservation of bio-diversity for the long term benefits of all stakeholders;

- To promote, through economic and fiscal measures, the stable development of an economically viable upgraded fishing fleet in order to target underutilized fisheries resources distant from the granitic islands, and to encourage the reduction of fishing effort near the granitic islands;
- To ensure that adequate provision is made for safety at sea and the protection of the rights of individual fishermen;
- To promote value addition to Seychelles fish products for the domestic and export markets whilst ensuring adequate food security for Seychelles;
- To encourage the development of adequate supporting infrastructure for the fishing industry.

More specific goals for the artisanal fishery should be considered and could include:

- To ensure stocks are fished sustainably;
- To ensure maximum employment in the sector;
- To rebuild stocks which are overfished;
- To promote the economic stability and realise the potential of the fishery;
- To minimize impacts on the reef ecosystem;
- To introduce specific management measures, explore area bound management, and promote comanagement.

At present no restrictions are imposed on the recreational sector. The following objectives are proposed for consideration:

- To promote sustainable fishing practices in the leisure industry, with appropriate levy structures and the introduction of management measures;
- To promote sustainable fishing practices by the general public, with a levy structure if appropriate and the introduction of management measures;
- To promote fishing practices which do not harm the reef environment.

6. Legal framework

The responsibility of formulation of fisheries policies lies with the Ministry for Natural Resources and Industries (MNRI). The executive arm of the Ministry with respect to fisheries is the Seychelles Fishing Authority (SFA). The functions of the SFA as defined in article (5) of the Seychelles Fishing Authority (Establishment Act) are inter alia:

- To promote, organize and develop fishing, fishing industries and fishing resources in Seychelles;
- To assist in the formulation of the national policy with respect to fishing, fishing industries and fishing resources and in the implementation of that policy;
- To conduct negotiations, or engage in meetings, seminars or discussions, with regard to fishing or fisheries or the establishment or operation of fishing industries, whether at a national or international level, on behalf of the Republic or otherwise;
- To identify the manpower training requirements of Seychelles with regard to fishing and fishing industries.

A number of other organizations are also involved in fisheries policy and administration, which include the Seychelles Tourism Board, the Department of Environment (DOE), the Seychelles National Park Authority (SNPA), the Seychelles Port Authority and the recently formed Seychelles Maritime Safety Administration (SMSA). Other important organizations are Seychelles Licensing Authority, the Coast Guard, the Seychelles Police, and the Attorney General's Office, as well as NGO's.

The Seychelles Fishing Authority was established in 1984 under the Seychelles Fishing Authority Establishment Act 1984. This act was subsequently amended in 1991.

The Act requires the SFA to collect and analyze statistical and other information on fisheries and to prepare and keep under review plans for the development and management of the fishing industry. In preparing these plans, the SFA is required to consult with fishermen and others stakeholders, and where practical with regional bodies. Currently management plans exist only for the lobster fishery. A sea cucumber management plan was prepared in 2005 with the assistance of the FAO Technical Cooperation Programme. However the fishermen rebuffed its recommendations hence the management plan is not being implemented.

The legislation allows the Minister responsible for fisheries to prescribe management measures including: closed seasons, closed areas, gear specifications, fishing methods or gear types, specification of species sizes or other characteristics of aquatic organisms that is permitted or forbidden to catch, and schemes for limited entry into the fishery.

Fisheries regulations (1987 and amended in 1998) currently exist for the management of net fisheries, the protection of certain shell fisheries, mesh sizes for fish traps, prohibition of the use spear guns, and closed season for the lobster and sea cucumber fisheries.

The main legal frameworks controlling fisheries in Seychelles are the following:

1. The Maritime Zone Act (1977). This act proclaimed Seychelles as a sovereign state and established and defined, the Seychelles EEZ, the baselines, the continental shelves, the territorial waters and the historic waters etc.
2. The Fisheries Act 1987. This act defined all the fisheries regulation concerning both the local and foreign fishery. It established the major fisheries management measures the fishing licenses procedures and the fines for breaching each license regulations.
3. The licenses (fisheries) Regulations (1987). These regulations define the various categories of fisheries licenses. The Regulations also sate the conditions of the licenses and the various fees applying for both local and foreign licenses.

A new Fisheries Amendment Bill has been in the process of being formulated for a number of years. The Bill has recently been presented to stakeholders and it is envisaged that it will be operational by 2013.

Importantly the new Bill makes provision for the introduction of management plans. However at the meeting between SFA and stakeholders (20/7/2012) it was stated that there is no intention currently to introduce management for recreational fisheries but the proposed Bill does make provision for this. Any proposed Management Plan will have to ensure compliance with the new Fisheries Bill as well as ensure that any proposed fee structure is discussed in terms of the licenses (fisheries) Regulations (1987).

7. Institutional and administrative frameworks for fisheries management

From its inception, the Seychelles Fishing Authority (SFA) has been given the autonomy and institutional support to manage and develop the country's fisheries to their fullest potential. There are a number of Government Institutions with mandates covering aspects of fisheries administration. Table 6 lists the major stakeholders involved in the fishing industry. The most important institutions are further discussed below.

Table 6. Main government institutions with responsibilities in the Fisheries Sector

Institution	Roles and responsibilities
Ministry for Natural Resources and Industry (MNRI)	Ministry responsible for fisheries, including all aspects of policy specification.
Seychelles Fishing Authority (SFA)	Agency mandated to promote and develop the fishing industry to its highest potential. Executive arm of government in all fisheries related matters. Employs over 100 staff. Created in 1984.
Seychelles Ports Authority (SPA)	Responsible for port management. Generates 80percent ofrevenues from the fisheries sector, and employ around 100 staff. Created in 2004.
Seychelles Maritime Safety Administration (SMSA)	Sets and monitors rules on vessel safety in accordance with international standards. Created in 2004
Seychelles Licensing Authority (SLA)	Responsible for the issuing of all fishing licenses, basedon recommendations from SFA. Created in 1986
The Seychelles Coast Guard (SCG)	Monitoring, Control and Surveillance. Created in 1994
Ministry of Foreign Affairs	Deal with international relations, aid donors, international and regional organizations (IOC,COMESA, SADEC, etc.). Also support the SFA vis a vis negotiations for the Economic Partnership Agreement with the EU.
Maritime Training Centre (MTC), Ministryof Education	Established in 1979 and was transferred under the Ministry of Education from MENR in 2005. Responsible for human capacity development, and focusing primarily on vocational training. Board of Directors includes fisheries stakeholders, e.g. CEO of the SFA.
SeychellesNational Park Authority(SNPA)	Responsible for the management of all Protected Areas including Marine Protected areas. Conduct research into marine environmental issues, coral reefs, marine mammals, etc. Falls under the Ministry of Environment and Energy.
Attorney General's Office	Drafting of fisheries legislation, and prosecution of offences.
Seychelles Investment Bureau (SIB)	Intended to be a "one-stop shop" for foreign and domestic investment promotion. Responsible for approving investment projects. Created in 2005.
National Bureau Statistics (NSB)	Compiles statistics from various sectors including from the fisheries sectors. Calculate fisheries contribution to the general economy.
Seychelles Bureau of Standards (SBS)	Falls under the Ministry for Natural Resources and Industry (MNRI). Responsible to sets physio-sanitary norms and other norms for all Seychelles industries/products. It is the competent authority for quality and standards of fisheries products.

Institution	Roles and responsibilities
Ministry of Land Use and Habitat (MLHU)	Responsible for land use planning, and allocation of land e.g. for port development. Also responsible for maritime boundary delimitation.
Islands Development Company (IDC)	Provide support to the SFA for aerial surveillance (leasing of plane).
Development Bank of Seychelles (DBS)	Provision of loans to the fisheries sector.

Seychelles Fishing Authority (SFA)

The SFA was created in 1984 at the time of intense development in the fishing industry, in particular in foreign industrial tuna activities in the Western Indian Ocean. SFA absorbed the staff from the defunct Fisheries Division and Fishing Development Company (FIDECO) and became the executive arm of the government in all fisheries related matters. SFA presently employs a staff of approximately 100 people, which includes scientific and administrative personnel. The main objectives for the creation of SFA have been outlined above.

SFA is therefore the only national fisheries organization with a mandate to perform management, planning development, scientific/development research and training functions as well as carrying out a regulatory function by:

- Conducting surveillance in collaboration with the Coast Guard in relation to fishing operations in the exclusive economic zone of the Seychelles.
- Monitoring the catch of all fishing vessels.
- Carrying out scientific and development research.
- Collect, compile, analyse and disseminate statistics on the sector upon which informed decision can be based.

Due to an extensive Exclusive Economic Zone of ~1.347 million km^2, monitoring control and surveillance is a major challenge for the Seychelles. With limited surveillance resources, IUU fishing activities occur, up to a certain extent, in the Seychelles water. Illegal activities such as poaching (turtles, dolphin, sea cucumber, lobsters) and illegal fishing practices (illegal shark nets, spear guns, etc) are common occurrence in the small scale fishing sector. Furthermore, there are the occasional reports from fishers of illegal activities by foreign fishing vessels in the Seychelles waters. Unfortunately the competent authorities cannot act on every single report, however a number of arrests and convictions have resulted from such reports.

Overall, monitoring control and surveillance systems have greatly improved over the last decade. VMS was introduced in 2003, mainly for industrial vessels fishing for tuna and tuna-like species and more recently on semi-industrial fishing vessels and some of the larger artisanal fishing vessels with autonomous power supply. A pilot project is currently underway to identify and implement the most appropriate systems on small scale fishing vessels lacking power supply. MCS issues have recently been addressed in conjunction with the regional IOC/EU-MCS Pilot Project, including efforts to train officers and harmonize critical elements of fisheries legislation throughout the IOC region.

In its articles 52 to 64, the IPOA-IUU encourages port States to put the necessary controls in place at the level of port installations (ports or offshore terminals).

An important number of Port State Control measures are already in place in the Seychelles, including the providing of advance notice before entering port, inspection of some 90 percent of all vessels calling to port Victoria, the refusal to authorize illegal fish to be transshipped or landed in port Victoria by vessels identified as having engaged in IUU fishing.

Similarly to MCS, the regional IOC/EU-MCS Pilot Project, is spear-heading a host of initiatives on Port State Control, most importantly, the sharing of information on an individual vessel basis through a centralized database system.

Over the last 12 years the SFA has experienced a shortage of qualified staff, as a result of resignations (including non-renewal of contracts) and high turnover rate of senior scientists. At the beginning of 2000, the SFA had 10 qualified scientists, including four with postgraduate degrees. However by 2003 the SFA had lost four of its scientific staff, and this problem was exacerbated in 2007 by the government‘s economic reform programme which saw the downsizing of public institutions, with the SFA losing more scientists. The SFA found it difficult to recruit new scientists over the years due to less attractive salary packages compared to what was being offered by other institutions. Currently the SFA has only one senior and five junior scientist. In 2012 a new service scheme was introduced for SFA staff, offering better salary packages, with the objective of maintaining the current workforce as well as attracting new recruits.

Fisheries Management is one area requiring urgent capacity enhancement to effectively develop and implement fisheries management plans. Currently there is only one Fisheries Administrator in the Fisheries Management Unit. Research and development, and MCS are other areas needing capacity building, to be able to deal withthe increasing commitments both nationally and regionally.

Ministry of Environment and Energy (MEE)

The Ministry for Home Affairs, Environment and Transport (MHAET) was created in May 2010 through an expansion of the previous Ministry of Environment and was previously in charge of the Natural Resource sector (previously under the Ministry of Agriculture and Marine Resources). Consequently in 2012, this ministry was changed to Ministry of Environment and Energy. The Department of Environment within this Ministry has a Principal Secretary (PS) dealing with Environment issues.

The Environment Department is responsible for issues related to pollution, and this responsibility involves policing of the environment. The Department is consulted on all projects that have a potential impact on the environment, and environmental issues are of significant political/public importance in the country; legislation specifies that industrial and tourism projects must be accompanied by an environmental impact assessment.

Ministry of Natural Resources and Industry (MNRI)

This Ministry, which was newly created in May 2010,was previously also responsible for fisheries. The Ministry is responsible for negotiating fishing agreements, and for the specification of fisheries policy. The responsibility is however delegated primarily to the SFA. The SFA works closely with the Ministry on all fisheries matters.

Seychelles National Parks Authority (SNPA)

This Authority, created in June 2009, replaced the defunct Seychelles Centre for Marine Research and Technology (SCMRT- MPA) that was created in 1987. The SNPA is a management and research organization, mandated for the management of the Seychelles Marine and terrestrial National parks and for promoting marine research in the Seychelles. The Centre has numerous research projects, such as looking at habitat use by juvenile hawksbill turtles, monitoring of turtle nesting beaches, coral reef monitoring, marine habitat mapping and rehabilitation of mangrove and coral reef habitats. The NPA is a parastatal organisation and is partly funded by the government.

Seychelles Coast Guard

The Seychelles Coast Guard falls directly under the office of the president. It was set up by the Defense Force Act, 1980, Section 34 of 14 November 1994, taking into account:

a) The extent of the EEZ;

b) The urgent need to stop illegal exploitation of resources within the EEZ and the territorial waters of Seychelles, and to ensure sustainable exploitation of resources. In the absence of means from the Police, SFA and other civil authorities, it undertakes the tasks under item b). In addition to controlling fisheries, the Coastguard has the responsibility for pollution prevention, surveillance of marine parks, hydrography, search and rescue, and assistance to port authorities (immigration, terrorism, and monitoring of seized vessels).

The Coastguard is staffed by 140 military officers, with 30 to 40 of them having received training in the control of fisheries. The major operational means that can be used for control of fisheries on the high-seas include two 42 m patrol vessels (M/V Topaze and M/V Andromache). The Coastguard also owns a middle range patrol vessel (26 m) and two inshore patrol vessels (12 m). The Coastguard has no airborne capacity for monitoring illegal fishing activities.

Liaison with SFA is organized through an informal committee meeting monthly. There is no formal planning of control activities per se. In practice, the Coastguard is solicited by SFA only when an infringement is detected through VMS or other indirect control means (including reports from fishermen at sea or based on the outer islands). The SFA has to financially support the mission requested (most importantly, with respect to fuel costs).

Patrol for the inshore fisheries is limited due to the resources of the Coast Guard and are more or less carried out by SFA, which are usually shore based enforcement. The capacity of the Coast Guard is more geared towards offshore fisheries patrol.

The role and importance of the coast Guard has increased significantly in the last three years, as in addition to its normal EEZ surveillance, it has been directly involved in protecting vessels operating both inside and outside the Seychelles EEZ (including fishing, cargo and pleasure crafts vessels) from Somali pirates.

Maritime Training Centre (MTC)

The Centre was established in 1979 with financial and human resource assistance from France, and as of January 2005 has come under the responsibility of the Ministry of Education. The MTC is the principal institution providing tertiary training in the maritime fields. This centre also provides training to private sector stakeholders involved in fisheries, outside of on the job training provided by fishing companies.

The MTC is divided into three divisions: Deck, Engineering and Fisheries and includes several supplementary courses such as diving, first aid, firefighting, radio-operators and in navigation. The current Certificate in Maritime Studies comprises 13 modules over a period of two years including one introductory module on the Environment and a three-month attachment within the industry. However, the Certificate course does not have a sufficiently high level of training for graduates to be able to work on foreign going or internationally registered vessels. This course provides the basic training required for employment at entry level or for example inter-islands vessels, semi-industrial and artisanal fishing vessels.

The MTC has an average of 250 applicants every year from which 27 are recruited making a total of 54 students attending the Centre at any one time. On completion of studies, trainees appear to find employment in both the private and public sectors. A notable achievement for the MTC is that at least half of the skippers and marine mechanics on the semi-industrial long line fleet (12 vessels) are former graduates of the MTC, as well as most of the crew on the SFA research vessel “L’AMITIE”.

A new Maritime Training Centre was opened in 2012. This new facility was funded by BADEA (Arab Bank for Economic Development in Africa). The new building is designed to accommodate 100 students a year with an annual intake of approximately 50 new students.

NGOs

There are no distinct fishing communities in the Seychelles and no fishing village as such. The fishermen are dispersed throughout the three main granitic islands. The first attempt in the 90’s to create a fishermen’s association was a worldwide catholic support movement called “Apostolat de la Mer”. The organization held consultations with fishermen to allow them to air their grievances and it also published a newsletter with the aim of transmitting their problems to higher authorities. Unfortunately the organization did not have enough political and financial support to be credible and although it still exists today, it is largely ineffective. The “Apostolat de la Mer” opened the door to independent fisheries-related associations, which marked a turning point in fishermen’s perception of such associations. In November 2003, the Fishing Boat-Owners Association (FBOA) was created. The association currently has 35 members and is expanding. A chairman was elected and the Association was given an office and secretary paid by SFA. Until recently, the Association held monthly meetings with the Fishing Authorities (MNRI and SFA) where issues of concern are discussed. Although there continues to be the problem of individuals bypassing the Association and going directly to higher authorities to vent their grievances, in general there is more cooperation between the members and SFA.

The FBOA has also achieved some measure of success in participating in discussions to obtain concessions on duty exemption for fishing material and safety equipment, and assisting fishermen in obtaining compensation for repair of vessels and replacement of equipment damaged in the tsunami disaster. Another area where the FBOA has been of assistance to SFA is to convince members of the need to submit regular and reliable statistics that will eventually be used to improve the management of fisheries. In general there is good cooperation between the association and the fishing authority.

The Praslin Fishers Association was formed in 2009, under the framework of the UNDP – GEF, Mainstreaming Biodiversity Management Programme, as a pilot project to test and develop comanagement systems for artisanal fisheries on Praslin. The project is currently in its final stages and the PFA is actively liaising with the government on fisheries matters. Other initiatives include, the Seychelles Sea Cucumber Committee (SSCC), set up by fishers and processors involved in the sea cucumber fishery, the Artisanal Shark Fishermen Association (ASFA). Other associations at district level are also emerging.

With regards to Governance in the fishery sector, the Seychelles Fishing Authority is also moving away from the traditional top-down management approach and adopting a participatory approach. This is evident in the number of committees (including key stakeholders) that have been set up over recent years. A NPOA shark committee was set up in 2007 to guide the implementation of the Seychelles National Plan of Action for the Conservation and Management of Sharks. A line-fishing committee was set up in 2010 to steer the development and implementation of a demersal line fishing management plan and is getting financial support from the EAF-Nansen program.

The Government in its effort toward better fisheries governance, support those initiatives from fishers and key stakeholders and encourage the active participation of all stakeholders in the decision making process with regards to fisheries matters.

8. Management measures and tools currently in use and status of implementation

The following management measures are currently in place (Table 7):

- Mothership ventures (with dories) are prohibited on the Mahé and Amirantes plateau and only restricted to some offshore banks in the southern islands Group;
- Prohibition of Live fish fishery for export since 1997;
- Demersal trawling was prohibited in the Seychelles EEZ since the early 80s;
- Restricted zones have been set where foreign fishing vessels are prohibited from any fishing activity – in particular for demersal species – within 3 kms from the 200-meter isobaths;
- Marine Parks and fish reserves have been set up around the granitic islands where all fishing activity is prohibited within the boundaries;
- There are protected fishing areas along the reef for all three main granitic islands where fishing with nets is prohibited;
- Restricted fishing period for the mackerel gill net fishery with no fishing allowed at night i.e. from the period between 5 pm and 6 am;
- Catching of sharks with nets is prohibited and in the new proposed shark management plans all vessels with an LOA above 24 meters must keep the fins attached to the carcass;
- Prohibition of deep-water monofilament gill net fishery targeting deep water snappers (mainly Pristipomoides spp);
- Introduction of Vessel Monitoring System (VMS) for all decked hand line fishing vessels larger then 8m in the early 2000s, not only to improve vessel safety at sea but to improve monitoring of the fishery. (VMS gives a more accurate indication of the distribution of fishing grounds fishing vessels are targeting).
- Only Seychellois-owned vessels or companies where Seychellois nationals have a majority share (51 percent) of the capital are authorized to target demersal species.
- The use of destructive fishing techniques such as the use of explosives, noxious substances, spear guns, inshore gill nets demersal trawl are prohibited, hence minimizing the destruction of inshore habitat.
- From the early 1970s regulations were enacted in Seychelles banning the removal of corals from reefs for the manufacture of quick lime. At the same time the law also prohibited the capture and export of tropical fish species for the aquarium trade. This minimized the destruction of coral reef habitat and the decline of tropical demersal fish species.

Table 7. Overview of current management measures

Type of management tool	Comments
Spatial (area) restrictions and closures	
Marine protected areas where fishing is prohibited	MPAs and fish reserves exist since late 70s. The MPAs close to the main island (Mahé) are well managed with good compliance. MPAs that are at further away lack monitoring and enforcement of regulations and poaching activities are rampant
No-take zones	All MPAs are no take zones
Temporal restrictions	
Defined fishing season(s)	3 months for spiny lobsters and 9 months for sea cucumber
Defined number of hours per day fishing	Mackerel gill netting is limited from 6am to 5 pm but regulations are not always enforced or complied with
Gear restrictions	
Gear size restrictions	A minimum mesh size of 40 mm for fish traps
Gear type restrictions	Gill nets not allowed inside reefs and on the plateau (on bottom). Demersal trawling prohibited. Both regulations are very effective with good compliance Spear gun prohibited
Size/Age restrictions (i.e., minimum or maximum sizes)	No landing of berried females spiny lobster
Participatory restrictions	
Licenses	All commercial fishing vessels should have a license (only 40percent compliance). All nets need licensing (95 percent compliance). A license is required to fish for spiny lobsters and sea cucumbers.
Limited entry	Only Seychellois-owned vessels are allowed to catch demersal species. This is a very effective measure with good compliance. A cap of 25 licenses applied for the spiny lobsters and sea cucumber fishery

8.1. Effectiveness of the current management

The mothership dory Management Plan

The mothership (with dories) fishing technique involves targeting specific fishing banks/corals with small outboard powered boats (launched from the mothership) was carried out in the 1970's by several vessels and again in 1991-1993 by a large converted reefer vessel "Le Pecheur Breton".

The mothership venture, because it fishes with a large number of boats, covering a restricted area, accounts for a high fishing pressure on the resource. It is an efficient fishing technique in terms of volume of fish caught but requires efficient handling, processing and freezing of the catch to ensure fish quality (Mees, 1997). In any case all fish caught by such fishing technique are frozen and the market value of the catch is automatically reduced. Therefore, unless such operations are well managed, it can be very wasteful in terms of the quality of the final product (fish is sometimes discarded or/and sold at a reduced price) while at the same time having severe repercussions on the state of the resource.

Following the "Le Pecheur Breton" venture SFA wrote a mothership-dory management plan (Harris 1994) restricting fishing operations for certain islands of the Amirantes, and Southern islands of the Seychelles Group but banning fishing operations on the Mahé Plateau. These measures are still enforced, and limited mothership dory operations areonly practiced on some offshore banks in the southern Island group.

Prohibition of the live-fish fishery

This fishery, which concentrated around the island of Farquhar (in the Southern island Group), took place over several months in 1997, involving a group of 40 fishers from Hong Kong. The company exported three consignments of approximately 20 tonnes of fish. A law has since been passed prohibiting any further live fish hand line fishing targeting high valued species (mainly emperors, snappers and groupers). The fishery is rather destructive both to fish stocks and to the environment with a high mortality rate even when fish of lesser value are used as trash food for feeding prized live fish. This measure has been well implemented and has been very effective so far.

Prohibition of demersal trawling in the Seychelles EEZ

This measure has proved to be particularly timely and effective and has proved to be exceptionally beneficial for the artisanal demersal fishery. The measure was taken in the early 1980's after several demersal trawling ventures proved financially unviable and very destructive to the sea bed and marine ecosystem. Demersal trawling is a particularly destructive fishing technique, in particular for tropical areas with large coral ecosystems, as it alters habitats most notably by destroying and disturbing bottom topography and the associated habitats (e.g. seagrass and algal beds, coral reefs) and benthic communities. In tropical areas fish congregate on areas of high coral density and hence the vulnerability of these habitats is particularly high. This measure has been effectively enforced to date.

Restricted zones have been set for foreign fishing vessels prohibiting fishing activity within 3 km from the 200-meter isobaths

This measure in effect prohibits all foreign vessels from fishing on the continental plateau, in particular on the two main fishing grounds i.e. the Mahé (40 000 km^2) and Amirantes Plateau (4000 km^2). With an average of 70 foreign fishing vessels (purse seiners and long liners) licensed to fish in the Seychelles EEZ at any one time, this measure has proved to be very effective and has preserved demersal stocks for the local artisanal fishery.

Establishment of MPAs and 'Fishing Reserves' around the main granitic islands

Unlike the four management measures mentioned above this measure has proved to be difficult to monitor and to enforce (in particular for the MPAs at a distance from Mahé) and at times it has been counter-productive. Due to lack of trained personnel and financial constraints, enforcement has proved to be difficult at best, if not impossible, with several of the parks considered as 'paper parks'. Possible reasons for this is the lack of enforcement personnel as well as resentment by stakeholders die to the fact that most MPA's have been chosen arbitrarily without previous consultation with the main stakeholders i.e. the fishing community.

Prohibition of deep-water monofilament gill net fishery

This technique that was experimented by SFA for approximately a year in 1996 was judged to be too costly (high percentage of expensive nets lost) and a very destructive (large volume of netted fish lost during net hauling) fishing technique. In addition, its potential damage to the ecosystem was judged to be high with a large percentage of nets tangled in corals and lost nets (ghost fishing). The prohibition of this fishing technique has proved to be very effective and extremely beneficial to other more 'selective' gears used in the artisanal demersal fishery.

Introduction of Vessel Monitoring System (VMS)

VMS was introduced for all decked hand line fishing vessels larger then 8m in 2003, not only to improve vessel safety at sea but to improve monitoring of the fishery and to have a better idea of the distribution/concentration of fishing grounds fishing vessels are targeting. There are now 190 VMS transponders on larger fishing vessels with autonomous power supply, and the demand to install more transponders is growing (SFA personal communication). This measure has proved to be very effective as besides improving safety at sea; it has enabled SFA to improve its statistical system with more accurate monitoring of vessel positioning and more specifically to have a more accurate picture of the distribution of species and fishing grounds. VMS data are also used in scientific analysis. However, more use can be made of the VMS data.

Only Seychellois-owned vessels or companies (where Seychellois nationals have a majority share (51 percent) of the capital are authorized to target demersal species commercially

This has proved to be a very effective measure as in effect it has reduced the fishing pressure on demersal species by eliminating most foreign fishing vessels wishing to enter the demersal fishery.

Restricted fishing period for the mackerel gill net fishery

This measure, which restricts the period for the mackerel gill net fishery to daylight hours (6 am to 5 pm), was meant to reduce the periodic glut in the fishery and hence minimize wastage. This is important as the Indian mackerel is the main source of bait utilized by the hand line demersal fishery. The measure however, has never been enforced and has not been effective in preventing occasional gluts (and wastage) in the fishery.

8.2. Compliance and enforcement issues

In general fisheries regulations governing the monitoring and control of foreign vessels are well enforced and compliance is good. The same cannot be said for the local artisanal fishery, in particular the inshore fishery where compliance and enforcement is almost non-existent. Perpetrators are rarely arrested and on the few occasions when they are, they are very seldom prosecuted or/and convicted. This is mostly due to the numerous loopholes existing in the present legislation, which needs to be reinforced and up-dated.

In this respect there is a need for the local laws to be harmonized and for the local enforcement Agencies-namely SFA, The National Park Authority (NPA), the Coast Guard, the Seychelles Police and the Attorney General's office- to work in closer cooperation so that the perpetrators can be apprehended and convicted. There is a need to improve the procedures for monitoring and enforcement and clearly defining the institutional and organizational responsibilities for fisheries management between the various ministries and departments.

There is a lack of capital investment to equip the relevant institutions with adequate equipment to undertake enforcement and monitoring of fisheries regulations leading to coastal and offshore illegal fishing activity by the artisanal fleet(with the notable exception of VMS at SFA).

Lack of sufficient key personnel such as inspectors, enforcement officers, rangers and planning inspectors to increase the effectiveness of the enforcement process. There is therefore a need to develop comanagement arrangements so as to have shared responsibility between the enforcement authorities and fishes in order to have an overall improvement in fisheries management capacity.

Although there is no vessel or individual fishing quotas for the demersal fishery, fishers have an obligation to keep a record of their catch and to report their landings to the authorities (SFA). This is not always complied with as some fishers refuse to provide information about their fishing activities to enumerators at landing sites.

The introduction of new enforcement measures such as VMS (Vessel Monitoring System) on all larger (above 8m) artisanal vessels has helped to improve this situation. Monitoring, Control and Surveillance of fishing vessels improves transparency and accountability of marine resources.

9. The way forward

There was broad agreement by the National Task Group (NTG) that the a single fishery management plan is required to encompass the different sectors catching demersal and semi pelagic reef fish using handlines, traps, gillnets and drop lines. It was agreed that there has to be a form of registration for all fishers, and it was necessary to investigate some form of access rights, for long-term management measures to be effective. It was agreed that any intervention should involve collaborative management. Given the sensitive and open access nature of this fishery, it was agreed that the first steps should involve a broad awareness drive, and for the medium term interventions should on primary fisheries management.

The following key priority issues were agreed upon for further discussion in the development of the management plan.

Conservation:

- Open access system for capture of demersal reef fish species, and concomitant lack of adequate management measures;
- Patchiness of catch and effort and biological data for the artisanal sector, and lack of any data for the recreational sector. Data is often not species specific;
- Gear restrictions need to be addressed;
- Some ghost fishing possible;
- Current understaffing of the SFA;
- Increase in water temperature and coral bleaching.

Social and economics:

- Lack of economic and social information on the all aspects of the fishery;
- Poor communication between fishers and SFA;
- Lack of understanding of fisheries management by the fishing sector;

- Reduction in catch in some areas;
- Piracy;
- Safety at sea;
- Cost of fishing vs. profits increasing;
- Lack of alternative livelihoods in some cases.

Governance:

- Lack of specific policy;
- Old Act inadequate, new fisheries act not yet finalized;
- Legal framework around the Act requires attention;
- Inadequate specific management measures for individual sectors targeting demersal reef species;
- MCS strategies and implementation require assessment and revision;
- A system of rights allocation needs to be assessed;
- Incentive schemes require revision;
- Fees and levies structure outdated.

References

Seychelles Fishing Authority. 2010. Artisanal fisheries statistic for 2010. SFA Technical Report.

Beaver, K. 2004. Seychelles Marine Ecosystem Management Project final report. Global Environment Facility and the Government of Seychelles. 243 pp.

British Seychelles Fisheries Commission. Seychelles annual status reports to the scientific subcommittee of the British-Seychelles Fisheries Commission.

FAO. 2005. FAO yearbook. Fishery statistics, Commodities. Vol. 97. Rome, FAO. 235 pp.

Grandcourt, E.; Hecht, T.; Booth, A. & Robinson, J. 2008. A retrospective stock assessment of the Emperor red snapper (*Lutjanussebae*) on the Seychelles Bank between 1977 and 2006. *ICES Journal of Marine Science*, 65: 889–898.

Harris, A.; Nageon; de Lestang, J.; Grandcourt, E.; Woodcock, P. & Marguerite, M. 1994. Mother ship line fishing management plan 1994. SFA/R&D/036. Seychelles Fishing Authority.

Jennings, S.; Marshall, S.; Cuet, P. & Naim, O. 1999. The Seychelles. *In*: T.R. McClanahan, C.S. Sheppard & D.O. Obura, eds. *Coral reefs of the Western Indian Ocean: their ecology and conservation.* New York, Oxford University Press. p. 399–432.

Lablache, G. & Carrara, G. 1988. Population dynamics of Emperor red snapper (*Lutjanussebae*), with notes on the demersal fishery on the Mahe´ Plateau, Seychelles. *In*: S.J. Venema, M. Christensen & D. Pauly, eds. Contributions to tropical fisheries biology: papers by the participants of FAO/DANIDA Follow-up Training Course on Fish Stock Assessment in the Tropics, Hirtshals, Denmark, 5–30 May 1986 and Manila, Philippines, 12 January to 6 February 1987, FAO Fisheries Report. Rome, FAO. ISSN 0429-9337. p. 171–192.

National Statistic Bureau. 2010. Statistical bulletin: Seychelles National Accounts Statistics. 30 pp.

Mees, C.C. 1989. Artisanal fishing boats of Seychelles. SFA/R&D/011. 49 pp.

Mees, C.C. 1990a. Seychelles catch assessment survey for the local fishery – a description of the programmes employed to generate the analysis of data. Seychelles Fishing Authority Working Document. 60 pp.

Mees, C.C. 1990b. A socio-economic study of Seychelles fishing community. South West Indian Ocean Fisheries Bulletin 33: RAF/87/008. 8 pp.

Mees, C.C. 1992. Seychelles demersal fishery: an analysis of data relating to four key demersal species. Seychelles Fishing Authority Technical Report SFA/R&D/019. 143 pp.

Mees, C.C. 1993. Population biology and stock assessment of *Pristipomoides filamentosus* on the Mahé Plateau, Seychelles. *Journal of Fish Biology*, 43:695–708.

Mees, C.C. 1997. Demersal fish stock assessment in Seychelles – an analysis of a mothership-catcher boat fishery. *In*: F. Arreguin-Sanchez, J.L. Munro, M.C. Balgos and D. Pauly, eds. Biology and culture of tropical groupers and snappers. ICLARM Conference Proceedings 48. p. 254–265.

Mees, C.; Shotton, R. & Marguerite, M. 1998. An inshore fisheries management strategy for the Seychelles. Final report of project no. FAO/TCP/SEY/6713(A), May 1998. Seychelles Fishing Authority/ FAO.

Robinson, J. & Shroff, J. 2004. The fishing sector in Seychelles: an overview, with an emphasis on artisanal fisheries. *Seychelles Medical and Dental Journal*, Special Issue, Vol 7, No 1.

Sweenarain S. & Cayré, P. 1998. *Impacts économiques des activités thonières industriel le set perspectives de développement dans les pays membres de la Commission de l'océan Indien. In* : P. Cayré & J.-Y. Le Gall, ed. : *Le thon enjeux et stratégies pour l'OcéanIndien. Actes de la Conférence thonière internationale 1996, 27 au 30 novembre1996, Maurice. COI/Orstom, Paris, collection Colloqueset Séminaire*s, p. 210–236.

Wheeler, J.F. & Ommaney, F.D. 1953. Report on the Mauritius-Seychelles fisheries survey 1948–49. Colonial Office Fishery Publication. HMSO.

Seychelles Fishing Authority. Seychelles national plan of action for the conservation and management of sharks. Victoria, Seychelles, Seychelles Fishing Authority. 2007. 59 pp.

Smith, J.L.B.; Smith, M.M. & Heemstra, P.C. 1994. *Smiths' sea fishes*. Johannesburg, South Africa. Macmillan South Africa. 525 pp.

Tarbit, J. 1980. Demersal trawling in Seychelles waters. Fisheries Bulletin No. 4. Fisheries Division, Seychelles, Department of Agriculture and Land Use, Mahé, Seychelles.

Wakeford, R.C. 2000. Management of the Seychelles artisanal fishery. Faculty of Science, Imperial College, University of London (Ph.D. thesis). 377 pp.

AN EAF BASELINE REPORT FOR THE ARTISANAL FISHERIES OF SIERRA LEONE

A. B. C. Jones, Sheku Sei, Victor H. Kargbo

1. Introduction

The Ecosystem Approach to Fisheries Management (EAF) is a developing concept that is now regarded as a modern management tool based on a holistic approach to fisheries management.

The principal objective of the present initiative is directed at strengthening the knowledge base for implementing the EAF concept in developing countries with the initial focus directed towards Africa.

The EAF is seen as an improved way of managing natural resources and it is designed to promote a structured and participatory approach to not only identify possible gaps in existing approaches but additionally to prioritise these gaps with a view to formulating potential management actions to address these gaps. Sierra Leone is one of the target countries benefiting from this initiative.

In this direction, the EAF Project "Improving the Artisanal Fisheries Management in Sierra Leone" has been developed under the sponsorship of the Norwegian Government working in close collaboration with various Global Environmental Fund and Large Marine Ecosystem (GEF-LME) regional projects.

One of the activities listed in the EAF-Nansen Project "Improving the Artisanal Fisheries Management in Sierra Leone" is to undertake a desk study on the management of the main fisheries including their socio-economic significance, usually referred to as Target Resource Oriented Management (TROM) review, which in this case is termed a "Baseline Report". This EAF Baseline Report is an agreed baseline for the fishery before introducing EAF in the management of the resource. It is also a reference material for EAF planning and should provide reference points for the monitoring and evaluation activities and other management actions including the preparation of a fisheries management plan for the artisanal fisheries of Sierra Leone. The guidelines for this study were prepared by FAO and the study itself, which included the preparation of the EAF Baseline Report, was led by the National Consultant.

The following sections present a brief overview of the geographical settings of Sierra Leone including the climate and population of the country.

Country Geography

Sierra Leone is bounded by the Atlantic Ocean in the west and southwest and borders on the Republic of Guinea in the north and northeast and the Republic of Liberia in the south and southeast (Figure 1). Claiming a geographical area of about 27 699 square miles, the country has a population of around 5 million people. Sierra Leone has a tropical climate which is controlled by the West African Monsoon, characterised by a rainy season that lasts from May to December and a dry season that lasts from December to April. Temperature ranges during the rainy season can be around 22-25°C and persists around 25-27°C for the dry season.

Figure 1. Map of Sierra Leone showing main rivers and cities.

The rainy season in Sierra Leone can be very severe and contributes to sea level rises that are often characterised by strong waves and currents. This causes coastal erosions and inundations of coastal communities, leading to the loss of major social and economic livelihoods assets including fishing time. Therefore the geography and climatic conditions influence the artisanal fishery and this underlines the reason why the effect of climate on coastal communities should be taken into account when developing a fisheries management plan for the artisanal fishery sector. The current management arrangement for the artisanal fishery is discussed in Sections 8 and 9.

2. Overview of the fishery and resources exploited

This section provides an overview of the artisanal fishery, including the type of crafts and fishing gears used, major fishing areas, the fisheries resource potential including production, and interactions between artisanal and industrial fisheries for target and non target species.

2.1. Fishing crafts, gear details and fishing areas

The fishing activities are largely concentrated within depth limits of 15-45 km from the coast and within depths below 50 m. This fishery comprises of variety of dugout and planked canoes and a recent survey (EU funded Institutional Support for Fisheries Management (ISFM) Project frame Survey Report; MFMR, 2010) has shown that there are about 9 516 fishing crafts of different sizes of which only about 10 percent are motorized. Artisanal fleet numbers have increased compared the 8 000 crafts recorded in the 2003 frame survey (MFMR, 2003). Artisanal fleet composition and characteristics are shown in Tables 1 to 3. These fishing crafts employ diverse ranges of fishing gears, which include castnets, ringnets, driftnets, setnets, beach seines and hooks.

Table 1. Composition of actual artisanal fishing craft in Sierra Leone.

District (Minor Strata)	Chiefdom	Craft composition					
		Kru	Std 1-3	Std 3-5	Std 5-10	Ghana	Total
Western Area	Western Urban	242	391	105	160	118	1 016
	Western Rural	155	163	121	128	46	613
	Total	**397**	**554**	**226**	**288**	**164**	**1 629**
Port Loko	Kaffu Bullum	86	381	135	91	1	694
	Koya	44	207	64	46	8	369
	Lokomasama	113	547	82	28	4	774
	Maforki	0	214	3	0	0	217
	Marampa	0	28	0	0	0	28
	Total	**243**	**1 377**	**284**	**165**	**13**	**2 082**
Kambia	Mambolo	4	184	73	0	0	261
	Samu	5	525	125	76	24	755
	Total	**9**	**709**	**198**	**76**	**24**	**1 016**
Moyamba	Kagboro	56	295	248	88	4	691
	Timdale	12	121	29	4	0	166
	Ribbi	0	91	13	1	0	105
	Lower Banta	16	49	6	2	0	73
	Banguwa	12	34	11	0	0	57
	Bompeh	0	14	0	0	0	14
	Total	**96**	**605**	**307**	**95**	**4**	**1 107**
Bonthe	Sittia	43	792	140	20	5	1 000
	Bendu Cha	12	250	11	1	0	274
	Bonthe Municipal	7	28	3	0	0	38
	Bonthe Town	16	59	0	0	0	75
	Dema	57	381	263	33	0	734
	Emperi	8	126	8	1	0	143
	Jong	21	75	11	0	0	107
	Kwamebaikrim	64	131	33	11	0	239
	Nogoba bullom	210	221	53	9	0	493
	Total	**438**	**2 063**	**522**	**75**	**5**	**3 103**
Pujehun	Kpaka	13	94	0	4	0	111
	Mano Sakrim	85	250	13	0	0	348
	Soro Gbeima	79	21	7	4	9	120
	Total	**177**	**365**	**20**	**8**	**9**	**579**
	Grand Total	**1 360**	**5 673**	**1 557**	**707**	**219**	**9 516**

Table 2. Composition of Active Artisanal Fishing Crafts in Sierra Leone (MFMR, 2003b).

District (Minor Strata)	Chiefdom	Craft composition					
		Kru	Std 1-3	Std 3-5	Std 5-10	Ghana	Total
Western Area	Western Urban	209	247	88	137	118	799
	Western Rural	134	132	109	98	46	519
	Total	**343**	**379**	**197**	**235**	**164**	**1 318**
Port Loko	Kaffu Bullum	68	332	110	73	0	583
	Koya	27	175	56	37	7	302
	Lokomasama	80	482	67	26	2	657
	Maforki	0	203	3	0	0	206
	Marampa	0	26	0	0	0	26
	Total	**175**	**1 218**	**236**	**136**	**9**	**1 774**
Kambia	Mambolo	4	142	55	0	0	201
	Samu	5	425	73	67	20	590
	Total	**9**	**567**	**128**	**67**	**20**	**791**
Moyamba	Kagboro	51	192	178	73	3	497
	Timdale	6	80	25	4	0	115
	Ribbi	0	74	8	1	0	83
	Lower Banta	10	28	6	2	0	83
	Banguwa	6	22	7	0	0	35
	Bompeh	0	14	0	0	0	14
	Total	**73**	**410**	**219**	**80**	**3**	**785**
Bonthe	Sittia	7	679	158	16	4	864
	Bendu Cha	9	220	10	0	0	239
	Bonthe Municipal	1	33	3	0	0	37
	Bonthe Town	10	62	0	0	0	72
	Dema	25	315	228	29	0	597
	Emperi	5	120	6	1	0	132
	Jong	10	60	10	0	0	80
	Kwamebaikrim	47	116	28	11	0	202
	Nogoba bullom	124	187	52	8	0	371
	Total	**238**	**1 792**	**495**	**65**	**4**	**2 594**
Pujehun	Kpaka	12	71	0	4	0	87
	Mano Sakrim	54	178	12	0	0	244
	Soro Gbeima	44	13	2	1	9	69
	Total	**110**	**262**	**14**	**5**	**9**	**400**
	Grand Total	**948**	**4 628**	**1 289**	**588**	**209**	**7 662**

Table 3. Artisanal craft characteristics

Boat type	Kru[1]	Std 1-3[2]	Std 3-5[3]	Std 5-10[4]	Ghana[5]
Mean length	4-5m	5-6m	6-8m	8-10m	12-18m

The artisanal fishery is the backbone of the national fish production and about 70 percent of the catch is mainly dominated by the small pelagic fish groups of the clupeidae and carangidae. These species are mainly caught by ringnets, beach seines and surface driftnets.

Description of artisanal fishing crafts

This section presents a general description of artisanal fishing crafts used in Sierra Leone. Artisanal fishing crafts comprise of local fishing crafts with lengths up to sixty feet and they can be motorised or non-motorised. Major artisanal fishing crafts can be categorised in to the following:

One man boat (Kru Canoe)

This is the smallest fishing canoe used in the artisanal fishery of Sierra Leone. It is a dugout canoe carved from timber and pointed at both ends. It is about 6 m long and can carry only one person, hence the name – ‘‘one man boat’’ (Figure 2). Means of propulsion is by paddle or a long pole. It can be used for hand lines, hook and line fishing, cast net and gillnet fishing.

Figure 2. Kru Canoe (One man boat)

---

[1] Kru canoe is a one-man dugout craft, propulsion is by paddle and sail.

[2] Std 1-3 is a dugout canoe with maximum capacity of 3 persons, propulsion by paddle and sail.

[3] Std 3-5 is a dugout with maximum capacity of 5 persons, propulsion by paddle and sail.

[4] Std 5-10 is a planked boat with maximum capacity of 10 persons, propulsion by outboard motors.

[5] Ghana boat is the largest in the artisanal fleet and can carry crew between 10 -20. Propulsion is by outboard motors.

Standard 1-3 Canoe

This is also a dugout fishing canoe (Figure 3) made of timber with planks lining the upper edges. It can be between lengths of 6-8 m and can carry up to 3 men as crew. These canoes are used for hook and line fishing, set net and drift net fishing. The majority of Standard 1-3 canoes are not motorized. Common modes of propulsion are by the use of sails.

Figure 3. Standard 1-3 Canoe.

Standard 3-5 Canoe

These canoes are made out of wooden planks. With lengths of about 7-8m, the crafts (figure 6) can take up to 5 crew members. They can be used for hook and line fishing, set and drift gill net fishing and ring net fishing. These are also made out of plank and they are usually motorized with 25hp or 40hp outboard motors. Standard 3-5 boat can carry up to 5 crew members. These boats are used for ring gill netting. They stay out longer for fishing. They can be fitted with an ice box/fish hold, insulated to preserve the catch over a period of about 3 days. Some standard 3-5 canoes are not motorized. Where motorised, they usually operate with 8 –15hp outboard engines. Means of propulsion also include the use of paddles and sails.

Figure 4. Standard 3-5 canoes.

Artisanal crafts to be reclassified as semi-industrial vessels

The Ministry is about to establish a new definition for semi-industrial fisheries. Under the new definition the following two types of fishing canoes are classified as un-decked semi-industrial fishing vessels. Licenses for these two canoe types will be exclusively issued by the Ministry of Fisheries and Marine Resources.

Standard 5-10 Canoe

The Standard 5-10 canoe (Figure 5) is also made out of plank wood and usually motorized with 25 – 40 hp outboard engines. The Standard 5-10 canoe can carry a crew of maximal 10 men.

Figure 5. Standard 5 -10 canoes in Sierra Leone.

These canoes are used for ring netting, bottom set gillnetting, surface drift netting or bottom drift netting. The canoes can also stay out at sea for longer periods when fishing. As obtained for standard 1-3 boats, these canoes can also be fitted with an ice box/fish hold, insulated with cork and protected with a sheet of canvas, to preserve the catch for up to 3 days. The Standard 5-10 canoes have been recommended for reclassification as semi-industrial vessels. If this reclassification if successful, the local councils will no more be responsible for the licensing of these canoes. Licensing for this category of canoes will be done by MFMR.

Ghana Boat (Ghana type Canoe)

The Ghana type canoe (commonly called Ghana boat) is constructed out of wooden planks and frames to produce a vessel used mainly for ring netting. The method of construction was introduced in Sierra Leone by Fante fishermen from Ghana in the 1950s, hence the name “Ghana Planked Boat” (Figure 6).

Figure 6. Massive Ghana type boats, used by local and migrant fishermen

These boats are open, double-ended and about 15 – 20 meters long. They are fast and light weighted, displacing up to 4.75 tonnes with net and 15 - 25 crew onboard. Effective propulsion is by means of a 40 hp outboard engine. The Ghana type canoes are used in all coastal districts in Sierra Leone by both local and migrant fishermen. Currently, the majority of these boats are found in the Western Area, Portloko District, Kambia District and Pujehun District. At Sulima, in the the pujehun District of Southern Sierra Leone, these boats are used by migrant fishermen from Liberia. The common names in different languages for artisanal crafts in Sierra Leone are presented in Appendix 1.

Artisanal Fishing Gear Details

Drift and set gillnets

Gillnets can be used as drift nets or as set nets. Drifting gillnets (Figure 7) used in Sierra Leone are buoyed up by floats and carried along with the current or tide. When the gears are drifting on the water surface, they are referred to as surface driftnets. When they drift close to the seabed, they are called bottom drift nets. Commonly, surface drift nets catch herring (*Sardinella* spp), bonga (*Ethmalosa fimbriatta*) and other species. The required mesh sizes for drift gillnets is 45 mm.

Figure 7. Drifting gillnet in Sierra Leone.

Bottom drift gillnet

The bottom drift gillnet is not set or fixed in any way. In fact the net is ‘mobile’, and it is allowed to drift with the prevailing currents, tides, river flows, etc. Bottom drift gillnets are suspended vertically in the water with floats attached to the top and weights fixed to the bottom so that they can drift along the water column. The gear is made up of long rectangular panels of netting with diamond- shaped meshes that are held vertically in the water column, attached to the canoe which follows the flow of the net over ground and tries to catch lucrative demersal fish species, like Barracuda, Dentex, Lady Fish, Spanish, Grouper and others. Bottom drift nets have average lengths of about 1 000 m at a depth of 6 m.

Surface drift gillnet

The surface drift gillnet (Figure 8) is the second type of net not fixed in any way. However, this net has more floats, which allow it to float near the surface. With fewer weights relative to floats, drifting surface gillnets can either drift along the water column at the surface or drift along the bottom aided by water currents. These nets target Herring, Bonga, Mackerel, Pollock Mackerel, Cowreh, etc. The length of the net is about 1 000 m and the depth is about 4 – 5 meters.

Figure 8. Surface drift gillnet

Bottom set gillnet

This is a passive fishing gear consisting of a single netting wall kept vertically by a floatline (headrope) and a weighted groundline (footrope). Bottom set gillnets are made up of long rectangular panels of netting with diamond-shaped meshes anchored vertically in the water column, so that the net touches the bottom or it is only slightly above the sea floor In this mode, the bottom set gill net is waiting for the fish to get trapped in it. The bottom set gill nets target demersal species like Spanish, Lady Fish, Barracuda and Catfish as well as Lobsters and Crabs. The net has an average length of 1000 m with a depth of 3 - 4 fathoms or 6 - 8m.

Surface set gillnet

They are similar to the bottom set gillnets except that the surface set gillnets have more floats, which makes it hanging above the sea floor. The surface set net consists of a single netting wall kept vertically by a floatline (headrope) and a weighted groundline (footrope). It is anchored and positioned close to the surface. The net is made up of long rectangular panels of netting with diamond-shaped meshes that are held vertically in the water column. Target species are Mackerel, Barracuda, Pomp, Cowreh and other larger fish species. The length of the surface drift net is about 1 000 m and it has a depth of about 6 fathoms or 12 meters.

Ring Net

Ring nets (Figure 9) are encircling gillnets. The net is made up of multifilament nylon netting of 700 m to 1 000 m mounted lengths, 210/d9 twine, with 500 to 800 meshes deep. A ring net is set in a circle around a shoal of fish, mostly herring or bonga that can be spotted by the fishing crew. The fish are then gilled into the net. The net is mainly operated from Ghana boats and targets bigger schools of Bonga, Herring and other small pelagics.

Figure 9. Ring nets used in Sierra Leone.

Ring nets can have lengths up to 500 m and a depth of 60 m. Most ring nets used in Sierra Leone are illegal, using undersized meshed nets and are referred to as 'channel nets'. This is presented in another section.

Cast Net

Cast net is a very common gear and can be used from small boats as well as from the shore in Sierra Leone. The net is usually made of nylon netting and comes in various sizes. The fishermen collect the folds of the net in his arm and cast the net out in a fanning motion into the water to catch the fish. The weighted line around the edge of the net helps to deploy the net.

Long Lines (Morrel)

Long lines can be many kilometres long, comprising of baited hooks, using fish or small shrimps or artificial lures, attached by short lines, called snoods, which hang off the main line. Long lines have a hook for every yard and target mainly demersal fish species, like Snappers and Groupers.

Hook and Line

Hook and line fisheries is the simplest form of fishing, where a canoe is used to lower one or several lines into the water. The hooks are mounted with bait and left hanging in the water column or on the seafloor to attract fish eating the bait and getting hooked by the canoe crew. Fishermen can feel the fish feeding on the bait. Fish is caught by the hook as they eat the bait. The line is slowly pulled to the surface of the water. Hand lines are usually operated from the one man canoe (Kru canoe). They can also be operated onshore at the edge of the water. The main catch comprises of demersal fish species, like Snappers, Groupers, Cowreh, Barracudas, and Crocus.

Illegal fishing gears in the artisanal fishery of Sierra Leone

'Channel Net'

The channel net is a special ring net used in shallow water areas to target specifically juvenile fish of commercially valuable fish species. The channel net has mesh sizes far below 45 mm, and has a depth of about 9 to 10 fathoms or 4 to 5 meters. The weights on the lead line for a channel net are 3.3 m apart in contrast to the legal ring net. This lead line is called 'lagba lagba' (Figure 10) and it is designed to enable the net to be able to fish in shallow waters and between rocks.

Figure 10. Illegal ring net ('Channel Net') used in Sierra Leone.
The arrow indicates the 'lagba lagba'.

Channel netting is prohibited, because they catch undersized juvenile fish in shallow waters that are either nursery or spawning grounds. The Channel net targets both juvenile as well as spawning schools of fish.

Mina net

The mina net (Figure 11) is a surface drift net with small mesh sizes. The mesh size is about 'one finger- tight' or 'one finger- slack' and the net is targeting small, undersized pelagics, like herring. The gear is prohibited because it is targeting juvenile small pelagics, depriving them of the opportunity of eventually reproducing.

Figure 11. Illegal surface drift net (mina net) used in Sierra Leone.

Beach seine Nets

The beach seine is a suitable means of catching fish in large quantities without using any propulsion. The gear is made up of multi filament nylon webbing hung on polyethylene ropes (Figure 12). This net can be more than 1 000 m in length with wings made up of 30 mm to 50 mm mesh webbing of 210/D12 twine. The net is operated from standard 3-5 canoe or 5-10 canoe and can be hauled to shore by a crew consisting of 10 to 16 men. The gear is prohibited, because it is mainly targeting undersized juvenile fish.

Figure 12. Beach seine net, an illegal fishing net used in Sierra Leone.

Fishing Grounds in Sierra Leone

The continental shelf of Sierra Leone has numerous fishing grounds used by artisanal fishers and industrial vessels. These fishing locations comprises of river systems including the Sierra Leone River Estuary in the Port Loko District of Northern Sierra Leone, the Sherbro River System in Bonthe District, Southern Sierra Leone, the Yawri Bay in the Western Area and

[6] First Schedule of the Revised 2010 Fisheries Regulations.

Moyamba District of Southern Sierra Leone, and the Scarcies River (Great Scarcies and Little Scarcies) in the Kambia District of Northern Sierra Leone. Specific fishing grounds include Yeliboya Point, Red Dotty, Banana, Yawri Bay and Saint Anne's. The continental shelf shows a marked tapering effect, as the northern continental shelf is about 100 km wide as compared to the southern shelf, which is only 20 km wide. The northern continental shelf has greater fish abundance than the southern part. Major fishing areas within the continental shelf of Sierra Leone are shown in Figure 13. The Inshore Exclusion Zone (Figure 14) is particularly reserved for the artisanal fishery.

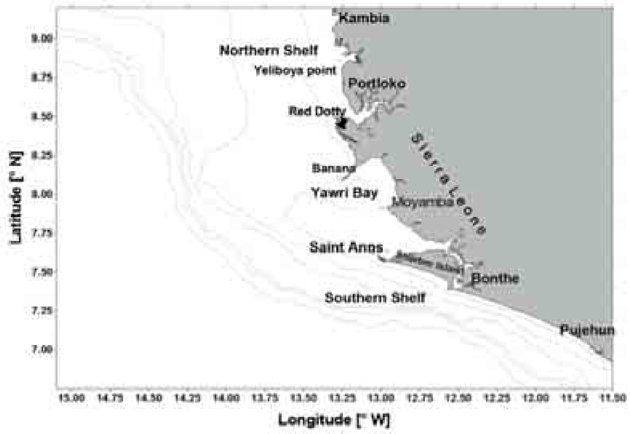


Figure 13. Continental Shelf of Sierra Leone showing major fishing grounds

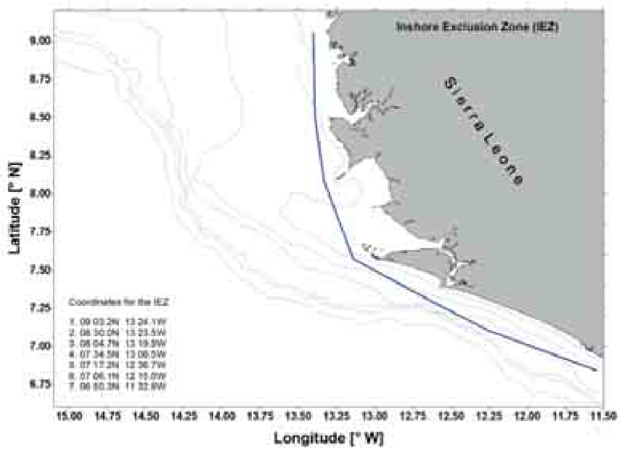


Figure 14. Inshore Exclusion Zone (IEZ) reserved for artisanal fishing.[6]

2.2. The Fishery Resources Exploited

This section provides brief information on the category and status of marine capture fishery resources exploited in Sierra Leone, including the artisanal fishery production and catch per unit of effort (CPUE). Brief information is given on oceanography and upwelling events and the large marine ecosystems (LMEs) that influence the fishery resources.

---

[7] Inland Lakes and Rivers in Sierra Leone occupy an area close to 2058 km^2, and can account for an annual fish production of about 16 500 tonnes (Vanden-Bossche and Bernacsek, 1990).

Upwelling Events, LMEs and Fishery Resources Exploited

The fisheries of Sierra Leone are influenced by three current systems: the Guinea Current, the Canary Current and the Equatorial Counter Current. The dominant current systems are the Guinea Current and the offshoot of the Canary Current, which flows eastwards along the coast from February to April, to meet the westward flowing South Equatorial Current that flows off the Liberian Coast from May-July. The influence of the dominant Canary Current is characterized by the north-south migration of the 25^{o}C isotherm (Johnson and Johnson, 1996; Coutin and Payne, 1986; Sheriff *et al*., 2009). As this cold current system flows towards the equator, its flowing intensity increases until February to April when it flows southwards bringing cold nutrient-rich water from the upwelling areas with a well defined thermocline occurring around the 'mid-shelf' which is about 10 m inshore and 20 m offshore. This nutrient rich water combined with the nutrient input from major river systems in Sierra Leone supports a large quantity of high value pelagic and demersal fish resources in the country's continental shelf.

The fisheries of Sierra Leone are among the economically important natural resources for economic growth, if managed effectively (MFMR, 2008). The fisheries sector is multi-gear oriented (Figure 15) and comprises of the marine artisanal fisheries sub sector which uses canoes and gill nets, and the industrial fisheries sub sector which is capital intensive and mainly operated by highly mechanized industrial fishing vessels including shrimpers, demersal finfish trawlers, purse seiners and long liners. The inland fisheries sector[7] uses scoop nets, fences and fish traps in small rivers, and similar artisanal gears for large rivers) while the aquaculture fisheries sector mainly consists of earthen ponds.

Commercially exploited fish stocks in the marine capture fisheries sector include the following:

Large pelagics: mainly the tunas (e.g. skipjack, yellowfin, bigeye, Atlantic bluefin tuna, and little tunny) and the barracudas;

Small pelagics clupeids: mainly the herrings and the bonga shad;

Carangids: mainly the scads, horse mackerels, mackerels, jacks, pompanos and Atlantic bumper;

Demersals: mainly snappers (Lutjanidae), croakers (Sciaenidae), seabreams (Sparidae), grunts (Haemulidae), Penaedae shrimps and prawns (Penaeidae); spiny lobsters (Palinuridae), squids, cuttlefish and octopus (Cephalopods); snails, oysters and clams (Gastropods), and the true crabs. The list and pictures of some major species exploited is provided in Table 7 and Appendix 2.

Figure 15. Fishing gear system in Sierra Leone.

Investment into the fisheries is gradually recovering. Licensed fishing vessels recorded by the end of 2010 were around 80, with nationalities of Chinese, Korean, Nigeria, Ghanaian, Greece, Spanish and Sierra Leone (MFMR, 2009). Artisanal and industrial fishery sectors target the same type of species, and there is often competition for fishing areas resulting to conflicts.

2.3. Fisher details and land based workers in the artisanal fishery

Fishing is the main activity in the six coastal districts of the artisanal fishery sector in Sierra Leone. Fishing is conducted from 640 landing sites with some 29 091 fulltime fishermen and 5 790 part-time fishermen. The part-time fishermen are also involved in land based works such as fish processing, mainly fish smoking (Figure 16), fish marketing, salt mining, farming and petty trading.

Figure 16. Fish smoking, a major land-based activity in coastal communities (photo taken by Sheku Sei, 2011).

The recently constructed fish receiving stations and landing jetties at Bonthe, Shenge, Tombo and Goderich landing sites will improve on fish processing and other land based activities.

The coastal districts form the minor strata from where fishing is conducted. They include Western Area, Port Loko District, Kambia District, Moyamba District, Bonthe District and Pujehun District. These minor strata belong to major strata, which are the provinces in Sierra Leone. Strata and landing sites including fisher details are presented in Table 4 and Figure 17.

The most active coastal districts in the artisanal fishery are Western Area, Port Loko District and Bonthe District. These districts have over 7 000 fulltime fishers who are fully engaged in fishing (Figure 18). Bonthe District has the highest number of landing sites, up to 307 landing sites as recorded during the 2009 frame survey.

Table 4. Landing Site and Fisher Details by Strata (MFMR, 2010).

Major Strata	Minor Strata	No of landing Sites	Fulltime fishers	Part-time fishers	Migrant fishers
Western Area	Western Area Urban and Rural	47	8 068	1 915	508
Northern Province	Port Loko District	133	7 578	1 434	205
	Kambia District	50	2 909	1 017	142
Southern Province	Moyamba District	60	2 234	464	100
	Bonthe District	307	7 426	748	127
	Pujehun District	43	876	212	196
Total		640	29 091	5 790	1 278

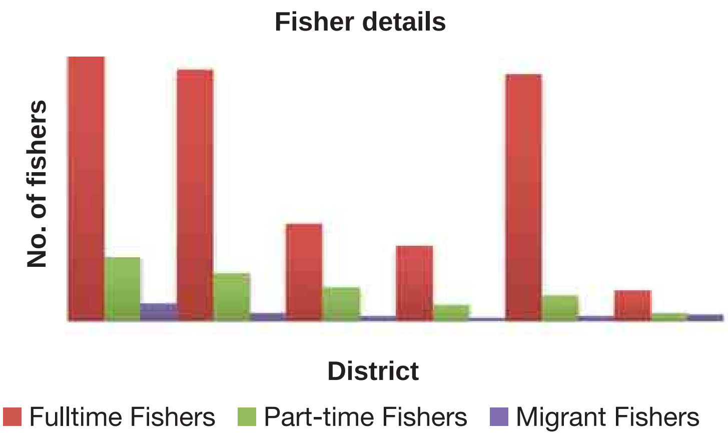


Figure 17. Fisher composition of major coastal Districts in Sierra Leone (MFMR, 2010).

Port Loko District has the second highest number of landing sites (133). The least active artisanal fishery district is Pujehun District (43), which comprises mainly of lakes and inland waters. All districts have migrant fishers, with the highest recorded in the Western Area, and where over 500 fishermen are migrant fishers who are made up of nationals and foreigners.

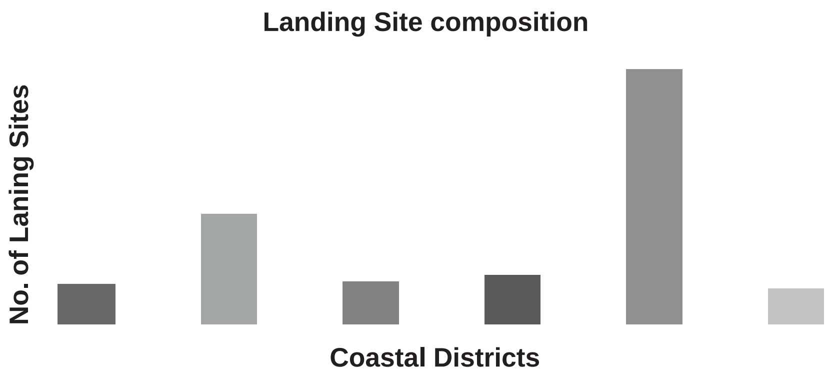


Figure 18. Landing site composition in coastal Districts (MFMR, 2010).

The national migrant fishers come from other fishing communities and this migration is either dependent on the weather condition or due to poor catches in other fishing localities. Illegal fishing practices perpetrated by fishers have led to poor catches, forcing fishers to always migrate to other fishing localities. The highest national migration for fishing occurs during the rainy season when weather conditions can be hash in some communities. Migrant fishers who are foreign nationals come mainly from the subregional countries of Guinea, Ghana and Senegal.

There are over 600 migrant fishers in the artisanal fishery of Sierra Leone, who are either engaged in active fishing or they are financiers of fishing activities. The croakers (*Pseudotolithus* spp) are among major fish stocks that are attractive to migrant fishers in the Sierra Leone artisanal fishery. This stock is a major export commodity with a popular market in Korea.

Sun Hu Fishing Company is one of the Fish Processing Establishments in Sierra Leone that is involved in the processing and trade of croakers caught in the artisanal fishery sector. The company serves as financier for artisanal fishers by providing fishing input including fishing gears, fishing boats and outboard engines. The Company supports the purchase of the fish stock from other fishers for onward processing and export. The counterpart Company (Teasun Fishing Company) is in Busan, South Korea. A form of batter system is in place where the cost of fishing gears provided to fishers is deducted from the cost of fish that they catch. The fishing crafts targeting croakers are among the crafts that have been proposed for reclassification into semi-industrial vessels, because these crafts could carry ice onboard and can stay out fishing for over 7 days. There is immense potential for artisanal fishers to be engaged in fish processing and fish export if they adopt responsible fishing practices.

The possibility exists for increased land based workers and value addition to artisanal fish catches if the landing facilities that have been constructed in Bonthe, Shenge, Goderich and Tombo fishing communities are properly managed. Plans are underway to put in place a management committee comprising of people from the community and technical personnel to manage these facilities.

2.4. Direct interaction of artisanal fishery with other fisheries

Fishing in Sierra Leone is done throughout the year, with more productive shrimp fishing during the rainy season (May-October). Shrimp trawlers take large amounts of Bycatch of coastal inshore fish species of high value. The high Bycatch rate is largely due to the incursion of industrial shrimp and other trawlers into the IEZ where juvenile fish and spawners are caught on breeding and nursery grounds. In addition, shrimp trawlers catch high quantities of finfish during the day because shrimps will burrow into the mud during the day and come out of their burrows at night to feed (Williams, 1958; Garcia and Le Reste, 1981). Bycatch estimates in the shrimp fishery are put around 75 percent of the total catch, with some 25 percent discarded every year (MFMR, 2008) The species composition of shrimp Bycatch includes valued finfish species and other shellfish species such as cuttlefish, squids, lobsters and crabs.

Average Bycatch and discards rates in the shrimp and demersal trawl fishery are presented in Tables 5 and 6.

Table 5. Average catch rates in shrimp fishery (kg/vessel/day) (MFMR, 2008).

Year	Shrimps (target species)	Bycatch (fish)
1991	140.04	409.73
1992	171.38	670.76
1993	195.22	750.12
1994	207.43	1 000.50
1995	211.63	874.96
1996	187.38	877.62
1997	228.17	772.87
1998	168.62	793.77
1999	197.09	635.78
2000	180.06	635.78
2001	163.39	519.05
2002	167.48	721.94

Table 6. Average discards rate in shrimp and demersal trawl fishery (MFMR, 2008).

Shrimp Trawl Fishery			
Year	Landings (tonnes)	Discards (percent)	% Discards
1994	9699.80	1978.86	20.40
1995	10006.03	2958.44	29.57
1996	11184.43	2381.04	21.29
1997	6601.82	2304.64	23.05
Demersal trawl fishery			
1994	2230.85	572.38	10.94
1995	2934.99	702.47	23.93
1996	4461.14	342.77	7.68
1997	2599.44	268.33	10.32

Discards rates are higher in the shrimp fishery, compared to the demersal trawl fishery. One way of reducing discards in the shrimp fishery is to carry out more fishing during the night than during the day. Other Bycatch species such as lobster and sea turtles are also caught in the industrial trawl fishery. A prudent management measure to adopt will be the use of Bycatch reduction devices (BRDs) such as turtle excluder devices, which will exclude turtles and retain fish during fishing. Sea turtles are incidentally caught (Figure 19) in shrimp and demersal trawl fishery and also in the artisanal fishery in Sierra Leone. Five species of sea turtles occur in Sierra Leone namely the Olive Ridley, Leatherback, Hawsbill, Green and Loggerhead turtles.

Figure 19. Olive Ridley turtle caught incidentally by demersal trawl in Sierra Leone.

3. Available scientific and traditional knowledge on the resources

This section presents information on scientific and traditional knowledge on the artisanal fishery of Sierra Leone. Information is provided on the biology of major fish stocks exploited, fishery resource status. The section further presents the biomass and CPUEs and interactions with other fishery and the ecosystems. The issue of pollution from land-based sources are also discussed.

3.1. Biology of the major species

Size and weight indicators are among the biological studies carried out for major fish species exploited in the artisanal fishery of Sierra Leone. The 2010 size composition of shared small pelagic fish stocks such as the herring (*Sardinella* spp) and the bonga shad (*Ethmalosa fimbriata*) exploited in major river systems including the Sierra Leone River and the Scarcies River in Northern Sierra Leone, and the Yawri Bay and Kargboro Creeks in South western Sierra Leone, shows that there has been considerable fishing pressure on these species (Figure 20). Major landings of *Sardinella* spp is comprised of size ranges from 9 to 15 cm of total length. Catches of cohorts of larger size ranges above 16 cm (adults) are very few.

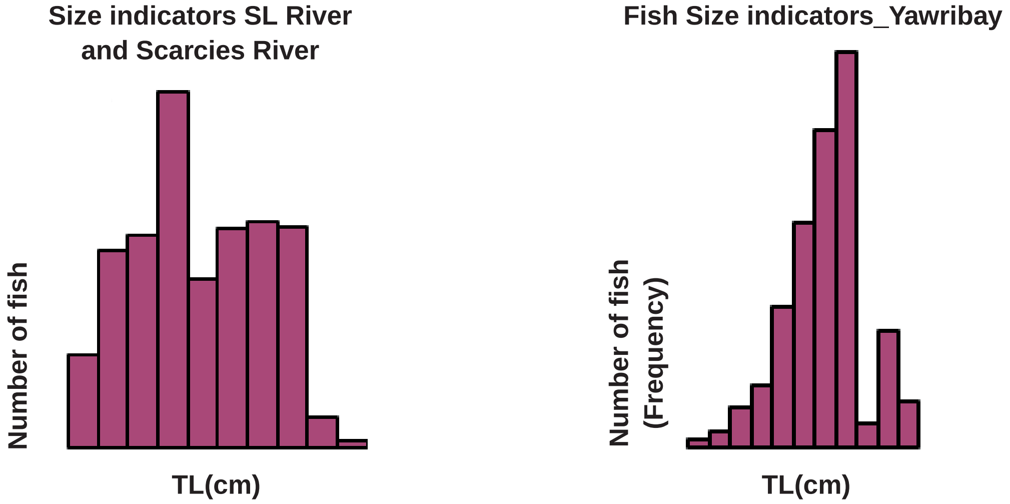


Figure 20. Size composition of herring *Sardinella* spp. (left) and Bonga Shad (right) in major river systems. Graphs generated with data from the 2009 Fisheries Resource Surveys.

Landings of *Ethmalosa fimbriata* is comprised mainly of size ranges from 21 to 24 cm. Catches of cohorts of the larger size ranges of 25 to 27 cm (adults) are very few. These size indicators of landings are signals of growth overfishing which will limit recruitment of these commercially exploited species. This has food security and livelihoods implications for artisanal fishing communities.

Further analysis of length weight relationships for some pelagic species caught during the May 2009 hydroacoustic survey indicates early maturity at smaller sizes as the stocks response to fishing pressure (Figure 21). The condition factor for *Sardinella maderensis* (flat herring), *Sardinella aurita* (round herring) and *Decapterus rhonchus* (false scad) is around 3, with large quantities of catches below 24 cm of total length.

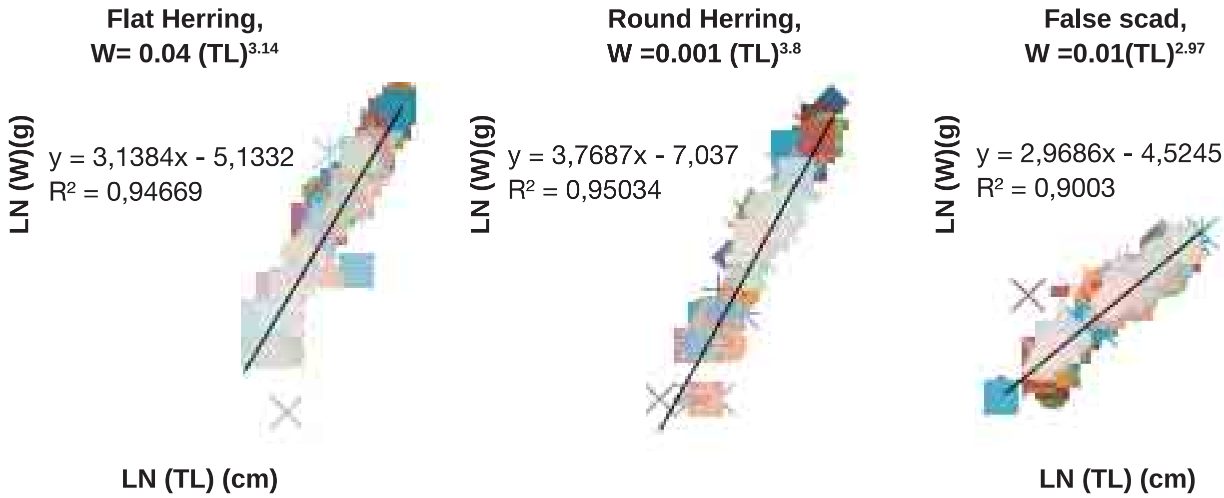


Figure 21. Length Weight Relationships for herring Sardinella spp. (top) and false scad (bottom). Graphs generated with data from the 2009 fisheries resource survey.

Analysis of size data of some of the exploited demersal and pelagic fish stocks such as sea breams (*Pagrus caeruleoistictus*) and the flat herring (*Sardinella maderensis*) using the FAO-ICLARM fish stock assessment tool (FISAT II) reveals low asymptotic lengths (L∞) and high probabilities of capture (50 percent chances) for juveniles within the size range of 10- 11 cm (Figure 22). Most of the fish are now caught at early stages before reaching adult sizes. Therefore fishing needs to be controlled on breeding grounds of major river systems in order to permit recruitment and the rebuilding of these stocks that are either fully exploited (E = 0.5) or overexploited 0.5 <E ≤1.

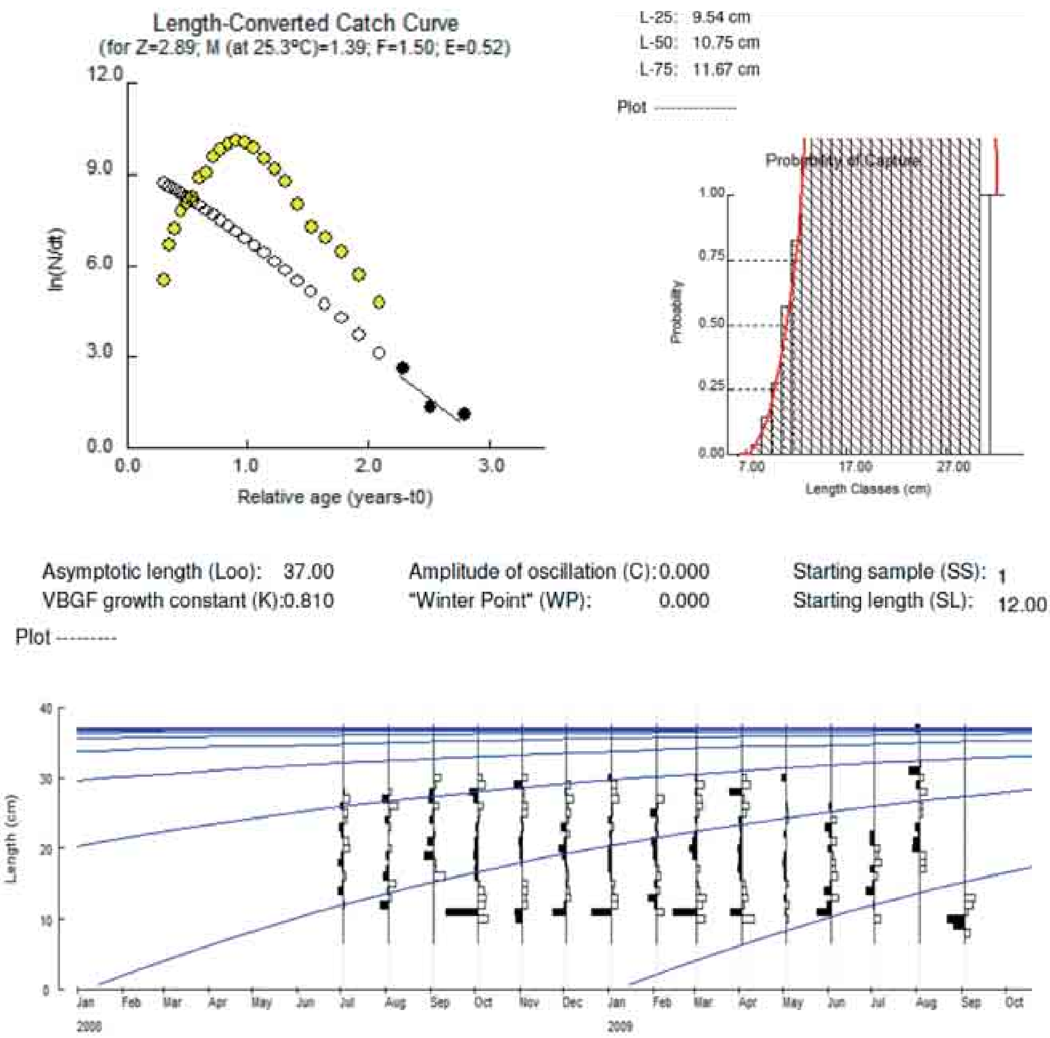


Figure 22. Exploitation status of sea breams (Pagrus caruleostictus).
Graphs generated in 2011, using commercial catch data.

The sea breams, which are commonly called snappers in Sierra Leone, are among the commercially valuable species that are under heavy pressure in both the artisanal and industrial fishing vessels. In particular, the incursion of industrial shrimp trawlers into the IEZ reserved for artisanal fishers, take high quantities of these stocks as Bycatch.

Pelagic fish resources such as the herring (*Sardinella* spp) are particularly vulnerable to high fishing pressure, as they are major target species in the artisanal fishery sector. The selection ogive (Figure 23) of the flat herring suggests 50 percent chances of capture for the size category of about 19 cm, which constitutes mainly of juvenile herring (mina). The cohorts in the smaller size categories (8 to 19 cm) have high fishing pressure with exploitation rates of about 0.5.

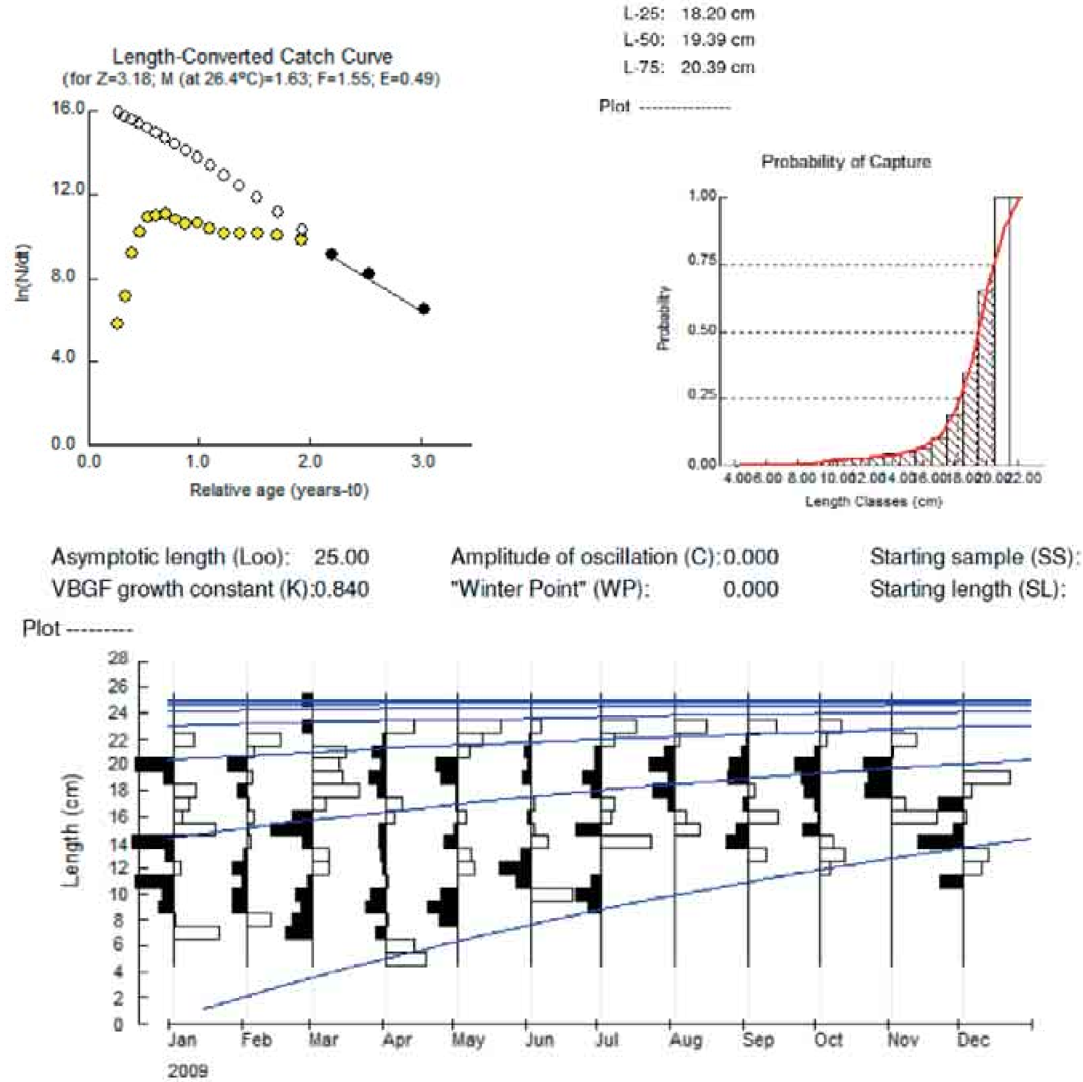


Figure 23. Exploitation status of Flat Herring (Sardinella maderensis).
Graphs generated in 2011, using commercial catch data.

The herring (*Sardinella* spp) and bonga shad (*Ethmalosa fimbriata*) are the most targetted species in the artisanal fishery sector. These stocks have experienced heavy pressure over the years mainly due to targets on spawners and juveniles, which have made the fish stocks to be overexploited. Recent landings, catch rates and catches per unit of effort (CPUE) for juvenile herring (mina) and juvenile bonga shad (Awefu) present a declining catch trend from 2002-2005 (Figure 24).

The herring (*Sardinella* spp) and bonga shad (*Ethmalosa fimbriata*) are the most targetted species in the artisanal fishery sector. These stocks have experienced heavy pressure over the years mainly due to targets on spawners and juveniles, which have made the fish stocks to be overexploited. Recent landings, catch rates and catches per unit of effort (CPUE) for juvenile herring (mina) and juvenile bonga shad (Awefu) present a declining catch trend from 2002-2005 (Figure 24).

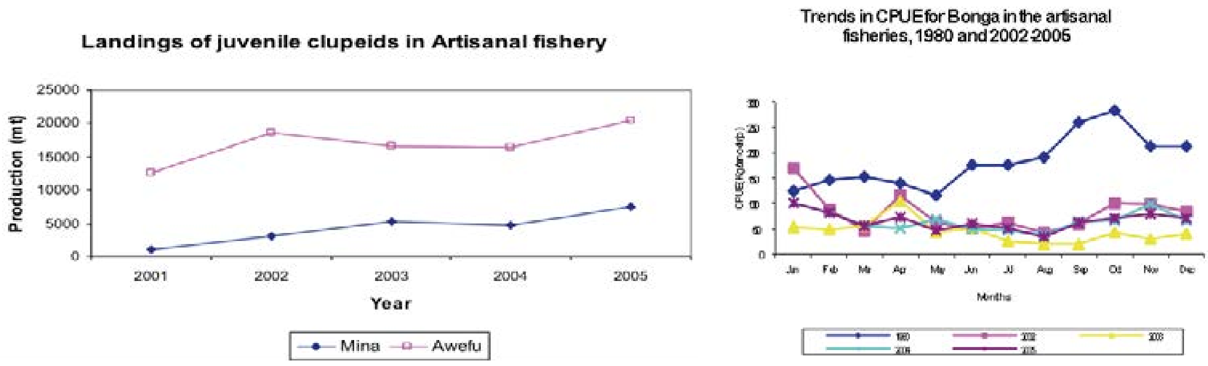


Figure 24. Artisanal landings and CPUEs of clupeids (MFMR, 2008).

3.2. Geographical distribution of major fish stocks

Major fish stocks of Sierra Leone are found in the country's 200 nautical mile continental shelf and the EEZ. The continental shelf and the EEZ of Sierra Leone were claimed under the Maritimes Zones Establishment Decree of 1996 (MZED). Section 2(1) of the MZED defines the continental shelf of Sierra Leone as the zone comprising of the sea and subsoil of submarine areas extending beyond the territorial sea, through natural prolongations of a land territory to the distance of 200 nautical miles away from the baseline where the breadth of the territorial sea can be measured[8]. This definition accords with the LOSC[9].

Major fish stocks in Sierra Leone continental shelf has an estimated biomass around 366 000 tonnes (Huse et al., 2006; Mehl et al., 2007; Turay et al., 2008), excluding shrimps, with a potential yield of about 161 000 tonnes (MFMR, 2008). The distribution of fish is denser in the Northern shelf, which is 100 km long, as compared to the Southern shelf, which is only 20km long. The distribution of some demersal and pelagic fish stocks in the continental shelf of Sierra Leone is presented in Figure 25.

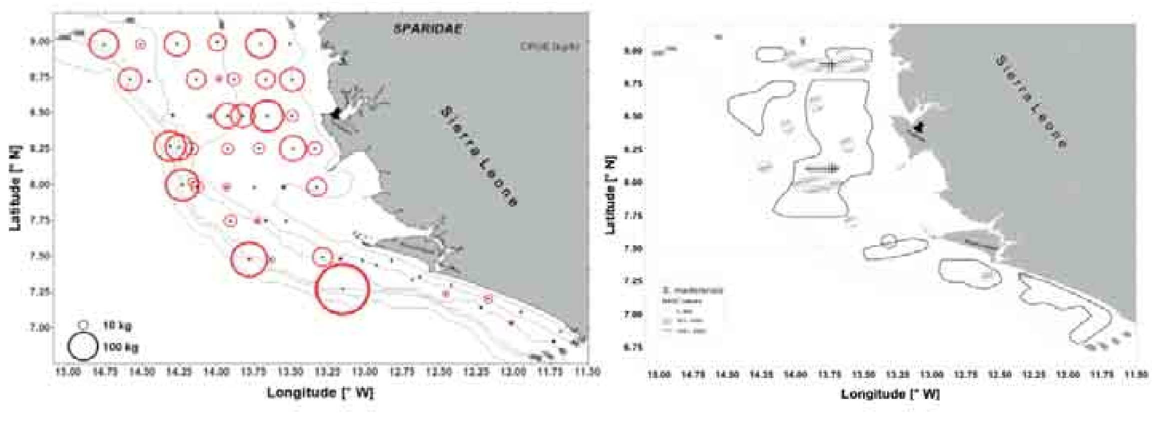


Figure 25. Sierra Leone continental shelf showing fish distribution.

[8] MZED, sec.11 (1), LOSC, art. 76 (1)

[9] LOSC, Part VI

3.3. Stock status

Assessments by FAO/CECAF demersal and pelagic working groups have shown that some of the commercially exploited fish stocks in Sierra Leone are either fully exploited or overexploited (Table 7).

Biomass, landings and potential yields

Demersal and pelagic resources are exploited by both industrial and artisanal fishery sectors. Fisheries surveys are carried out under various projects in order to estimate the biomass of fish resources in the continental shelf of Sierra Leone. Recent biomass estimates for the last five years are provided in Table 8. Production data is collected through observer data sampling programmes in the artisanal and industrial fisheries. Fish production trends are presented in Tables 8 and 9. The fisheries of Sierra Leone have the potential to bounce back to prewar levels if managed effectively. The artisanal fish production (Table 8 and Figure 26) contributes greatly to the total landings compared to the industrial fish landings, most of which is usually exported overseas for foreign currency.

Table 7. Status of major fish stocks in Sierra Leone (source FAO/CECAF Pelagic and demersal working group reports, 2006/2008).

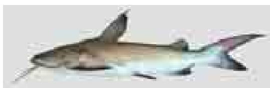
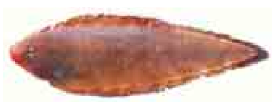
Fish Species	Status	
***Pseudotolithus elongatus* (Bobo Croaker**	Overexploited	
***Pseudotolithus* spp (Other Croakers)**	Fully Exploited	
***Galeiodes decadactylus* (African Threadfin)**	Fully Exploited	
***Arius* spp (Sea catfish)**	Overexploited	
***Sparidae* (Dentex and Sea Breams)**	Overexploited	
***Sardinella aurita* (Round Herring)**	Fully Exploited	
***Sardinella maderensis* (Flat Herring)**	Overexploited	
***Ethmalosa fimbriata* (Bonga Shad)**	Overexploited	
***Pomadasys spp* (Grunts)**	Overexploited	
***Cynoglossus spp* (soles)**	Overexploited	

Table 8. Biomass estimates of fish resources of Sierra Leone. Data compiled by the authors using referenced sources in MFMR (2008). Biomass estimates presented here exclude shrimps because the draught of the vessel was unable to trawl in 10 m depth range where shrimps occur abundantly.

Programme and Year	Biomass (tonnes)
GoSL/USSR/FAO 1982-1991	Demersal fish:105 000 Pelagic fish: 513 400
IMBO, 2000	Demersal fish: 110 000 Pelagic fish: 360 000
GCLME-RV Dr. Fridtjof Nansen, April-May 2006	Demersal fish: 35 663 Pelagic fish: 269 000
GCLME-RV Dr Fridtjof Nansen, May-June 2007	Demersal fish: 24 044 Pelagic fish: 100 000
ISFM-RV Itaf Deme, May-June, 2008	Demersal fish: 109 906 Pelagic fish: 256 000
ISFM-RV Itaf Deme, November-December, 2008	Demersal fish: 109 170 Pelagic fish: 227 000
ISFM-RV Itaf Deme, May-June, 2009	Demersal fish: 170 332 Pelagic fish: 282 100
ISFM-RV Itaf Deme, May-June, 2010	Demersal fish Pelagic fish
ISFM-RV Itaf Deme, November-December, 2010	Demersal fish: 84 004 Pelagic fish: 231 400
Potential Yields	
Fox Model, 1996-2005	Shrimp fishery, 1 555 Fmsy, 4 081 fishing days Bycatch yields: 9 286
Fox Model, 1991-2005	Demersal trawl fishery 6 664 Fmsy, 4 081 fishing days
Cadima Estimator, 2008	Demersal fish: 23 915 Pelagic fish: 137 392

Table 9. Fish Production from 1991-2009.

	Industrial								Artisanal	Total
Year	Shrimp	Lobster & crab	Cuttlefish & Octopus	Snail	Sharks & Rays	Demersal Fish	Tuna	Pelagics	Mix	
1991	1 241	21	202	–	–	5 045	3 173	65 555	48 071	123 308
1992	2 484	47	644	–	–	15 790	3 644	31 424	47 477	101 510
1993	2 425	427	58	–	–	14 655	2 463	1 000	46 928	68 756
1994	2 010	186	885	–	–	11 386	3 358	516	46 779	65 120
1995	2 420	278	658	–	–	9 416	3 029	299	46 708	62 808
1996	2 443	353	1 069	–	–	10 612	1 011	1 109	46 673	63 270
1997	1 989	197	557	–	–	5 905	2 010	479	46 656	57 793
1998	1 317	111	398	–	–	5 344	4 980	467	46 648	59 265
1999	1 483	157	537	–	–	9 442	3 662	537	46 420	62 238
2000	1 505	198	308	–	–	11 127	0	1 061	45 910	60 109
2001	1 277	337	1 169	–	120	10 993	6 166	2 536	39 950	62 548
2002	1 119	194	3 562	–	126	7 315	–	1 405	55 659	69 380
2003	1 541	215	4 598	–	150	9 549	–	1 112	65 458	82 623
2004	1 445	127	1 596	1 266	175	8 011	–	1 611	106 216	120 447
2005	1 378	106	2 017	1 883	135	7 756	–	2 522	116 614	132 411
2006	1 354	159	982	1 065	143	8 526	–	1 413	120 490	134 132
2007	1 433	262	717	106	439	12 945	–	1 947	111 937	129 785
2008	1 000	242	793	955	413	13 347	–	4 308	164 703	185 761
2009	828	1 197	–	–	108	14 339	9	3 176	243 634	263 291

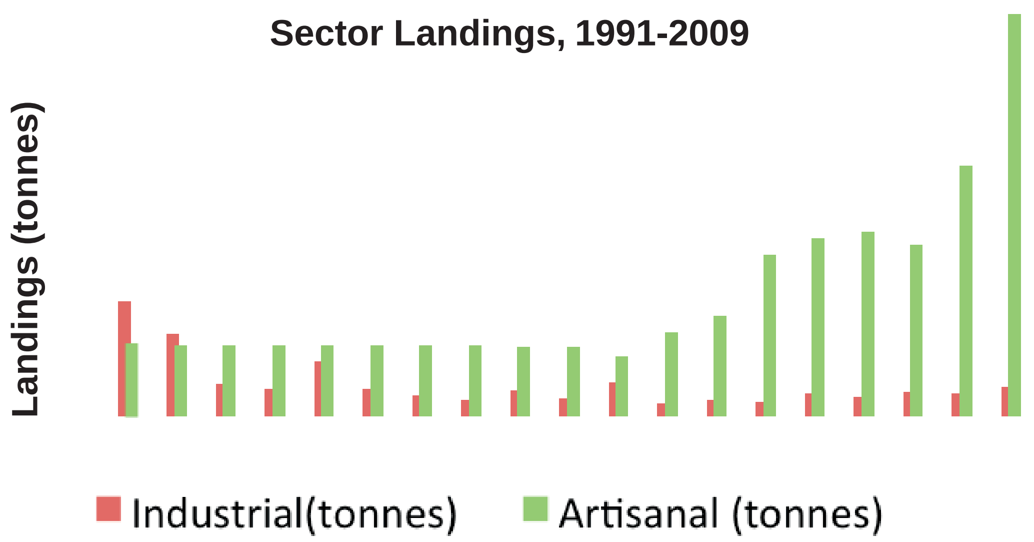


Figure 26. Fish production trend, 1991-2008.

Lower industrial fish production was felt most from 1993-2002 when fisheries investment was low, as fishing company agents, vessel owners or captains hardly called to the Sierra Leone port for licensing matters. This also means that during this period, most industrial fishing vessels were mostly involved in illegal, unreported and unregulated (IUU) fishing.

Fish production dropped as a result of an eleven-year civil war that ended in 2002. Production increases by the end of the war indicates that the fishery resource potential can bounce back to prewar levels. Recent potential yields as compared to biomass are shown in Figure 27.

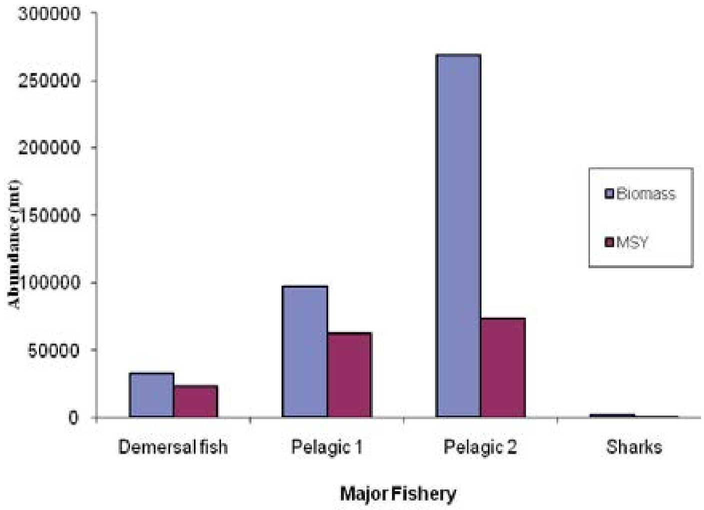


Figure 27. Biomass and potential yields (tonnes) of major fish stocks (MFMR, 2008).

3.4. Direct Interactions of artisanal fishery with marine ecosystems

This subsection presents details on direct artisanal fishery interaction with the marine environment including fishing impacts on spawning and fishing grounds. Artisanal fishery interacts with several activities causing direct impact on the marine ecosystems in Sierra Leone. Major impacting activities include: fishing, cutting of mangrove forests for fuel wood and waste disposal at sea.

Impacts on spawning/feeding grounds

Illegal fishing is carried out in shallow areas of rivers and lakes, which serves as breeding grounds for fish. The use of illegal fishing nets in areas such as the Yawri Bay and Sierra Leone River Estuary has lead to landings of large quantities of juvenile fish in most of the artisanal fishing communities. A recent consultative visit to Konakridee, Bailor and Masulimani fishing communities in Northern Sierra Leone reveals that a market exist for juvenile fish trade in neighbouring Guinea. This has also caused the targeting of juvenile on breeding and feeding grounds around the Bailor and Masulimani fishing communities (Figure 28). Such activity if not minimized can impact negatively on marine ecosystem functioning, as it can cause recruitment failure and declines of major fish stocks. Indication of such effects is currently felt through low catches of fish that has commercial value. In addition, the cutting of mangrove forest can lead to degradation of ecosystems and displacement of fish assemblages.

Figure 28. Large quantities of juvenile fish waiting to be exported to Guinea (Sei et al., 2011).

Pollution Effects of Fishing and coastal development

Fishing activities in coastal waters of Sierra Leone is often associated with indiscriminate dumping of plastic and human wastes in the sea and on the beaches. Most artisanal fishing communities do not have litterbins and neither do they have toilet facilities. It is therefore a common habit to dump wastes indiscriminately into the sea.

Fishing nets such as monofilament nets often get destroyed at sea and the damaged nets are rarely removed from the sea. These nets are non-biodegradable, meaning that they do not get rot easily. They remain in the sea and carryout ‘ghost fishing’, thereby contributing to fish stock declines. Reckless handling of fuel and lubricants at sea is also a major source of pollution, as petroleum oil contains hydrocarbons, which can also reduce oxygen content and suffocate fish larvae. It is therefore important that fuel and lubricants are properly handled at sea. In addition, wastes from land-based sources are usually washed into rivers through runoff. This is partly responsible for marine environment pollution. The organic matter that is loaded into the sea can reduce the availability of dissolved oxygen to fish stocks and create anoxic conditions with adverse consequences for recruitment and abundance of fish populations.

Furthermore, coastal developments such as the construction of jetties, residents and hotel infrastructure around beaches in coastal communities are also associated with pollution. In addition to the dumping of wastes by tourists and other coastal residents, the construction materials such as cements can be poisonous to fish larvae.

Climate Change Effects on Fishing and Coastal Communities

The impact of sea level rise as a result of global climate change is having negative effect on coastal communities in the artisanal fishery sector in Sierra Leone. Erosions and inundations have forced fisher folks to relocate to safer zones at heavy costs after losing livelihoods assets and fishing time (Figure 29).

Most island communities in Sierra Leone are heavily reliant on fisheries for income, food and employment, and these communities have low capacity to respond to adverse climatic variations. The adaptation imperatives are weak and there is no resettlement or relocation scheme in place for coastal communities. The indiscriminate cutting of mangroves and other forests for fuel wood has exposed island communities to direct inundations. A study that appraised village level information on changes that have occurred on a five years scale due to climate change vulnerability of Plantain Island in the

Moyamba District of Southern Sierra Leone shows that climatic changes in combination with human induced habitat degradation including overexploitation of fish stocks are the main causes of low fish catches and destruction of homes (Sei, 2010).

> *"Meandering sea, under the influence of high scoring tides inundate homes with loss of livelihood elements such as household utensils, fishing gears, fishing crafts, fishing days, national monuments and human lives. High temperature regimes have destroyed exposed shallow reefs and degraded mangrove habitats, thereby displacing fish assemblages and reducing recruitments"* (Sei, 2010).

In Sierra Leone, fishers target juvenile fish as a result of limited fishing range during bad weather. Therefore daily fish catches have been of low economic value with negative effects on food security and livelihoods in coastal communities (Sei and Aruna, 2010).

Figure 29. Juvenile herring and bonga shad as major target species during bad weather.

Furthermore, Sea level rise effects favour severe inundations of Yeliboya, Kortimo, Bunce Island and Konakridee landing sites in Northern Sierra Leone, while Banana (Plantain Island) in Southern Sierra Leone is the most vulnerable community (Figure 30, right).

Figure 30. Plantain Island (left) and Konakridee landing site (right) under severe erosion.

Konakridee landing site is a very active landing site in Northern District of Portloko. There are plans underway to construct fish landing clusters along the Konakridee landing site but erosion and inundations due to sea level rise will be a major concern for establishment of landing clusters at this landing site.

Plantain Island is within the Yawri Bay, which is a major breeding ground for fish stocks. These Islands if not appropriately protected, may vanish within the next five years, leading to livelihoods problems and the lost of heritage sites such as the Bunce Island, which housed the slave trade castle and was used as a centre for the recruitment of the British Army.

Traditional Knowledge base on artisanal fish resources

Traditional knowledge of fishers is utilized in the management of artisanal fishery in Sierra Leone. In a recent consultative forum for the establishment of MPAs in 2010, fisher's knowledge on spawning seasonings and spawning grounds of fish was used to demarcate proposed areas for the establishment of MPAs.

Fisher's knowledge was captured in a facilitated forum to identify high impact and vulnerable areas for the establishment of MPAs within major river systems of coastal areas (Figure 31) in Sierra Leone, including the Yawri Bay and Kagboro Creek, the Scarcies River, the Sherbro River Systems and the Sierra Leone River Estuary.

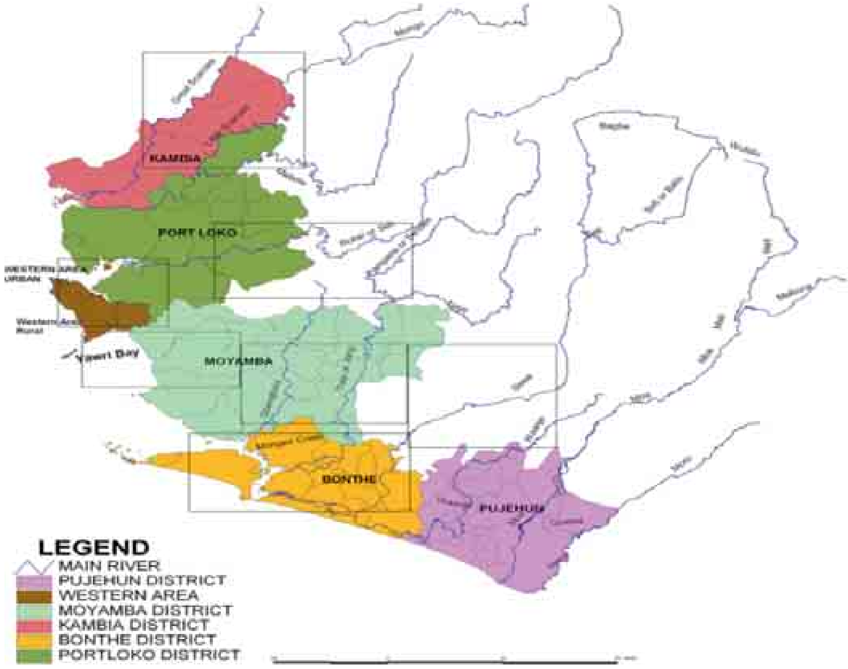


Figure 31. Coastal Districts in Sierra Leone.

Through consultations, fishers were able to identify and demarcate major spawning grounds and spawning season, including the occurrence of marine megafauna in major river systems. For example, in identifying spawning grounds and spawning seasons for bonga shad (*Ethmalosa fimbriata)* in the Sierra Leone River Estuary (Figure 32) fishers observed that in January, matured awefu (juvenile bonga) migrate from offshore areas towards river systems, estuaries and creeks to spawn.

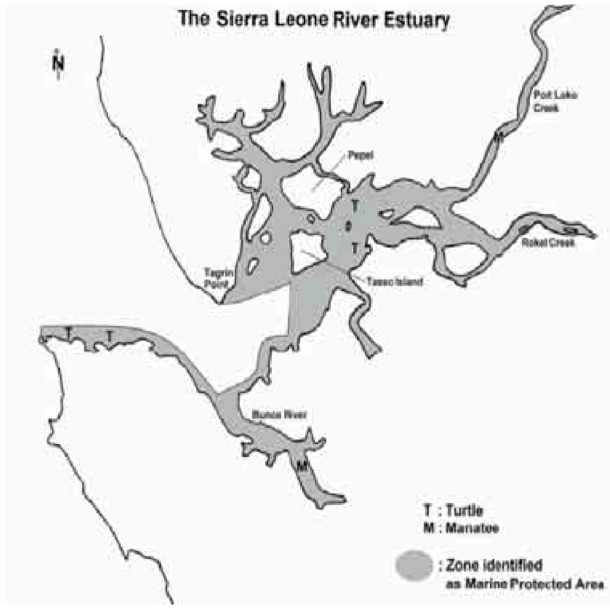


Figure 32. Proposed areas for MPAs in Sierra Leone River Estuary.

The juveniles will remain in the creeks until March and return to offshore areas for recruitment from June to July. During the month of December, the recruits will begin to move to the Portloko Creek, Madina River and the Rokel River for spawning.

For demersal fish stocks such as guangwa (*Pseudotolithus elongatus*) and the red groupers (Lutjanidae) the adults will move into the creeks to feed during the dry season (November to January), when salinity is high to permit feeding. They will remain in the creeks to spawn during this period, while the juveniles will return to offshore areas to commence recruitment from June to July. Fishers were also able to show that there is presence of manatees in the mahela creek in the Great Scarcies (Figure 33), around Sasiyeck, Kychon and kortimau Island. In addition, the high occurrence of sea turtles in the rivers around Sasyieck and Makompang in the Scarcies River was debated during the contemporary discourse.

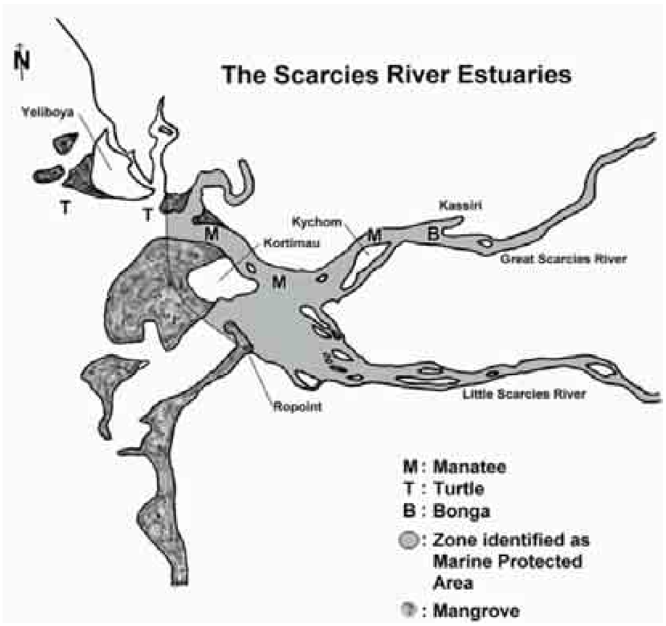


Figure 33. Proposed areas for MPAs in the Scarcies River.

Bonga shad (*Ethmalosa fimbriata*) spawning grounds and mangrove vegetation were also identified on maps by fishers. This underlines the importance of traditional knowledge in designing fisheries management plans.

In a similar consultation, vulnerable and high impact areas were identified by fishers for the establishment of MPAs in the Yawri Bay (Figure 34), in the Western Area and Moyamba Coastal Districts. The highly knowledgeable Master Fishermen were able to discern spawning grounds for specific fish stocks such as the croakers: Gwangwa (*Pseudotolithus elongatus*) and Whiting (*Pseudotolithus brachygnathus*), and the Catfish (*Arius* spp). Furthermore, based on experience, the spawning season for these species was identified to be from November to June, with spawning grounds in the Ribi River, the Bumpe River and the Kargboro Creek.

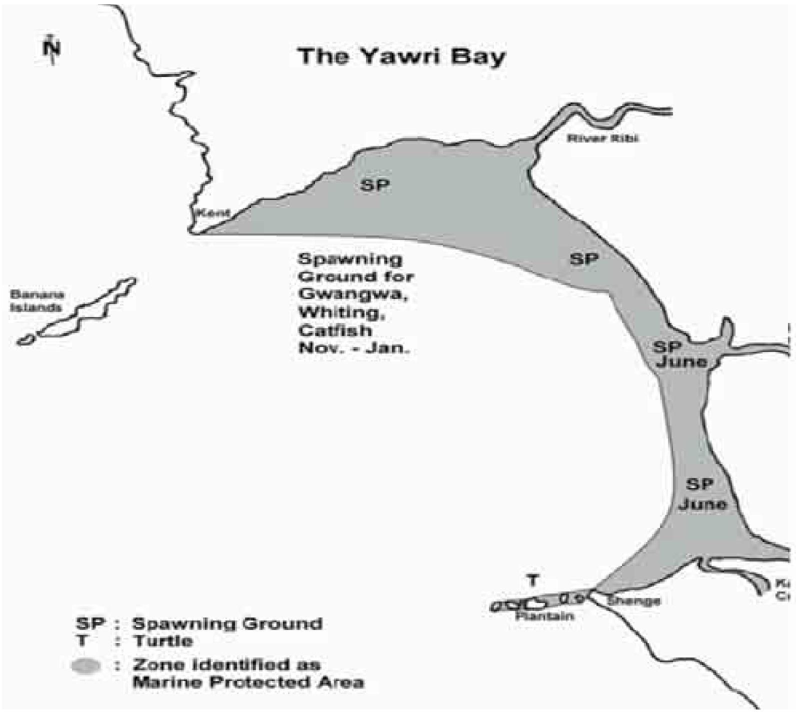


Figure 34. Proposed areas for MPAs in the Yawri Bay.

Based on the knowledge of fishermen and the numerous occurrence of breeding grounds and over 34 ha mangrove cover in the Yawri Bay and Kargboro Creek, fishermen agreed to allow only hook and line fishing within MPAs that will be established in the Yawri Bay (Figure 35) and to disallow the use of motorised boats within the MPAs.

The Sherbro River system in the Bonthe Coastal District, which contains over 50 percent of the costal mangrove cover in Sierra Leone, is one of those areas that was identified by fishers to be rich in biological diversity including wading birds, and to comprise of fringes of mangroves up to 15 km in the Northern reaches of Sherbro Island, Lake Mape and Masa Island in the River Wanje (Chong, 1987). This mangrove vegetation serves as important feeding and spawning grounds for various fish species of commercial value in Sierra Leone.

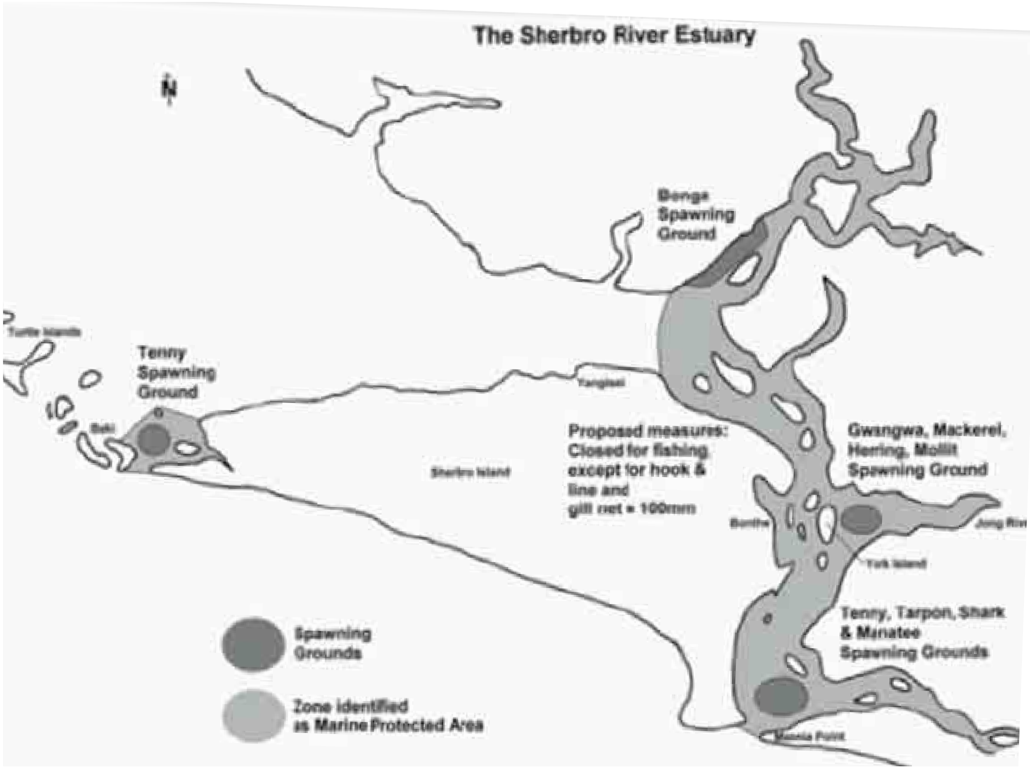


Figure 35. Proposed areas for MPAs in the Sherbro River System.

Fishers identified spawning grounds for tenny, sharks, the West African Manatee, Tapong to be in the Sheba Entrance and the Sewa Rives and gwangwa spawning areas to be found in the River Jong, in proximities of coastal villages of Momaya and in the Sherbro River in the proximities of Mokolo, Tokpombu, Bonthe Town, Bomplake, Jayahun, Yangisie, Guagutebu, Kpatobu, and in the Bagru Creek in proximities of Bompiya, Nyonigeihun and Moleleh. Abundant catches of juvenile bonga shad (awefu), mollit, gwanga, bonga, herring and mackerel were used as indicators in identifying spawning grounds. This was combined with scientific evidences such as size indicators to discern nursery spawning and nursery grounds. Fish sizes landed in these areas are less than 30 cm.

4. Annual catches

Artisanal fishery catch and effort data collection dates as far back as 1971 when the fishery was in a much healthier state with less effort and pressure on juveniles. The same fishing gears used today were used in the past. The fishery in the 1970s comprised of dugout canoes that operated in coastal waters including rivers and estuaries (Department of Fisheries and Marine Resources. 1994). The sector contributed significantly to local fish consumption as it does today, and none of the catch was exported. About 70 percent of artisanal catches is comprised of herring (*Sardinella* spp) and Bonga Shad (*Ethmalosa fimbriata).* Artisanal fish production trend from 1971-2009 is shown in Figure 36. The catch data is presented in Appendix 3.

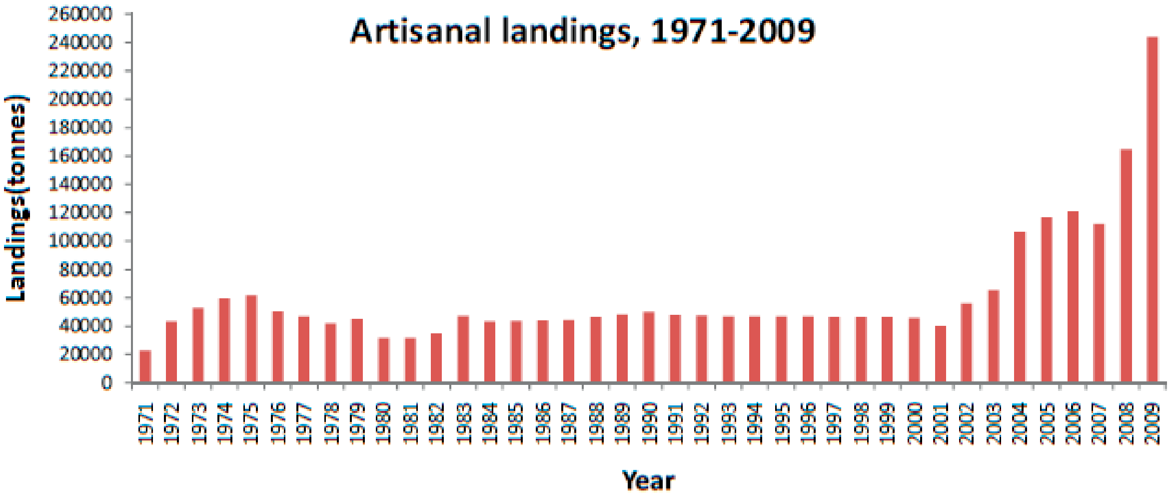


Figure 36. Historical artisanal catch trends, 1971-2009.

Artisanal catch trends shows increasing production from 1971 to 1975, followed by decreasing trends and slight fluctuations from 1976 to 1982. Catches increased slightly from 1983 to 1990. Due to prolonged civil war, artisanal fish production showed decreasing trend from 1991 to 2001. By the end of the civil war, artisanal fish production increased from 2002 to 2009 with a slight drop in 2007. In general increasing production in recent years is due to increasing effort as the craft number increased from 6 150 in 1974 to 7 942 in 2003. The number of artisanal crafts recorded in 2009 was 9 516 with some 7 662 active crafts. Currently, the Western Area, Portloko and Kambia coastal districts land the bulk of artisanal catches.

5. Importance of the fishery in the national economy

This section looks at the contribution of the fishery sector of Sierra Leone especially the artisanal sector to the national economy. The economic and development policies of Sierra Leone are based on the Agenda for Change, Poverty Reduction Strategy Paper (PRSP; Government of Sierra Leone, 2008). Support for agriculture and fisheries are among the priority areas of the agenda for change, with an emphasis on increasing the productivity of the poor. These policies aim at meeting the millennium development goal of reducing extreme poverty by 2015, amongst others.

5.1. Economic value of Sierra Leone fisheries

Sierra Leone does not operate a national fishing fleet in the industrial sector, which generates most of the fishery revenue for Government. Therefore substantial benefits from export earnings are enjoyed by the private companies and fishing vessel owners (Table 10). Another bottleneck to optimal fishery benefits is that Sierra Leone is currently not among the countries allowed to export fish and fishery products to the EU markets because the country do not currently meet the minimum sanitary and hygiene standards set by the EU. Additionally, an estimated USD 29 million potential fishery benefits is lost through IUU fishing every year[10]. The absences of a fishing harbour and weak surveillance capability further exacerbate the problem as illegal fishing and illegal transhipments of fish continue at sea, with additional loss of revenue from royalties. Indicative value of standing stock biomass and potential yields is provided in Table 11.

[10] FAO & World Bank estimates

Table 10. Export values (thousands USD) for finfish, shrimps and other shellfish (MFMR, 2008).

Year	Finfish	Shrimps	Other shellfish
2001	3 765	6 759	7 543
2002	1 845	6 054	11 227
2003	1 551	7 161	10 556
2004	1 490	9 493	6 090
2005	939	7 661	3 638
2006	1 827	7 553	4 040

Table 11. Indicative economic values (thousands USD) for yields (Anon, 2003). Biomass and yield values are based on prices quoted in the latest edition of INFOPESCHE Trade News, African Edition.

Standing stock biomass	Economic value (thousands USD)
Clupeids	49 915 – 73 620
Carangids and Tunas	122 850 – 91 350
Demersal fish and shellfish	42 630 – 91 350
Balistes spp	56 000 – 90 000
Total	271 295 – 499 830
Potential Yields	
Small pelagics (clupeids and carangids)	40 600 – 69 600
Large pelagics (Tunas, barracuda etc)	12 300
Demersal fish	15 660 – 39 150
Shrimp	23 700
Cephalopods	53 300
Total	92 313 – 144 803

5.2. Value Addition, Marketing and Employment Status in the artisanal fishery

The fisheries sector of Sierra Leone contributes about 10 percent to the national GDP and the artisanal fishery contributes about 80 percent of the total fish landed in Sierra Leone (MFMR, 2003). About 80 percent of the Sierra Leone population depends on fish as a source of animal protein. Before the war, the artisanal fisheries sector employed over 100 000 youths (MFMR, 2003), who served either as fishermen or were involved in ancillary activities such as fish processing and marketing and boat building. The social and economic effects of a decade long civil war were devastating for the country. There was destruction of fishing infrastructure in coastal communities thar led to a drastic reduction in the production of fish from prewar levels. The 2009 frame survey records about 36 159 fishers working in the artisanal fishery sector.

In recent years, over 100 000 tonnes of fish is produced yearly in the artisanal fishery sector, making the sector a major contributor towards food security and the enhancement of livelihoods in coastal communities. Increased fish production can still be obtained through reform, involving a robust capability to minimize IUU fishing, major investment in technology, fish handling and processing infrastructure as well as capacity building (Thorpe *et al*., 2009).

Major impediment to increased fish production in the artisanal fishery sector is trawler incursions into the IEZ, which leads to the destruction of artisanal nets, causing conflicts between the industrial and artisanal fishery sector. There are other illegal activities such as the use of undersized meshed nets and targeting of juvenile fish on spawning and feeding grounds of shallow rivers.

Value addition to artisanal fish catch is expected to increase due to the recent establishment of fish receiving facilities, including landing jetties at active fish landing sites of Bonthe, Shenge, Tombo and Goderich, through the support of the African Development Bank (ADB) funded artisanal fisheries development project (AFDEP). With the support of the West African Regional Fisheries Program for Sierra Leone (WARFP-SL), a 12 km road will be constructed from Lungi to Konakridee landing site in the Northern Coastal District of Port Loko. In addition, fish landing clusters will be constructed at the Konakridee landing site with a cold storage facility around the Lungi Airport, which will add value to the fish caught around the fishing communities in the Port loko and Kambia Districts and facilitate artisanal fish export.

6. Fisheries management plan and objectives

Sierra Leone Artisanal Fishery Management Regime

In the past, there have been policy documents (Acts, Regulations, Cabinet Conclusions, Fisheries Committee Reports, etc.) that have served as policy management instruments. There was no single document that was called The Fisheries Policy of Sierra Leone. This situation was improved on in 2002, when the Ministry of Fisheries and Marine Resources with assistance from FAO (both technical and financial) developed the first document referred to as **"The Fisheries Policy of Sierra Leone 2002"**. This has been fairly recently revised to give the new "Fisheries Policy of Sierra Leone 2010".

This revised fisheries policy and operational framework of 2010 (MFMR, 2010) has management objectives for the artisanal fishery. There is an operational management framework for shared small pelagic fish stocks. This framework calls for cooperation and concerted effort in the management of shared pelagic fish stocks exploited in the subregion by West African countries.

The 'Agenda for Change' and Results Based Artisanal Fishery Management

Recent works of the Ministry of Fisheries and Marine Resources is based on the President's Agenda for Change (Government of Sierra Leone, 2008) approach for the fisheries sector, which include stakeholder consultation, the provision of adequate extension services for the artisanal fishery, provision of adequate surveillance capability, improvement of fisheries infrastructure and commercialization of fishing, and ensuring institutional strengthening. This Agenda for Change is implemented in tandem with the country's results based management (RBM) framework, which is based on a performance tracking table (PTT; MFMR, 2011). In order to adopt EAF in the management of the artisanal fishery, the major activities of the EAF in country project has been incorporated into the MFMR results based management. Therefore the expected output for artisanal fishery identified for the 2011 PTT includes:

i. a baseline report on the artisanal fishery developed;

ii. a management plan for the artisanal fishery that incorporates the ecosystem approach to fisheries (EAF) completed;

iii. two marine protected areas (MPAs) established in the Yawri Bay and the Sherbro River Systems in Sierra Leone; and

iv. coastal aquatic fish stocks in designated MPAs assessed.

Including activities of the EAF in country project into MFMR result based management performance tracking for 2011 is a good start for the implementation of EAF in Sierra Leone.

Policy objectives for the management of the artisanal fishery

The management of the artisanal fishery of Sierra Leone is based on the following policy objectives:

i. Improve national nutrition and food security through increased fish production based on responsible fishing and the reduction of spoilage;

ii. Increase employment opportunities;

iii. Enhance livelihoods in fishing communities with emphasis on women and youth;

iv. Improve skills in the fishing communities and increase wealth through rational management based on scientific research;

v. Emphasize the role of both marine and inland artisanal fishery for local affordable animal protein production in Sierra Leone;

vi. Strengthen regional and international collaboration in the sustainable use, management and conservation of fish resources in shared water bodies.

Based on the above policy objectives, the 2010 revised fisheries policy and operational framework identifies four objectives which can enhance the management of the artisanal fishery:

a) conservation and sustainable use of fish resources;

b) promotion of comanagement in collaboration with stakeholders;

c) diversification and increase in international trade of fish and fishery products, and

d) implementation of cost-effective and functional extension services for improved management of fish resources. These objectives were identified in line with the legal framework for the management of the fishery as presented in Section 7.

7. Legal framework

The legal platform for all fisheries in Sierra Leone was the Fisheries Act of 1988, which also covered artisanal fisheries. This was replaced by the Fisheries Management and Development Act 1994[11] (FMDA 1994) articulated with World Bank support. A comprehensive set of Regulations, i.e. the Fisheries Regulations 1995[12] were also developed to complement the FMDA 1994. The 1994 Fisheries Act and the 1995 Fisheries Regulations were developed on the basis of UNCLOS (the 1982 United Nations Convention on the Law of The Sea)[13].

---

[11] The Fisheries (Management and Development) Act, 1994, Supplement to the Sierra Leone Gazette CXXV, No. 58 (8th December, 1994): 65(hereafter: 1994 Fisheries Act).

[12] The Fisheries Regulations 1995 Act, 1994, Supplement to the Sierra Leone Gazette, No. (hereafter: 1995 Fisheries Regulations).

[13] The United Nations Convention on The Law Of The Sea 1982 (hereafter UNCLOS 1982).

The artisanal fishery is conducted in the near-shore area within the 200 nautical miles continental shelf of Sierra Leone which was claimed under the Maritime Zones Establishment Decree of 1996[14] based also on the same 1982 UNCLOS.

In addition, there is the Fisheries Product Regulations of 2007[15] which provides for sanitation and fish hygiene to enable Sierra Leone and fishery products to access international markets including the European Union (EU).

It should be noted that FMDA 1994 and the Fisheries Regulations 1995 are currently under review and are expected to give rise to the FMDA 2011 and Fisheries Regulations 2011 respectively. The Fisheries Products Regulations 2007 is also being reviewed.

The revision of these national legal instruments has been necessitated by recent developments in international fisheries management instruments such as the Compliance Agreement[16] and the EU Regulations.

The 1994 Act and the Fisheries Regulations 2010[17] provide necessary regulations, conservation measures and monitoring, control and surveillance (MCS), which are useful for artisanal fisheries management.

8. Institutional and administrative frameworks for fisheries management

The Ministry of Fisheries and Marine Resources (MFMR) is in charge of the management of fisheries in Sierra Leone, in collaboration with line Ministries, other government institutions and cooperation with multilateral agencies and regional fisheries management organisations (RFMOs). The fisheries management framework under MFMR (Figure 37) consists of professional staff and administrative staff, with an overall supervision by a political head who is a Minister of Fisheries and Marine Resources, assisted by a Deputy. The professional head is the Director of Fisheries and the Administrative head is the Permanent Secretary.

[14] The Maritme Zones Establishment Decree 1996, S Supplement to the Sierra Leone Gazette, No. (hereafter: 1995 Fisheries Regulations).

[15] The Fisheries Regulations 2007 Act, 1994, Supplement to the Sierra Leone Gazette CXXV, No. 58 (8th December, 1994): 65(hereafter: 1994 Fisheries Act).

[16] 1993 FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas.

[17] The Fisheries (Management and Development) Act, Draft Fisheries Regulations, 2010 (hereafter: The Fisheries Regulations, 2010)

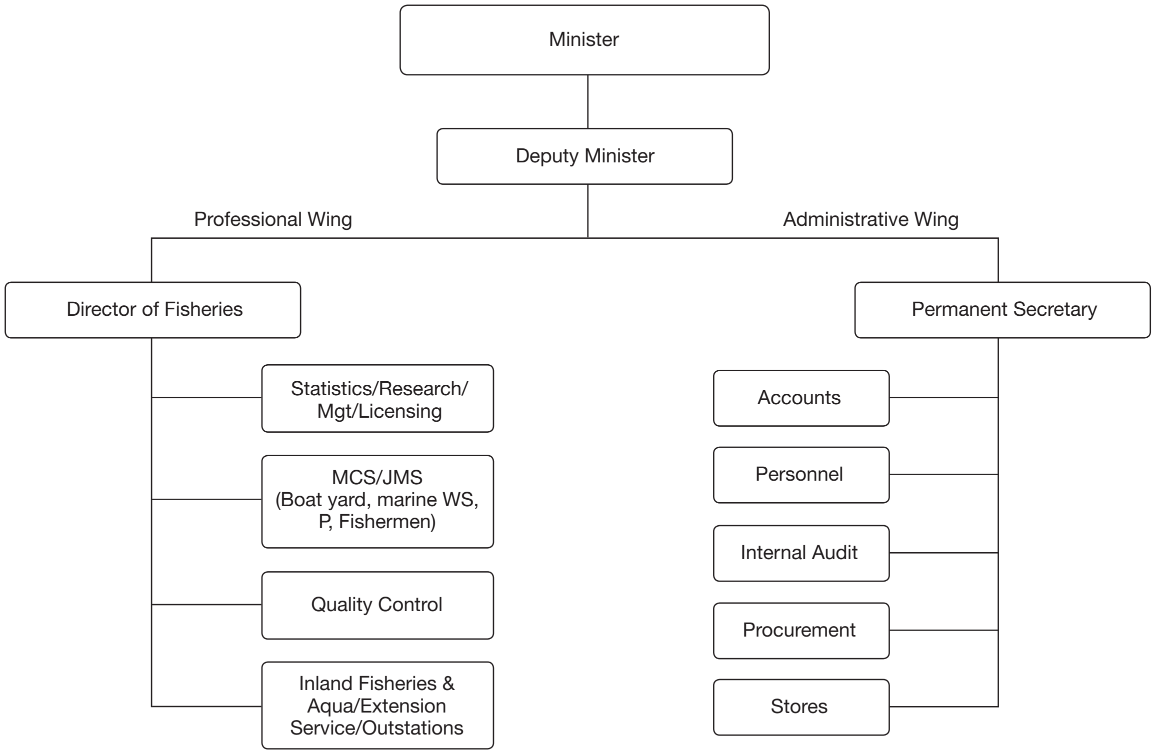


Figure 37. Simplified Fisheries Management Organogram under MFMR (MFMR, 2011).

Major institutions that collaborate with MFMR include:

i. The Sierra Leone Maritime Administration (SLMA);

ii. The National Revenue Authority (NRA);

iii. The Maritime Wing of the Republic of Sierra Leone Armed Forces (MW-RSLAF);

iv. The Sierra Leone Ports Authority (SLPA);

v. The Foods Unit of the Environmental Health Division of Ministry of Health and Sanitation (MOHS);

vi. The Sierra Leone Agricultural Research Institute (SLARI);

vii. Ministry of Employment, Social Security and Industrial Relations;

viii. The Office of National Security (ONS);

ix. The Immigration Department;

x. Institute of Marine Biology and Oceanography (IMBO);

A Joint Maritime Committee (JMC) has been established by Cabinet, in order to improve on monitoring, control and surveillance (MCS). The JMC comprises of all major maritime institutions as listed above, including the MFMR and Office of National Security (ONS). The JMC is in charge of fisheries protection and maritime security, including the regulation of other customs related issues such as contraband goods. Under the JMC a fleet management system and an automatic information system has been established in order to monitor the position of licensed fishing vessels at sea.

The governance of the fisheries of Sierra Leone is based on deconcentration[18] and moving towards decentralisation[19]. There has been devolution[20] of management functions such as licensing of fishing canoes. Devolution is a key element of decentralisation which introduces stewardship responsibilities to the local people. Fisheries management and administrative activities in which stakeholder institutions are involved include: fisheries policy formulation through consultative meetings and validation workshops, training activities on data collection, fish processing, fish farming and extension services, fishing vessel inspection and registration, transhipment activities, enforcement of fisheries laws and regulations, licensing, fish quality control and certification, regional and international conferences and fisheries administration.

Local Councils are now in charge of revenue collection through licensing of canoes in the artisanal fishery sector. They have very high influence over fisheries governance decisions. Their continuous agitation for the replacement of illegal fishing nets by government have been reckoned through the GEF/World Bank funded project, where fishing nets will be provided to fishers under an incentive for change package. A Scientific and Technical Committee has been established which comprises of experts in fisheries science and economics including retired Directors of Fisheries. This Committee provides fisheries management advice to the Director of Fisheries. Considerations are made to include fisher organisations as members of the Scientific and Technical Committee, in order to capture the traditional knowledge of fishers in fisheries management. All fishing licenses and fines are paid to government consolidated revenue through the NRA which has an Office at MFMR. There is an Audit Section which audits financing and expenditure mechanisms. SLMA is the responsible institution for registration of fishing vessels, pollution controls and safety of fishing vessels including crew safety. The SLPA coordinates traffic for industrial fishing vessels calling at the port of Freetown.

There is collaboration with regional, multilateral and bilateral agencies facilitating capacity building, project formulation and mobilization of donor support for projects, including the provision of technical advice. These projects form the backbone of the management of the fisheries. A Strategy and Policy Unit (SPU) has been established by Government in the Office of the President. The SPU has developed a Results Based Management (RBM) system where the performance of Ministries and Departments are appraised in a performance tracking table (PTT) on quarterly evaluations, based on specific policy outcomes (Figure 38).

[18] Distribution of people and facilities to less populated areas.

[19] Transfer of authority and financial responsibility to lower levels of government e.g. local government.

[20] The transfer of rights and responsibilities by Government to opinion leaders of user groups such as fisher organisations and councillors at the local level.

ministry of fisheries and marine resources							
PERFORMANCE TRACKING TABLE							
IMPLEMENTING YEAR: 1st January TO 31st DECEMBER 2011							
Output (specific deliverable at the end of 2011)	Baseline (status at end of 2010	Progress Indicators					Implementing institution/s
		Q1		Q2			
		Planned	Actual	Planned	Actual		
Policy Outcome One: Foster Good Governance for sustainable commercial fisheries development and economic growth							
5.Management plan for small scale fishery developed and Ecosystem Approach to Fisheries Management Promoted	There is no fisheries management plan for small scale fisheries, but a project document is available; National Task Group on Ecosystem approach to fisheries management (EAF) Project in place	1) Baseline report on the artisanal fishery in line with EAF guidelines developed (2) Management and co-management issues identified through stakeholder consultations. 3. TOR developed for Fisheries management plan for the small scale sector	1) A Baseline report on the artisanal fishery have been developed (2)Stakeholder consultations on co management have been done in Shenge, Bonthe and Konakridee Outstaions. Key management issues identified include: the management of fish receiving facilities, the construction of fish landing clusters at Konakridee. Reports on the consultation is available	1. Local Councils, Unions and MFMR staff trained on EAF principles; 2. Consultant hired for the development of fisheries management plan for small scale fishery (4)First draft of the fisheries management plan framework developed.		MFMR, WARFP.nLocal Govt., SLAFU, SLAAFU	
Fishing Vessel Licenses Ensured	80 licensed fishing vessels as at end 2010	60 fishing vessels licensed		70 fishing vessels licensed (cumulative)			
Policy Outcome Two: Sustainable Artisanal Fisheries Commercialisation and Effective Extension Support							
Completion of the Construction of the fish receiving centres and jetty at Bonthe and Effective support to extension services	Fish receiving centers in Goderich, Tombo and Shenge completed and operational. 90% completion of the Bonthe Station.	(1) Bonthe Fish receiving center and jetty completed (2) Management committees of the jetties set up comprising of MFMR and community (3) Jetty facilities commissioned and handed over (4) Operation to the public commenced	Bonthe fish receiving centre and jetty has been completed 2) Management committees have been set up 3)plans are underway to commission jetty facility and operationalise jetty	(1) Mechanism of monitoring fisheries activities at the centers developed (2) Monitoring exercise of the fisheries activities at the center carried out		MFMR, ISFM, Local Govt, SLAFU, SLAAFU	

Figure 38. Performance Tracking Table showing major output for artisanal fishery management.

The management of artisanal fishery is implemented in tandem with this performance contract signed by the Minister at the beginning of every year. The appraisal of activities in the PTT identifies implementation bottlenecks, implementing institutions and reasons for failing to meet specific targets. The 2011 performance indicators for the artisanal fishery are embedded in:

- Policy Outcome One: Fostering good governance for sustainable commercial fisheries development and economic growth, and
- Policy Outcome Two: Sustainable artisanal fisheries commercialization and effective extension support.

The output for artisanal fishery management as identified under Policy Outcome One include:

- effective protection and conservation of fishery resources;
- review of 1994 Fisheries Act;
- implementation of revised fisheries policy and fisheries regulations;
- the establishment of two marine protected areas (MPAs); and
- the development of fisheries management plan in line with the ecosystem approach to fisheries (EAF).

The expected deliverables identified under Policy Outcome Two include:

- completion of construction of fish receiving centres at artisanal fishery landing sites;
- the construction of integrated fish landing site clusters;
- upgrading of 200 artisanal crafts to semi-industrial vessels;
- streamlining of fishery product regulations and ensuring export of fish and fishery products to the EU markets.

Project activities are also captured by the PTT. Among the activities identified for first quarter of 2011 under the EAF-NANSEN project include:

- the development of baseline report for the artisanal fishery in line with EAF guidelines;
- the identification of fisheries management and comanagement issues through stakeholder consultation; and
- the development of a management plan for the artisanal fishery based on EAF principles.

8.1. Artisanal fisheries consultative issues

Sierra Leone participates in national and regional consultations on the management of artisanal fisheries. National consultative forum are organised to discuss fisheries management issues with key stakeholders in the artisanal sector. In addition, fisheries policies and legislation are reviewed together with stakeholders from artisanal fishing communities in order to include their views in the formulation and implementation of fisheries management measures.

For example, the revised 2010 fisheries policy and operational framework for Sierra Leone was developed together with representatives from fisher organisations: The Sierra Leone Artisanal Fishermen Union (SLAFU) and the Sierra Leone Amalgamated Artisanal Fishermen Union (SLAAFU). Sierra Leone also collaborates with regional fisheries management organisations such as the SubRegional Fisheries Commission (SRFC), which is actively involved in the management of fish resources.

Additionally, the implementation of the ecosystem approach to fisheries in Sierra Leone is done through consultative meetings with a national task group (NTG) comprising of various stakeholders. The views of stakeholders and the consensus building on artisanal fisheries management issues has served as an important tool in the implementation of the EAF in Sierra Leone.

Furthermore, the implementation of fisheries management activities through a performance contract signed by Ministers, utilizes a performance tracking table which attracts discussions among different Departments of MFMR who have different responsibilities to meet targets set within the performance contract.

The SubRegional Fisheries Commission (SRFC) is one of the regional fisheries management organisations (RFMO) for which Sierra Leone is a member. Artisanal fisheries management issues are discussed during several meetings organised by the SRFC. The SRFC was established under the SRFC convention[21], which requires State parties to cooperate in the implementation of measures for the sustainable management of fisheries in the subregion. The head quarter of the SRFC is in Senegal. The SRFC is composed of the Conference of Ministers. Member States collaborate in scientific exchanges for fisheries management[22]. The SRFC member States also collaborate with international organisations for capacity building in fisheries matters and to source funding for fisheries management projects[23]. The SRFC is the regional coordinating wing for the West African Fisheries Programme, which was successfully negotiated through cooperation with member States.

In 2009, a meeting was organised by SRFC on the management of small pelagic shared stocks, where the issue of harmonisation of fisheries management plans for the small pelagic fishery was discussed.

Another RFMO through which artisanal fisheries management meetings are held is the Ministerial Conference for Fisheries Cooperation among African States Bordering the Atlantic Ocean (COMMAHFAT/ATLAFCO). ATLAFCO was established by the Dakar Convention with the objective of bringing together fisheries management experts in the African Region bordering the Atlantic Ocean, to discuss fisheries management issues in the region. The headquarters of ATLAFCO is in Morocco.

The 2010 Ministerial Conference was held in Accra, Ghana, where various fisheries management issues were discussed. The Japanese Fisheries Cooperation provides support for ATLAFCO through a trust fund that is part of the Regional Development fund established by the Dakar Convention[24]. A key fisheries management issue that ATLAFCO conference identified for member States to implement is IUU fishing. This is important for the sustainable use and management of artisanal fishery in Sierra Leone.

9. Management measures and tools currently in use and status of implementation

The 1994 Fisheries Act gives the statutory mandate to MFMR for the management and conservation of living aquatic resources in Sierra Leone. The Fisheries Regulations 2010 provides sound legal framework for the sustainable use, management and conservation of the fisheries, by stipulating robust measures including shared responsibility through comanagement that is particularly useful for artisanal fishery governance. These provisions include prohibited fishing gears and methods, and conservation issues including the protection of endangered marine megafauna and the establishment of MPAs. The 1994 Fisheries Act provides directives for fisheries management, fisheries development and conservation plans that include consultations on international fisheries management that can contribute towards sustainable development. There are provision for monitoring, control and surveillance, including community surveillance and the exclusion of industrial trawlers and decked semi-industrial vessels from the inshore exclusion zone (IEZ)[25], which comprises of an area of the fishery waters situated landward of a line drawn between the points, as provided in the first schedule of the Fisheries Regulations 2010 (see Section 2).

---

[21] Convention on the Establishment of the SubRegional Fisheries Commission, 29 March 1985, amended July 14, 1993, Praie, Cape Verde (hereafter: SRFC Convention)

[22] SRFC Convention, Art.14.

[23] SRFC Convention, Art.18

[24] Dakar Convention, Art.18.

[25] 1994 fisheries Act, Section 30 (1); The Fisheries Regulations, 2010, Part II Section 7.

The IEZ extends about 5-7 nautical miles from land in the north and southern coast respectively. This provision is important for the artisanal fishery because law enforcement principles form the backbone for the sustainable exploitation of living marine resources (Long, 2007). The IEZ is reserved exclusively for artisanal fishing crafts, un-decked semi-industrial vessels, and for recreational fisheries[26]. Although these provisions do not limit artisanal fishers to fish in the IEZ, they must use lights on their boats for visibility at night whenever they go further offshore. This will prevent gear destruction by industrial vessels, thus preventing conflicts and maritime insecurity for the artisanal fishers. A key provision of the 1994 Fisheries Act, which is in favour of the artisanal fishery, is that the destruction of artisanal gears by trawlers requires full compensation[27].

The legal provisions for the conservation of other organisms that interact with the fisheries and the establishment of MPAs in collaboration with stakeholders are key elements of EAF and forms part of the international law making that commands more authority and power (Hunter et al., 2002).

Part VI, Sections 30-49 of the 1994 Fisheries Act gives specific provisions for fisheries conservation, which are useful for the artisanal fishery. These include fishing area limitations, guides for instituting closed seasons, the requirements for importation and sales of fishing nets, fishing methods and fishing gear regulations. Biological control measures and marine biodiversity conservation and the impact of fishing on aquatic habitats are also provided. The protection of marine mammals and the establishment of marine reserves, and trade restrictions for fish and other marine species are among the important conservation provisions as mentioned inter alia.

Furthermore, the 1994 Fisheries Act provides for closed seasons and fishing gears authorised for fishing[28]. The 45 mm stretched diagonal mesh size requirement for all gillnets operating in the artisanal fishery will contribute towards the rebuilding of over exploited fish stocks. Finally, under the Local Government Act 2004[29], fisheries management functions such as the licensing of fishing canoes and attendant fishing gears have been devolved to local councils. This confers stewardship to fishing communities and can improve on the management of the artisanal fishery in Sierra Leone.

Access regulations

The fisheries of Sierra Leone is open access, meaning that it is non excludible. Anybody that has a fishing craft or fishing gear and fishing authorization is allowed to fish. Resource access in the artisanal fishery is only regulated through licensing. The licences issued should be valid for a period not more than one year. Licenses issued are guided by restrictions, and in particular, they are not transferable. All fishing canoes are required to have markings, which are done by the licensing authority, and any falsification of such markings is an offence that carries a penalty. In addition, not all fishing gears and fishing methods are authorized under the licensing scheme. Unauthorized fishing gears and practices in the artisanal fishery include beach seine, monofilament nets, the use of poisons or explosives, channel nets (“lagba lagba)[30]”, scoop nets, “mina” fishing nets.

---

[26] 1994 Fisheries Act, Sec.30.

[27] 1994 Fisheries Act, Sec.31 (1-2).

[28] Section 38, 1994 Fisheries Act.

[29] Sierra Leone Local Government Act 2004.

[30] These are specially designed nets with undersized meshed nets that are capable of fishing in shallow waters including fish breeding grounds and even between rocks, catching large quantity of juvenile fish.

9.1. Management measures and tools

This section presents an analysis of artisanal fishery management measures in Sierra Leone, including the management tools used for informed decision. Current management measures employed and the status of implementation are presented in Table 12.

Table 12. Analysis of management measures and tools applied to artisanal fisheries in Sierra Leone.

Type of Management Tool	Comments
Spatial (area) restrictions	
Marine protected areas where fishing is prohibited	The establishment of marine protected areas is part of the draft 2010 fisheries regulations. Four river systems have been identified for the establishment of MPAs. In a consultative forum, stakeholders have demarcated vulnerable areas in the Yawri Bay, Scarcies River, Sherbro River and Sierra Leone River Estuary for MPAs. Desk review, socio-economic studies, governance and hydrological studies have been done to identify livelihoods and environmental problems in the proposed MPA areas.
Nursery area closure	Section 35 of the 1994 fisheries Act (under review) provides for riverine areas and lakes which are nursery areas for fish to be prohibited for the use of beach seine nets, multi filament nets of meshes of 50 mm stretch diagonal length, and monofilament nets of meshes 70 mm stretched diagonal length. In the Kollenten River (Scarcies) and Mapotoloh around Yeliboya in the Kambia District, byelaws are implemented for spawning and nursery area closure
Marine reserves where fishing is sometimes allowed	Section 46 (1) of the 1994 Fisheries Act provides for the establishment of marine reserves in the fishery waters of Sierra Leone. Section 46 (2)(a)-(c) prohibits fishing, dredging and other activities in marine reserves. This provision has not yet being implemented.
Other temporary area closures for specific purpose (e.g. spawning aggregation)	Implemented in Sierra Leone through byelaws in specific areas.
Temporal Restrictions	
Defined fishing season(s)	Section 32(1) of the 1994 Fisheries Act (under Review), provides for closed seasons, and states that the Director of Fisheries can declare in writing closed seasons and their duration, which will prohibit fishing in specific areas of the coastal waters or riverine areas of Sierra Leone. This provision has not yet been implemented.
Defined number of days fishing	Not implemented for fisheries management measures but for religious holidays in Sierra Leone (Fridays for some Muslims and Sundays for some Christians).
Gear restrictions	
Gear size restrictions	Section 30(1) of the 1994 Fisheries Act (Under review) prohibits the use of industrial and semi-industrial vessels greater than 50GRT in the IEZ. This is currently implemented.
Gear type restrictions	Industrial vessels of all sizes are prohibited from the IEZ. Sections (34-39) of the 1994 Fisheries Act prohibits the use of beach seine nets in coastal waters if the mesh size of stretch diagonal length is less than 25 mm. Monofilament nets with meshes less than 70 mm are also prohibited for fishing in coastal waters. Shrimp trawl nets less than 45 mm cod-end stretch diagonal length and 100 mm wing length are prohibited for fishing. Demersal trawl nets.
Participatory Restrictions	
Licenses	Access to artisanal fish resources in Sierra Leone is through licensing. However, there is no user right to the fishery, meaning that the fishery is open access. Any one that has license for his fishing craft or gear can be allowed to fish. The Local Council is in charge of licensing of fishing canoes pursuant to Section 56 of the Local Government Act 2004.
Catch Restrictions	
Total allowable catch (TAC) limits	Required by legislation but currently not implemented due to multi-species nature of the fishery
Rights-/incentive-adjusting regulations	
Territorial use rights	Provided in the draft 2010 fisheries regulations. Plans are underway for its implementation under the WARFP-SL project.

9.2. Effectiveness of Current Artisanal Fishery Management Measures

The current provisions for the management of artisanal fishery are robust but the measures are not effectively enforced. For example, the ban on illegal fishing nets in the artisanal fishery has not been effectively enforced.

Fishers are still using monofilament nets and undersized meshed gill nets in rivers and coastal waters, thereby taking large quantities of juvenile fish of low market value. The issue of livelihoods in fishing communities and the lack of strong political will to implement the management measures continue to be a major problem.

Sustainable use and conservation

The illegal fishing practices in the artisanal fishery and the incursion of trawlers into the IEZ are major factors threatening the sustainable use and conservation of fish resources. Therefore as stated earlier, most fish stocks are now exploited unsustainably. The most vulnerable areas that will require sustainable use are the major river systems where numerous fish breeding grounds can be found.

Fishers have requested Government to provide them with legal fishing nets free of cost as a replacement for illegal nets which they continue to use. This condition appears to be difficult to meet as Government policy is to avoid total fisheries subsidies which will increase fishing effort and cause further decline to fish resources.

In order to ensure sustainable fish resource use, the fisheries laws and regulations will need to be fully enforced without any favour or repress.

Effectiveness of Governance Arrangements

The current governance arrangement for the artisanal fishery sector is not effective. The devolution of fisheries management functions such as the licensing of fishing canoes and attendant fishing gears under the Local Government Act of 2004 was rushed, as the main aim of the devolution exercise was for the Local Councils to generate revenue, without properly evaluating the problems and the capacity needs for licensing and fishing canoe registration.

Local Councils are now issuing licenses to fishing canoes operating illegal fishing gears. Although devolution of fisheries management functions is a good step towards decentralisation, which is an important element of good governance, the Local Councils will require to work under the technical guidance of MFMR staff in order to adopt the professional procedure for the licensing of fishing canoes.

The incentive for change package under the WARFP-SL will be providing fishing nets for compliance at 50 percent subsidised cost. It is expected that this will minimize the use of illegal fishing gears in the artisanal fishery sector, but this activity will need to be properly planned to ensure that the wrong people are not compensated.

There is a tendency for fishers to declare some portion of the illegal nets they are using, realising that the incentive for change package might not be enough to replace large quantities of fishing nets already in use. It is assumed that the distribution of the nets will be based only on the quantities that will be supported by the project at any given time. Therefore the enforcement of the ban on illegal fishing must be strengthened before and even after the incentive for change scheme has been implemented by the WARFP-SL project.

9.3. Compliance problems facing the artisanal fishery in Sierra Leone

Major compliance problems in the artisanal fishery of Sierra Leone are:

- IUU fishing including IEZ violations and destruction of artisanal fishing gears;
- the use of undersized meshed nets by artisanal fishers;
- licensing of artisanal fishing crafts and attendant gears;
- indiscriminate dumping of wastes into the sea;
- myths and culture.

These problems emanated as a result of poverty and livelihoods related issues including low literacy rates, poor social amenities such as lack of drinking water, toilet facilities, limited credit facility and limited fish processing and storage infrastructure. All these will have to be considered in the development of a good fisheries management for the artisanal fishery sector. Due to weak surveillance capability, trawlers operating in the fishery waters of Sierra Leone often enter into the IEZ which is reserved for artisanal fishers. This IEZ incursion can be violent and often causes the destruction of fishing gears belonging to the artisanal fishers and this have been followed by bodily harm or even death.

In addition to the use of illegal fishing nets by fishers in the artisanal fishery sector, the incursion of trawlers into the IEZ has caused untold suffering to artisanal fishers who are heavily dependent on fishing with very little alternative livelihoods. These trawlers catch large quantities of juvenile fish on breeding grounds within inshore waters. Therefore catches in the artisanal fishery sector are now considerably low. Sometimes as fishers fear trawlers, they are restricted to fish within most inshore localities, targeting mainly juvenile fish with very little economic value to support livelihoods in fishing communities. Recent investment analysis of artisanal fishing unit of standard 5-10 employing ringnet fishing with 15hp engine and targeting herring and snappers shows that fishers in living in the Yawri Bay fishing communities of Southern Sierra Leone are fishing at a loss. An internal rate of return analysis generated several negative net present values, showing that fishers will require long term investment before they can break even or make any profit. The analysis of average rate of return for this investment also revealed low rate of 0.32, showing an unprofitable investment for the fishing economic unit of standard 5-10 ringnet fishing in the Yawri Bay (Sei and Aruna, 2010).

10. The way forward for a sustainable artisanal fishery in Sierra Leone

The current artisanal fisheries governance reform should be reinforced because devolution is a strong pillar of decentralisation, which is an element of good governance. There is no doubt that the proper enforcement of this good governance arrangement can contribute towards meeting the millennium development goal of reducing extreme poverty.

A key area of the artisanal fishery management regime that requires immediate attention is the open

---

[21] Convention on the Establishment of the SubRegional Fisheries Commission, 29 March 1985, amended July 14, 1993, Praie, Cape Verde (hereafter: SRFC Convention)

[22] SRFC Convention, Art.14.

[23] SRFC Convention, Art.18

[24] Dakar Convention, Art.18.

[25] 1994 fisheries Act, Section 30 (1); The Fisheries Regulations, 2010, Part II Section 7.

access regime, which can lead to unsustainable resource use because there will be overutilization since anyone who has fishing boat and obtains license is allowed to fish. This is exactly the situation that might lead to ‘‘tragedy of the commons’’ because fishing effort will increase over time when there will be so many fishing crafts running after very few fish in the coastal waters of Sierra Leone.

A possible way to rebuild declining fish stocks and ensure sustainable fishery is to establish MPAs in vulnerable areas of the major river systems already identified by stakeholders. These MPAs when established will need to be managed by the community in collaboration with staff from MFMR. Community surveillance systems must be supported where the stakeholder groups managing the MPAs will obtain detailed training to be able to operate basic surveillance equipments such as hand held radio communication systems, GPS and speed boats which can be used to police the MPAs. Only passive fishing should be allowed in these MPAs, as agreed during previous consultations and ongoing stakeholder consultations.

In addition, broader sensitization will be required at community level in order to properly sensitize stakeholders in areas where the MPAs will be established. Furthermore, there will be a need to establish management committees, which will be responsible for enforcement of regulations within MPAs. These management committees must consist of key stakeholders in the communities and who have influence over decisions. They must come from community leaders including the Local Councils, fisher organisations and other stakeholders.

Within the MPAs where there had been serious habitat degradation including mangrove deforestation and the destruction of shallow reefs, artificial coral reefs should be established to support spawner aggregation, re-establish feeding grounds to support the rebuilding of declining stocks, and to prevent the incursion of trawlers into the MPA areas. Once stocks have rebuilt over time, the artificial reefs can be removed to ease navigation of seafarers.

Furthermore, the establishment of territorial use rights in fisheries (TURFs) must be based on successes of the management of MPAs, and again these TURFs must be managed by the community in collaboration with the Local Councils, and MFMR staff.

Another important area that will need to be considered in developing a fisheries management plan for the artisanal fishery is the impact of climate change on coastal communities. Global climate change effect is now been felt at artisanal fishing communities. Sea level rise causes inundations in island communities leading to the loss of livelihoods assets and fishing time. Studies have shown that there is a possibility for the Human Rights Commission to work together with the civil society, other NGOs and MFMR in the development of climate change adaptation strategy for coastal communities in Sierra Leone (Sei, 2011).

In order to enhance sustainable use and conservation of fish resources, regular surveillance patrols will be required to police the 5 to 6 nautical mile IEZ so as the prevent the incursion of trawlers into river systems which serve as major breeding grounds for fish stocks.

Finally the issue of marine biodiversity must be considered in developing a management plan for the small-scale fisheries. There should be support for the monitoring of manatee, sea turtle bycatch and bycatch of other marine megafauna in the artisanal and industrial fishery sectors, in collaboration with fisher organisations.

Early warning systems should be put in place for coastal communities affected by climate change, and also for averting sea accidents. In addition, sea defence programme should be considered in collaboration with the Ministry of Works Housing and infrastructure that have started the implementation of similar programmes. Mangrove reforestation in vulnerable/degraded areas should also be considered in the management plan. The effect of sand and salt mining should also be considered, especially around the Yawri Bay because of the closeness of the Bay to the Western Area Peninsular.

Acknowledgements

The effective completion of this study has been achieved with support from the EAF-NANSEN project and the cooperation of several projects and staff of the Ministry of Fisheries and Marine Resources in Sierra Leone.

The authors express their thanks and appreciation to all whom in any way contributed to the success of this exercise. Their appreciations are also due to the NTG members for their tireless contributions in the preparation and validation of the report.

References

Chong, P.W. 1987. Proposed management and integrated utilization of mangrove resources in Sierra Leone. FAO/Ministry of Agriculture, Natural Resources and Forestry. Field Document no. 6: 1–75.

Coutin, P.C. & Payne, A.I. 1986. The effects of long term exploitation on tropical multispecies marine fish stocks. First interim report.

Department of Fisheries and Marine Resources. 1994. Fisheries of Sierra Leone. First edition. p. 1–19.

Garcia, S. & Le Reste, L. 1981. Life cycles, dynamics, exploitation and management of coastal penaeid shrimp stocks. FAO Fisheries Technical Paper 203: 215.

Government of Sierra Leone. 2008. The agenda for change, policies for Sierra Leone's poverty reduction strategy. p. 1–7.

Hunter, D.; Salman, J. & Zaelk, D. 2002. *International environmental law and policy.* University Case Book Series. New York, Foundation Press. 1547 pp.

Huse, I.; Alvheim, O. & Turay, I. 2006. Surveys of the fish resources of the western Gulf of Guinea. Cruise report of the R/V *Dr Fridtjof Nansen*. Bergen, Norway. Institute of Marine Research.

Johnson, R.G. & Johnson, R. G. 1996. Upwelling phenomenon in the region of Sierra Leone exclusive economic zone and its link with the fisheries. *In*: Summaries of contributions presented at the Workshop on West African Fisheries, organised during the advanced course on upwelling systems (Atlantic Ocean Eastern Boundary Current), a joint effort of the Intergovernmental Oceanographic Commission of UNESCO and the European Union Marine Science and Technology Programme, Las Palmas, Gran Canaria, Spain, 9–10 August 1995. IOC/INF–1045 (1996): 17–18.

Long, R. 2007. *Marine resource law.* Dublin, Thomson Round Hall. 840 pp.

Mehl, S.; Turay, I.; Sei, S. & Lamptey, E. 2007. Surveys of the fish resources of the western Gulf of Guinea. Cruise reports of the R/V *Dr Fridtjof Nansen*. Bergen, Norway. Institute of Marine Research.

Ministry of Fisheries and Marine Resources. 2003a. Fisheries of Sierra Leone, second edition.

Ministry of Fisheries and Marine Resources. 2003b. 2003 Artisanal fisheries frame survey report.

Ministry of Fisheries and marine Resources. 2008. Fisheries of Sierra Leone second edition. p. 2–3.

Ministry of Fisheries and Marine Resources. 2009. Results based management performance tracking table (RBM-PTT), Fourth Quarter Report. Strategy Policy Unit, Office of the President, Republic of Sierra Leone.

Ministry of Fisheries and Marine Resources. 2010. 2009 Frame survey results.

Ministry of Fisheries and Marine Resources. 2010. Policy and operational framework for the fisheries of Sierra Leone. p. 1–38.

Ministry of Fisheries and Marine Resources. 2010. Training manual for local councils. p.1–27.

Ministry of Fisheries and Marine Resources. 2011. Performance tracking table, implementing year: 1 January–31 December 2011.

Ministry of Fisheries and Marine Resources. 2011. Retreat on NEPAD/DFID support to the fisheries programme in Sierra Leone.

Sei, S. 2010. Climate change impacts on fisheries in Sierra Leone: vulnerability of island communities. Proceedings of Oceanology International, 9–11 March 2010, London. *In*: L. Murphy, ed. The complete guide to Oceanology International. p. 1–50.

Sei, S. 2011. Fisheries governance reform in Sierra Leone: law, policy and institutional arrangements. Research paper. United Nations–Nippon Foundation Fellowship Programme.

Sei, S. & Aruna, E. 2010. Report on socio-economic studies for the establishment of marine protected areas (MPAs) in the Yawri Bay. Pilot project for coastal zone management, Sierra Leone. West African Regional Coastal Zone Management Programme (PRCM), Conservation Society of Sierra Leone. p. 1–52.

Sei, S.; Sankoh, S.; Koroma M. & Sesay, S. 2011. Report on consultative and assessment visit to Konakridee, Bailor and Masulimani fishing communities. West African Regional Fisheries Programme Seirra Leone. Ministry of Fisheries and Marine Resources.

Sheriff, M.F.; Seisay, M.B.; Jalloh, K.; Turay, I.; Sei, S. & Seilert, H. 2009. Co management of the small pelagic fisheries in Sierra Leone. Regional Seminar on Mechanisms for Management of Shared Stocks of Small Pelagics in North West Africa, SubRegional Fisheries Commission, 15–17 April, 2009.

Thorpe, A.; Whitmarsh, D.; Ndomahina, E.; Baio, A.; Kemokai, M. & Lebbie, T. 2009. Fisheries and failing states: the case of Sierra Leone. *Marine Policy*, 33 (2): 393–400.

Turay, I.; O'Donnell, C.; Schaber, M.; Corten, A.; Sarre, A.; Sei, S.; Seisay, L.D.; Mustapha, C. & Lahai, M. 2008. Sierra Leone resource survey cruise report, 19 May to 8 June, 2008. Institutional Support to Fisheries Management project in Sierra Leone. Ninth EDF ACP SL 019/1 (2008): 56.

Vanden-Bossche, J.P. & Bernacsek, G.M. 1990. Source book for the inland fishery resources of Africa. Committee for Inland Fisheries and Aquaculture 2, Technical Paper No. 18.2:411. Rome, FAO.

Williams, A.B. 1958. Substrates as a factor in shrimp distribution. University of North Carolina 3 (3): 283–290. Morehead City, USA. University of North Carolina Institute of Fisheries Research.

Appendix 1. Common names for artisanal fishing crafts and gears (MFMR, 2010).

English Name	Krio	Mende	Temne	Sherbro
Boats				
Kru Canoe	Kru Canoe	Koru Beya Te Ndendeh	One man labour Len Kunu	Gbail-Ku
Standard 1 – 3 Canoe			Ngbankay	Gbail-Gbampoi
Standard 3 – 5 Canoe	Bonga Canoe Shalla Boat	M'Boimu – Ndendeh Shalla – Ndendeh	Eh Sallah Comfort Eh Bill Bana	Gbail-Gbampoi
Standard 5 – 10 Canoe	Pampa (Shella) Shark Boat	Gbembeh – Ndendeh	Sallah Eh Pampa	Gbail-Yemendeh
Ghana Boat	Ghana Boat	Ghana Ndendeh	Reggeh Bone to Bone	Gbail-Ghana
Gears				
Bottom – Set Gillnet	Lego Chain	Lego - M'Boimeh	Lego chain Korthieh	Pel-Mendeh Men-Korchegbei
Bottom – Drift Gillnet	Drifty - Chain	Kendeh - M'Boimeh	Oreg Chain	Pel-Gbeyeh-Mendemen
Surface Drift Gillnet	Float Chain	Nda – Nga – Yee	Ic'Foee	Yelleh Fonfon
Surface – Set Gillnet			Ilem Sown Yellefufu Ke' Yelleh	
Cast Net	A – Cha - Kie	Ka Matee	Archielcee Kotolone Ke' Cheekee	Pel-Kamananthch
Long Line	Morrel	Teligraphi	Morem	Tele-Gram
Hook and Line	Bottom Line	Ngangi	Boita-line Ke' Yakee Morem	Bothah

Appendix 2. List of commercially exploited fish stocks in Sierra Leone.

Commercial name	FAO English name	Scientific name
Fish		
Shinenose	Lasser African Threadfin	*Galoides decadactylus**
Spanish	Giant African Threadfin	*Polydactylus quadrifylis**
Bearbear fish	Royal Threadfin	*Pentanemus quinquarius*
Seafowl	Grey Triggerfish	*Balistes capriscus*
Seafowl	Blue Spotted Triggerfish	*Balistes punctatus*
Rogie	West African Goatfish	*Pseudopenus prayensis**
Mollit	Flathead Grey Mullet	*Mugil cephalus*
Big eye	Atlantic Bigeye	*Priacanthus arenatus*
Butterfish	Flagfin Mojarra	*Gerres melanopteris*
Caima	Bigeye Grunt	*Brachydeuterus auritus*
Bonita	Cobick	*Racycentron canadium*
Sheephead	African Sickle fish	*Drepane africana**
Lady fish	Cassava Croaker	*Pseudotolithus senegalensis**
Qwangwa	Bobo Croaker	*Pseudotolithus elongates**
Whiting	Law Croaker	*Pseudotolithus brachygnathus**
Lady Longneck	Long Neck Croaker	*Pseudotolithus typus**

Commercial name	FAO English name	Scientific name
Black gwangwa	Guinea Croaker	*Pseudotolithus epipercus**
Red Snapper	Angola Dentex	*Dentex angolensis**
Red Snapper	Canary Dentex	*Dentex canariensis**
Red Snapper	Congo Dentex	*Dentex congoensis**
Red Snapper	Pink Dentex	*Dentex gibosus**
Red Snapper	Red Pandora	*Pagellus bellottii**
Red Snapper	Large eye dentex	*Dentex macrophthalmus**
Red Snapper	Bluespotted Seabream	*Pagrus caeruleostictus**
Black Snapper	Atlantic Emperor	*Lethrinus atlanticus**
	Red Pandora	*Pagellus bellottii**
Catfish	Roughhead Catfish	*Arius latiscutatus**
Catfish	Smoothmouth Sea catfish	*Arius heudelotii**
Catfish	Giant Sea Catfish	*Arius gigas**
Catfish	Guinea Sea Catfish	*Arius parki**
Record	White grouper	*Epinephelus aenus**
Record	Golden grouper	*Epinephelus alexandrinus**
Record	Dungat grouper	*Epinephelus goreensis**
Grouper	Golden African Snapper	*Lutjanus fulgens**
Grouper	African Brown Snapper	*Lutjanus dentatus**
Grouper	African Red Snapper	*Lutjanus agennes**
Grouper	Gorean Snapper	*Lutjanus goreensis**
Crocus	Sompat Grunt	*Pomadasys jubelini**
Hognose	Biglip Grunt	*Plectorhynchus macrolepis**
Hognose	Ruberlip Grunt	*Plectorhynchus mediterraneus**
Sole	Senegalese Tongue Sole	*Cynoglossus senegalensis**
Crocus	Parrot Grunt	*Pomadasys peroteti**
Crocus	Pigsnout Grunt	*Pomadasys rogeri**
Mockmackerel	Little Tunny	*Euthynnus alleteratus**
Mackerel	Chub Mackerel	*Scomber japonicas**
Bonga (large)	Bonga Shad	*Ethmalosa fimbriatta**
Awefu (juvenile bonga)	Bonga shad	*Ethmalosa fimbriata**
Flat Herring	Mediterranean Sardinella	*Sardinella maderensis**
Mina (juvenile herring)	Sardinella	*Sardinella spp**
Round Herring	Round Sardinella	*Sardinella aurita**

Commercial name	FAO English name	Scientific name
Lati	West African Ilisha	*Illisha africana**
Pomp	African moonfish	*Selene dorsalis**
Pollock	Round Scad	*Decapterus punctatus**
Pollock	False Scad	*Decapterus rhonchus**
Pollock	Bigeye Scad	*Selar chrominophthalmus**
Cowreh	Crevalle Jack	*Caranx hippos**
Cowreh	Blue Runner	*Caranx crysos**
Cowreh	Senegal Jack	*Caranx senegalus**
Pomp	Alexandria Pompano	*Alectis alexandrines**
Pomp	Greater Amberjack	*Seriola dumerili*
Kente (Cutmoney)	Atlantic Bumper	*Chloroscombrus chrysurus**
Joefish	Longtail Pompano	*Trachinotus goreensis**
Joefish	Pompano	*Trachinotus ovatus**
Pollock	Atlantic Horse Mackerel	*Trachurus trachurus**
Pollock	Cunene Horse Mackerel	*Trachurus trecae**
Mackerel	West African Spanish Mackerel	*Scomberomorous tritor**
Langa mina	Guyana Anchovy	*Anchviella guianensis**
Anchovy	European Anchovy	*Engraulis encrasicolus**
Silverfish	Largehead Hairtail	*Trichurus lepturus**
Tenny	Bonefish	*Albula vulpes**
Pomp	Greater Amberjack	*Seriola dumerili**
Dogsole	Spottail Spiny Turbot	*Psetotodes belcheri*
Congo eel	European Conger	*Conger conger**
Sailfish	Atlantic Silfish	*Istiophorus albicans*
Baracuda	Great Barracuda	*Sphyraena barracuda**
Couta (larger size)/Kini (smaller size	Guachanche Barracuda	*Sphyraena guachancho**
Couta (larger size)/Kini (smaller size	Guinea Barracuda	*Sphyraena afra**
Couta (larger size)/Kini (smaller size	European Barracuda	*Sphyraena sphyraena**
Sharks, Rays and Skates		
Hammerhead Shark	Scalloped Hammerhead Shark	*Sphyrna Leweni**
Shark	Smooth Hound	*Mustelus mustelus**
Basking Shark	Milk Shark	*Rhizoprionodon acutus**
Whale Shark	Whale Shark	*Rhinocodon typus**
Big Yai Shark	Bigeye Spurdog	*Squalus megalops **
Shark	Blacktip Shark	*Cacharhinus limbatus**

Commercial name	FAO English name	Scientific name
Shark	Sandbar Shark	*Cacharhinus plumbeus**
Pig Yai Shark	Pigeye Shark	*Cacharhinus amboinsis**
Shovelnose	Common Guitarfish	*Rhinobatus rhinobatus**
Ray	Undulate Ray	*Raja undulata**
Ray	Brown Ray	*Raja miraletus**
Ray	Leopard Ray	*Raja leopardus**
Ray	Striped Panray	*Zanobatus Schoinleni**
Ray	Common Stingray	*Dasyatis Pastinaca**
Ray	Roughtail Stingray	*Dasyatis centroura**
Ray	Daisy Stingray	*Dasyatis magarita**
Ray	Common Torpedo	*Torpedo (Torpedo) torpedo**
Invertebrates		
Crustaceans		
Spiny Lobster	Royal Spiny Lobster	*Panulirus regius**
Spiny Lobster	Carribean Spiny Lobster	*Panulirus argus**
Pink Shrimp	Pink Shrimp	*Penaeus notialis**
Tiger Shrimp	Caramote Prawn	*Penaeus kerathurus**
White Shrimp	Guinea Shrimp	*Parapenaeopsis atlantica**
Deep water rose shrimp	Deep Water Rose Shrimp	*Parapenaeus longirostris**
Molluscs/Gastropods		
Cuttlefish	Common Cuttlefish	*Sepia officinalis hieredda**
Cuttlefish	African Cuttlefish	*Sepia bertheloti**
Octopus	Common Octopus	*Octopus vulgaris**
Squid	Shortfin Squid	*Illex coindettii**
Squid	African Squid	*Alloteutis africana**
Squid	European Squid	*Loligo vulgaris**
Snail	Pig's Snout Volute	*Cymbium cymbium**
Snail	Naptune Volute	*Cymbium Pepo**
Snail	Elephant Snout Volute	*Cymbium glans**
Crab	Bigfisted Swim crab	*Callinectes amnicola**
Crab	Gladiator Swimcrab	*Callinectes Pallidilus**
Crab	Smooth Swimcrab	*Portinus validus**
Crab	Spotted Box Crab	*Callapa robroguttata**

Appendix 3. Artisanal catch data, 1971 – 2009.

Year	Catch (tonnes)	Year	Catch (tonnes)
1971	22 764	**1991**	48 071
1972	43 129	**1992**	47 477
1973	52 669	**1993**	46 928
1974	59 456	**1994**	46 779
1975	61 945	**1995**	46 708
1976	50 275	**1996**	46 673
1977	46 772	**1997**	46 656
1978	41 881	**1998**	46 648
1979	45 166	**1999**	46 420
1980	31 544	**2000**	45 910
1981	31 600	**2001**	39 950
1982	34 616	**2002**	55 659
1983	47 247	**2003**	65 458
1984	43 272	**2004**	106 216
1985	43 704	**2005**	116 614
1986	44 142	**2006**	120 490
1987	44 500	**2007**	111 937
1988	46 350	**2008**	164 703
1989	48 200	**2009**	243 634
1990	50 000		

AN EAF BASELINE REPORT FOR THE TANZANIAN SMALL AND MEDIUM MARINE PELAGIC FISHERY

Fisheries Development Division

1. Introduction

Tanzania lies just south of the Equator between 1°–11°45′ S and 29°21′–40°25′ E, covering an area of about 945 200 km^2. The length of the coastline in Tanzania is considered to be 1 424 km (TCMP, 1999). The coastal and marine environments include rivers, estuaries, mangrove forests (reported to cover a total area of about 115 500 ha; Semesi 1991), sandy beaches, cliffs, muddy tidal flats, seagrass beds and coral reefs. The coastal fisheries of Tanzania (Figure 1), which extend from the border with Kenya to the border with Mozambique (Francis and Bryceson, 2001), are augmented by nutrient input from numerous large rivers along the coast. These include the Pangani, Wami, Ruvu, Rufiji, Matandu, Mbwemkuru, Lukuledi and Ruvuma, each of which forms extensive deltas and large areas of brackish coastal waters with high primary productivity. These river delta areas provide extensive nursery habitat for numerous marine species.Although the numerous secondary rivers donot have significant deltas that support juveniles they do contribute greatly to enrichment of the coastal waters, mainly during the rainy seasons.

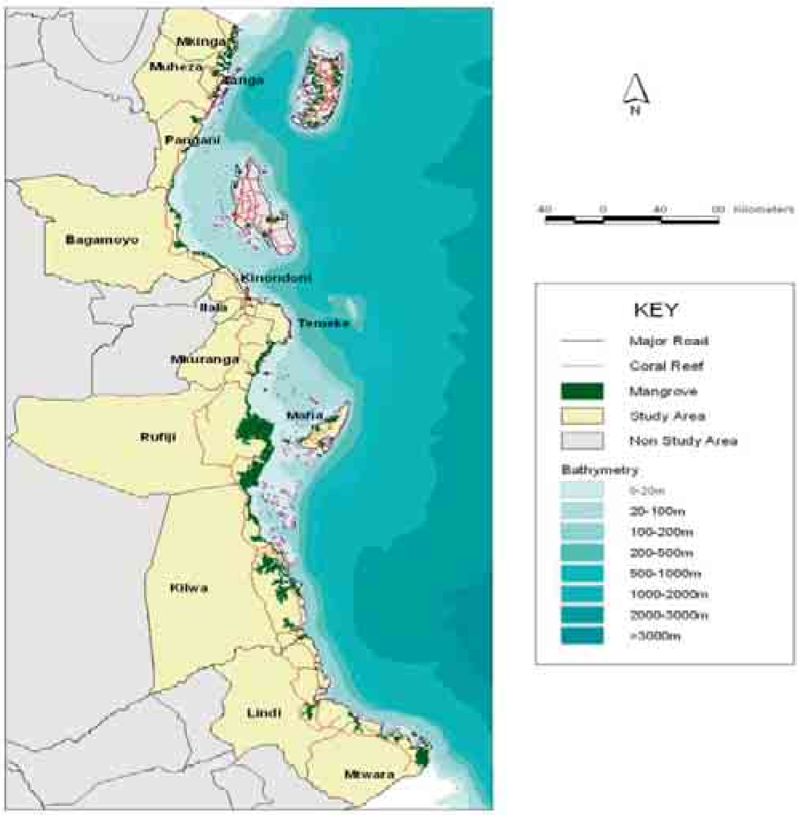


Figure 1. Coastal Districts of Tanzania.

The artisanal pelagic fishery is of major socio-economic and cultural importance and contributes significantly to food security in Tanzania. The artisanal fishery is a multispecies fishery targeted by a wide range of boat-gear combinations on fishing grounds across the national jurisdiction waters. At the assemblage (all species) level, yields in the artisanal fishery indicate stability. However, vessels are increasingly targeting high value species and recent assessments show that stocks are overexploited. Demand for pelagic marine resources for local consumption and export is growing, leading to further pressure on the finfish. Furthermore as an open access fishery, there is inefficient management control and this fishery will increasingly face problems of overexploitation.

The management of the Tanzanias artisanal pelagic fishery has relied on conventional methods where human activities are managed in a way that maximizes fisheries production, economic benefits, employment and national revenues. The traditional management approach does not adequately take into consideration the broader effects of fishing activities on the environment as well as the effect of other non fisheries related anthropogenic activities on fisheries and the ecosystem. In response, The Fisheries Development Division of the Ministry of Livestock and Fisheries Development, Tanzania Mainland, in collaboration with FAO is implementing the EAF as part of the Nansen Project “Strengthening the Knowledge Base for and Implementing an Ecosystem Approach to Marine Fisheries in Developing Countries”.

The key principles of EAF are that: fisheries should be managed to limit their impact on the ecosystem to an acceptable level; ecological relationships between species should be maintained; management measures should be compatible across the entire distribution of the resource; precaution in decision-making and action is needed because the knowledge on ecosystems is incomplete; and that governance should ensure both human and ecosystem well-being and equity.

Introducing an EAF for the management of artisanal fisheries will ensure a broader range of ecosystems services and functions. This will in turn provide a greater array of human benefits, guarantee long-term pelagic fish resources sustainability and ensures the resilience of the ecosystems. Among the activities undertaken under the EAF-Nansen project in Tanzania Mainland was to conduct a desktop study on the management of the pelagic fisheries, including their socio-economic significance, usually referred to as TROM (Target Resource Oriented Management) review, the output of which is the present EAF Baseline Report (EAF – BL).

The EAF – BL represents the agreed baseline for the pelagic fishery before introducing an EAF. It is the reference material for EAF planning and provides reference points for monitoring and evaluation of EAF activities and management actions.

This document gives the baseline information pertaining to the Tanzanian marine pelagic fisheries that will contribute to the development of the plan for the management of artisanal fisheries in accordance with the principles of Ecosystem Approach to Fisheries.

2. Overview of the fishery and resources exploited

2.1. Fishing gear used and areas fished

Masalu *et al.*(2010) have given a detailed description of the status of fishing gears in themarine waters of Tanzania and pointed out that artisanal fisheries are characterized by the use of simple, traditional fishing gears that are mostly used in depths less than 30 metres. The types of gear and their uses vary within and between coastal communities. The 73.2 percent of fishers use nets of differing mesh sizes followed by hooks and lines (39.2 percent), basket traps (19.6 percent), sticks for octopus (19.6 percent), gleaning (18.8 percent), weir/fence traps (3.5 percent) and cotton cloths (3.5 percent). Cotton cloths fishing gear is mainly used near the shore.

The Marine Fisheries Frame Survey of 2009 (MLFD, 2010) revealed that, the most common fishing gear used in the pelagic fishery were: gill nets, hand lines, long lines, shark nets, cast nets, scoop nets, ring nets, spears and beach seines. Beach seines appear to have increased by 25 percent compared to the 2007 frame survey. Other gears recorded, but not utilised in pelagic fishery were traps and spears.

The distribution of fishing gear by types and numbers over the coastal districts is shown in Table 1 and Figure 2. The fishing effort and catch in the Tanzanian coastal fisheries was recorded by the Fisheries Development Division (2009) (Table 2).Total effort ranged from a low of 37 010 fisher days in 1995 and 1996 to a high of 95 349 fisher days in 2007. Total catch ranged from 36 685 tonnes in 1993 to 58 780 tonnes in 1996.

Table 1. Fishing gear type, effort (fisher days) and distribution over the Tanzania coastal districts during 2009.**TRP** = Traps, **BS** = Beach seines, **GN** = Gill nets, **HL** = Hand lines, **LL** = Long lines, **SN** = Shark nets, **RN** = Ring nets, **TN** = Trawl nets, **SP** = Spears, **CN** = Cast nets, **NK** = Scoop nets.

Region/District	TRP	BS	GN	HL	LL	SN	RN	TN	SP	CN	NK	Total
Tanga Region												
Muheza	95	-	111	317	-	227	9	-	36	-	-	795
Tanga City	408	65	478	1 521	234	159	70	-	25	-	13	2 973
Pangani	332	19	196	320	11	245	2	-	25	37	-	1 187
Mkinga	493	73	376	1 150	-	259	284	-	-	20	-	2 655
Sub total	1 328	157	1 161	3 308	245	890	365	-	86	57	13	7 610
Cost Region												
Bagamoyo	56	35	917	984	926	191	36	3	-	-	-	3 148
Mkuranga	42	1	355	273	2	85	4	-	12	-	-	774
Rufiji	181	6	14 057	297	6 517	438	12	-	25	-	-	21 533
Mafia	781	-	1 411	954	1 575	580	365	-	611	111	-	6 388
Sub total	1 060	42	16 740	2 508	9 020	1 294	417	3	648	111	-	31 843
Dar es Salaam												
Ilala	4	-	127	1 265	-	92	74	-	8	-	-	1 570
Kinondoni	485	18	116	1 179	3	85	42	-	-	6	20	1 954
Temeke	145	32	188	1 197	-	70	119	-	36	37	7	1 831
Sub total	634	50	431	3 641	3	247	235	-	44	43	27	5 355
Lindi Region												
Lindi urban	66	2	111	241	54	160	-	-	-	-	-	634
Lindi rural	176	11	254	478	1	386	1	-	-	10	-	1 317
Kilwa	214	8	159	816	112	42	69	-	117	8	-	1 545
Sub total	456	21	524	1 535	167	588	70	-	117	18	-	3 496
Mtwara Region												
Mtwara rural	1 068	15	690	2 306	2	714	23	-	420	-	-	5 238
Mtwara urban	128	483	394	657	-	-	131	-	-	-	-	1,793
Sub total	1 196	498	1 084	2 963	2	714	154	-	420	-	-	7 031
Grand Total	4 674	768	19 940	13 955	9 437	3 733	1 241	3	1 315	229	40	55 335

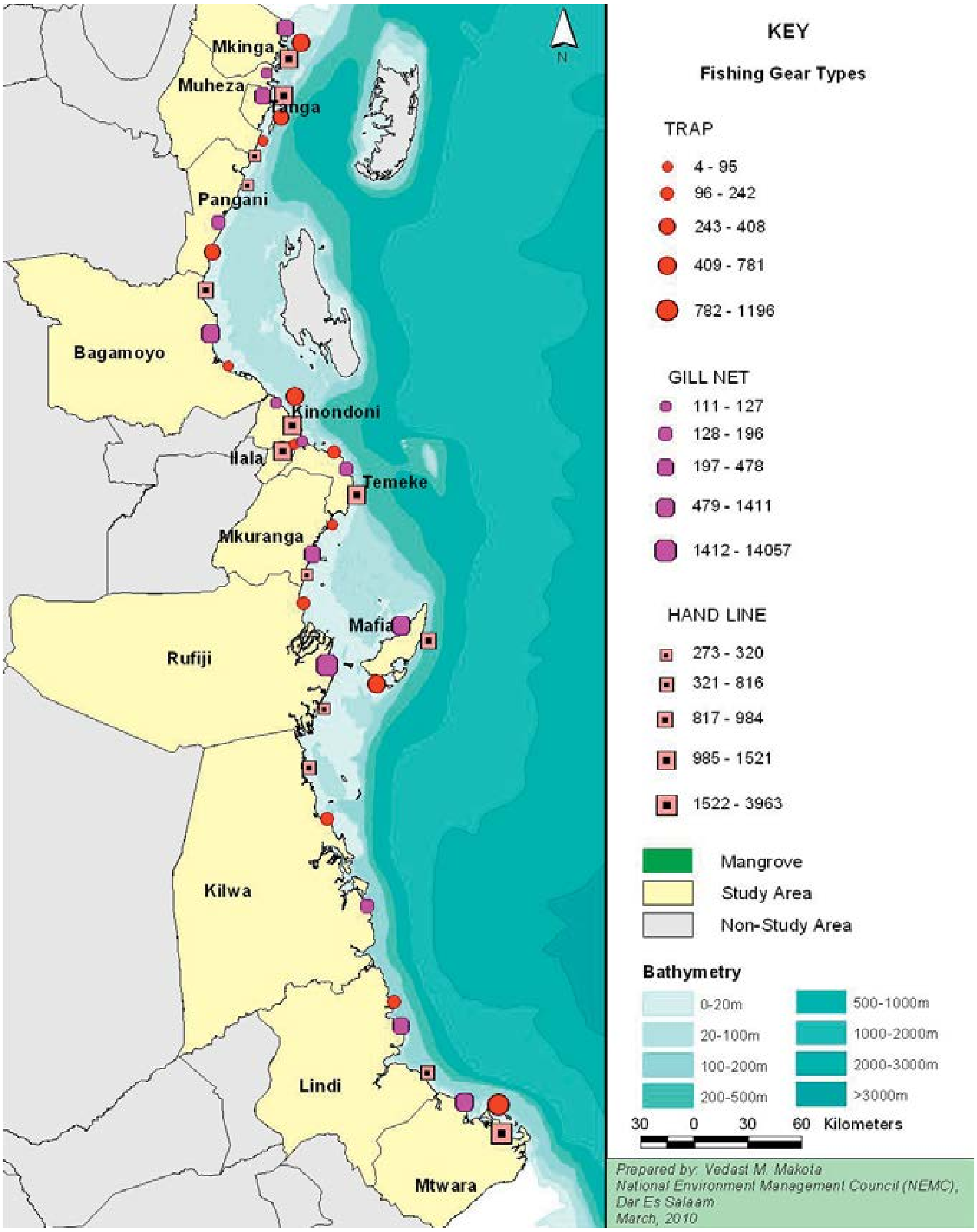


Figure 2. Common fishing gears used in the coastal districts and their distribution.

Table 2. Catch and effort (fisher days) in marine capture fisheries of Tanzania between 1984 and 2009. Source: Fisheries Development Division, Ministry of Livestock and Fisheries Development.

Year	Vessels	Fishers	Shark nets	Traps	Fixed traps	Beach seines	Hooks	Ring nets	Cast nets	Scoop Nets	Gill Nets	Total Effort	Catch (tonnes)
1984	3556	13783	2342	9418	2182	371	6757	0	408	462	6955	46234	40890
1985	3045	11392	3093	9159	6418	1288	12351	0	622	1288	4943	53599	42847
1986	3690	12619	3590	9159	3159	1003	13478	0	216	1013	8842	56769	46985
1987	3595	12739	3193	7888	3052	1087	10708	0	516	1087	9549	53414	39095
1988	4390	13855	3751	6351	176	832	7088	56	653	832	7810	45794	49382
1989	4399	15491	3649	2056	233	588	5786	56	645	690	5022	38615	50242
1990	4354	16178	2856	5873	167	1189	7083	96	374	1225	5887	45282	56779
1991	4402	16361	2530	4736	234	665	6721	104	398	615	6018	42784	54343
1992	3514	15027	3427	5183	34	537	5672	92	124	70	3388	37068	43886
1993	3232	15027	3427	5593	34	537	5672	92	124	70	3388	37196	36685
1994	3232	15027	3427	5593	34	537	5672	92	124	70	3388	37196	40785
1995	3768	13822	3351	3390	25	350	7839	221	49	75	4120	37010	51073
1996	3768	13822	3351	3390	25	350	7839	221	49	75	4120	37010	58780
1997	—	—	—	—	—	—	—	—	—	—	—	—	50210
1998	5157	20625	3463	5299	254	319	9383	128	0	0	9125	53753	48000
1999	—	—	—	—	—	—	—	—	—	—	—	—	50000
2000	—	—	—	—	—	—	—	—	—	—	—	—	49900
2001	4927	19000	2852	5557	72	485	13382	224	173	252	5136	46924	52935
2005	7190	29754	8820 ?	5907		453	14980		73	710	18802	86689	54969
2007	7342	36247	299	4185		615	13990	1 076	169	306	31210	95349	43498
2008													
2009	7664	36321	3733	4674		768	13955	1241	229	40	22666	91331	52 232

The following types of gear are employed in the pelagic fishery:

Nets

The main types of nets used are gill nets, shark nets, purse seine, ring net, beach seine nets, scoop nets and cast nets. Most of the netting activities are conducted in groups and involve locating fish from a distance, getting close to them and entangling them without disturbing them. In this case fishers have to be familiar with the nature of the fishing habitats to avoid injuring themselves, as well as the gear and habitats.

Gill nets (Nyavu za makila) and shark nets (Jarife)

In the past, gill nets and shark nets were made from coconut husk fibres for catching large pelagic species such as rays and sharks in deep waters. Since the size of the mesh for the shark nets was large (to about 6 inches), the nets were assembled with a large plate locally known as sinia. However, recently gill nets are made from mono or multifilament mesh. Gill nets and shark nets are used in tidal, subtidal, and reef areas to capture fish moving with the tides.

Purse seine nets (Nyavu)

Purse seining uses light to attract pelagic fish on moonless nights, targeting mackerels, sardines anchovies, etc.

Drag nets (Kavogo/ Kigumi)

Any seine net can be used as a drag net, but fishing with a drag net is illegal (Fisheries Regulation, 2009; see Section 9).Divers may be used to chase fish into the nets and once captured, to untangle and retain them. These nets are set from a boat or from the beach. Drag netting can also be conducted using two vessels, and run nets on the bottom catching both pelagic and demersal fishes.

Beach seine nets (Juya)

Traditional beach seine nets are used in shallow waters by dragging onto the beach to catch demersal and pelagic species. Beach seining is prohibited by Fisheries Regulation, 2009 (see Section 9).

Cast nets (Kimia)

Cast nets are circular nets that are thrown over a shoal of fish or allowed to sink to the bottom and are closed during retrieval. They are used in sheltered areas.

Scoop nets (Senga)

Scoop netsare used in conjunction with lights to catch small pelagic fishes. These nets are also used for catching prawns and other small fish such as eels, catfish, mullet and silver biddy swimming near the water’s surface in shallow waters.

Hook and line (Mshipi)

This is one of the most popular fishing methods. It can be done from a vessel or from the shore and is available in different weights so that the fisher can alternate his lines depending on what he expects to catch. This gear is less energy-intensive and it can be used even by elder fishers. This fishery practice is considered environmentally-friendly and selective. The hook and line can be categorized into handlines, longlines and troll lines.

Legal status of the fishing gears and methods

The use of fishing gears and methods of operation are guided by the Fisheries Regulation 2009, details of which are in Section 9. Destructive and hence illegal fishing gears include: Monofilament nets, harpoon guns, spear guns, "mtando[1]", "juya ya kojani", "kavogo", "kigumi", beach seine, any net with a mesh size below 1½ inches or 38 mm except in the sardine (dagaa) fishery, "dagaa" net with a mesh size below 10 mm, trawl nets with mesh size below 2 inches or 45 mm capturing prawns.

Status of fishing vessels

Masalu *et al.*(2010) described the types and distribution of Tanzania's coastal fishing vessels. Fishers use traditional fishing vessels such as non-motorized outrigger canoes (ngalawa), dugout canoes (mitumbwi) and dhows (dau). An outrigger canoe consists of a single log with outriggers which provides additional stability to these vessels. A dugout canoe is made up from a single log – its bottom is usually flattened for stability and it has no outriggers. Dhows are constructed out of timber planks. Its bow is more pointed than the boat and the stern is rounded or pointed. Boats (mashua) constructed out of timber planks, with a square stern are also used. The highest concentration of ngalawa are found in the Bagamoyo and Tanga provinces, while the highest concentration of dhows are found in the Kilwa, Mtwara and Tanga Provinces, and the highest concentration of boats are found in the Temeke Province (Figure 3).

[1] "Mtando", or "Juya la Kojani" or "Kigumi" or "Kavogo" means a surrounding net with a float line and a bottom line with sinkers or any other modification. It is used in shallow water to target fish living in coral reefs and other shallow water fish. It operates on the bottom and causes damage to the sea bed.

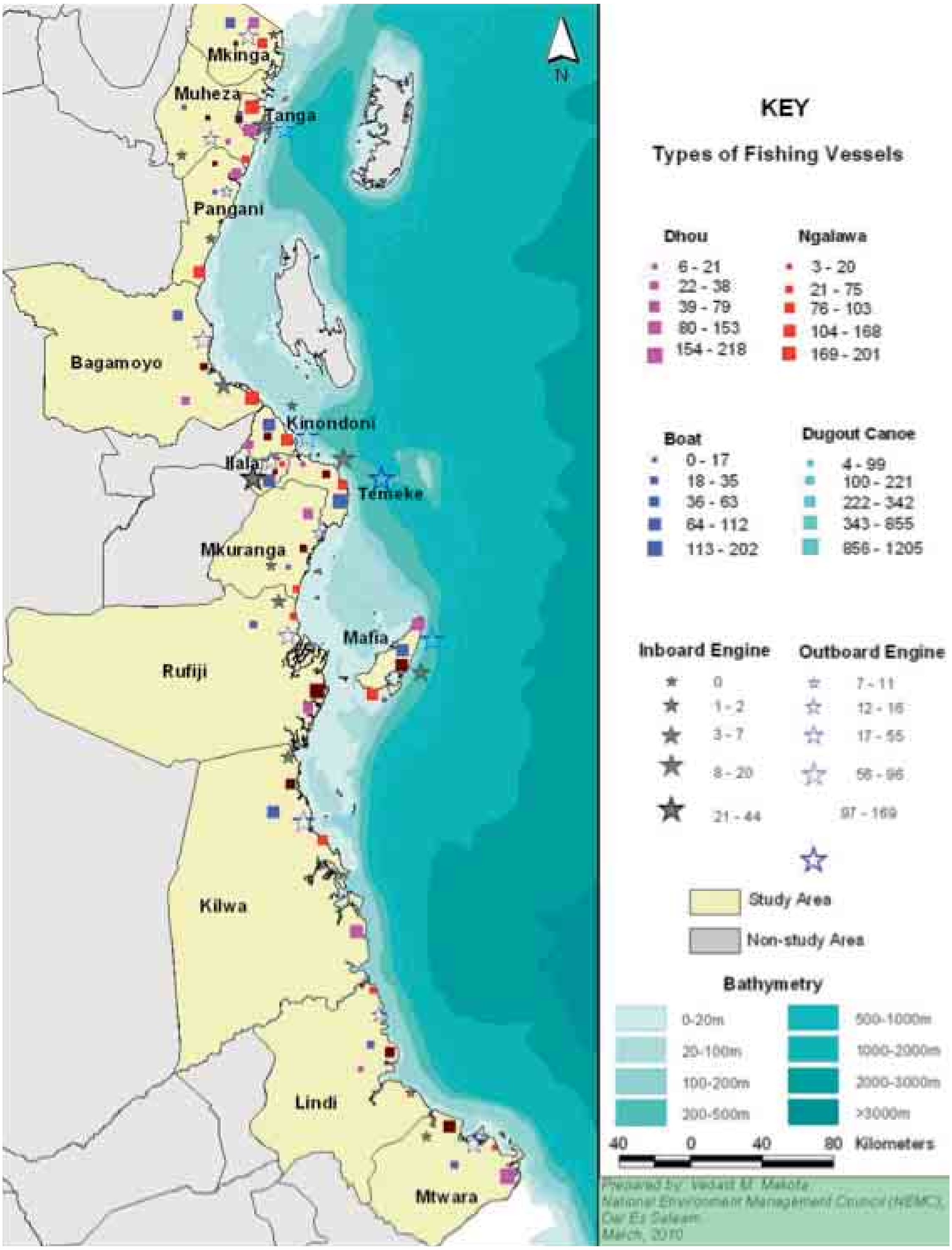


Figure 3. Distribution of fishing vessels along the coast of Tanzania mainland.

Fishing grounds for pelagic fish

In the early 1980s, Dr Fridtjof Nansen’s East African Coast programme investigated small pelagic fish using acoustic methods and demersal fish using bottom trawlsalong the Tanzanian shelf from the Zanzibar Channel south to the Rufiji delta, during three surveys, June-July 1982, November-December 1982 and May 1983 (Figure 4) (Iversen *et al.*, 1984). Large concentrations of small pelagic fisheswere found all along the coast, particularly in Tanga, Dar es Salaam, Rufiji, Mafia and Kilwa areas. Large pelagic fishes were found mainly in the Zanzibar Channel (particularly kingfish) and beyond the shelf dropoff.

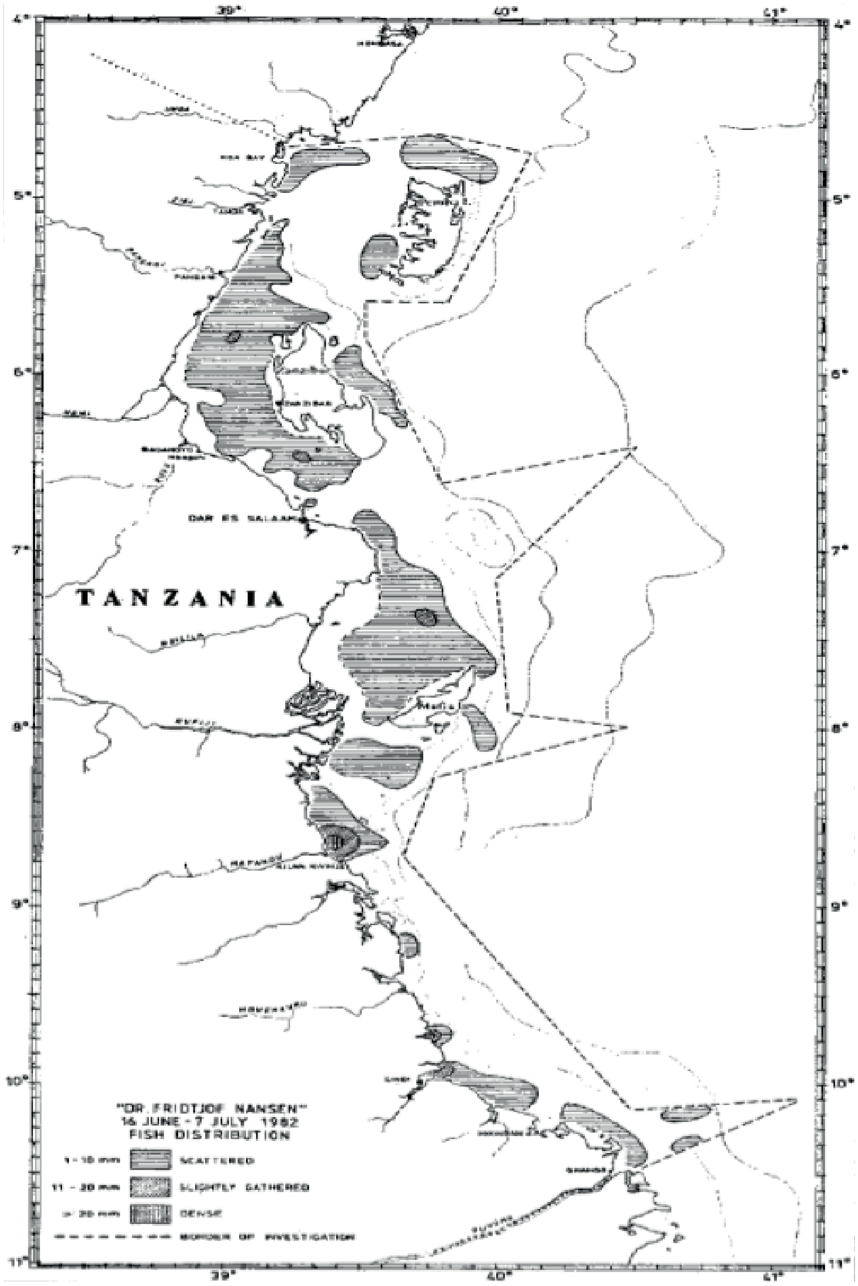


Figure 4. Integrated echo intensities (mm per nautical mile) classified as pelagic fish. R/V “Dr Fridtjof Nansen”, 16 June - 8 July 1982.

Pelagic fishing grounds

Shallow waters protected by the reefs

Pelagic fishing activities are concentrated in theextensive shallow waters protected by the reefs. The reef flats are quite productive and protected, and a fisherman paddling a small dugout and using a small gillnet, hook and line or basket traps can go out nearly every day and usually catch some fish. This shallow-water fishery is limited by the scarcity of fish due to overfishing, short periods of excessively high winds or strong tidal currents during spring tides.

Rocky bottoms, submerged reefs, ridges and troughs

Most small-scale fishermen are also active outside the reef areas, particularly around near-shore banks (rocky bottoms, submerged reefs, ridges and troughs). These grounds are primarily in the 15 - 100 m depth range and are often part of the shelf slope.

2.2. Resources exploited

Efforts to investigate the pelagic fishes in Tanzania commenced way back in the 1980s. By then the Tanzanian shelf formed part of Dr Fridtjof Nansen’s East African Coast programme to investigate small pelagic fish with acoustic methods and demersal fish with bottom trawling. Dr Fridtjof Nansen’s cruise reported that of the typical pelagic community comprised various species of *sardinella* and scads. Sardinella were dominated by *Sardinella sirm*, with lesser contributions from *Sardinella gibbosa*, *Sardinella albella* and *Sardinella leiogaster.* The scads catch comprised *Decapterus maruadsi*, *Decapterus macrosoma*, *Decapterus kurroides* and *Selar crumenophthalmus*. Some yellowtail scad (*Atule mate*) was also present, as well as a variety of the “semi-pelagic” cavallas (*Carangoides* spp.). The mentioned pelagic species also constituted the bulk of the midwater trawl catches at night over shallow grounds.

Berachi (2003) reported that small pelagic fish such as sardines (*Clupeidae*), anchovy (*Engraulidae*), small mackerel (*Scombridae*) and horse mackerel accounted for approximately one-third of the total marine catch in Tanzania. These fishes were subject to high demand as they are much cheaper than others. Large pelagic fish species mainly included jacks and trevally (*Carangidae*), kingfish (*Scomberocoridae*), tunas, mullet, swordfish and sharks (Berachi, 2003). According to Mgaya *et al*. (1999) the main targets of the artisanal marine fishery were the large and usually long-live predators high up in the food chain like emperors, snappers, groupers, jacks, trevally, swordfish, kingfish, sharks and rays.

Everett *et al.* (2010) pointed out that there were 35 unique pelagic resource catch items listed in the WIOfish database for the Tanzanian fisheries as shown in Appendix 1**.** Bianchi (1985) recorded 70 commercial pelagic fish species in Tanzania as shown in Appendix 2.

2.3. Number of fishers and land-based workers by sector

The number of artisanal fishers along the coast has increased considerably over the years and is estimated at 36 321 according to the 2009 fisheries frame survey results, which is about 0.8 percent of the population (4 615 890)in the coastal districts (MLFD, 2010).

The artisanal fisheries related activities create employment which includes: boat/vessel building, boat/vessel repair, fishing gear supply, net mending, engine supply, engine repair, fish transport, fish sale, fish processing and food vendoring. This raises the ratio of fisheries and related livelihoods dependent population in the coastal districts to ten times the number of fishers (approximately 360 000).

The results of the fisheries frame survey conducted in 2009 also showed that there was a 4.6 percent increase in the number of fishers using fishing vessels (29 312) compared to 2007 (28 010) fishers. In contrast, foot fishers decreased from 8 237 in 2007 to 7 009 in 2009. Nationally, there has been a rapid increase in the number of artisanal fishers, which has not been matched by the increase of output in marine fish production (Table 2).

Magimbi (1997a;b) pointed out that consistency of data on the distribution of artisanal fishers in the coastal regions of mainland Tanzania over the years was complicated by the fact that young men join and leave fishing rapidly and that many of the artisanal fishers are very mobile, moving from one region to another while seeking better fishing opportunities or specific species. Other factors that may influence the data are occasional fishers who may operate on foot or hire boats and fishing gear.

2.4. Interactions with other fisheries

Everett *et al.* (2010) identified three and five bycatch species in the pelagic and non- pelagic fishery respectively (Table 3). In addition, several species captured in both the pelagic and non-pelagic fisheries were classified as threatened (Table 4).

Table 3. Tanzania pelagic species marked as Bycatch in WIOfish database 2010.

Fishery name	Number/List of species
Pelagic fisheries	
Small nets, surface (drift) gill net, pelagics	Grampus griseus (Risso's dolphin), Tursiops truncatus (Bottlenose dolphin), Stenella longirostris (Spinner dolphin), Stenella attenuata (Pantropical spotted dolphin) Megaptera novaeangliae (Humpback whale) Testudinata (Marine turtles) and Tursiops aduncus (Indo-Pacific bottlenose dolphin)
Industrial nets, purse seine	Cluponella engrauliformis (Anchovy sprat)
Small nets, hand/ scoop net	Amblygaster sirm (Spotted sardinella)

Table 4. Tanzania pelagic and non-pelagic fisheries with threatened species in WIOfish database 2010.

Fishery name	Scientific name
Pelagic fisheries	
Small nets, surface (drift) gill net, pelagics	*Tursiops aduncus, Megaptera, novaeangliae* (humpback whale) *Stenella attenuata* (dolphin*)*
NON-PELAGIC FISHERIES	
Diving, gathering, sea cucumber	Holothuria atra, Holothuria edulis, Holothurioidea, Holothuria nobilis
Industrial nets, inshore, crustaceans	Penaeidae, Penaeus japonicus, Penaeus semisulcatus, Penaeus monodon, Penaeus indicus, Metapenaeus monoceros
Shore gathering, intertidal, sea cucumbers	Stichopus hermanni, Holothuria nobilis, Thelenota ananas,Holothuria scabra, Holothurioidea
Shore gathering, sandy shores, turtles	Eretmochelys imbricata
Small and large mesh nets, bottom gill net	*Tursiops truncatus* (dolphin*) Sousa chinensis*(dolphin)

3. Available scientific and traditional knowledge on the resources

3.1. Biology of the major species

Sardines

Sardines are referred to as herrings, and belong to the family Clupeidae (suborder Clupeoidei). All are characteristically migratory, forming heterogeneous (sometimes homogenous) shoals of varying sizes and densities. The shoals are only formed during migration, but are broken off during feeding, spawning and at night. The shoals sometimes contain larvae or younger mackerels which are also pelagic. Sardines are plankton feeders. Although the biology of the sardines has been well described these studies were not conducted in East Africa (Losse 1964; Blaxter and Holliday 1965). However, Losse (1964) outlined the spatial distribution and relative occurrence and abundance of the sardines along the East African coast.

Bianchi (1985) identified 14 species belonging to the family Clupeidae in the coastal waters, estuaries, lagoons, bays and rivers of Tanzania. Individuals of some species can attain 25 cm Total Length (TL) (eg. *Hilsa kelee*) while others only attain 6 cm TL (eg. *Spratelloides delicatulus*).

Euthynnus affinis (Cantor, 1849) - Kawakawa (Sehewa/Jodari)

Euthynnus affinis occurs in open waters but always remains close to the shoreline. The young may enter bays or harbours and often forms multi-species schools of between 100 and 5000 individuals with other similar sized scombrid species *E. affinis* is a highly opportunistic predator that feeds indiscriminately on small fishes, especially clupeoids and atherinids; but also on squids, crustaceans and zooplankton (Collette, 2001).

Acanthocybium solandry (Cuvier, 1831) - Wahoo (Nguru)

An oceanic, epipelagic species frequently solitary or forming small loose aggregations rather than compact schools. Feed on fishes and squids. Eggs and larvae are pelagic (Collette, 1986).

Gymnosarda unicolor (Rüppell, 1836) - Dogtooth tuna (Jodari)

An offshore species found mainly around coral reefs. Generally solitary or occur in small schools of six or less. Preys on small schooling fishes such as *Decapterus*, *Caesio*, *Nasio*, *Cirrhilabrus*, *Pterocaesio* and squids (Collette, 2001).

Rastrelliger kanagurta (Cuvier, 1817) - Indian mackerel (Kibua)

Adults occur in coastal bays, harbours and deep lagoons, usually in turbid, plankton-rich waters. This species feed on phytoplankton (diatoms) and small zooplankton (cladocerans, ostracods, larval polychaetes, etc.) in schools (Collette, 2001). However, small groups were seen eating eggs of *Cheilio inermis* immediately after a spawning event (Kuiter and Tonozuka, 2001). Adults feed on macroplankton such as larval shrimps and fish. The eggs and larvae of *R. kanagurta* are pelagic (Collette, 1986).

Sarda orientalis (Temminck & Schlegel, 1844) - Striped bonito

A coastal schooling species often associated with small tuna species (Collette, 1995). May be found around islands (Collette, 2001).Feeds on clupeoids, other fishes, squids and decapod crustaceans.The spawning season appears to be dependent on the timing of the monsoon season (Collette, 2001). This species is also captured with troll lines, encircling nets (Collette, 1995) and drift nets (Collette, 2001).

Thunnusalalunga (Bonnaterre, 1788) - Albacore (Jodari)

An epipelagic and mesopelagic, oceanic species, abundant in surface waters of 15.6° to 19.4°C. Deeper swimming, large albacore are found in waters of between 13.5° and 25.2°C with very low temperatures (9.5°C) tolerated for short periods (Collette and Nauen, 1983). Known to concentrate along thermal discontinuities (Collette and Nauen, 1983). Form mixed schools with skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*) and bluefin tuna (*T. maccoyii*). Schools may be associated with floating objects, including sargassum weeds (Collette and Nauen, 1983). Feed on fishes, crustaceans and squids. Sexual maturity reached at 90 cm (Bianchi *et al*., 1999). Eggs and larvae are pelagic (Collette, 1986). Largely caught with live or dead baitfish such as mullet, sauries, squid, herring, anchovies, sardines, and other small fish. Albacore strike hard and make powerful runs (Schultz, 2000).

Thunnus albacares (Bonnaterre, 1788) - Yellowfin tuna (Jodari)

An oceanic species occurring above and below the thermocline.Pelagic in open water, but rarely seen near reefs (Kuiter and Tonozuka, 2001). They school primarily by size, in monospecific or multi-species groups. Larger fish frequently school with porpoises and are often associated with floating debris and other objects. Feed on fishes, crustaceans and squids. This species is sensitive to low oxygen concentrations and is therefore not usually caught below 250 m in the tropics (Sharp, 1978; Brilland Holland, 1990). Peak spawning occurs during the summer, in batches (Collette, 2001; Murua and Saborido-Rey, 2003). Eggs and larvae are pelagic (Collette, 1986). Encircling nets are employed to catch schools near the surface (Collette, 1995).

Thunnustonngol (Bleeker, 1851) - Longtail tuna (Jodari)

Predominantly neritic species avoiding very turbid waters and areas with reduced salinity such as estuaries. May form schools of varying sizes.Feeds on a variety of fishes, cephalopods, and crustaceans, particularly stomatopod larvae and prawns (Collette, 2001).

Alectisindicus, (Ruppell, 1830) - Indian threadfish (Kolekole)

The Indian threadfish is a predatory fish, consuming of a wide range of fishes, small squids, jellyfish and crustaceans. As with *A. ciliaris*, the trailing fins of juveniles are thought to resemble jellyfish medusae, causing predators to avoid the young fish. Relatively little is known about the reproduction of this species, although observations made in Indonesia show spawning occurs in pairs during the day between the ebb and flow tides. The spawning area was approximately 35–45 m and located in a deeper channel between two islands (Westernhagen, 1974).

3.2. Status of the stocks

Resource assessment surveys conducted in the mid 1980s estimated the standing stocks for coastal waters at between 94 000 tonnes and 174 000 tonnes (Iversen *et al.,*1984)**.** Annual yield estimates were about 23 000 tonnes for pelagic species, such as sardines and small tuna. An optimistic estimate of a potential annual yield in Tanzania’s territorial waters is 100 000 tonnes (Linden and Lundin, 1996).

Regarding the general status of fish resources in the South West Indian Ocean, the South West Indian Ocean Fisheries Commission (SWIOFC) has described the status of the fish stocks occurring on the different countries in South West Indian Ocean (SWIO). SWIOFC also provided a description on whether the stock is increasing, decreasing or remaining stable and noted the presence or absence of management measure for each stock. Table 5 shows the stock status of the Tanzanian species.The

Tanzanian pelagic tuna and related species namely the yellowfin (*Thunnus albacares*), big-eye (*Thunnus obesus*), albacore (*Thunnus alalunga*), skipjack tuna (*Katsuwonus pelamis*), swordfish (*Xiphias gladius*) and the marlins (*Istiophorus platypterus*, *Makaira indica*, *Makaira mazara* and *Tetrapturus angustirostris*) are considered to be underexploited. The small pelagics are moderately exploited and cuttlefish and squids are fully exploited.

Table 5. The status of Tanzanian pelagic fish stocks occurring in the South West Indian Ocean. Stock status: U underxploited; M moderately exploited; Ffully exploited (Source: FAO, 2008).

Species group	Stock	Trans-boundary (T)/ Straddling (S) / EEZ	Stock status	Management Measure(s)
Tuna and related species	Pelagic	S	U	Control/ reducing effort
Cuttlefish and squids	Pelagic	T	F	—
Small pelagics	Pelagics	—	M	—

Masalu *et al.*(2010) interviewed 260 fishers from 14 fishing villages about trends in the artisanal fishery. A total of 82.3 percent (214) acknowledged that the fishery was declining, 15.0 percent (39) suggested that the fishery was improving and 2.7 percent (7) were of the opinion that there was no change in the fishery. Reasons for the declining trend were identified as:

a) Destructive fishing practices (73.8 percent) such as dynamite fishing, drag nets and beach seine nets were seen as a major cause of the declining trend of the fish catch;

b) A lack of marine reserves (66.2 percent) (either traditional or modern) contributes to the declining fish catch. Areas where marine closures were practiced because of either government or traditional initiatives proved to have high fish stock all year round;

c) Overfishing (59.6 percent) was blamed for contributing to the declining fish catch;

d) The increasing number of fishers has caused a decrease in the fish catch. In coastal villages, most primary or secondary school leavers whose performance does not allow them to continue with their education opt for fishing as a source of income;

e) The increased number of degraded habitats results in reduced stock;

f) Poverty among fishing communities. Because of poverty, fishers in most cases do not think of the sustainability of their fishery resources. They just harvest whatever is available to sustain their lives;

g) Lack of awareness on environmental conservation. This contributed to the failure of many initiatives aimed at conservation of coastal and marine resources. Fishers were reluctant to embrace strategies and conditions that would favour the success of indigenous management of coastal and marine resources. They feel that such measures would harm fishing arrangements in their fishing grounds;

h) The breakdown of indigenous conservation practices. This caused the increase of open access to most of the fishing grounds;

i) Commercialization of fishery resources. Fishery resources have been commoditized. With the presence of an assured market, it attracts many people to engage in fishing as a source of income;

j) Trawling and ring net fishing. When trawling is done in shallow waters, it causes damage to the fishing habitats. Ring net fishing used to catch sardines contributed to the decrease in fish catch in shallow waters;

k) Price increase of fish resources. An increase in prices for fishery resources motivates many people to engage in fishing;

l) Seasonality. Availability of fish depends on seasons. During the northeast monsoon, fish are plentiful compared to during the southeast monsoon. During the northeast monsoon the ocean is calm and many more fish are found near the shore;

m) Population increase. The increase in human population, particularly in coastal areas, results in an increase in fishers and in the demand for fish.

3.3. Direct interactions with the ecosystem

Land-based pollution

Increased economic activities and expanding populations in the growing coastal towns in Tanzania have resulted in production of large amount of waste including sewage and industrial effluent. Unfortunately, raw domestic sewage and industrial effluents produced in all coastal towns in Tanzania are released directly into the nearby estuaries and coastal habitats. In this regards the coastal waters of all major cities and townships in Tanzania such as Dar es Salaam, Tanga, Lindi and Mtwara are badly affected by sewage pollution. Sewage discharges in the sea brings many pollutants including organic matter, nitrates, phosphates that enhance plant and algal growth.

High levels of nutrient loads and other indicators of sewage pollution have been detected in waters fronting major towns in Tanzania. Excess nutrient loadings have been recorded in water fronting Tanga township. Effluents from a fertilizer factory and the municipal sewage have been reported to cause proliferation of macroalgae in Tanga coastal waters (Munisi, 1999). In addition, Shilungushella (1993) reported the contribution of sisal decorticating plants to coastal pollution in Tanga. He revealed that several sisal plants discharge their wastes onto the estuaries and sea via nearby rivers.

In Dar es Salaam, raw sewage generated by 15 percent of the city residents who are connected to the sewer system is directly discharged into the sea untreated. Msimbazi creek receives pollutants such as dyes, paint wastes and strong alkalis, oil and tars, as well as organic wastes from breweries and meat plants (Bryceson, 1982). Furthermore, about 79 percent of the population in Dar es Salaam is estimated to use onsite sanitation facilities encompassing pit latrines (Mashauri and Mayo, 1989; Mgana and Mahongo, 1997). Leachate and overflow from pit-latrines have led to contamination of most surface waters including the ocean.

Other sources of coastal pollution in Dar es Salaam are industrial wastes from Keko, Chang'ombe, Kurasini, Mtoni and Temeke which discharge heavy metals, pesticide, organic, paint, nutrients and other pollutants near the harbour (Bryceson, 1983). Consequently, the coastal water in Dar es Salaam has been shown to be relatively polluted in many investigation conducted in that area. For instance, Lyimo (2009) found high levels of nutrients in water fronting the city of Dar es Salaam in a study conducted between August 2005 and August 2006. Nitrate levels of up to 54 $\mu molL^{-1}$, phosphates of up to 45 $\mu molL^{-1}$ and nitrites of up to 20 $\mu molL^{-1}$were recorded in this particular study. Several thousand counts of microbials ranging between 1 700 to > 240 000 for total coliform, 200 to 92 000 for faecal coliform and 11 to 4 900 for enterococci were also observed during the same investigation. The levels of faecal indicator bacteria and nutrients were higher during the rainy seasons than the dry seasons, showing that run-off is a major source of contamination (Bryceson, 1983).

Other coastal areas of Tanzania outside the major cities and townships are less impacted by domestic wastes but might suffer from input of agricultural wastes, including pesticides and fertilizers, via rivers and streams. Most major rivers in the country drain agricultural lands and deposit their waste loads and sediments on the coast. Unfortunately, this area of interest has not received sufficient attention from researchers.

Reviews on marine pollution including nutrients in Tanzania have been compiled by several authors for example Mohammed (1997; 2002), Uronu (1995), Mgana and Mahongo (1997) and Shilungushela (1993).

Persistent organic / inorganic pollutants

The most studied area of marine pollution in Tanzania involves contaminants emanating from sewage waste. Few studies have looked at other sources of marine environmental degradation and their impacts on the ecosystem and on human health. Studies have mainly focussed on nutrient loads and distribution, BOD and coliforms levels and other indicators of sewage pollution. Presence of heavy metals, agrochemicals and other persistent pollutants is poorly documented and not well understood. However, there are few reports indicating existence of persistent organic pollutants and heavy metals in Tanzania coastal areas. Machiwa (1992a;b) reported alarming levels of PCBs in the Dar es Salaam harbour. Furthermore, Mwevura *et al.* (2002) investigated organochlorine pesticides residues in Dar es Salaam. An additional report on chlorinated compounds is that of Mmochi (2005) that describe pesticide pollution in the Chwaka bay emanating from the inland rice farms at Cheju, Zanzibar.

Heavy metals such as lead (Pb), zinc (Zn), cadmium (Cd), chromium (Cr), mercury (Hg) and copper (Cu) have been found in Dar es Salaam harbour and surrounding coastal areas (Machiwa 1992a; Kondoro 1997; Muzuka 1997). Concentrations of these metals exceeded the maximum values recommended by the World Health Organization. Similarly, Mtanga and Machiwa (2007) recorded high concentrations of Cr, Pb, Cu, Hg and other heavy metals in the sediments collected from Mzinga creek mangrove stand in Dar es Salaam. These metals were also shown to accumulate in tissues of Polychaete worms (Mtanga and Machiwa, 2007). Other studies on the impacts of heavy metal on flora and fauna dwelling in the polluted habitats are that of Mwandya (1996) and Wekwe *et al.* (1989) who separately investigated the effects of heavy metals on bivalves and several species of macroalgae found in the Dar es Salaam coastal waters. In another investigation Kangwe (1999) looked at the environmental impact of Pb, Hg and Cd on calcification rates of the reef building calcareous algae *Amphipora tribulis*. Further information on heavy metal pollution in Tanzania coasts is that of Machiwa (1992a) on sedimentation of heavy metal pollutants such as iron (Fe), magnesium (Mn), Zn, Pb, Cr, Cd and organic carbon in sediments close to Dar es Salaam.

3.4. Traditional knowledge about the fishery and the resources exploited

Tanzanian coastal communities have long histories of interaction with the marine environment (Masalu *et al*, 2010). Their unique customs and taboos have been developed over many centuries and communicated from generation to generation to ensure the sustainability of coral reefs and fishery resources. However, very little has been documented on indigenous knowledge in Tanzania, particularly the customs and taboos.

Masalu *et al.* (2010) documented some customs and taboos pertaining to fishery management, habitats management, fishing gears and vessels.

4. Annual catches

The most significant event for fisheries development was the establishment of a Fisheries Division in Tanzania in 1965. Annual fisheries reports back to 1965 when the first annual fisheries report was produced. However, due to financial constraint, inadequate human resources and facilities annual reports were not compiled between 1997 and 2006. Table 6 presents the available catch composition data by region between 1993 and 1995.

Table 6. Marine fish distribution by region and by species (average percent caught).

Species/ regions	Tanga			Coast				Dar es Salaam			Lindi			Mtwara		
	1993	1994	1995	1993	1994	1995	1996	1993	1994	1995	1993	1994	1995	1993	1994	1995
Pelagic fishes																
Sardines	20.07	22.38	28.49	16.94	31.93	27.65	49.86	29.25	25.11	25.24	6.73	24.61	3.92	5.09	5.17	4.44
Sharks	3.09	1.71	2.26	2.66	3.89	2.78	1.17	0.61	0.45	0.53	3.23	6.37	6.16	4.81	2.57	6.65
Half beaks	0.09	0.36	0.12	2.19	3.67	4.42	3.82	1.87	2.51	1.31	5.99	1.97	1.66	8.19	6.66	7.03
Mackerels	0.64	1.6	0.79	2.02	3.31	5.16	1.45	5.02	8.71	4.25	13.47	6.89	15.95	16.94	23.58	12.64
King fish	1.23	1.07	1.23	3.49	2.36	3.55	1.63	2.16	2.11	2.04	1.41	1.27	1	0.27	0.48	0
Tuna	1.29	1.77	1.79	0.3	0.14	0.65	0.11	1.64	1.9	1.02	0.69	0.56	1.47	4.05	9.53	2.57
Jacks	3.81	2.73	2.93	2.22	1.24	1.52	0.61	2.2	2.46	2.21	3.59	2.29	1.54	3.03	1.98	2.35
Mullet	0.21	0.23	0.19	2.52	0.36	0.3	0.01	0.18	0.14	0.31	3.29	2.49	1.8	0.08	0.17	2.84
Milk fish	0.05	0.02	0.25	0.02	0.08	0.1	0	0.06	0	0.1	0.17	0	0	0.06	0.23	0.2
Sword fish	1.34	1.47	1.53	0.04	0	0.03	0	0.54	0.83	0.49	1.18.0	0.96	1.59	4.8	8.24	12.85
Queen fish	1.13	0.1	0.1	1.12	1.08	2.03	0.76	0.26	0.24	0.77	3 0.31	1.08	0.88	0.19	0.18	17.41
Others	27.21	26.32	18.99	12.53	8.14	7.58	3.97	19.49	20.87	25.91	23.71	19.25	22.93	10.34	7.06	15.86
Non-pelagic fishes																
Octopus	0.41	0.21	2.18	3.51	0.93	0	0.01	0.14	0.05	0.05	0.67	1.38	0	0.99	1.15	0.42
Prawns	0.26	0.13	1.37	11.45	4.85	0.69	0.38	0.14	0.06	0.08	2.91	0	0	0	0	0
Flat fish	0.2	0.06	1.37	0.36	0.29	0.3	0.09	0.01	0.01	0.01	0	0	0	0	0	0
Rays	7.86	8.09	10.38	8.96	7.77	8.38	7.36	1.89	1.92	1.33	7.91	7.49	9.57	9.8	6.4	5.94
Thread fish	0.91	0.59	0.34	1.12	0.61	1.33	2.99	0.35	0.2	0.21	0	0	0	0.45	0.15	4.3
Cat fish	0.54	0.61	0.9	6.83	3.79	12.96	6.83	1.26	0.84	0.26	0.38	0.93		0.17	0	0
Parrot fish	12.41	14.3	12.05	8.65	10.51	8.53	10.38	5.06	5.17	4.37	1.17	0.42		2.64	2.54	6.79
Rabbit fish	5.32	5.2	8.64	5.92	7.4	5.78	5.09	6.34	6.52	7.09	5.66	4.39		11.47	9.05	3.57
Scavengers	10.14	8.76	6.28	4.16	5.35	3.88	3.2	20.73	18.81	22.01	12.79	14.28		15.76	14.14	5.72
Rock cods	0.74	0.68	0.55	1.22	0.75	0.6	0.22	0.31	0.41	0.23	1.26	2.33		0.52	0.17	3.63
Silver biddies	0.26	1.34	0.22	1.01	1.03	1	0.02	0.36	0.5	0.24	2.62	0.4		0.22	0.46	1.34
Cobia	0.82	0.36	0.3	0.9	0.51	0.79	0.05	0.19	0.17	0.12	0.86	0.67		0.11	0.07	0.07
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

5. Importance of the fishery in the national economy

Artisanal fishing is the main economic activity of the majority of the people living along the coast of Tanzania (Tarbit, 1986). It provides an important source of income, food and employment opportunities, directly as well as indirectly. In Tanzania, fish comprise about 30 percent of the total animal protein consumed nationally, with the per capita fish consumption ranging from 6 to 8 kilograms per year (Berachi, 2003) and estimated at between 25 and 30 kilograms per year in the coastal region. Commercial fishing along the coast also contributes significantly to employment opportunities and foreign exchange earnings (Bakari, 1997).

Ardill and Sanders (1991), reported that fisheries contributed relatively little to national economies in the WIO region, although fish product exports provide a valuable source of foreign exchange with fishery products contributing between 1 and 5 percent (average 2 percent) to GDP's. Ardill and Sanders (1991), also reported that, in Tanzania, The marine fisheries sector in Tanzania contributed between 2 percent and 5 percent of GDP in the mainland and between 2 percent and 10 percent in Zanzibar. However, the contribution of fish to the GDP of Tanzania has decreased from 1.9 percent in 1998 to 1.3 percent in 2008, as shown in Table 7.

Table 7. Fish percentage share in total GDP at current prices in Tanzania.
Source. Bank of Tanzania, 2008.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Percent	1.9	1.9	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.3	1.3

Tanzania's exports include pelagic fishery products as squids and non-pelagic marine fishery products as prawns, shells, lobsters, crabs and octopus (Anon., 2001). A summary of the contribution of the pelagic fish resources to the total exports of marine fish and fishery products is shown in Table 8.

Table 8. Percentage contribution of pelagic fish resources to the total marine fish and fishery products exports by weigh, value and royalties.

Year	Pelagic fish contributing to the exports (percent)			
	Weight (kg)	Value (USD)	Value (Tsh)	Royalty (Tsh)
2005	3.6	2.1	2.1	2.4
2006	5.1	7.7	7.7	7.1
2007	3.2	2.5	2.5	2.6
2008	1.7	5.7	3.6	2.8
2009	1.7	1.6	1.6	5
2010	2.8	0.87	0.9	1.4

Pelagic fisheries contributed about 60 percent of the total marine catch between 1993 and 1996 (Table 6). However, the contribution of pelagic fisheries in terms of total weight to fish exports did not exceed 5.1 percent in 2010 (Table 8). It is therefore, probable that most of the pelagic fish catches are utilised or consumed locally, thus contributing to ensuring of protein food security.

5.1. Value of the catches

The total value of the marine fish production ranged from Tsh[2] 39 239 352 in 2007 to Tsh 82 452 900 in 2005. Based on the relationship between annual catch and the value of the catch, the price of fish tends to fluctuate significantly between years (Table 9).

Table 9. Annual catch values for the years 2005 to 2009.

Year	Annual catch (tonnes)	Catch value (Tsh)
2005	54 968.6	82 452 900.0
2006	48 590.5	72 885 750.0
2007	43 498.5	39 239 352.2
2008	43 130.2	51 756 216.0
2009	52 231.97	Not available

Records of the fish catches have not been availed in taxonomic groups.

5.2. Products and markets

A review of fish supply and demand in Tanzania has shown that fish supply volume for the population has dropped over the years in the face of stagnating fish supply, and a growing population (Anon., 2001). According to FAO statistics, the per capita fish consumption dropped from 10.7 kg in 1998 to 9.4 kg in 1999 and 5.9 kg in 2000.

Markets and Distribution

The total amount of fish marketed from the marine sector in 1990 was estimated to be with in the vicinity of 35 000 tonnes (Rupamoorthy, 1991). Of this fish, close to 80 percent was processed and the sold fresh. Although figures are not available, it is assumed that most of the marine fish is purchased on the domestic market. A large number of rural poor are involved in the domestic fish marketing chain as fishermen, processors, traders, intermediaries, day labourers and transporters.

The market chain from fishermen to consumers includes primary, secondary and retail markets and involves sales agents, suppliers, wholesalers and retailers. Fish traders may visit markets daily or irregularly, depending on the distance of the village from the major towns along the coast and the city of Dar es Salaam (Bagachwa and Maliyamkono, 1994). Therefore, the fish price is dependent on the cost of transportation and tends to be lower further as one move away from the large towns. The price of fish also depends on species, quality, size and weight, seasonality, market structure, supply and demand, consumption behaviour. Fish are traded whole, un-gutted, and fresh without processing apart from sorting and icing. Léon *et al*. (2004) identified a lack of infrastructure (*e.g.*, cold storage facilities) and undeveloped markets as reasons for the predominance of local markets. Nevertheless, some fish are dried and transported to Dar es Salaam. In some cases, larger export companies travel and buy fish from local markets. Léon *et al*. (2004) also identified a lack of proper storage facilities and market access as significant limitations to the development of fisheries in coastal communities. Post harvest loss remains high, anecdotally reported to be up to 50 percent of the catch.

---

[2] 1 Tanzanian Shilling (Tsh) = 0.0006 USD (2013)

In general, facilities at fish markets are minimal with poor hygiene and sanitation. Concerns arise about the long-term sustainable fish marketing systems due to poor road and transport facilities, lack of credit facilities and an insufficient supply of ice. It is therefore necessary to provide training to the market operators for sustainable fish marketing systems.

Generally the fish landing sites that are utilized by fishing boats are natural sandy harbours. There are no fish landing sites that are dedicated exclusively for fishing boats. At the landing sites where tidal differences are large (about 4 meters), fishing boats are forced to moor several hundred feet away from the anchorage site due to the sandy harbour and access to the boats is difficult during high tides (MNR&T/JICA, 2002). Additionally, due to lack of mooring facilities, fish catches are often unloaded onto a small canoe and landed in the harbour.

Land based fish storage facilities

Many of the markets along the coast are located within the landing sites and do not have cold room facilities. To keep them fresh, landed fish are placed in insulated boxes containing ice or water. Fish are normally sold on the same day. If fish are not sold on the day, the retail price drops drastically and often these fish have to be discarded.

Currently, a World Bank funded project (MACEMP) in collaboration with Local Government Authority managed to build 3 modern landing sites at Rufiji, Mafia and Kilwa to improve post-harvest handling procedures

(a) Ice making facilities

Many of the fresh fish retailers in the landing sites depend on ice to store the fish that is not sold immediately. In most cases the ice is provided by private processors outside the fish market and supplied through trucks. The ice blocks are sold in different sizes to suit the customer demand.

(b) Processing plants

Presently there are two types of processing facilities in Tanzania. Processing plants that produce export products, and the processing operations of small-scale processors who produce traditional processed products for the local market. There are a only a few processing operators in Tanga, Dar es Salaam, Mafia and Kilwa. There are many small-scale processors who process sardines (dagaa) and other dried fish products for local distribution. To improve general hygiene, these small scale processors require upgrading including the development of tap and drainage water facilities, electricity supply, sanitation and an improved working environment. Most of the small scale processing is done either by sun drying, or salt and sun drying or smoking.

(c) Transportation

To facilitate the proper function ofland based fish storage facilities, ice making facilities and processing plants an efficient transportation system is required. Customers wanting to buy fish need easy access to the fish market centre. Often times the fish is transported on trucks or bicycles to reach the buyer. Many of the roads that connect to fisheries communities are unpaved and become impassable during the rainy season. This has negatively affected the marine fishery, being a major factor behind the complex marketing system connecting the middlemen, the buyer and the artisanal fisher. In addition, the additional time required for transport results in greater post harvest losses.

Fish marketing and constraints

The local market includes the local production areas and other parts of the country. The overall flow of fish supply from the coast can largely be divided into three channels:

i) Fisheries production and marketing cantered around Dar es Salaam;

ii) Production and marketing in northern areas such as Tanga, Pangni, etc.;

iii) Production and marketing in southern areas such as Lindi, Mtwara, Mafia, Kilwa, etc.

Dar es Salaam has the largest consumer market along the coast. Fishing boats based in Dar es Salaam and some from other areas of Bagamoyo, Mafia, Zanzibar, Lindi and Mtwara land their catches at the city's modern fish market situated at Kivukoni area. Local fish marketing in the other coastal regions is a daily transaction but on smaller scale. Markets remain undeveloped and fish transactions are carried out by a small number of retailers at the fish landing sites. Processed (basically dried) fish from these areas also find its way to inland markets and into neighbouring countries but through traders.

Fish marketing constraints include:-

a) Low and irregular (unreliable) fish prices;

b) A poor distribution network;

c) High post harvest losses, resulting from the generally poor infrastructure (both fresh and dried fish);

d) Inadequate fish post-harvest handling knowledge;

e) Lack of marketing information, particularly prevailing fish prices;

f) Lack of marketing infrastructure.

Reliable information on the household income and expenditure of fishers is limited and requires attention. The data is important to enable planners to project the needs and support required to improve the livelihoods of artisanal fishers.

6. Fisheries management plan and objectives

Tanzania has not yet developed a fisheries management plan for the pelagic fishery. However, Tanzania has a Fisheries Management Plan for one demersal fishery, namely the Prawn Fishery Management Plan which was produced with FAO TCP support. A second demersal fishery management plan, namely the Octopus Fishery Management Plan is in the development process.

Some arrangements for the pelagic fisheries management

Tanzania has management arrangements that are achieving the management objectives of the marine fisheries. However, these are not formally collated into a document called a Fisheries Management Plan (FMP). The arrangements management objectives are based on the National Fisheries Policy and Strategy Statement of 1997. The overall goal of the National Fisheries Policy is to promote conservation, development and sustainable management of the Fisheries Resources for the benefit of present and future generations.

According to the National Fisheries Policy and Strategy Statement of 1997 the Policy Statements are based on its main objectives, specifically:

(a) To put efficient use available resources in order to increase fish production so as to improve fish availability as well as to contribute to the growth of the economy;

(b) To enhance knowledge of the fisheries resource base;

(c) To establish national strategic applied research programmes that are responsive to the fisheries sector;

(d) To improve fisheries products utilization and their marketability;

(e) To establish National training and educational programmes based on assessed needs and optimize the use of national and international training institutions;

(f) To integrate conservation and sustainable utilisation of the fisheries resources into the social economic programmes of the community;

(g) To encourage and support all initiatives leading to the protection and sustainable use of the fish stock and aquatic resources;

(h) To protect the productivity and biological diversity of coastal and aquatic ecosystems through prevention of habitat destruction, pollution and overexploitation;

(i) To promote small scale, semi-intensive aquaculture systems with simple technologies and low capital investment;

(j) To promote the sound utilization of the ecological capacity of water based areas as a means of promoting diversification of income sources and diet;

(k) To promote effective farm and fish health management practices favouring hygienic measures and vaccines;

(l) To improve the involvement of the fisher communities in the planning, development and management of fishery resources;

(m) To prove the availability, accessibility and exchange of fisheries information;

(n) To incorporate gender perspective in the development of the fisheries sector;

(o) To strengthen collaboration on cross-sectoral issues between the fisheries sector and other sectors;

(p) To develop and strengthen inter-sectoral cooperation in general fisheries development to minimize operational conflicts;

(q) To pursue continuing fisheries integrated programme of effective management of coastal zone to met the ecological and socioeconomic needs of the present and future generations;

(r) To strengthen regional and International collaboration in the sustainable exploitation, management and conservation of resources in shared water bodies and the Exclusive Economic Zone (EEZ).

7. Legal framework

Tanzania is a United Republic, which is the result of a Union between the Tanganyika and Zanzibar that is made up of the islands of Unguja and Pemba, that took place on the 26th of April 1964. Under the Union, Zanzibar has retained a sovereign government giving it jurisdiction in non-union matters including fisheries. Both the mainland and Zanzibar have their own fisheries policies and laws. The Fisheries Policy of Zanzibar (promulgated in 1983 and extensively reviewed in 1997), is set to promote, protect, develop and sustainably utilize fish and other living aquatic resources and to provide food, employment and foreign exchange earnings through export of surplus fish and other fish products.

The mainland Fisheries Act No.22 of 2003 does not cover the territorial waters of Zanzibar, and Zanzibar has its own fisheries legislation (Fisheries Act 1988). However, two pieces of legislation apply to both sides of the Union: The Deep Sea Fishing Authority Act of 1998 that administers fisheries matters in the EEZ, and the Territorial Sea and Exclusive Economic Zone Act of 1989 that declared the marine zones of Tanzania.

The current National Fisheries Sector Policy and Strategy Statement adopted by the Government in 1997 gives guidance and direction on sustainable development and utilization of the fisheries resources. The overall goal of the National Policy is to promote conservation, development and sustainable management of the fisheries resources for the benefit of the present and future generations.

Other relevant policies

In the Marine sector, there are several policies relevant to fisheries and may influence the development of this sector. Such policies include:

National Environmental Policy, 1997

The environmental policy on fisheries stipulates that in order to preserve the environment and at the same time, provide nutrition to the people and enhance their income from fish sales.

National Forest Policy, 1998

One of the objectives of the Forest Policy is to ensure the ecosystem stability through conservation of forest biodiversity, water catchments and soil fertility.

The Wildlife Policy of Tanzania, 1998

One of the challenges of the Wildlife Policy is to conserve areas with great biological diversity which is representative of the major habitats of Tanzania. The overall objective is to preserve representative examples of Tanzania’s terrestrial and aquatic habitats and their physical environments. The aquatic habitats include, among others, brackish or salty waters including areas of marine water the depth of which at low tide does not exceed six metres. It may also incorporate riparian or coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands.

The National Investment Promotion Policy, 1996

The Investment policy may not take into consideration the question of the maintenance of coastal marine environment in its promotion of development. Such promotion may lead to excessive deposition of industrial effluence and negatively affect the marine ecosystem and thus the fish resources. In this case, an Environment Policy becomes an extremely important tool in maintaining the natural environment through, for example, the requirement of Environmental and Economic Impact Statements before the approval of development plans.

Legislation directly pertaining to fisheries

The Fisheries Act No. 22 of 2003

The primary national legislation relating to fisheries is theFisheries Act No. 22 of 2003 that makes provision for sustainable development, protection, conservation, aquaculture development, regulation and control of fish products, aquatic flora and its products and for related matters.

The Fisheries Act regulates fishing and the fishing industry, and aquaculture development on the Tanzania mainland. The Act consists of 59 sections divided into 10 Parts: Preliminary provisions (I); Administration (II); Development of the fishing industry (III); Aqua cultural development (IV); Management and control of the fishing industry (V); Fish quality, management and standards (VI); Financial provisions (VII); Enforcement (VIII); Offences and penalties (IX); General provisions (X).

The Fisheries Regulations, 2009

The Fisheries Act No. 22 of 2003 is supported by the Fisheries Regulations, 2009 put forth by Government Notice No. 308 published on 28/8/2009. The Fisheries Regulations,2009, consist of 147 Sections divided into 8 Parts: Preliminary Provisions (I); Registration, Licensing of fishing vessels, fishers and fish dealers (II); Development of the fishing industry (III); Aquaculture development and management (IV); Management and control of the fishing industry (V); Fish and fishery products standards (VI); Offences and penalties (VII); General provisions (VIII).

Other Legislations pertaining fisheries

Marine Parks and Reserves Act, 1994 (Act No. 29 of 1994)

The Act provides for the establishment, management and monitoring of marine parks and reserves, to establish a Park and Marine Reserves Unit and to repeal certain provisions of existing legislation.

Marine Parks and Reserves (Declaration) Regulations, 1999 (G.N. No. 85 of 1999)

The Marine Parks and Reserves (Declaration) Regulations implement the Marine Parks and Reserves Act, 1994 (Act No. 29 of 1994).The Declaration points out that all areas described in the Schedule are declared to be Marine Reserves (reg. 2). Regulations 3-9 specify prohibited or restricted activities in these areas. The remaining Regulations prohibit activities in marine reserves such as dredging, excavating, drilling (7), anchoring or mooring of vessels (8). (10 regulations and Schedule).

The Tanzania Fisheries Research Institute Act (1980)

Tanzania Fisheries Research Institute (TAFIRI) was established by the Act of Parliament No. 6 of 1980 to promote, conduct, and coordinate fisheries research in Tanzania. However, Regulations to support TAFIRI Act are not yet in place.

Territorial Sea and Exclusive Economic Zone Act (1989)

Provides for the implementation of the Law of the Sea Convention, and establishes the Territorial Sea and EEZ of the United Republic of Tanzania (URT). Asserts the rights of the URT to control, within the Territorial Seas and EEZ: exploration or exploitation of resources; research; drilling, constructing or operation of any structure or device; and any economic activity. This explicitly does not apply to fishing by a citizen of the URT or a vessel registered in the URT. All allowable fisheries catch from the EEZ shall be determined by the URT, such as to promote the proper conservation and management of the resource.

Deep Sea Fishing Authority Act (1998)

The Deep Sea Fishing Authority Act (1998) established the Deep Sea Fishing Authority (DSFA) to regulate deep sea fishing (and other uses) in the EEZ. DSFA has the primary function of: promotion, regulation and control of fishing in the EEZ; the licensing of persons and ships; initiation and implementation of enforcement policies; formulation and coordination of scientific research; formulation of fisheries policies; and negotiation of fishing agreements.

Environmental Management Act (2004)

The Act guides preparation and coordination in implementation of Environmental Action Plans, public awareness and education programmes, and provision of environmental advice and technical support.

National Integrated Coastal Environment Management Strategy (2003).

The National Integrated Coastal Environment Management Strategy defines strategies and implementing mechanisms, particularly with respect to planning and integrated management, conservation, research and monitoring, stakeholder participation, and capacity-building for management.

International Agreements:

International agreements relevant to fisheries resource management in Tanzania are:

- Convention on International Trade in Endangered Species of Fauna and Flora (CITES) (1979).
- United Nations Convention on the Law of the Sea- UNCLOS (1985).
- Convention on Biological Diversity (1992).
- Cartagena Protocol on Biosafety (2000).
- Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (the Nairobi Convention) and Related Protocols (1996).
- Convention on the Conservation of Migratory Species of Wild Animals (CMS) (1979).

8. Institutional and administrative framework

The United Republic of Tanzania is composed of Tanzania mainland (former Tanganyika) and Tanzania Island (Zanzibar). Mainland Tanzania has two levels of government: (1) Central Government: Ministries, Regional Commissioner's Office, District Commissioner's Office and Divisional Offices; and (2) Local Government: District, Wards and Villages. (Wells *et al.,* 2007). Under the Union arrangement, the inland and inshore marine fisheries are not union matters, hence Zanzibar has full mandate over her respective inshore fisheries Thus the fisheries management is divided in the separate but similar administration of the mainland Tanzania fishery and the Zanzibar fishery.

Government administration is conducted at both regional and district levels, with more functional powers at district level. The Fisheries Development Division in the Ministry of Livestock and Fisheries Development is the responsible institution for Tanzanian mainland fisheries sector administration. The institutional fisheries sector management functions at the various levels of the government are as follows:

Fisheries Development Division (Central Government)

The Development Division is responsible for the fisheries management and administration as well as conservation. This entails formulation of the policy and oversee its implementation; sectoral planning and budgeting; formulation and review legislation; law enforcement and surveillance; monitoring and evaluation of the sector performance; management information system; manpower planning and human resources development; extension services; research, training and curriculum development; coordination of other stakeholders; licensing; revenue collection; and international cooperation.

Tanzania Fisheries Research Institute (TAFIRI)

The Government has established the Tanzania Fisheries Research Institute (TAFIRI) in order to cater for fisheries research and development in the country. TAFIRI was established by the Act of Parliament No. 6 of 1980 to promote, conduct and coordinate fisheries research as well as to disseminate fisheries information to government agencies, public institutions and private companies engaged in the fishing industry.

To date, TAFIRI has 62 (sixty two) researchers who carrying out research activities in marine and freshwater. The research capacity at TAFIRI is considered to be adequate to serve the research needs of the marine pelagic fishery.

Marine Parks and Reserves Unit (MPRU)

The Marine Parks and Reserves Unit was established under the Marine Parks and Reserve Act Number 29 of 1994. The functions of MPRU are:

i. To establish and monitor, the control, management and administrationof marine parks and reserves;

ii. To seek funds for the establishment and development of marineparks and reserves;

iii. To establish anddevelop Marine Parks and Reserves;

iv. To implement and enforce the provisions of this Act and subsidiary legislation pursuant to section 18 to 38 of this Act;

v. To do all such other things which are necessary and within the powers of the Unit.

Fisheries Training Institutes

In an effort to ensure quality and adequate human capacity to serve the fisheries sector, the Government has established and is running some Institutions which produce experts for the fisheries management at village, district, regional and national levels. These Institutions are:

Mbegani Fisheries Development Centre (MFDC)

Mbegani Fisheries Development Centre is located in Bagamoyo district, Coast region. The Centre was established in 1966 to provide training and education to cover development needs for the fishing industry in Tanzania.

Nyegezi Freshwater Fisheries Institute (NFFI)

Nyegezi Freshwater Fisheries Institute (NFFI) was established in 1967 as an experimental Fish Processing Centre. In 1978 the centre was transformed into a training institution to offer a two years general certificate course in Fisheries Science. In 1997 the Institute started to conduct one-year courses in Fish Culture and Fish Handling, Processing and Quality Control. The Institute has full accreditation status granted by the National Council for Technical Education (NACTE) on 30th November 2005.

The Department of Aquatic Sciences and Fisheries of the University of Dar es Salaam

The genesis of the Department Aquatic Sciences and Fisheries (DASF) partly comes from the Government's decision to establish the then Kunduchi marine Fisheries Research and Training Institute (KMFRTI) in 1967 with the aim of training fisheries managers at General Diploma level who were to carry out their duties at district and regional levels. There were five main areas of study (Departments): Fishery Biology, Fishery Management & Administration, Food Technology, Marine Engineering and Nautical Science. In the absence of a degree programme in fisheries science in Tanzania, the then Ministry of Natural Resources and Tourism proposed a post-graduate diploma in fisheries and advanced diploma in fisheries management, aquaculture, food technology and nautical science. On considering demands for running these programmes, the Ministry realized that it did not have the relevant human resource capacity. The UDSM was therefore approached to consider integrating the KMFRTI with the UDSM, develop the proposed programmes to relevant degree programmes and continue running the Diploma programme offered at KMFRTI.

The department offers four academic programmes:

(a) Diploma in Fisheries (2 years)

(b) B.Sc. in Fisheries and Aquaculture (3 years)

(c) B.Sc. in Aquatic Environmental Science and Conservation (3 years)

(d) Postgraduate programmes leading to M.Sc. (2 years) and Ph.D. in Aquatic Sciences (3 years by thesis).

Local Governments

Considering the recent devolution of power from the central to the local government, the management responsibility of the fisheries sector has been expanded both in scope and scale. In this context local government is responsible for:

a) Issuing licences for artisanal and small-scale fisheries operations;

b) Coordination of extension services;

c) Law enforcement and surveillance;

d) Issuing of by-laws and participation in the formulation of regulations;

e) Revenue collection emanating from various fees;

f) Involvement in the conservation of aquatic and coastal areas;

g) Proposition of areas with conservation and biodiversity values for subsequent gazetting of protected areas;

h) Involvement in the management of aquatic and coastal protected area e.g. marine parks, marine reserves etc.;

i) Promotion of aquaculture and quality seed production.

Local government is involved in fisheries management and decision making through Village Councils, Ward Executive Officers, District Executive Director and District Fisheries Officers.

Local Communities:

The management of the fisheries resources for sustained production entails among other things a change in attitude towards fisheries resource use practice. Thus the user community who are in day to day contact with the resource have to be empowered to become aware of their own situation and support them to become responsible for their own destiny. Their roles are:

a) Employment in fisheries management, utilisation and fisheries based industry;

b) Production of the various fisheries products and services;

c) Conservation and management of aquatic resources and aquaculture practice;

d) Participation in joint management in aquatic and coastal protected areas;

e) Formulation and enforcement of by-laws.

Non-Government Organizations (NGOs)

In order to enhance the capacity and foster sustainable development of the fisheries sector, the role of NGOs is vital as a catalytic means in the implementation of fisheries management decision and policy making. The NGOs will therefore be responsible for:

a) Awareness and extension services;

b) Capacity building;

c) Training and technical assistance;

d) Financing of fisheries and environment activities;

e) Promote gender roles, women and user community empowerment.

Some of the International NGOs that assist in the fisheries management of Tanzania are:-

Worldwide Fund for Nature (WWF)

WWF is an independent conservation organisation and a global network of national organizations, associates, and programme offices. It is a science-based, solution-oriented conservation body involved in conservation, environmental policy, capacity building and environmental education projects. WWF also supports current MPAs in Tanzania and has positively influenced the designation of new MPAs. In particular the WWF supports the Mafia Island Marine Park, the Mafia-Rufiji-Kilwa Seascape Project, and projects on lowland coastal forests (Zaraninge forest and Matumbi forest).

International Union for the Conservation of Nature (IUCN)

IUCN is a union of governments, government agencies, and non-governmental organisations, scientists and experts working at the field and policy levels to protect nature. IUCN advises and assists governments, organizations and local communities in devising conservation strategies. In Tanzania, it is involved in the implementation of a project designed to protect coral reefs. Some notable initiatives that have been carried out by IUCN are:

- Mnazi Bay – Ruvuma Estuary Marine Park, Tanzania. Here the IUCN worked in collaboration with Marine Park and Reserve Unitto establish and prepare a strategy for the park. Tanga - Collaborative Management Areas (CMAs) Project The IUCN helped establish a community-based fisheries management project to establish multiple use reserves (CMAs). Six CMAs are in operation, covering 1 604km^2 each with its own management plan. Villages have voluntarily closed certain reefs to allow fish stock replenishment and reef recovery.

- Tanga - Tanga Coastal Zone Conservation and Development Project (TCZCDP). The project has built capacity in integrated coastal management for both fishery and coastal forestry resources.

Private Sector

The private sector should enhance investment, improve business and general management in the fishing industry, revitalize financing operations and promote the marketing of fishery products. The role of the private sector may include:

a) Facilitate and/or finance of investment in the fisheries sector;

b) Provision of employment and fisheries inputs and services;

c) Production of food and by-products;

d) Marketing of products;

e) Application of biodiversity guideline in fisheries management;

f) Application of EIA in fisheries investment;

g) Involvement in the conservation areas, development and sustainable management;

h) Provision of awareness and extension services;

i) Investment in environmental sound production technologies;

j) Ecotourism development.

Regional and International Community

These are partners in sustainable development. Their roles include:

a) Provision of financial assistance;

b) Capacity building through technical assistance, training, research and transfer of technology;

c) Facilitate in the implementation of international obligations;

d) Promote technical cooperation among developing countries.

Government agencies and other state machinery

They will assist in the management of fisheries administration and environmental conservation.

8.1. National and regional forums for discussions on fisheries management

The Fisheries Development Division has a number of platforms for discussions on management of the pelagic fishery resource. They include:

National Annual fisheries sector meeting

These meetings are theme based. Participants to the meetings include district fisheries officers, fisher associations, members of BMUs, local and international NGOs, academics, researchers as well as some other relevant government ministries and agencies.

Southern Africa Development Cooperation (SADC)

Tanzania is dedicated to implementation of its regional obligations that include the SADC protocol on fisheries. The most recent demonstration of its commitment to the endeavour was the successful development and implementation of SADC Regional Monitoring, Control and Surveillance (MCS). The initiative is a contribution towards strengthening regional capacity to meet the human resources development challenge as required by the SADC protocol on fisheries. It goes a long way to ensuring sustainable development and management of fishery resources in the SADC region, which is the overriding objective of the protocol. Tanzania became a signatory of the Statement of Commitment by SADC Ministers Responsible for Marine Fisheries on IUU fishing, on the 4th of July, 2008. The progress on the implementation of the Statement of Commitment will be reviewed at the end of 2011.

South West Indian Ocean Fisheries Project (SWIOFP)

The SWIOFP is a multinational research project which aims to improve the understanding and management of marine resources in the Southwest Indian Ocean. It involves nine countries, including Comoros, France, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa and Tanzania.

The project has been organized into seven components namely:

Component 1: Data gap analysis, data archiving and information technology.

Component 2: Assessment and sustainable utilization of crustaceans.

Component 3: Assessment and sustainable utilization of demersal fishes (excluding crustaceans).

Component 4: Assessment and sustainable utilization of pelagic fish.

Component 5: Monitoring of fishing effort and catch, existing value, and exploitation conflicts.

Component 6: Mainstreaming biodiversity in national and regional fisheries management.

Component 7: Strengthening regional and national fisheries management.

Tanzania is the Lead country for Component 3.

South West Indian Ocean Fisheries Commission (SWIOFC)

SWIOFC was established in 2004 by Resolution 1/127 of the FAO Council under Article VI 1 of the FAO Constitution. Its Rules of Procedures were adopted by the Commission at its First session in 2005. The main objective of the Commission is to promote the sustainable utilization of the living marine resources of the South West Indian Ocean region, through the proper management and development of the living marine resources, without prejudice to the sovereign rights of coastal States and to address common problems of fisheries management and development. The Commission has due regard for and promotes the application of the provisions of the FAO Code of Conduct on Responsible Fisheries, including the precautionary approach and the ecosystem approach to fisheries management.

The functions and responsibilities of the Commission are to:

a) contribute to improved governance through institutional arrangements that encourage cooperation amongst members;

b) help fishery managers in the development and implementation of fishery management systems that take due account of environmental, social and economic concerns;

c) keep under review the state of the fishery resources in the area and the industries based on them;

d) promote, encourage and coordinate research related to the living marine resources in the area and draw up programmes required for this purpose, and to organize such research as may be necessary;

e) promote the collection, exchange, dissemination and analysis or study of statistical, biological, environmental and socio-economic data and other marine fishery information;

f) provide a sound scientific basis to assist Members in taking fisheries management decisions;

g) provide advice on management measures to member governments and competent fisheries organizations;

h) provide advice and promote cooperation on monitoring, control and surveillance, including joint activities, especially as regards issues of a regional or subregional nature;

i) encourage, recommend and coordinate training in the areas of interest of the Commission;

j) promote and encourage the utilization of the most appropriate fishing craft, gear, fishing techniques and post harvesting technologies.

9. Management measures and tools currently in use and status of implementation

A number of management measures are currently used in the management of both pelagic and non-pelagic fisheries resources. These management measures are spelt out in the Fisheries Act (2003) that makes provision for sustainable development, the protection and conservation of fish stocks, aquaculture development, regulation and control of fish products and aquatic flora and its products. The relevant management tools based on the Fisheries Act (2003) and their status of implementation are shown in Appendix 3.

Fishery Management Practice

The artisanal fishery is the most important marine sector in Tanzania as it lands almost all the marine catch and supports the majority of fishermen. From management point of viewhowever, it is the most difficult sector to manage since fishing effort is widespread, entry into the fishery is free, and fishing is the main source of income and employment in the coastal fishing communities (Daffa *et al*., 1997). There are several management regulations for the artisanal fishery (Sobo, 1998). These include:

*Gear limitations:*This includes minimum mesh size limits on beach seines and other nets.

*Closed fishing areas:*Several marine reserves have been established under the Marine Parks and Reserves Act of 1994 to conserve fish populations.

Zonation: a management strategy created to reduce overcrowding of fishing vesselsor fishing efforts in the most productive areas especially if the fishing area is small(Linden and Lundin, 1996). This is meant to minimize or avoid potential conflictbetween industrial vessels and artisanal fishers.

*Licensing of vessels:*It is mandatory that fishing vessels be registered and licensed

*Prohibition of destructive fishing practices:*The use of explosives, poison, and other destructive fishing methods like spear is illegal under the Fisheries Act 2003 and the accompanied Fisheries Regulations 2009.

Unfortunately, many fishermen are unaware of these regulations. In cases where officials enforce the legislation, the fishers consider this to be harassment. In principle, fishing methods such as beach seines, nets of illegal mesh size, dynamite, spear and unlicensed fishing are prohibited, but law enforcement is difficult to achieve as the capacity to manage widely scattered fishing grounds is limited (Sobo,1998). Some sets of management measures/primary management tools currently being used in the marine fishery are shown in Table 10.

Table 10: Marine fisheries management measures

Type of management tool and measures	Comments
Spatial (area) restrictions and closures	The zoning plan of Mafia Island Marine Park (MIMP) has categorized the park area into three zones: THE CORE ZONE, in which no resource extraction is allowed, but where diving (snorkelling) for tourism purposes and research is permitted. According to the MIMP management, the core (no-take) zone occupies hardly 1.3 per cent of the total MPA area, and comprises the reefs of Kijiwe Nyara, Kitutia, Chole, Kinasi and others. These areas have the richest coral ecosystems. THE SPECIFIED USE ZONE, where permissible fishing gear is specified, and fishing (including sport fishing) by non-residents is prohibited; and THE GENERAL-USE, where fishing is allowed, but where non-residents require a permit to fish. Dragnets and fishing nets with a mesh size of less than 2.5 inches are not permitted.
Marine protected areas where fishing is prohibited	To date the following marine and reserves have been established: 1. Dar es Salaam Marine Reserves, which comprise Bongoyo, Pangavini, Mbudya and Fungu Yasini, and were gazetted in 1975; 2. Mwakatumbe, Kendwa and Sinda islands, which were gazetted in 2007; 3. Maziwi Island, 1981; 4. Nyororo, Shungumbili and Mbarakuli marine reserves, 2007.
No-take zones	Resource extraction is not allowed in Core zone of MIMP and MBREMP
Marine reserves where fishing is sometimes allowed	Fishing is sometimes allowed as provided for in the specified use and general use zones of Mafia Island Marine Park (MIMP), established in 1995 and Mnazi Bay-Ruvuma Estuary Marine Park, established in 2000.
Other temporary areas closures for specific purpose (e.g., spawning aggregations)	There are no temporary areas closures for specific purpose applied to pelagic fisheries. However, temporary areas closures for specific purposes has been applied to prawn demersal fishery. In 1990 the fisheries authorities introduced a closed prawn fishing season from December to February (this was a time where many young shrimps were observed in catches) to protect young shrimps.
Zoning and rotation of fishing vessel on fishing grounds	There are no zoning and rotation of fishing vessel on fishing grounds applicable to pelagic fisheries. However, this regulation was introduced in 1988 just a year after the government had licensed foreign prawn fishing vessels. The objective of this regulation was to spread fishing effort evenly over the fishing grounds and minimize environmental degradation on a particular fishing ground where most of the fishing vessels seemed to cluster (Haule, 2001). The regulation was also aimed at encouraging fishing vessels to search for new fishing grounds and minimize conflicts which were starting to arise among trawlers and artisanal fishers. At first, five zones were delineated. With time some of the zones were merged together to form three zones. Although this measure seemed to work to reduce conflict among trawlers, it did not solve the conflict between artisanal fishers and trawlers. Artisanal fishers complained that they are denied their livelihoods by trawlers who destroy their fishing gears.

Type of management tool and measures	Comments
Temporal restrictions	
Defined fishing season(s)	In prawn fishery
Defined number of days fishing	In prawn fishery
Defined number of hours fishing	Trawling for research
Restricting fishing time	A regulation to restrict fishing time was introduced in 1990 aiming to solve the conflict between artisanal fishers and trawlers as well as reducing fishing pressure. Fishing time for trawlers was set and they were allowed to operate between 06.00 hours and 18.00 hours. This includes scouting time and steaming time to the fishing grounds. The regulation was believed to give artisanal fishers time to set their nets at night and haul them at dawn without being fouled by trawl nets (Haule, 2001). Day time operation was also thought to allow for captains ensure good visibility so that they could avoid coming into contact with artisanal fishing gear.
Gear restrictions	
Engine size restrictions	Restriction on vessel capacity. In 1997 the Fisheries Division introduced a regulation to restrict vessel capacity to no more than 500 HP. This regulation managed to reduce the capacity of the vessel to 500 HP. Before this regulation engine power of the vessels were ranging between 220 to 992 HP while gross registered tonnage ranged between 45 and 296 (Haule, 2001).
Gear size restrictions	This is provided for in the Fisheries Regulations, 2009, Section 19.-(2) (d) and Section 66.-(1) (a) to (x) [Appendix 1]
Gear type restrictions	This is provided for in the Fisheries Regulations, 2009, Section 19.-(2) (d) and Section 66.-(1) (a) to (x) [Appendix 1]
Size/Age restrictions (i.e., minimum or maximum sizes)	59.- (1) A person shall not fish, cause to fish, land, possess, collect, process, trade in or export- (a) any lobster whose individual weight is below five hundred grams; (b) any mangrove crab whose individual weight is below five hundred grams; (c) any berried lobster having eggs attached; (d) any octopus whose individual weight is below five hundred grams; (e) other species with external eggs. (2) A person shall not harvest, pluck or cause to pluck, possess, collect, process, trade in or export eggs from lobsters, crabs, squids and cuttlefish.
Participatory restrictions	

Type of management tool and measures	Comments
Licenses	Under the Fisheries Act (2003) section 17. (c) all fishing vessels are required to be licensed and section 17. (d) all fishers are required to be licensed. All fishing vessels are subjected to registration fees which are paid when vessels are commissioned for the first time and vessel and fishing licence fees which are paid annually. Registration fees are aimed to keep track of how many vessels enter the industry and also to collect revenue, while licence fees are seen as means to control entry to some extent, keep track of how many vessels are actively engaged in fishing activities each year and also as a way to collect revenue. In the commercial shrimp fishery, fishing vessels licences are charged per gross registered tonnage (grt) and the rates vary with vessels size, flagship and shore infrastructure. For example, for a Tanzanian registered vessel with land processing facility, both the licence and fishing licence fee is USD 2.4/GRT, while for a foreign vessel without land based processing facility the fee is USD 108/GRT for fishing and USD 162/GRT for a fishing vessel licence (Wilson, 2003). This annual fishing licence fee is one way to reduce fishing effort in commercial shrimp fishery. Despite of all the management measures which have been put in place, fishing effort continues to increase and many more entrants demand to join the fishery. Currently the fisheries authorities are not issuing new licences for commercial shrimp fishing; however, there is an increasing pressure from those who want to join the fishery. The decision to stop issuing new licences for the commercial shrimp fishery was made due to concerns that the fishery is not sustainable.
Limited entry	Limited entry is practiced in the industrial prawn fishery
Rights- / incentive-adjusting regulations	
Territorial use rights	Territorial use rights are used in the coastal fish resources exploitation where prawn trawlers are restricted to areas beyond 5 m depths to accommodate the small-scale fishers .Fisheries Regulation 2009, Section 20. - (3) specifies that a prawn trawler shall not operate within two nautical miles from the lowest water mark in the inner waters of the Indian Ocean [Appendix1].

9.1. Customary marine tenure

In Tanzania customary marine tenure restricts the fishing grounds used by fishers and the guarding of gear.

Restrictions of fishers in certain areas

The traditional restriction on the amount of fishing gear in one area led to the creation of informal territory within the fishing ground for each fisher. In Kimbiji village it is a tradition for youth not to fish at the same place as the older people. This kind of customary marine tenure exists even today as fishers have their own territory for fishing using names like *kati, kilango cha boya, kizima, kilango cha kasa* and *vyambani*.

In Mangapwani village, basket trap fishers have their own fishing arrangements. Each fisher has his own territory to avoid theft, conflict and destruction of the traps. Likewise, at Kizingani village it is a tradition for hook and line fishers not to fish at the same place where net fishers are fishing. In Msangamkuu and Mgao villages, traditional restrictions on concentration of fishing gear are in place. This restriction is essentially a form of zonation where basket traps and net fishers do not overlap. This was traditionally done to respect elders and ensure that there was no competition between the two groups of fishers.

Restrictions of fishers in certain areas inadvertently protects fish stock and fishing habitats. However, due to poverty, this type of customary marine tenure is no longer used in some parts. In some areas such as Kunduchi-pwani village fishers concentrate on one reef where fish stocks are abundant.

Guarding

It is not common for all fishers to return to camp while out fishing. Some fishers remain behind at the fishing ground to guard the fishing ground from encroachment. This inadvertently protects fish stock and fishing habitats.

Taboos and beliefs

Fourteen forms of taboos and beliefs that inadvertently protect fish stocks and consequently protect fishing habitats have been identified in Tanzania (Masalu *et al.*, 2010). These are:

Dietary restrictions

Taboos against eating certain marine species because of religious influence or beliefs exist among coastal villagers in Tanzania. For example, “Kasa” and “Kaa koko” are not eaten by some Muslims because they live both in marine and terrestrial areas. These taboos, which caution against eating certain marine species, unintentionally limit fishing.

Restrictions on fishing without bathing after sex

For coastal fishers, whether married or not, it is a taboo to go fishing without having a bath after having sex. This is due to a belief that having intercourse dirties the body. The ocean is the home of evil spirits and, according to beliefs, they dislike meeting with impure person. This taboo is strictly adhered to in order to avoid misfortune during fishing activities. This taboo again involuntarily limits fishing.

Restrictions on fishing for menstruating women

According to Islamic religion, a menstruating woman is considered impure. She is not allowed to fast, pray or read the Koran. Additionally, to avoid misfortune it is a taboo for a menstruating woman to go fishing. This taboo involuntarily protects fishing habitats on the near shore reefs.

Restrictions on fishing during strong winds and heavy rains

It is taboo for the artisanal fishers to fish when there are heavy rains and strong winds. This is due to the nature of the fishing vessels – most fishers still use traditional fishing vessels and gears which cannot withstand strong winds. Heavy rains during fishing may result in poor visibility and loss of direction. In most places fishing activities are generally reduced during the strong winds (southern monsoon winds) and heavy rains. This unintentionally allows some marine fish species to breed and grow.

Lost fishers during fishing

In early times when fishers were lost while fishing, other fishers would not continue fishing but rather search for the lost fishers until they were found. This taboo unknowingly limited pressure on marine habitats in the study areas. Nowadays, this is not common in some areas, but in other places like Kizimkazi and Mkokotoni villages, the practice still exists although it is not as strongly adhered to as it was in early times.

Death events

In early times when there was a death at the village, no fishing activities could take place until the body was buried. According to this taboo, misfortune would occur if you went out to fish while others were involved in burial activities. This taboo involuntarily helped to limit pressure on marine habitats. Nowadays some people continue with fishing activities even if there is a death in their village.

Mentioning names of terrestrial animals

In some fishing communities, for example Mangapwani village, fishers cancel fishing activities if one among them inadvertently mentions a name of terrestrial animal. This is considered to be a sign of bad luck.

Alcohol consumption

It is a taboo for coastal fishers to drink alcohol when going out for fishing. This taboo is connected with the Islamic religion which says that consuming alcohol makes the body impure. If a fisher is identified by others as having consumed alcohol, he is dropped off to avoid misfortune and other dangers during fishing. This taboo, too, decreases pressure on marine habitats and reduces the destruction of the coral reef.

Festivals and special days

It is a taboo for Muslim fishers to go out to fish during the Islamic religion ceremonies. This inadvertently protects fish stocks and protects coral reefs habitats. Most coastal fishers are Muslims and accordingly it is a taboo for them to fish on Fridays. This day is regarded as a special holy day for them to rest at home and conduct the Friday prayers. However, some fishers, because of poverty and lack of alternative livelihood, continue to fish on Friday night. It is also a taboo for Muslim fishers, who have been fasting, to dive for octopus during the holy Ramadhani month. Similarly, it is a taboo for some fishers to fish during 'mwaka-kogwa', wedding ceremony, election days and during neap tides. Furthermore, in early times, there was a one-day ceremony during male circumcision during which there was no fishing. These taboos inadvertently reduce pressure on marine habitats and hence protect the environment.

Meeting with one person

Some fishers cancel fishing activities if, when going out to fish or check nets/traps, they meet with one person. This is believed as a bad omen on that day and nothing will be caught. On the contrary, it is considered a lucky sign to meet with two or more people when a fisher goes out to fish. This reduces pressure on the fish stocks and coral reef environment.

Fishing without success

If a handline fisher goes out for fishing and spends some time without any success, they do not continue but rather return home because it is a sign that something is wrong at home. For example, their wives might be having sex with another man, or there may be a death in the family. Handline fishers also cancel fishing activities if they hook a bottle, which is a bad sign. These beliefs inadvertently reduces fishing pressure.

Receiving payment for fish in advance

Most fishers believe that it is a taboo to receive payment for fish in advance. If this happens, some fishers don't accept the payment and cancel the fishing activities on that day. To some extent it reduces fishing pressure in the coral reefs environment.

Fabrication and deployment of fishing vessels

It is a taboo for another carpenter to take up unfinished fabrication work on a vessel without prior approval of the initial carpenter. It is believed that both the vessel and the new carpenter will be accompanied by bad omens. The vessel may not be able to catch fish and may cause accidents during fishing. This controls much the number of fishing vessels and thus reduces fishing pressure.

Impurity of fishing vessels and gears

Fishing vessels and gears must be free from impurity of any kind. For instance, in most places it is believed that nothing will be caught if a goat urinates on the basket traps. It is also a taboo for fishers to defecate or urinate inside or nearby the fishing vessels in the belief that nothing will be caught on that day. Impure fishing vessels and gear reduce the pressure on fishing. For many fishers it is a taboo for a woman to touch basket traps (madema) and nets during fabrication and deployment. If they do, it is believed the basket traps and nets won't catch fish.

Magical power

Fisheries in coastal communities have long been associated with innumerable magical practices. Some fishers believe that, in order to catch more fish, a talisman must be tied to the fishing gear or vessels, and/or a prayer must be said in order to give fishermen confidence in the face of a wide range of hazards and threats. The traditional healer should be consulted to find the best time and day to leave home and the best direction for fishing and camping. In addition, some fishers believe that a big tree found along the coast is a home of evil spirits, so a special prayer must be said before cutting down the tree for vessel construction to avoid misfortune. In the absence of traditional healers the number of fishing vessels is greatly reduced, thus reducing fishing pressure and protecting fishing habitats.

Closures for octopus fishery

In early times area-based restrictions were used in some villages to manage octopus stocks. In Kisimkazi village, there was a traditional management system which included seasonal closures of fishing for octopus, with controls on fishing gear, such as spears, and controls on access to the area by outside fishers.

Closing and opening was entirely based on norms and traditions. The closing periods were not fixed; it could be three months or more depending on their needs. They normally closed and opened the area when religious festivals were approaching. They did so in order to have money for the festivals.

Management of offenders during the closed season was through supernatural sanctions. There were special elders responsible for punishing offenders. For example, if a fisher was found fishing octopus during the closed season, the octopus would stick around their body with the removal requiring traditional healing. The thought of such a punishment made many people afraid to conduct fishing for octopus during the closed season. However, this traditional management strategy has recently collapsed due to the erosion of traditions and customs.

Technical inadequacies

Traditionally, most of artisanal fishers in Tanzania use traditional fishing vessels without engines such as dugout canoes (*mtumbwi*), outrigger canoes (*ngalawa*), and dhows (*dau*). They also used mashua for ferrying people. These vessels are not capable of carrying many fishers and cannot withstand harsh conditions of the sea. As a result, the number of fishers and the time duration of fishing were greatly minimized. Also, artisanal fishers use traditional fishing gears, such as basket traps, hook and lines, as well as scoop nets, which are environmentally-friendly. This, to some extent, protects fish stocks and reefs.

Restrictions on destructive fishing gears

In some villages there are regulations restricting or banning fishing gears as a way of reducing the impact on fishing habitats. Restricted fishing gears are dynamite, beach seine, the use of small meshed nets, poisonous plants, drag nets and spear fishing. These gears have a varied impact on the habitats and fishery resources. The use of dynamite and poisonous plants destroys fishing habitats and kills all marine fish species. Beach seine, drag nets and spear fishing destroy fishing habitats while the use of small, meshed nets harvests all sizes of marine fish species and negatively influences reproductive output.

Habitat Management

Beliefs on coral reefs

In early times, traditional beliefs suggested that evil spirits protected some coral reefs. Traditionally, some reefs remained untouched and healthy due to unexplained events that were observed by fishermen during fishing. Information on the presence of evil spirits in some reefs was spread by word of mouth. These beliefs inadvertently helped to protect the reefs from being overfished and hence they remained in good health.

Beliefs on peninsulas

Morphology of coastline may cause refraction of waves which result in wave turbulence and long shore currents. The effects of long shore currents are rip currents which are very strong so that fishers with traditional fishing gear and vessels cannot withstand them. Most traditional fishers associate rip currents with supernatural powers. The presence of rip currents in fishing grounds near a peninsula sometimes limits fishing activities, which unknowingly protects fishing habitats and fishery resources.

In Chunguruma village, the fishing grounds near *Mbizi* peninsula were associated with evil spirits and people were not allowed to conduct any fishing activities in these areas. *Nkumbi/Mnarani/Silambi* peninsula in Bweni village has strong winds which are believed to be associated with evil spirits. Sacrifice in form of eggs, tobacco, lime and rice flour mixed with sugar is placed in the area for safe fishing. However, fishers with modern fishing vessels go there without problems.

Beliefs on islands and sandbanks

In early times it was believed that islands and sandbanks were the home of evil spirits. Traditionally people were not allowed to take anything from the islands due to the belief that by doing so you would take evil spirits back home. Islands and sandbanks were used as sites for performing traditional rituals.

Fishing close to the islands was also influenced by traditional beliefs. For example, in past years people did not fish at Pungume Island (located in the Menai Bay area) due to the fear of evil spirits and misfortunes. At Nyemembe island (Menai Bay area) people were afraid to fish during the night because of beliefs. Some islands have been protected from humans because of their physical features. For instance, Pangavini Island (in Dar es Salaam) is surrounded by steep cliffs so it is not accessible by humans.

In early times, the Fungu Yasini sandbank at Kunduchi pwani village was used by fishers and other people for performing traditional rituals to avoid misfortune and natural disasters like droughts, floods and diseases. Also the sandbank was used as a teaching ground to test trainees to see if they had mastered fishing methods properly. The experienced fishers might request the trainee fishers bring sands from the sandbank to estimate the time taken to and from Fungu Yasini sandbank.

Beliefs on caves

Caves are used for performing traditional rituals. The coastal forests around the caves usually are never tampered with because they are associated with ancestors who reside in the caves. In this regard, coastal natural forests around caves are ecologically important for protecting coral reefs from sedimentation. The presence of *pange*, *kwamwinyingazi, fufuma, kitokambe* and *kwamwanamkuu* caves at Bweleo village, *machomwe, usine, pange, maegea*, *mnarani*, *kivuka, kwaza* and *juga* caves at Kizimkazi village and *kisima cha chini kwa chini* (coral well), *Nyumba ya chini kwa chini* (slave chamber) and *Mbozani* caves at Mangapwani village helped to maintain patches of coastal natural forests in Zanzibar. These caves were used by responsible clans to perform traditional rituals. They are located close to the Indian Ocean and surrounded by small patches of forests, although in early times they were surrounded by dense forest.

The *Pange* cave was originally surrounded by a dense forest. The cave was used for performing traditional rituals to ask for rains, avoid misfortune and diseases. Due to the erosion of traditional beliefs, currently fish and turtles have been placed in the cave as a trial for mariculture. Water inside the cave has a direct link with the ocean tides.

9.2. Effectiveness of the current management measures

There is limited information on the performance of Tanzania's pelagic fisheries management. In assessing the effectiveness of the current management measures it may, in the first place, be helpful to have a common understanding of what fisheries management is. FAO (1997) uses the following working definition of fisheries management:

"The integrated process of information gathering, analysis, planning, consultation, decision making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives"

Social success

Social successrequires that fish resources contribute to social welfare in an equitable manner. The Tanzanian government relies on the fish resources to provide livelihoods to resource-dependent communities. However, a review of the conditions of fish supply and demand in Tanzania has shown that fish supply volume, despite growth in the population, has stagnated between 52 231 and 54 968 tonnes between 2005 and 2009.

Economic success

Economic successrequires that fisheries operate in an efficient manner, avoiding problems of over capacity. A key issue in economics is the resource rent that the fishery is capable of generating. Leaving the rent in the fishery can lead to its dissipation through excessive levels of exploitation. In Tanzania, artisanal marine fishing activities are concentrated in the extensive shallow waters protected by the reefs. This shallow-water fishery is limited by the scarcity of fish due to overfishing. Studies have revealed that the artisanal marine fishery has expanded beyond the economically optimum point, and that nationally, there has been a rapid increase in the number of artisanal fishers from 11 292 in the year 1985 to 36 321 in 2009 (Table 2). The increase in the number of fishers has not been matched by the increase of output in marine fish productionhas stagnated between 54 968 and 52 231 tonnes over the years 2005 to 2009. However, there are opportunities to explore the potential fisheries in waters deeper than 20 m, particularly in the EEZ area.

Biological success

Biological successrequires that management regulates the harvest so that it does not exceed the long-term productive capacity of the target stocks either by directly harvesting the stocks or in some way undermining the resilience of the ecosystem. Studies have revealed that the artisanal marine fishery has expanded to a level where the current level of effort is beyond that of maximum sustainable yield resulting in suboptimal yield, i.e., it is evident that the inshore waters are overfished (Berachi, 2003). The most easily accessible fishing areas maintain significant fishing pressure and overexploitation with no time given for natural recovery. The temporary closure of the industrial prawn fishery since 2008 is a result of the stock being overexploited. The biological success is also jeopardized by the existence of destructive harvesting practices, particularly dynamiting which undermines the resilience of the marine ecosystem.

Environmental consideration

Habitat degradation of coral reefs is occurring through dynamite fishing and other sources of impacts. Degraded reefs environments are prevalent in the shallow depths and reefs adjacent to areas of high population density are the most damaged and are found to have the lowest abundance of commercially important fish species. Overall, successful fisheries management in Tanzania must strike a balance among the social, economic, biological dimensions. However, a lack of information on each of these hinders sustainable development.

9.3. Compliance or enforcement problems

A Surveillance Unit was established as highlighted in the Fisheries Act, 2003 PART VIII Section 31. – (1) and (2). As stipulated in Section 32.-(2) of the Act, the function of the Unit is to protect fishes and their environment, to monitor fishery products and aquatic flora and prevent unlawful dealing and generally enforce the Fisheries Act of 2003. This includesthe issue of fishing licenses, prevention of illegal fishing and the enforcement of fishing gear and other restrictions. In Tanzania, a national MCS programme was established with law enforcement agencies and stakeholders including communities to monitor fisheries activities.

Fisheries enforcement is conducted at national and local levels where the local authorities are involved. Generally the costs associated with enforcement are too high to be met by the government alone. To assist, fisheries patrols have been organized and conducted in near and offshore marine waters and an observer program has been instituted in the inshore prawn and commercial offshore fisheries. The prawn fishery is monitored in three specified industrial prawn fishing zones. The Fisheries Development Division has also developed a system, that involves fishing communities, particularly Beach Management Units, in the implementation of their MCS programme. The local authorities have begun developing their own bylaws, which are relevant in their communities.

The efficacy of MCS in Tanzania has been questioned (Makaramba and Kweka, 1999). Generally, enforcement bodies have inadequate personnel, facilities, and finances to enforce the regulations. Moreover, the judicial system in Tanzania doesn't provide for fisheries courts and violations are heard in civil courts. This undermines the MCS system due to the lengthily process, the poor record of prosecution and unrealistically low penalties. Various attempts have been made to revise the fisheries legislation, to create deterrent penalties and to train Fisheries staff in MCS and prosecution.

Heavy reliance on donor support for control of illegal fishing including dynamite fishing and the inability of local councils to finance control measures, have been cited as major setbacks to control use of dynamite. Control trend shows that dynamite fishing seemed to remain under control during donor funded programmes. Dynamite fishing was reduced to almost zero during the Irish government supported Tanga Coastal Zone Conservation and Development Programme (TCZCDP). However after the program ceased in 2006, the number of dynamite blasts rose from almost zero in 2006 to 69 in 2007.

The enforcement capacity varies amongst institutions. For example, in Tanga region the MCS Patrol Unit has four patrol boats fitted with outboard engines. Each of Tanga Municipal Council, Pangani District, Muheza District, Mkinga District and Tanga Marine Police, has a patrol boat fitted with an outboard engine. Tanga Coelacanth Marine Park has two functional patrol Boats. Each of the institutions has acquired a vehicle. Thus the Tanga region has 11 patrol boats fitted with outboard engines and no less than six vehicles for MCS.

In the Dar es Salaam region, the Marine Parks and Reserves Unit has five patrol boats and two vehicles. Temeke, Kinondoni and Ilala Municipal Councils have neither Patrol boats nor vehicles. The Kinondoni region has one boat (with a few life jackets), mapping equipment, and a short distance camera but has no vehicle. The Marine Police DSM has one boat fitted with two outboard engines of 250HP each, Digital camera and GPS on board the boat; the MCS Patrol Unit in the Fisheries Division H/Qs of Dar es Salaam has 3 patrol boats, 3 vehicles, video cameras, still cameras and two-way radio. In total, the Dar es Salaam region has 10 patrol boats fitted with outboard engines and no less than 5 vehicles at the disposal of containing dynamite fishing.The MCS Patrol Unit in Mtwara has 3 patrol boats and no vehicle while that of Mafia has 2 patrol boats and no vehicle.

In total there are 26 patrol boats and 11vehicles that can be used in marine fisheries patrols on the Tanzania mainland. Given that the length of the coastline is 800km, the 26 patrol vessels could be dispatched at a distance of every 30 kilometres.The greatest challenge remains to be adequate financial resources to meet the running cost ofboats, engines and vehicles in terms fuel and repair.

10. The way forward

Tanzania has 35 fisheries (WIOFish database) of which the majority are artisanal (Everett *et al.*, 2010). Many of these fisheries (three pelagic and twenty-two non-pelagic) have significant impacts on the habitats within which they operate. These impacts vary from trampling in the intertidal zone to destructive fishing methods such as dynamite fishing. Since these habitat impacts will affect the pelagic artisanal fishery, only a holistic management approach will promote sustainability in this fishery. The key principles are that: fisheries should be managed to limit their impact on the ecosystem to an acceptable level; ecological relationships between species should be maintained; management measures should be compatible across the entire distribution of the resource; precaution in decision-making and action is needed because the knowledge on ecosystems is incomplete; and that governance should ensure both human and ecosystem well-being and equity. Most fishers in Tanzania rely on their fisheries for personal food security and parts of the catch are retained for consumption by them and their families.

References

Anon. 2001. Frame survey report. Ministry of Natural Resources and Tourism, Fisheries Division. United Republic of Tanzania.

Ardill, J.D. & Sanders, M.J., eds. 1991. Proceedings of the seminar to identify priorities for fisheries management and development in the Southwest Indian Ocean. FAO Fisheries Report No. 457. Rome, FAO.

Bakari, R. 1997. Trade liberalisation and the exploitation of crustacean resources in Tanzania marine waters. University of Dar es Salaam, Tanzania (MA thesis).

Bagachwa, M.D & Maliyamkono, T.L. 1994. *Fisheries and development in Tanzania.* London, Macmillan Press.

Bank of Tanzania. 2008. Bank of Tanzania economic operations report 2008.

Berachi, I. 2003. Bioeconomic analysis of artisanal marine fisheries of mainland Tanzania. Norway. Norwegian College of Fishery Science, University of Tromso.

Bianchi, G. 1985. FAO species identification sheets for fishery purposes. Field guide to the commercial marine and brackish-water species of Tanzania. Prepared and published with the support of TCP/URT/4406 and FAO (FIRM) Regular Programme. Rome, FAO. 199 pp.

Bianchi, G.; Carpenter, K.E.; Roux, J.-P.; Molloy, F.J.; Boyer, D. & Boyer, H.J. 1999. Field guide to the living marine resources of Namibia. FAO species identification guide for fishery purposes. Rome, FAO. 265 pp.

Blaxter, J.H. & Holliday, F.G. 1965. The behaviour and physiology of herring and other clupeids. *Adv. Mar. Biol.* 1: 262–372.

Brill, R.W. & Holland, K.N. 1990. Horizontal and vertical movements of yellowfin tuna associated with fish aggregation devices. *Fish. Bull.* 83(3): 493–507.

Bryceson I. 1982. Pollution of Dar es Salaam coastal environments by industrial and domestic effluents. *In*: Proceedings of the workshop The Current State and Development of Marine Sciences in Tanzania. Institute of Marine Sciences, Zanzibar. 2–8 April. p. 32–41.

Bryceson, I. 1983. Pollution of Dar es Salaam coastal environments by industrial and domestic effluents. *In*: Status and problems of marine resources development in Tanzania. Recommendations and selected papers from the workshop The Current State and Development of Marine Sciences in Tanzania. Zanzibar, 2–8 April, p. 32–41.

Collette, B.B. 1986. Scombridae (including Thunnidae, Scomberomoridae, Gasterochismatidae and Sardidae). *In*: P.J. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese, eds. *Fishes of the north-eastern Atlantic and the Mediterranean*, Volume 2. Paris, Unesco. p. 981–997.

Collette, B.B. 1995. Scombridae. Atunes, bacoretas, bonitos, caballas, estorninos, melva, etc. *In*: W. Fischer, F. Krupp, W. Schneider, C. Sommer, K.E. Carpenter & V. Niem, eds. *Guia FAO para Identification de Especies para lo Fines de la Pesca. Pacifico Centro-Oriental.* 3 Vols. Rome, FAO. p. 1521–1543.

Collette, B.B. 2001. Scombridae. Tunas (also, albacore, bonitos, mackerels, seerfishes, and wahoo). *In*: K.E. Carpenter & V. Niem, eds. FAO species identification guide for fishery purposes. *The living marine resources of the Western Central Pacific. Vol. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles*. Rome, FAO. p. 3721−3756.

Collette, B.B. & C.E. Nauen. 1983. FAO Species Catalogue. Vol. 2. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. *FAO Fish. Synop*. 125(2).137 pp.

Daffa, J.M.; Chande, A.I.; Ngoile, M.A. & Amaral, M. 1997. Coastal management in Tanzania. Report of USAID mission to Tanzania.

Everett, B.I.; van der Elst, R.P.; Jiddawi, N.; Santana-Afonso, P.; Dorizo, J.; Khadun, S.; Okemwa, G.; Fondo, E.; Assan, C.; Robinson, J.; Ngoca, G.; Ramkissoon, S. & Mohit, R. 2010. WIOFish database: a catalogue of small-scale fisheries of the western Indian Ocean: annual report, September 2010. 132 pp.

FAO. 1997. Technical guidelines for responsible fisheries No. 4: Fisheries management. Rome, FAO.

FAO. 2008. First session of the Scientific Committee for the South West Indian Ocean Fisheries Commission, Dar es Salaam, United Republic of Tanzania, 31 May–3 June 2006. FAO Fisheries Report No. 806. Rome, FAO.

Fisheries Development Division. 2009. Annual report statistics report. Ministry of Livestock and Fisheries Development.

Francis, J. & Bryceson, I. 2001. Tanzanian coastal and marine resources: some examples illustrating questions of sustainable use. *In*: Ahmed, J., et. al, eds. Lessons learned: case studies in sustainable use. IUCN. p. 74−100.

Haule, W.V. 2001. Reducing the impact of tropical shrimp trawling fisheries on living marine resources through the adoption of environmentally friendly techniques and practices in Tanzania. *In*: Tropical shrimp fisheries and their impact on living resources. FAO Technical paper No. 974. Rome, FAO. p 216−233.

Iversen, S.A.; Myklevoll, S.; Lwiza, K. & Yonazi, J. 1984. Tanzania marine fish resources in the depth region 10−500 m investigated by R.V. Dr Fridtjof Nansen. *In*: S.A. Iversen & S. Myklevoll, eds. The proceedings of the Norad−Tanzania seminar to review the marine fish stocks and fisheries in Tanzania, Mbegani, Tanzania 6−8 March, 1984. Norway, Institute of Marine Research. p. 45−84.

Kangwe, J.W. 1999. The effect of land-based pollution on reef building calcareous algae in the reefs near Zanzibar Town. University of Dar es Salaam, Tanzania (M.Sc. thesis). 97 pp.

Kondoro, J.W. 1997. Dispersion of heavy metals along Msimbazi River Basin in Dar es Salaam, Tanzania. *Tanzania Journal of Science* 23: 1−10.

Kuiter, R.H. & Tonozuka, T. 2001. *Pictorial guide to Indonesian reef fishes*. Part 3. Jawfishes − Sunfishes, Opistognathidae − Molidae. Australia, Zoonetics. p. 623−893.

León, Y.; Tobey, J.; Torell, E.; Mwaipopo, R.; Mkenda, A.; Ngazy, Z. & Mbarouk, F. 2004. MPAs and poverty alleviation: an empirical study of 24 coastal villages on mainland Tanzania and Zanzibar. Report prepared for the World Bank, Dar es Salaam, Tanzania.

Linden, O. & Lundin, C.J. 1996. Integrated coastal zone management in Tanzania. Proceedings of the national workshop, May 1995, Zanzibar. Stockholm, The World Bank and SIDA-SAREC.

Losse, G.F. 1964. Sardinella investigations: 11−12 EAMFRO annual report.

Lyimo, T.J. 2009. Microbial and nutrient pollution in the coastal bathing waters of Dar es Salaam. *Aquatic Conservation* 19: S27–S37.

Machiwa, J.F. 1992a. Heavy metal content in coastal sediments off Dar es Salaam, Tanzania. *Environment International*, 18: 409−415.

Machiwa, J.F. 1992b. Anthropogenic pollution in the Dar es Salaam harbour area, Tanzania. *Marine Pollution Bulletin* 24 (11): 562−567.

Magimbi, S. 1997a. Demographic changes in coastal zone of Tanzania: focus on artisanal (small-scale) fishers. Occasional Papers, Vol 2. Demographic Unit, University of Dar es Salaam.

Magimbi, S. 1997b. Population characteristics and trends of fishing communities in Tanzania and their relationship to the level of exploitation of fisheries resources. Proceedings of the Workshop on Population Characteristics in Coastal Fishing Communities, Madras, India, 10−14 March, 1997.

Makaramba, R. & Kweka, L. 1999. Legal and policy matrix. Dar es Salaam, Tanzania Coastal Management Partnership.

Masalu, D.C., Shalli, M.S. & Kitula, R.A. 2010. Customs and taboos: the role of indigenous knowledge in the management of fish stocks and coral reefs in Tanzania. 64 pp.

Mashauri, D.A. & Mayo, A. 1989. The environment impact of industrial and domestic waste water in Dar es Salaam. A research paper presented at the symposium on environmental pollution and its management in Eastern Africa. Faculty of Science, University of Dar es Salaam, Tanzania.

Mgana, S. & Mahongo, S. 1997. Land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environment: Tanzania mainland. Report presented at the UNEP Regional Workshop, Institute of Marine Sciences, Zanzibar. 6−9 October, 1997. 50 pp.

Mgaya, Y.D.; Muruke, M.H.; Chande, A.I. & Semesi, A.K. 1999. Evaluation of crustacean resources in Bagamoyo district, Tanzania. In: K.M. Howell & A.K. Semesi, eds. Coastal resources of Bagamoyo District, Tanzania. Proceedings of a Workshop on Coastal Resources of Bagamoyo, 18−19 December 1997, Bagamoyo. Faculty of Science, University of Dar es Salaam. p. 55−63.

Ministry of Livestock Development and Fisheries. 2010. Marine fisheries frame survey results 2009.

Ministry of Natural Resources and Tourism/Japan International Cooperation Agency. 2002. The master plan study on fisheries development in the United Republic of Tanzania. System Science Consultants INC., Overseas Agro-Fisheries Consultants Co. Ltd.

Mmochi, A.J. 2005. Chemodynamics of pesticide residues and metabolites in Zanzibar coastal marine environment. Chemistry Department, University of Dar es Salaam. 238 pp.

Mohammed, S.M. 1997. Assessment of land-based sources of pollution in Zanzibar. Institute of Marine Sciences, Zanzibar. 12 pp

Mohammed, S.M. 2002. The assessment of water quality and pollution in Tanzania. *Ambio* Vol. 31 (7−9): 617-620.

Mtanga, A. & Machiwa, J. 2007. Assessment of heavy metal pollution in sediment and polychaete worms from the Mzinga Creek and Ras Dege Mangrove Ecosystems, Dar es Salaam, Tanzania. *Western Indian Ocean Journal Marine Science* 6: 125–135.

Munisi, J.J. 1999. A comparative study of polluted and unpolluted intertidal floral communities near Tanga Town. A report submitted for the fulfilment of the forth term programme at the University of Dar es Salaam. Department of Zoology and Marine Biology. 17pp.

Murua, H. & Saborido-Rey, F. 2003. Female reproductive strategies of marine fish species of the *North Atlantic. J. Northwest Atl. Fish*. Sci. 33:23−31.

Muzuka, A.N. 2007. Distribution of heavy metals in the coastal marine surficial sediments in the Msasani Bay−Dar es Salaam harbour area*, Western Indian Ocean. Journal of Marine Science* 6: 73–83.

Mwandya, A.W. 1996. Variability and morphometric relationships of lead and cadmium in Saccostrea cuccullata and Pinctada marginitifera along the Dar es Salaam coast. Third Year student project. Department of Zoology and Marine Biology, University of Dar es Salaam. 31 pp.

Mwevura, H.; Othman, O.C. & Mhehe, G.L. 2002. Organochlorine pesticide residues in sediments and biota from the coastal area of Dar es Salaam city, Tanzania. *Marine Pollution Bulletin* 45: 262−7.

Rupamoorthy, M. 1991. National Food Strategy: The fisheries sector of Tanzania. Rome, FAO.

Schultz, K. 2000. *Fishing encyclopedia: worldwide angling guide*. Foster City, United States, IDG Books Worldwide Inc.

Semesi, A.K. 1991. Management plan for the mangrove ecosystem of Mainland Tanzania, Vol. 1. Mangrove management plan of Tanga and Muheza Districts. Ministryof Natural Resources and Tourism/ NORAD. Catchment Forest Project, 1991.

Sharp, G.D. 1978. Behavioural and physiological properties of tunas and their effects on vulnerability to fishing gear. *In*: G.D. Sharp & A.E. Dizon, eds. *The physiological ecology of tunas.* New York, Academic Press.

Shilungushela, J.M. 1993. Inventory of destructive activities to the freshwater bodies and the marine environment along the Tanga region coastal area. Report commissioned by National Environment Management Council (NEMC), Dar es Salaam. 57 pp.

Sobo, F.A. 1998. Fisheries management in Tanzania. Dar es Salaam, Ministry of Natural Resources and Tourism, Fisheries Division.

Tarbit, J. 1986. Inshore fisheries of the Tanzanian coast. *In*: Proceeding of the NORAD-Tanzania seminar to review the marine fish stock and fisheries in Tanzania, 6−8 March 1984, Mbegani, Tanzania.

TCMP. 1999. Tanzania ICM country profile.

Uronu, W.E.M. 1995. Sewerage issues in the Dar es Salaam area. In: Proceedings of the National Workshop on Integrated Coastal Zone Management in Tanzania. May 8−12. The World Bank.

Wekwe, W.W.; Othman, O.C. & Khan, M.R. 1989. Seaweeds as heavy metal pollution indicators. In: M.R. Khan & H.J. Gijzan, eds. Environmental Pollution and its Management in Eastern Africa. Dar es Salaam, University of Dar es Salaam. p. 241−248.

Westernhagen, H. Von. 1974. Observations on the natural spawning of *Alectis indicus* (Rüppell) and *Caranx ignobilis* (Forsk.) (Carangidae)". *Journal of Fish Biology (Blackwell Synergy)* 6 (4): 513–516.

Wells, S.; Makoloweka, S. & Samoilys, M., eds. 2007. Putting adaptive management into practice: collaborative coastal management in Tanga, Northern Tanzania. Nairobi; Kenya, IUCN. 197 pp.

Wilson, J.D. 2003. Fiscal arrangements in the Tanzanian fisheries sector. Rome, FAO.

Appendix 1. Pelagic fish species of Tanzania as of WIOfish data base 2010.

1. *Acanthocybium solandri*	19. *Plotosus papuensis*
2. *Amblygaster sirm*	20. *Plotosus* spp
3. *Caesio caerulaurea*	21. *Rastrelliger kanagurta*
4. Carangidae	22. *Rastrelliger* spp
5. *Caranx ignobilis*	23. *Sardinella albella*
6. Chaetodontidae	24. *Sardinella brachysoma*
7. *Coryphaena hippurus*	25. *Sardinella gibbosa*
8. *Decapterus* spp	26. *Scomberoides* spp
9. *Engraulis* spp	27. *Scomberomorus commerson*
10. *Euthynnus affinis*	28. *Scomberomorus plurilineatus*
11. *Hemiramphus* spp	29. *Scomberomorus* spp
12. Istiophoridae	30. Scombridae
13. *Istiophorus albicans*	31. *Selar crumenophthalmus*
14. *Istiophorus platypterus*	32. *Thunnus albacares*
15. *Katsuwonus pelamis*	33. *Thunnus obesus*
16. *Makaira indica*	34. *Tylosurus* spp
17. *Mugil cephalus*	35. *Xiphias gladius*
18. Mugilidae	

Appendix 2. Commercial pelagic fish species of Tanzania (Bianchi, 1985).

Family: Megalopdae	**Family: Engraulidae**	**Family: Belonidae**
Megalops cyprinoides	*Engraulis japonicus*	*Ablennes hians*
Family: Elopidae	*Stolephorus heterolobus*	*Platybelone argalus platyura*
Elops machnata	*Stolephorus punctifer*	*Strongylura leiura*
Family: Clupeidae	*Stolephorus indicus*	*Tylosurus acus melanotus*
Sardinella leiogaster	*Stolephorus commersonii*	*Tylosurus crocodilus crocodilus*
Sardinella sirm	*Stolephorus devisi*	**Family: Pomatomidae**
Sardinella melanura	*Thryssa baelama*	*Pomatomus saltatrix*
Sardinella albella	*Thryssa setirostris*	**Family: Rachycentridae**
Sardinella gibbosa	*Thryssa vitrirostris*	*Rachycentron canadum*
Sardinella neglecta	**Family: Chirocentridae**	**Family: Carangidae**
Dussumieria acuta	*Chirocentrus dorab*	*Alectis ciliaris*
Etrumeus teres	*Chirocentrus nudus*	*Alectis indicus*
Herklotsichthys punctatus	**Family: Chanidae**	*Atule mate*
Herklotsichthys quadrimaculatus	*Chanos chanos*	*Caranx ignobilis*
Hilsa kelee	**Family: Atherinidae**	*Caranx sem*
Pellona ditchela	*Atherinomorus lacunosus*	*Decapterus macarelus*
Spratelloides delicatus	*Atherion africanus*	*Decapterus russelli*
Spratelloides gracilis	**Family Scombridae**	*Elagatis bipinnulata*
Family: Coryphaenidae	*Scomber japonicus*	*Megalapsis cordyla*
Coryphaena equiselis	*Acanthocybium solandri*	*Naucrates ductor*
Decapterushippurus	*Auxis thazard*	*Seriola rivoliana*
Family: Lutjanidae	*Euthynnus affinis*	*Uraspis secunda*
Aprion verescens	*Katsuwonus pelamis*	**Family: Mobulidae**
Family: Xiphiidae	*Rastrelliger kanagurta*	*Manta birostris*
Xiphius gladius	*Sarda orientalis*	*Mobula diabola*
Family: Carcharhinidae	Scomberomorus commerson	Aetobatus narinari
Rhizoprionodon acutus	Scomberomorus plurilineatus	
Family: Loliginidae	*Thunnus obesus*	
Loligo duvauceli	Thunnus tonggol	
Loligo forbesi		

Appendix 3. Marine fisheries management tools of Tanzania mainland based on the Fisheries Act (2003).

Fisheries Act Provision	Management measure	Implementation status
PART III. DEVELOPMENT OF THE FISHING INDUSTRY 9.- (2) The Director shall, based on the best scientific evidence available, adopt such appropriate measures to maintain or restore stocks at levels capable of producing maximum sustainable yield pursuant to relevant environmental and economic factors including:	(a) avoidance, of excessive fishing capacity and over-exploitationof the stocks in order to maintain an economically availablefishery;	In the prawn fishery, the Fisheries Division holds a stakeholders meeting before the beginning of a fishing season whereby the number of industrial prawn fishing vessels to be engaged in the particular season is decided upon. The decision is guided by analysis of the performance of the previous fishing season. Thus the number of fishing vessels was reduced from 25 in 2004 to 10 in 2007 with subsequent temporal closure as from 2008, pending research findings on the health of the resource. Tanzania Fisheries Research Institute has since then been instructed to carry out research on the health of the prawn resource, whose findings shall be the basis for decisions on the future exploitation of prawns. The research is still ongoing. However artisanal fishers continue catching the prawns by traditional methods of using stationary traps, cast nets and seines
	(b) taking into account the interest of local fishers such as thoseengaged in artisanal fisheries;	Although the prawn fishery has been temporarily been closed since 2008, artisanal fishers continue catching the prawns by traditional methods of using stationary traps, cast nets and seines. The Fisheries Regulations, 2009 Section 20.-(1) limits prawn trawlers to operate between 06:00 hs and 18:00 hs in order to safeguard artisanal fishery operators in the period from 18:00 hs to 06:00 hs.
	(c) conservation and protection of biodiversity of aquatic habitats,ecosystems and endangered species;	At International level Tanzania has signed and ratified a number of Conventions. They include:- Convention on Biological Diversity (CBD) Tanzania signed the Convention on 12-06-1992 and ratified it on 08-03-1996 Convention on the Conservation of Migratory Species of Wild Animals (CMS). Tanzania's entry came into force on 1.07.1999 Indian Ocean and South East Asian Memorandum of Understanding on the Management and Conservation of Marine Turtles. Tanzania signed the MoU on 23 June 2001 became effective on 1 September 2001 The Memorandum of Understanding on the Conservation and Management of Dugongs (Dugong dugon) and their Habitats Throughout their range. Tanzania signed the MoU on 31 October 2007 International Whaling Commission (IWC). Tanzania's date of receipt of notification of adherence was June 23, 2008, and date of entry into force was also June 23, 2008 Convention on International Trade in Endangered Species (CITES). Tanzania ratified CITES on 29/11/1979 and came into force on 27/02/1980 The prohibition of dealing with rare and endangered species is provided for in the Fisheries Regulations, 2009, PART V MANAGEMENT AND CONTROL OF THE FISHING INDUSTRY Section 67.-(1) (2) (3) (4)
	(d) restoration and recovery of depleted stocks;	Industrial prawn trawling has been closed since 2008 pending recovery of the stocks. Export of sea cucumber has been suspended pending recovery of the stocks.
	(e) minimization of pollution, waste, discards, catch by lost orabandoned gear, catch of non target fish or species and impactson associated or dependent species through the developmentand use of selective, environmentally safe and cost effective fishing gear and techniques.	Protection of the fisheries resource from water pollution is provided for in the Fisheries Regulations, 2009, Section 51.- (1)

Fisheries Act Provision	Management measure	Implementation status
PART V. MANAGEMENT AND CONTROL OF THE FISHING INDUSTRY 17. The Minister shall by notice published in the Gazette imposeconditions that are necessary for the proper management of fisheries which are:	(a) restricting the entry of foreign fishing vessels in territorialwaters;	Foreign vessels are not given license to fish in the territorial waters. This requirement is provided for in the Fisheries Regulations, 2009, Section 56.-(2)
	(b) requiring all fishing vessels to be registered;	The requirement is provided for in the Fisheries Regulations, 2009 PART II REGISTRATION,LICENCING OF VESSELS,FISHERS AND FISH DEALERS(a) Registration of Fishing Vessels However, the 2007 Fisheries Frame Survey reported that 68 percent of the fishing vessels were not registered while in the 2009 Fisheries Frame Survey,73 percent were not registered.
	(c) requiring all fishing vessels to be licensed;	The requirement is provided for in the Fisheries Regulations, 2009 PART II REGISTRATION,LICENCING OF VESSELS,FISHERS AND FISH DEALERS (b)Licensing of Fishing Vessels, fishers and fish dealers
	(d) requiring all fishers to be licensed;	The requirement is provided for in the Fisheries Regulations, 2009 PART II REGISTRATION,LICENCING OF VESSELS,FISHERS AND FISH DEALERS (b)Licensing of Fishing Vessels, fishers and fish dealers
	(e) prohibiting the use of certain types of fishing vessels and gears;	The prohibition is contained in the Fisheries Regulations, 2009 Section 66.-(1) (a) to (x).
	(f) imposing closed season for designated areas, species of fish and methods of fishing;	These are provided for in the MIMP General Management Plan
	(g) prohibiting fishing in designated areas;	These are provided for in the MIMP General Management Plan
	(h) limiting the amount, size, age and other characteristics andmonitoring species composition of fish that may be caught, landed or traded	The fishing of lobster, octopus, crab, squid, cuttlefish and other species with external eggs has to abide to Fisheries Regulation 2009, Section 59.- (1) and (2)
	(i) regulating the landing of fish and providing for management offish landing stations;	Management of landing sites is provided for in the Fisheries Regulations, 2009 section 84.- (1), (2), (3a, b, c, d, e, f), (4a, b, c, d, e, f, g, h, i, j), (5), (6), (7). The 2009 Fisheries Frame Survey showed that there were 257 landing sites, 57 percent of which, were accessible by all whether road, 52 percent had good water supply. 117 landing sites had gear repair facilities and 101 had boat repair facilities
	(j) controlling the importation of fish and fishery products or the introduction of exotic species;	This is provided for in the Fisheries Regulations, 2009 Section 29. – (1) (a) (b) (c) and (d)
	(k) establishing a mechanism that will reduce excessive fishing capacity to levels commensurate with the sustainable use of fisheries resources;	The Fisheries Development Division holds a Stakeholder's forum to review the performance of the prawn fishery in order to decide the number of industrial fishing vessels that shall be licensed for the forthcoming fishing season.

Fisheries Act Provision	Management measure	Implementation status
	(l) regulating fishing in such a way as to avoid the risk of conflictamong fishers using different vessels, gear and fishing methods;	This is provided for in the Fisheries Regulations, 2009 Section 20.-(1) limits prawn trawlers to operate between 06:00 hs and 18:00 hs in order to safeguard artisanal fishery operators in the period from 18:00 hs to 06:00 hs.
	(m) ensuring that traditional practices, which are consistent withresponsible fisheries, needs and interests of indigenous people and local fishing communities which are highly dependent of fisheries resources for their livelihood are given due regard;	This is provided for in the Fisheries Regulations, 2009, Section 49 whereby "Notwithstanding the provisions of these Regulations, licence, permit or permission shall not be required for fishing by means of any of the following methods: (a) using cloth commonly known as 'KUTANDA UDUVI' for fishing 'uduvi' Sergestid shrimp (Acetes species) (b) using rod and line or hand line from the beach without using a fishing vessel whether for domestic consumption or sale, except in a declared trout stream or spawning ground."
	(n) establishing effective mechanism for fisheries monitoring,surveillance control and enforcement, to ensure compliance withconservation and management measure as well as those adoptedby regional or sub regional organizations or arrangements;	The Fisheries Development division has established Monitoring, Control and Surveillance Unit that works in all the marine waters including the EEZ
	(o) conducting joint surveillance, and enforcement in collaborationwith other related agencies and fisher communities to ensureeffective implementation of this Act;	The MCS Unit conducts joint surveillance within the framework of the SADC
	(p) facilitating the formation of community management units and authorized associations for the purpose of protecting and conserving fishery resources;	The following sections of the Fisheries Regulations 2009 provide for the establishment and management of Beach Management Units 133.- (1), (2), (3), (4a, b, c, d, e, f), (5), (6), (7), (8a, b, c), (9 a, b, c, d, e), (10), (11), (12), (13), (14a, b, c, d, e, f, g, h, i), (15) The functions of the Beach Management Units are spelt out in the Fisheries Regulations 2009 section 134.- (1)

Appendix 4. Year 2010 monthly average price of fish in Tanzania shillings at Ferry fish market, Dar es Salaam**.**

Fish Species	Month												Average price
	Jan.	Feb.	March	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
PELAGIC FISHES													
Sardines	654.61	581.00	537.43	542.10	750.00	555.85	567.53	635.40	662.70	657.65	734.39	702.00	631.72
[2](Vibua) **Scombridae:** **Carangidae :**	1,362.84	1,253.00	1,445.76	1,464.87	1454.40	1505.21	1508.76	1,665.06	1497.30	1405.72	1609.92	1639.29	1,484.34
(Mbono) **Caesionidae:** *Caesio caerulaureus,* *C. xanthonotus*	1,300.00	1,168.00	1,293.76	1,329.67	1241.70	1363.64	1314.95	1282.74	1324.50	1497.84	2043.66	1654.29	1,401.23
[3](Nguru) **Scombridae:**	3,000.00	2,703.00	3,003.10	2,979.66	3000.00	3037.65	3154.57	3072.29	3000	3064.63	3326.27	3508.77	3,070.83
[4](Chuchunge) **Hemiramphidae:**	779.49	1,011.00	1,000.00	1,019.96	1047.05	1000.00	1000	N/A	1000	N/A	N/A	1102.51	995.55
[5](Jodari) **Scombridae:**	3,000.00	2,088.00	3,000.00	3,000.57	3001.17	3020.50	2946.70	2912.03	3227.17	3386.52	3187.91	3225.80	2,999.70
[6](Kolekole) **Carangidae:**	2,000.00	2,112.00	1,418.07	1,777.00	1252.40	1601.40	1973.33	2121.46	1604.27	1784.63	2299.24	2000.55	1,828.70
[7](Mikizi) **Mugilidae:**	847.65	901.00	1,025.64	844.16	946.37	874.64	1104.41	969.98	1028.27	996.40	1076.92	1079.69	974.59
[8](Mizia) **Sphyraenidae:**	1,833.33	1,333.00	1,177.06	N/A	1216.09	1025.64	1598.17	2285.25	1058.20	1057.58	1125.17	1923.93	1421.22
[9](Misusa) **Sphyraenidae:**	766.28	1,070.00	985.18	1,148.78	1054.83	1201.35	1042.52	1216.11	1293.77	1394.71	1668.65	1369.86	1184.337
[10](Pandu) **Carangidae:**	1,190.48	748.00	750.00	945.07	912.36	800.00	N/A	897.44	800	1418.44	1169.59	947.05	961.67
(Papa) Sharks	1,047.98	1,107.00	1,167.32	N/A	1747.31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1267.40
[11](Samsuli)/ (Nduwalo) **Xiphidae:** *Istiophoridae:*	2,500.00	N/A	2,702.70	2,188.68	N/A	2816.90	N/A	3000.00	N/A	3100.62	N/A	N/A	2718.15
(Sehewa) **Scombridae:** *Euthynnus affinis*	1,946.90	1,350.00	1,306.02	1,350.63	1349.98	1350.61	1350.06	2001.79	1336.39	1400.54	1471.03	1402.24	1,468.02

(Songoro) **Rachycentridae:** *Rachycentron canadum*	N/A	2,604.00	N/A	2,800.00	2769.43	1750.32	2866.89	2985.07	N/A	3026.52	3225.80	2247.19	2697.24
(Mkonge) **Chirocentridae:** *Chirocentrus dorab, C. Nudus*	N/A	676.00	N/A	750.00	777.27	800.00	N/A	839.81	800	763.24	N/A	N/A	772.33
(Antepa) **Trichiuridae:** *Trichiurus lepturus,*	N/A	N/A	N/A	N/A	875.30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[12](Ngisi) **Sepiidae:** **Loliginidae:** **Onychoteuthidae:** **Ommastrephidae:** **Thysanoteuthidae:**	N/A	1,929.00	2,277.43	2,747.93	2307.69	N/A	2796.61	3254.49	3000	3343.02	3243.24	N/A	2766.60
NON PELAGICS													
(Kamba) **Penaeidae:**	N/A	5,000	3,013.70	3,500.00	N/A	4109.59	6000	5000.00	N/A	5750.00	6000	5000	4819.22
[13](Chaa) **Gerreidae:**	952.38	1,119.00	938.09	941.83	1163.87	1000.00	1501.83	1058.10	N/A	1208.33	N/A	1000	1088.34
[14](Tembo-uzi) **Lutjanidae:**	1,000.00	N/A	884.96	907.34	956.61	1000.00	961.53	2000.00	1025.64	929.92	1098.90	989.01	1068.53
[15](Kihalua) **Carangidae:**	N/A	N/A	N/A	N/A	1233.24	1100.32	N/A	N/A	1111.11	N/A	N/A	N/A	1148.22
[16](Changu) **Lutjanidae:** **Lethrinidae:**	3,000.00	3,000.00	2,800.32	2,792.93	2991.54	3032.07	2898.85	2963.38	2705.95	3067.71	2992.36	3077.72	2943.56
(Numba) **Lutjanidae:** *Lutjanus sebae,*	N/A	N/A	1,734.10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
[17](Janja/Majanja) **Lutjanidae:**	N/A	841.00	895.52	840.02	1074.24	N/A	889.96	1034.48	N/A	966.67	1150.15	1073.51	973.95
(Kifimbo) **Lutjanidae:** *Aprion virescens*	N/A	2,722	1,602.56	N/A	N/A	N/A	N/A	1628.66	N/A	N/A	2702.70	2777.77	2286.8
(Fuatundu) **Lutjanidae:** *Lutjanus sanguineus*	N/A	2,615	2,802.10	3,000.00	2503.36	2970.30	3000	2955.67	3000	3025.64	3000	2114.02	2816.90

[18](Tasi) **Siganidae:**	931.59	1,041.00	1,018.87	1,234.38	1158.26	1047.38	1489.36	1234.57	1148.40	1624.75	1135.22	1250	1192.815
[19](Taa) (Batoid fishes)	850.00	813.00	1,074.07	N/A	933.50	1025.64	1250.60	1000.00	1098.90	1125.27	1200	1103.23	1043.11
[20](Pweza) **Octopodidae:**	2,500.00	2,346.00	2,500	1,828.57	2518.96	3502.30	2802.54	3431.37	2721.08	3978.02	N/A	N/A	2812.884
[21](Puju) **Acanthuridae:**	656.40	840.00	756.14	724.19	1027.13	1694.92	1012.65	975.16	1000	1257.01	1466.16	1155.06	1047.068
[22](Kangaja) **Acanthuridae:**	1,010.29	N/A	955.88	N/A	1008.69	N/A	1000	1414.14	N/A	982.76	1746.72	1639.34	1219.7275
(Pono) *Labridae and Scaride*	1,025.00	1,004.00	949.54	1,003.64	1052.37	908.00	971.96	1197.77	1021.27	1054.35	1074.52	1213.87	1,039.69
(Palawe) *Leognathidae*	422.83	N/A	N/A	N/A	819.27	821.89	985.10	653.34	465.11	N/A	N/A	N/A	694.59
(Komba) *Haemulidae*	2,000.00	1,002.00	911.68	1,098.90	1022.72	1015.23	1000	1071.43	1000	N/A	N/A	N/A	1124.66
(Chewa) *Serranidae*	2,500.00	2,482.00	2,131.90	2,689.30	2817.77	2748.09	2700.42	2875.94	2985.07	3023.62	2804.87	2703.25	2705.18
[23](Hongwe) **Ariidae:**	N/A	N/A	686.11	840.34	922.14	840.71	1066.66	934.58	1020.08	878.45	N/A	940.69	903.30
[24](Kalamamba) **Haemulidae:**	N/A	N/A	1,133.33	1,069.52	1100.91	N/A	1000	1133.23	1121.23	N/A	1953.48	N/A	1215.95
[25](Koana) **Nemipteridae:**	N/A	N/A	1,087.53	893.47	998.21	1025.64	1151.07	1000.00	N/A	N/A	N/A	N/A	1025.98
[26](Mkundaji) **Mullidae:**	N/A	N/A	1,010.10	1,023.34	1023.96	1075.03	1149.94	1088.27	967.74	1065.18	1052.63	1125	1058.11
[27](Gayogayo) **Psettodidae:**	N/A	N/A	N/A	N/A	1488.09	N/A	1250	2666.67	1100.91	N/A	1216.93	N/A	1544.52

NB:

(1) N/A = Records not available.

(2) Species under (Vibua) **Scombridae are:***Rastrelliger kanagurta;***Carangidae :** *Atule mate*

(3) Species under (Nguru) **Scombridae are:** *Acanthocybium solandri, Scomberomorus commerson, Scomberomorus plurilineatus, Scomber japonicus, Sarda orientalis*

(4) Species under (Chuchunge) **Hemiramphidae are:** *Hemiramphus far, H. lutkei, H. Dussumieri*

(5) Species under (Jodari) **Scombridae are:** *Thunnus alalunga, T. albacares, T.obesus, T. tonggol, Gymnosarda unicolor*

(6) Species under (Kolekole) **Carangidae are:** *Alectis ciliaris, A. indicus, Carangoides caeruleopinnatus, C. Chrysophrys, C. fulvoguttatus, C. malabaricus, Caranxignobilis, C. melampygus, C.papuensis, C. sem, C. sexfasciatus, C. cynodon*

(7) Species under (Mikizi) **Mugilidae are:***Crenimugil crenilabis, Liza macrolepis, L. melinoptera, L.vaigiensis, Mugil cephalus, Valamugil buchanani, V. cunnesius, V.engeli, V. seheli*

(8) Species under (Mizia) **Sphyraenidae are:** *Sphyraena jello, S. putnamiae, S.flavicauda*

(9) Species under (Misusa) **Sphyraenidae are:** *Sphyraena barracuda, S. forsteri, S.obtusata*

(10) Species under (Pandu) **Carangidae are:** *Scomberoides commersonnianus, S.lysan, S.tol*

(11) Species under (Samsuli)/(Nduwalo) **Xiphidae is** *Xiphias gladius* and**Istiophoridae are:** *Istiophorus platypterus,Makaira indica,M. mazara, Tetrapturus angustirostris, T. audax*

(12) Species under (Ngisi) **Sepiidae are:** *Sepia latimanus, S. pharaonis, S. prashadi;* **Loliginidae are:** *Loligo duvauceli, L.forbesi;* **Onychoteuthidae is:** *Onychoteuthis banksi,***Ommastrephidae are:** *Ommastrephes bartrami, Symplectoteuthis oualaniensis;* **Thysanoteuthidae is** *Thysanoteuthis rhombus*

(13) Species under (Chaa) **Gerreidae are:***Gerres acinaces, G. filamentosus, G. oblongus, G. oyena*

(14) Species under (Tembo-uzi) **Lutjanidae are:** *Lutjanus kasmira, L.lutjanus*

(15) Species under (Kihalua) **Carangidae are:** *Parastromateus niger,Seriolina nigrofasciata*

(16) Species under (Changu) **Lutjanidae are:** *Lutjanus argentimaculatus, L. bohar, L. erythropterus, L. fulvus, L.gibbus, L. lunulatus, L. malabaricus, L.monostigma, L. rivulatus, L.russelli, L.vittus,***Lethrinidae are:** *Lethrinus conchyliatus, L.elongatus, L.harak, L. kallopterus, L.lentjan, L.mahsena, L. mahsenoides, L.microdon, L.nebulosus, L.ramak, L. rubrioperculatus, L. variegatus, L. xanthochilus*

(17) Species under (Janja/Majanja) **Lutjanidae are:** *Lutjanus bengalensis, L. ehrenbergi, L. fulviflammus,*

(18) Species under (Tasi) **Siganidae are:** *Siganus canaliculatus, S.luridus, S.argenteus, S. stellatus, S. sutor*

(19) Species under (Taa) (Batoid fishes) *Dasyatis jenkinsii, Himantura uarnak, Hypolophus sehpen, Taeniura lymna, T. melanospila, Manta birostris, Mobula diabola, Aetobatus narinari*

(20) Species under(Pweza) **Octopodidae are:** *Octopus aegina, O. cyaneus, O. macropus, O. vulgaris*

(21) Species under (Puju) **Acanthuridae are:** *Naso hexacanthus, N. unicornis,*

(22) Species under (Kangaja) **Acanthuridae are:** *Acanthurus bleekeri, A.dussumieri, A. xanthopterus, Ctenochaetus striatus*

(23) Species under (Hongwe) **Ariidaeare:** *Arius africanus, A. madagascariensis, A. oplustaphylodon, A. thalassinus, A. venosus*

(24) Species under (Kalamamba) **Haemulidaeare:** *Pomadasys kaakan, P. multimaculatum*

(25) Species under (Koana) **Nemipteridae are:** *Nemipterus bleekeri, N. japonicus, N. metopias*

(26) Species under (Mkundaji) **Mullidae are:** *Parupenaeus barberinus, P.indicus, P. macronema, Upeneus bensasi, U. moluccensis, U. sulphureus, U. taeniopterus, U. tragula, U. vittatus*

(27) Species under Gayogayo) **Psettodidae are:** *Psettodes erumei, Bothus myriaster, B. pantherinus, Chascanopsetta lugubris, Pseudorhombus arsius, Pardachirus marmoratus, Cynoglossus lachneri, C. zanzibarensis, Paraplagusia bilineata*

[1] Kru canoe is a one-man dugout craft, propulsion is by paddle and sail.

[2] Std 1-3 is a dugout canoe with maximum capacity of 3 persons, propulsion by paddle and sail.

[3] Std 3-5 is a dugout with maximum capacity of 5 persons, propulsion by paddle and sail.

[4] Std 5-10 is a planked boat with maximum capacity of 10 persons, propulsion by outboard motors.

[5] Ghana boat is the largest in the artisanal fleet and can carry crew between 10 -20. Propulsion is by outboard motors.