FISHERIES IN ANGOCHE, MOMA AND PEBANE

A Preliminary Description

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0.Executive Summary

The objective of this survey is to describe the various fisheries practices of the region encompassing the districts of Angoche, Moma and Pebane. This description shall include a consideration of the catches, fishing methods, yields, the species sought, vessel types, socioeconomic characteristics of fishermen, commerce, processing and storing of the fish, together with the activity's problems and repercussions.

Three types of fishing occur in the region in question: artisenal (non-industrial), semi-industrial and industrial scale, all of which affect the country as a whole. Artisenal fishing in this region is an intensive enterprise considering the great number of fishermen, fisheries, vessels and methods employed, especially when compared to other coastal regions. Throughout the region, an important shrimp and gamba-fishing effort is underway at the Sofala Bank, one that greatly affects the export economy of the country.

The Ministry of Fisheries, through IIP [National Fisheries Research Institute] and IDPPE National Institute for the Development of Artisenal Fishing], programs that gather and analyze the chief biological data on fishing, is charged with the oversight of the region's fisheries.

Artisenal fishing in the region occurs chiefly at the subsistence level. The coastal population is almost entirely dependent upon it. The fishing method involving the greatest number of fishermen and which accounts for the highest yields employs the beach seine. Both yields and earnings, however, have decreased over the years.

The primary concerns have been reduced levels of earning from the activity and obstacles affecting the sale and preservation of the catch. The chief causes have been the use of mosquito nets that take in large quantities of young spawns, together with the fishermen's disregard of closed seasons, prohibition periods amounting to the government's primary fisheries management effort.

At the Sofala Bank, industrial fishing over the years has at once become more intensive and yielded less income. The IIP's recommendation has been to reduce fishing by 40% from 2005 levels, thereby allowing greater protection of stocks and improved fisheries efficiency. The primary management measure would be the imposition of a closed season lasting normally three months. Unintended fish captures are very large, often

accounting for 80 – 85% of the catch. These rejected fish are either returned to the sea or retrieved by small-scale fishermen.

Grave repercussions, including conflicts with small-scale fishermen, result from disregard of the closed season and the three-mile exclusion zone. Infractions have diminished, however, since the introduction of the VMS system. One of the primary problems has been the increase in fuel prices that renders businesses less competitive in the international market. Besides this problem, farm-raised shrimp represents an ever-increasing source of competition.

1. Introduction

The fisheries sector occupies a position of prominence in the economy of Mozambique and is one of the nation's principal sources of foreign exchange. In 2004, the fisheries industry accounted for approximately 2% of GNP and employed more than 100,000 formal and self-employed workers (see Yussuf & Biquiza, 2007).

Three types of fishing are found in Mozambique: industrial, semi-industrial and artisenal. All three types exist in the districts of Angoche, Moma and Pebane, where their importance is national in scope. Artisenal fishing, limited to the estuaries and coastal zones, involves a great number of fishermen and has enormous socioeconomic relevance. Semi-industrial fishing is practiced primarily in the district of Angoche. Along the three districts is situated the northern extreme of the largest fishing bank of the Mozambique Exclusive Economic Zone – the Sofala Bank. We find in this area important industrial-scale fishing activities involving various species of shrimp.

The three sectors account for an estimated 91,374,100 tons of fish per year, representing a value in the order of US$ 263,600,000. In 2005, production was estimated at 89,276,88 tons, valued at US$ 284,800,000 (Yussuf & Biquiza, 2007).

The most important fisheries resources, such as shrimp, are harvested by means of the three referenced techniques, although the stocks are not managed collectively (Palha de Souza, *et al*., 2005). The three types of fishing are interconnected in the sense that artisenal fishing affects the adult fish stock by reducing the number of small fish and, in its turn, industrial fishing, by harvesting mature fish of reproductive size, also diminishes the number of young spawns (Appendix I).

Shrimp represent the principal fisheries export item (Palha de Sousa *et al*., 2006). Fisheries products account for aproximately 12% of Mozambique's total export revenue, with the shrimp, recognized the world over for its quality, ranking first in importance. Pescamar, a fishing company, was the nation's largest exporter in 2005 (Yussuf & Biquiza, 2007).

Portugal and Spain are the most important importers of the national fish production, accounting for 60% of the total. They are followed by South Africa and Japan, representing 13% and 12% of the export market, respectively (DNEP, 2002).

This study will present, in summary form, the available information concerning the various fishing methods that prevail in the region comprising the Angoche, Moma and Pebane districts. Most of the research was conducted on the basis of investigations of regional fisheries resources carried out by IIP - National Fisheries Research Institute and the IDPPE - National Institute for the Development of Artisenal Fishing.

The specific objectives of the study are to:

1. Characterize artisenal fishing in the Angoche, Moma and Pebane districts, describing the catch, the intensity of activities, catch per unit of effort (CPUE), chief species sought, fishing techniques, vessels, and socioeconomic aspects of fishermen, such as earnings, marketing practices, fish processing and storage. Outline the primary difficulties inherent to non-industrial fishing in the region;

2. Present the characteristics of industrial and semi-industrial fishing operations in terms of catches, effort, CPUE's, primary species sought, fleets, by-catches earnings and numbers of fishermen employed. Outline the primary difficulties inherent to artisenal fishing in the region;

3. Describe the most important affects of each kind of fishing and their interrelationships.

1.1. Artisenal Fishing in Mozambique and its Supervision

According to the Maritime Fisheries Regulation definition, artisenal fishing in Mozambique must be a local, geographically limited operation that can be conducted with or without a boat (no greater than ten meters; oar, sail or in or out-board motor-propelled not in excess of 100 cv or 75 kW).

Artisenal fishing is of great socioeconomic importance because of the number of those it employs and by virtue of its being a subsistence occupation. Agriculture is another, parallel activity constituting the primary means of livelihood for the coastal communities. Often the catches are intended for the local population, for which fish is the exclusive source of animal protein (Bâcle & Cecil, 1990). Fisheries, then, are vital to the economies and demographic stability of the coastal districts.

The activity employs 80,000 fishermen distributed among 787 fishery centers, where 2,781 artisenal fishing vessels have been licensed. The number of fishermen is particularly high in the northern and central regions of the country. According to the IDPPE (2001), most fishermen (58%) employ the beach seine method, followed by gillnets (18%) and handlines (17%).

Besides employing the greatest proportion of fishermen, artisenal fishing is responsible for the greatest portion of the catch, or 70% of the national total (sanders, 1988). The artisenal catch was estimated at approximately 57 thousand tons in 2005. At 27,998 tons, Zambézia is the most productive fishing province, followed by Nampula at 15,844 tons (IPP, 2005). Beach seines account for the greatest proportion of the artisenal catch at 65% of the national total. The catch is composed essentially of small pelagic species that provide an essential source of protein accessible to the poorest segments of the population (Wilson & Zitha, 2007). Other relevant fishing methods include gillnets, accounting for 20% of the artisenal catch and handlines that contribute to 10% of the total. Fish constitute the greater portion of the catch at 87%, followed by shrimp at 8% (IIP, 2005).

The Ministry of Fisheries is charged with oversight of the industry. Artisenal fishing is characteristically the kind for which data and information collection is most difficult. The great diversity of species, the dispersal of unloading points and difficulties of access to fisheries centers are but some of the factors that render the industry difficult to

manage (Baloi *et al*., 1998). The Ministry of Fisheries, through the National Institute of Fisheries Research (IIP), Department of Evaluation of Resources Accessible to Small-Scale Fishing (IDPPE), began in 1996 an artisenal fishing statistical data-gathering program in a number of provinces. This information has been crucial for the implementation of sustainable development strategies for the fisheries sector in Mozambique (Baloi *et al.*, 1998).

To implement this program, IIP, the institute responsible for evaluating and monitoring fisheries resources, created provincial delegations. The Nampula delegation is situated in Angoche. The Zanbézia delegation has its headquarters in Quelimane. The IIP must rely upon five licensed technicians, four mid-level technicians, twenty-six samplers and another twenty-six assistants to carry out this effort in both provinces (IIP, 2005). The sampling program, encompassing 33 fisheries centres and 61% coverage, was begun in 1997 in the Angoche and Moma districts (Baloi *et al*., 1998).

The program encompasses the sampling through a stratified random method to obtain information on earnings, total yields and the proportions of those fishing per fishing method. The fisheries centers in closest proximity and that share similar characteristics were grouped such that they could be covered by a team of two survey takers travelling by bicycle or motorized transport. This system allowed the area to be covered at minimal cost. Both the days as well as the sampling locations were chosen at random. On each sampling day data are collected in reference to fishing method, catch size and composition and the sizes of certain species selected randomly at each fisheries center. The estimate of the total catch for each sampled net type is calculated by multiplying the average catches for sampled castings by the total number of castings. The total yield of a fisheries center on a given day is estimated by the average total catch per net by the number of active nets. The total monthly yield in all fisheries centers in a stratum is estimated by extrapolating the average daily catch in each center for all centers and days of the month. The haul and effort are calculated at zero for those days in which no fishing takes place. (Masquine *et al*., 2006).

The IDPPE focuses above all on socio-economic advancement and organization of the fishermen and on fishing technology The institute also maintains a delegation in Angoche and stations in Moma and Pebane.

These two institutes currently work to promote the Artisenal Fishing Project of the Sofala Bank (PPABS), which covers the entire Sofala Bank coast encompassing, in its northern region, the districts of Angoche, Pebane and Moma. They count for partnership and financial support on the IFAD, NORAD and BSF. This project, which began in 2002 and is scheduled to conclude in 2008, has as its main objective the promotion of community organizations that promote co-management committees and the improvement of socioeconomic conditions such as medical care, potable water and road access to markets in the region's fishing communities. Improvements of access have allowed for a more streamlined delivery of products to market, along with a greater number of traders who travel to the fisheries centers to purchase fish directly. In addition, one of the program's chief components is an effort to make rotating micro-credit available to fishermen and related workers, such as fish sellers and processors (IFAD, 2001; UNOPS, 2003; Hoksnes & Tvedten, 2004).

PPABAS is the successor to another fisheries-fisheries development pilot project, the Nampula Artisenal Fishing Project, financed by the IFAD (US$ 6,000,000.00), the Government of Mozambique (US$ 3,300,000.00) and OPEC fund (US$ 2,000,000.00) from 1996 to 2002 (Wilson & Tovela, 2003). This project resulted in a tax and tariff reduction on fishing implements and equipment, the establishment of new private retailers in Angoche and Moma, the successful testing through partnerships with fishermen of alternative fishing methods, such as those that employ larger gillnets, bottom lines, and trammel nets for shrimp, as well as other approaches to fish processing and preservation, such as smoking ovens and pickling and drying grills. In addition, the project played a key role in the formation of 142 community organizations - 14 co-management fisheries commissions, 2 fishers associations, 122 water commissions and 4 micro-project commissions (IFAD, 2000).

1.2. Semi-Industrial and Industrial Fishing in Mozambique and its Oversight

Semi-industrial fishing utilizes motorized vessels of no more than 20 meters in length. These vessels operate along coastal waters, where they can remain for periods of up to one week. Ice is used to preserve the fish on these vessels (Maritime Fisheries Regulations). The fleets that operate in the area surveyed are based in the ports of Beira and Angoche (Palha de Sousa *et al*., 2006).

Industrial fishing employs vessels that are greater than 20 meters in length and that contain on-board refrigeration systems for preserving the catch. These vessels can remain at sea for a number of weeks. Their nets are able to catch fish at depths ranging from five to 70 meters (Maritime Fisheries Regulations). These industrial-scale operations occur essentially at the Sofala Bank (Fig. 1), situated along the coast between Beira and Angoche. The area is extensive, representing 65% of Mozambique's entire continental shelf. The land is characterized by sand and sediment that provide the optimum conditions for trawl fishing. Fishing banks are normally very productive areas that support important fisheries of invertebrates and fish.

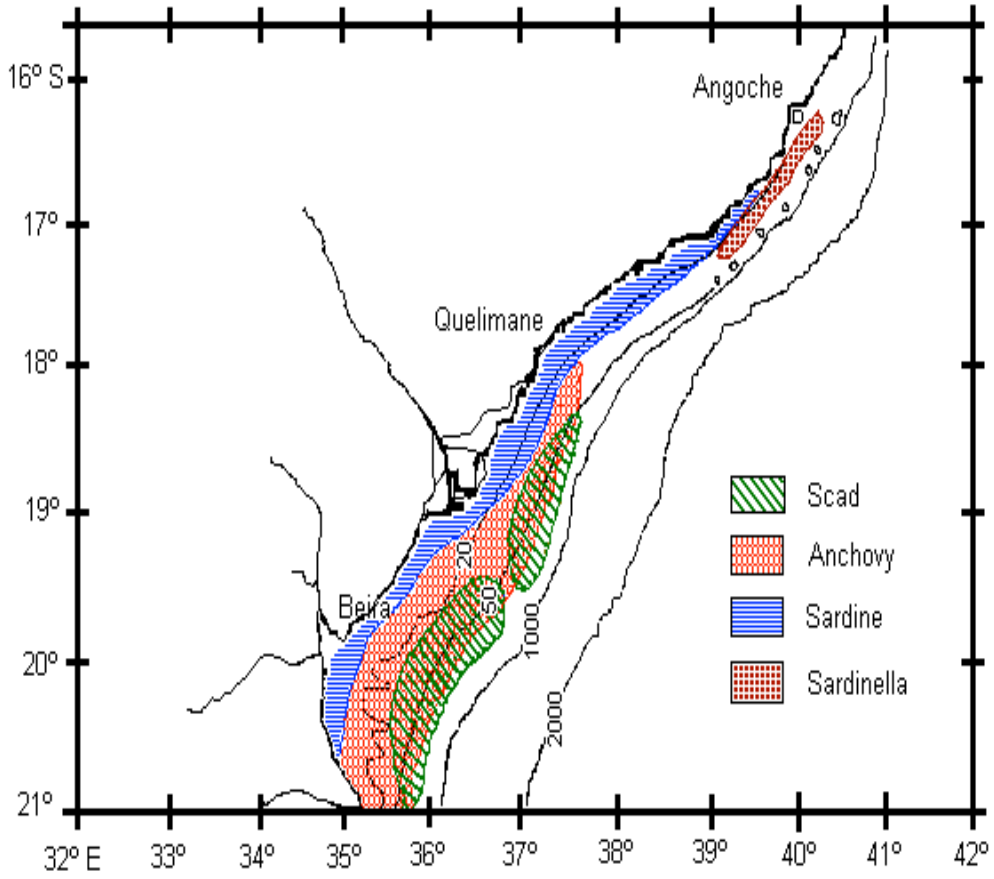


Figure 1: Location of the Sofala Bank and its fisheries resources.
(From Rui Paula e Silva, 2000)

Industrial fishing employs approximately 1,550 fishers, of whom approximately 80% are Mozambicans (Kelleher, 2002).

Industrial fishing operations at the Sofala Bank harvest specific prawn species, particularly *Feneropenaeus indicus* and *Metapenaeus monoceros*, together representing 95% of the catch. *Penaeus japonicus*, *Penaeus latisulcatus* and *Penaeus monodon* are harvested in smaller quantities. The entire prawn catch is frozen on board and exported without the need of further processing at the Mozambican coast.

The referenced fishing operations are those for which we have the most available data. Industrial and semi-industrial fisheries have been monitored on a regular basis since 1977.

The IIP conducts annual cruises for the purpose of evaluating the state of prawn exploration. The cruises generate scientific data that serve as a basis for the management of the resource. Besides these cruises, it is now common practice to place observers aboard fishing vessels to collect data concerning catches, effort and biological samplings of the prawn yields. All of this information is recorded in diaries on board the vessels (Tembe, 2005).

As regards association membership, both semi-industrial and industrial fishing are organized as follows: approximately 70% of the vessel owners are represented by AMAPIC – the Mozambican Association of Industrial Prawn Fishing Vessel Owners – and, in the case of owners of smaller vessels, by ASSAPEMO the Association of Mozambican Fishing Vessel Owners.

1.3. Management of fisheries in Mozambique

The Ministry of Fisheries (MIPE), a ministry formed by the government of Mozambique after the 2000 elections, manages the industry. Between 1994 and 1999, the sector was the responsibility of the Ministry of Agriculture and Fisheries. The MIPE encompasses three national directorships: the National Directorship of Fisheries Administration (DNAP), the Human Resources Directorship (DRH) and the National Directorship of Fisheries Economy (DNEP). The ministry also encompasses three departments and four financially-independent institutions, namely, the Fisheries Stimulus Fund (FFP), the National Institute of Fisheries Research (IIP), the National Institute of Small-Scale Fisheries Development (IDPPE) and EP, the Fisheries School (Tembe, 2005).

The role of the DNAP is, among others, to ensure implementation of fisheries policies, oversee the sustainable administration of fishing practices and to generally monitor the fisheries (Tembe, 2005).

The work of the IIP focuses on evaluating resources pertaining to the environment and aquaculture. The first involves intervention, distribution studies and evaluation and monitoring of fisheries resources to ensure their rational exploration and to properly control management efforts introduced to preserve key resources. Environmental studies include a consideration of the evolution of oceanographic and limnologic phenomena that influence biological processes in these waters (Tembe, 2005).

The IDPPE is responsible for promoting and developing the artisenal fishing sector. The institute conducts studies and gathers information used in ministerial level decision-making and the development of projects designed to improve conditions in fishing communities, typically through sustainable intensification of fisheries exploration accessible to artisenal fishermen (Tembe, 2005).

In the provinces, the Fisheries Ministry is represented by the Provincial Fisheries Administration Service (SPAP), which principal role is to represent the fisheries sector at the provincial government level. Because of the insufficiency of human resources, the Fisheries Ministry delegated oversight responsibility and licensing authority to the Maritime Administration (ADMAR), which is under the aegis of the Ministry of Transport and Communication. This institution, together with the National Maritime

Administration and Monitoring Service (SAFMAR), is responsible for issuing fishing operator's licenses (Lopes & Pinto, 2001 *in* Tembe, 2005).

At the regional level there are yet the Provincial Delegations that monitor and control local fisheries operations. Besides institutional organizations, fisheries resources management has been shared by local fishing communities through Co-Administration Committees in cooperation with Provincial Fisheries Directorates (Tembe, 2005).

The fisheries sector is currently regulated by the Fisheries Director Plan (1994), the Fisheries Policy (11/96), the Fisheries law (3/90) and the following regulations: Inspection and Quality Guarantee of Fisheries Products (10/98), Inland Waters (3/6/99), Sport Fishing (51/99), and the General Maritime Fisheries Regulation (04/03). Besides these regulations, the Ministerial Diploma of July 20, 1999 establishes the minimum net mesh size at 38 mm (1.5 inches) for seine nets and a three-mile fishing zone for artisenal fishing. The zone had previously been demarcated at one mile from the coast until 1997, when it was extended to three at the Angoche and Moma districts. As of 2003 the three-mile zone was extended throughout the entire Sofala Bank.

Artisenal fishing is subject to an annual tax or permit that cannot be transferred. Beach seines must pay an annual 600 Meticais. No limitation exists as to the number of permits per province, nor are there restrictions as to where one may fish (Wilson & Zitha, 2007).

As regards industrial fishing, such as prawn trawling with on-board refrigeration systems, deep-water fishing for gambas and large demersals are restricted to TACs (Total Admissible Capture) and annual quotas, in addition to fishing permits. The shrimp yield depends upon the annual emergence of various species having a one-year life cycle, thereby rendering the fixing of quotas difficult (Palha de Sousa *et al*., 2005). For this reason, together with the economic importance of the species, prawn fishing has been subject to a greater number of restrictions. Ministerial Diploma no. 40/2001 has therefore adopted a measure to close this category of fishing to new operators. A prohibition period is imposed as well, thereby limiting the allowable fishing period to nine months of the year (Tembe, 2005).

Besides the referenced laws, there are norms pertaining to international agreements into which Mozambique has entered. These relate to coastal administration, under the

"African Convention on Nature and Natural Resource Conservation" (1981); the "Marine and Coastal Environment Management, Protection and Development Convention for the East Africa Region" (1996); and, the 1996 "United Nations Convention on the Law of the Sea" (Tembe, 2005). Mozambique is also a partner in the SADC/DFID project for the development of fisheries information systems.

The fisheries sector, namely the DNAP, IIP, IDPPE and the Department of Fish Inspection, have cooperated since 1994 with a number of institutions such as NORAD (Norwegian Development Agency), DANIDA (the Danish International Development Agency), ICEIDA (the Icelandic Agency for Development), OPEC, DFID, the European Union and various cooperative agreements with countries including France, Japan, Belgium, Italy, South Africa, Ireland and Spain. Mozambique furthermore cooperates with such agencies as the IFAD (International Fund for Agricultural Development) and AFDB, the African Development Bank (Lopes, 2006).

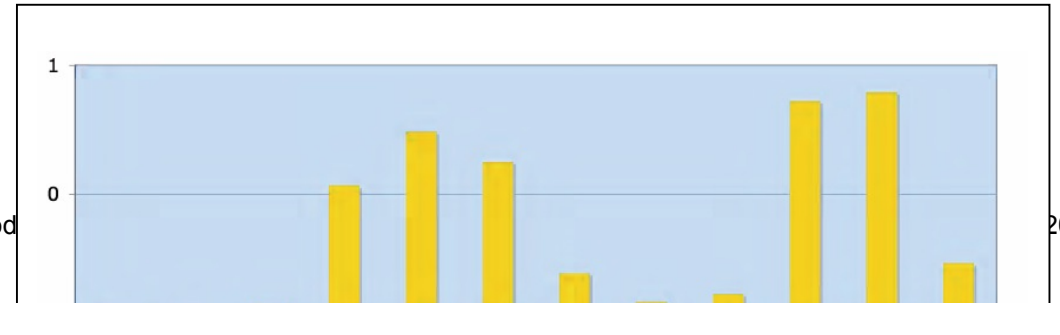
The fisheries treaty between Mozambique and the European Union was renewed in 2004. As regards prawn fishing, the protocol provides for a maximum of 10 vessels authorized to fish, in deep waters, a 1,000-ton prawn quota, in addition to 535 tons of secondary catch. The total financial compensation is established at 4,090,000.00 euros per years, of which 3,490,000.00 euros go to cover the deep-water prawn catch (including the secondary haul) and the remaining 600,000.00 euros for tuna and other species (CCE, 2003).

2. Artisenal Fishing in the Angoche, Moma and Pebane Districts

Approximately half of the artisenal fishermen of the Nampula province inhabit the Angoche and Moma districts. In Quelimane province, approximately 42% of fishermen are in Pebane (IDPPE, 2004). These figures reveal the importance of fisheries resources to the three districts.

The population of this region relies almost entirely upon the coastal zone and its resources for its livelihood (Baloi *et al*., 1998; Wilson & Zitha, 2007). Not many income-generating alternatives to fishing and agriculture exist. Fishing accounts for 52% and agriculture 41% of total income for the region's households. These figures suggest not only the high degree of dependence upon these activities and their resources, but also people's vulnerability to environmental conditions, management systems and regulations affecting fisheries and agriculture.

Comparing the annual cycles for these two activities (Fig. 2), one notes that the peak in agricultural production from April to June compensates for the low fishing productivity during this same period. Likewise, increased fishing production during the first three months of the year makes up, to a degree, for low agricultural productivity. The months from October to December constitute maximum productivity periods for both fisheries and agriculture. The first trimester, then, is critical to communities as reserves of cereals and other agricultural products have reached their limits or may even be depleted. Fish, then, becomes an enormously vital a source of food during this period for both fishermen and the general population (Wilson & Zitha, 2007).



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2.1. Fisheries centers and number of fishermen

Intensive fisheries activities occur in Angoche, Moma and Pebane. The last artisenal fisheries census in the region was conducted in 2002 by the IDPPE.

As regards artisenal fisheries, there are areas along the coast where fishing units and yields are regularly maintained, denominated by fishery center. According to the IDPPE (2004), the census recorded 158 important artisenal fisheries centers in Nampula Province. The Angoche and Moma districts encompass almost half of these centers (Table 1).

Table 1: Fisheries centers in the coastal districts of Nampula province (from IDPPE, 2004)

Districts	Fisheries Centers
Memba	22
Nacala-a-Velha	6
Nacala Porto	9
Mossuril	20
Ilha de Moçambique	8
Mogincual	16
Angoche	40
Moma	35
Total	**158**

The fisheries centers included in the IIP sampling program are: Malane, Metalbox, Praia Nova, Thamole, Boleia, Moruruwa, Mullola, Kwirikwige, Malacassa, Naconha, Munhanhala, Natupi, Quelelene, N'kandine, N'kunha, Namavile and Natempo/Muhabuêliua. In the Moma district the centers are: Mwanantepa/Namacuti, Naholoco, Namichiri, Mingolene, Muripa, Nacalela, Natomoto, São Patrício, Mucoroge, Nancuacua, Coropa, N'puitine, Napito, Moholone, Mualaze and Pilivili (Baloi *et al*., 1998).

One Hundred and fourteen fisheries centers were recorded in the Zambézia province in 2002 (Table 2). The Pebane district contains almost half of the district's centers (IDPPE, 2004).

Table 2: Fisheries centers in the coastal districts of Zambézia province (from IDPPE, 2004)

Districts	Fisheries Centers
Pebane	50
Maganja da Costa	25
Namacurra	8
Inhassunge	2
Nicoadala	8
Total	**114**

Figures 3 and 4 provide maps of the coastal districts of the provinces of Nampula and Zambézia with fisheries centers locations.

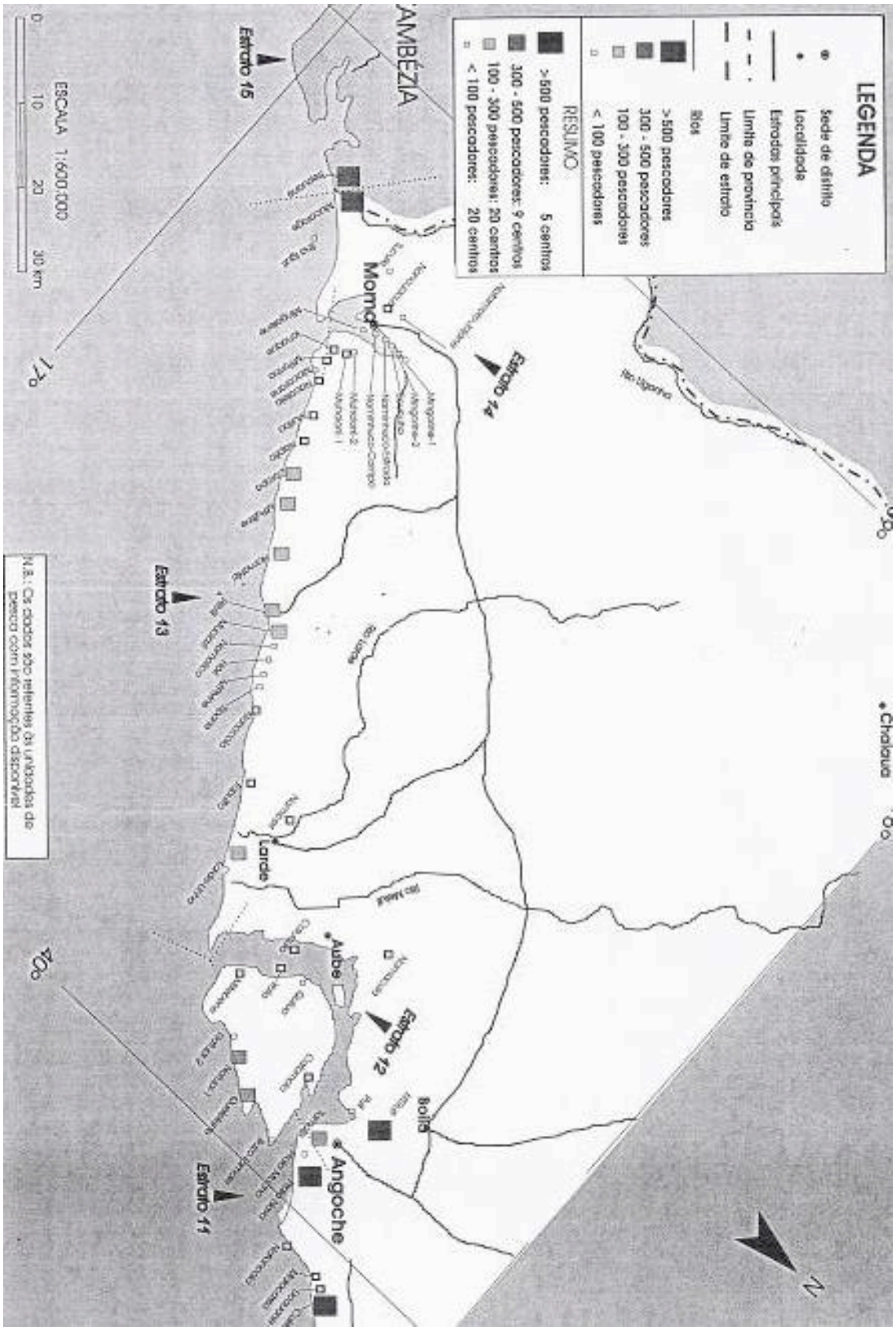


Figure 3: Map of the last artisenal fishing census of Nampula province (from IDPPE, 2001)

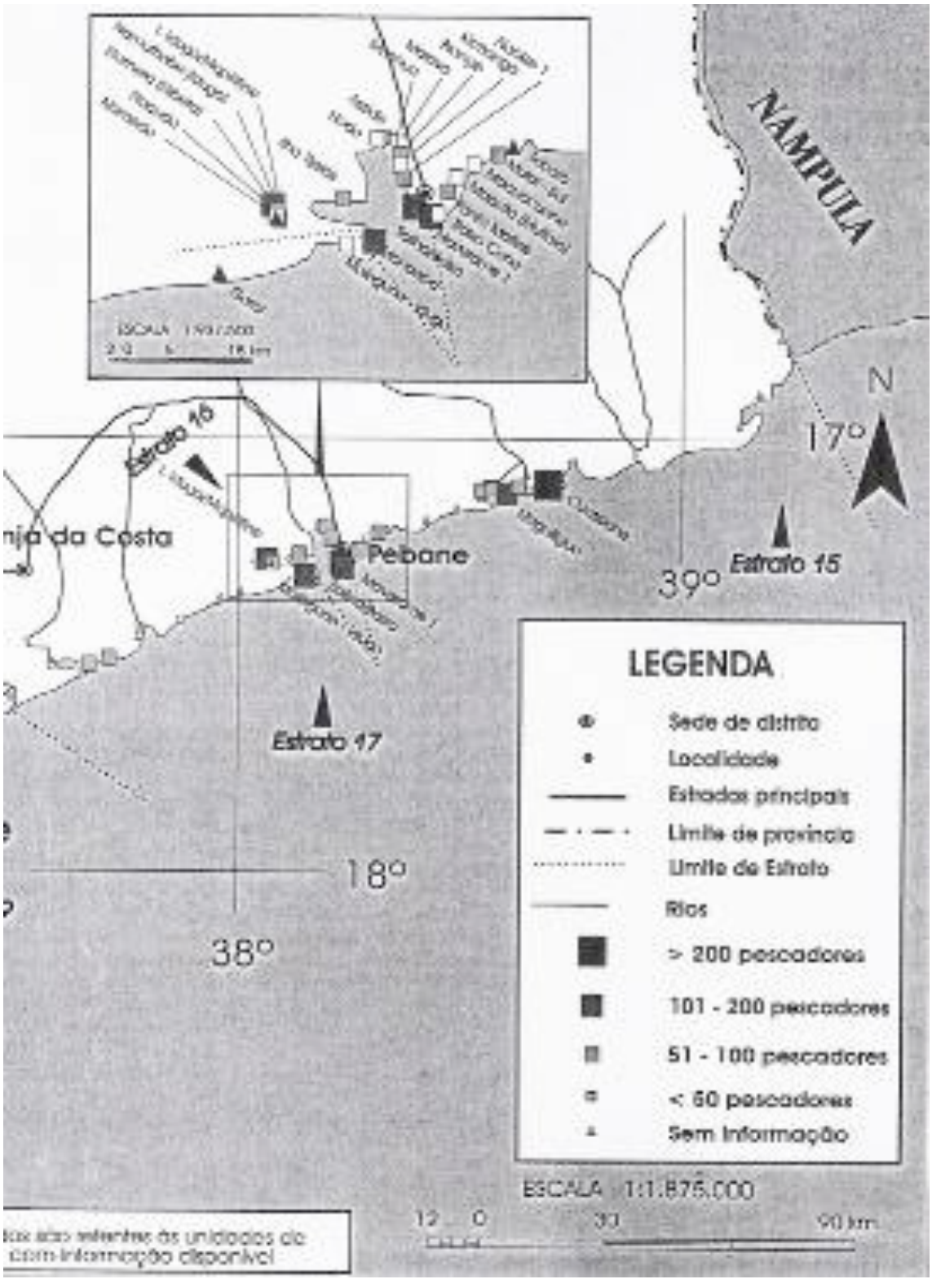


Figure 4: Map of the last artisenal fishing census of Zambézia province (from IDPPE, 2001)

In the Nampula coastal districts, there are approximately 38,373 individuals directly involved in artisenal fishing and another 13, 787 in Zambézia. These numbers include permanent crew, temporary crews, fishermen without vessels, gatherers and divers. Table 3 illustrates the distribution of fishermen in Angoche, Moma and Pebane according to these categories.

Table 3: Distribution of artisenal fishers in the districts of Angoche, Moma and Pebane (from IDPPE, 2004)

Districts	**Permanent crew**	**Temporary crew**	**Fishers without boats**		**Gatherers**		**Divers**	
			Men	Women	Men	Women	Men	Women
Angoche	5631	552	560	725	162	1052	103	1
Moma	6543	735	303	31	28	209	36	0
Pebane	5238	215	488	19	2	10	6	0

Besides artisenal fishermen, a portion of the population is involved in fishing-related or derived activities, such as fish processing and boat carpentry (Table. 4).

Table 4: Those involved in activities related to artisenal fishing in the districts of Angoche, Moma and Pebane (from IDPPE, 2004)

District	**Processors**		**Carpenters**	
	Men	Women	Master	Apprentice
Angoche	586	31	151	195
Moma	461	18	93	59
Pebane	185	5	56	30

A number of fishermen's associations and co administrative committees operate in the region (four in Angoche and eight in Moma). The co administration committees are able to participate in decisions that establish the fishing prohibition period and define its duration. The committees also enjoy oversight authority to ensure implementation of locally-establishment management norms and to report infractions of laws and regulations. The committees are assisted at the local level by IDPPE and IIP delegations (Tenreiro de Almeida, 2006). In 2002, nine co administration committees were in their implementation phases in Pebane, Terepuane, Txotxo, Cuassiane, Mulai, Maderane, Malaua, Maganja da Costa and Gorai. According to the IDPPE, the responsibilities conferred upon these committees pertain to the rational and sustainable utilization of resources, together with intercession of conflicts among artisenal fishers and between these and the industrial and semi-industrial prawn-trawlers.

2.2. Vessels

Artisenal vessels are built locally by carpenters (Fig. 5). Operating in the region are fishing boats (lanchas), almadias and traditional, flat and Moma-type canoes (Tenreiro de Almeida, 2006).

Figure 5: Building a lancha in Angoche (Photo Camila de Sousa)

The lancha (Fig. 6)is a vessel common to the east coast of Africa. Known also as a "dhow", it has a characteristic triangular lateen sail that allows the vessel to sail close-hauled. This type of vessel was developed in the Mossuril region after Arab and Portuguese naval designs. Lanchas are between five and nine meters in length and equipped with oars and one or two lateen sails. The hull is usually rounded and open-mouthed, although there are also vessels of the flush-deck sort with small false rims with open hatches in the middle. These vessels are smooth-ribbed, formed by longitudinal boards placed on top of one another and secured to keels and calked with old rigging. The prow is characterized by its tack's sharp angles and has a stern wheel with cutwater. The stern is vertical and wider with a vertical post. These vessels have

forward and aft benches. The rim of the forward bench contains an opening for a short mast where the sail can be hoisted on a keelson and supported, in general, by cables secured to the rims. A bamboo yardarm (Fig. 7) is attached to the mast, usually one-third the length of the former (Moura, 1972)

Figure 6: A Lancha in Angoche (Photo Camila de Sousa)

Figure 7: Schematic view of a lancha (from Santos, 2004)

The almaida or Moma canoe, five to nine meters in length, is another, lighter vessel made of wood. This vessel can also use both oars and sail and its forward and aft extremes are similar. It is open-mouthed as well but very narrow, with enables the vessel to cut water with little effort. The almaida was probably developed in the Moma region to overcome the obstacles presented by breaking waves in sand bank areas.

The canoes (Fig. 8 and 9) are fashioned from trunks using machetes and fire. They are driven either by oars or, in certain low-water areas, bamboo poles. Some can be equipped with sails. Canoes range from three to four meters in length and they generally maintain the natural curvature of the trunk. The hull and stern is usually rounded on these vessels used primarily within the estuaries (IDPPE, 2001).

Figure 8: Fisher travelling in a canoe on the Island of Angoche (Photo Camila de Sousa)

Figure 9: Fisher with a canoe on the Island of Angoche (Photo Camila de Sousa)

The flat canoe (Fig. 10) is characterized by its flat bottom. This boat is made of wood boards that are nailed to the keels. With the centreboard practically at the level of the bottom, this forms a false keel. The embarkation stern is the "mirror" type. The rear guard panel is wide, the prow conventional and the length varies between 2.5 and 5 meters. Oars, sail or outboard motor propels these boats. At times one finds a rear deck behind the last bench where nets and cables are stored (IDPPE, 2001; 2004).

Table 5 illustrates the distribution of the number and types of vessels in the three surveyed districts. Canoes prevail, representing 80% of the total number of vessels.

Table 5: Number and types of vessels in Angoche, Moma and Pebane (IDPPE, 2004).

Districts	Moma-type canoe	Trunk carved canoe	Flat-bottom boats	Lanchas	Fibreglass boats	Others	Total
Angoche	1012	147	2	0	0	0	1161
Moma	783	30	1	1	1	0	816
Pebane	233	1007	0	93	0	0	1333

2.3. Fishing Methods

The fishing technique that involves the greatest number of fishermen and yields the largest catches by weight is the beach seine (Baloi, 1998; Wilson & Zitha, 2007). In Angoche and Moma, 71% of all fishing vessels in 1994 utilized seine nets (Baloi, *et al*., 1998). Within Nampula province, Moma is the district with the greatest number of seine nets (497 nets), followed by Angoche with 473. The seine net is also the most widely employed technique in Pebane, where there are approximately 500 such nets (Table. 6).

Other fishing techniques include surface-lowered gillnets, hooked longlines, casting or mosquito nets (hand-pulled), trammel nets, fish weirs (barrier-type traps), cage traps, fence traps and hand-gathering ((Baloi, *et al*., 1998; Wilson & Zitha, 2007). Fishing conducted from vessels (seine, gillnet and longline) is typically a male-dominated task. The women are involved primarily in the transport and selling of the catch, but also contribute to fishing that does not require vessels. Hand gathering of marine invertebrates in the intertidal zones and cast netting is almost exclusively the province of women and children.

Table 6: Number and types of fishing techniques in Angoche, Moma and Pebane (from IDPPE, 2004)

Districts	Beach seine	Longline	Gillnet	Trammel net for shrimp	Deep-water line	Ringnet	Gather accompanying fauna	Cage	Other
Angoche	473	225	438	1	2	1	2	0	19
Moma	497	41	123	4	2	0	49	3	2
Pebane	500	414	199	0	14	1	105	63	60

The beach seine (Fig. 11) is composed of two wings sewn to a central section so as to form a sac. The rectangular wings are 100 to 200 m in length with a mesh size of 24 to

38 mm (1 to 1.5 in) and cables extending 200 to 300 meters. The sac is made of a finer mesh and is often replaced with mosquito netting. The cloth is generally woven on an upper polyethylene cable of 6 to 10 mm in diameter (ϕ). The floaters, spaced two to five meters apart, are placed on the upper cable. On the lower cable, which is normally nylon (ϕ 15-25 mm), go the lead sinkers. To the wings' extremities sticks are sewn for tying the cables used to pull the net. The net is usually arranged on the stern of the vessel, from which it is cast in a broad arch. The most commonly utilized vessels are lanchas or almadias 100 to 250 meters from the shore or, should these find themselves in the estuaries, 40 to 70 meters from the banks. One of the cables remains with the fisherman, on the beach or on a sand bank towards which it is pulled (Fig. 12). Once the net is cast, the fishermen separate into two groups and pull the two cables in a synchronized fashion until the net forms a sac for the catch. The operation requires seven to ten fishermen. When the haul is unusually large and additional men must pull the heavier net, then these are rewarded with a portion of the catch. The nests are generally cast at high tide and pulled against the ebbing current (Silva *et al*., 1991; Baloi, *et al*., 1998; Wilson & Zitha, 2007).

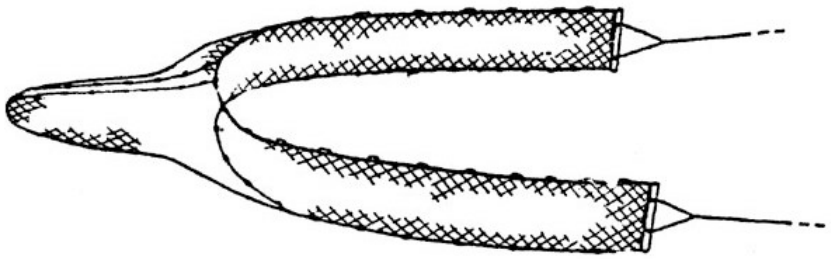


Figure 11: Beach seine for pulling towards the beach (from FAO)

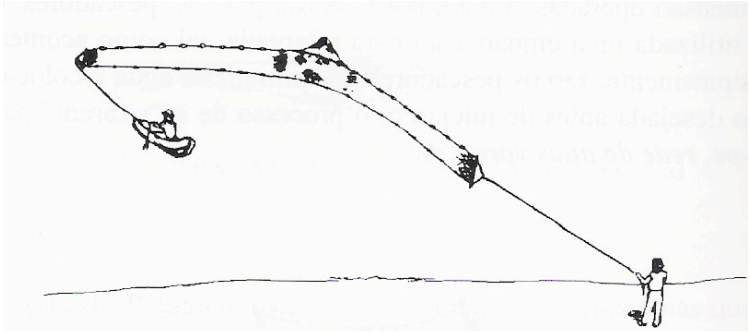


Figure 12: Method of dragging towards the beach (from FAO)

Nets that must be pulled towards the beach manually do not travel very quickly. The larger, more highly valued fish are swift and often able to escape these nets.

At times small dragnets (Quínia or casting type) are fitted around the seine nets at the final phase of casting to catch species that would otherwise escape. The haul is then shared with the beach seine owner (Wilson & Zitha, 2007). The casting or quínia net is composed of a fine, five to ten-meter net, the ends of which are attached to two 1.5-meter stakes. The technique requires vertical dragging by two individuals, generally women an/or children, against an ebbing, shallow tide. The catch is collected after each casting and placed in pails. The process is repeated until the tide lowers (De Freitas, 1966).

The surface gillnets are placed to drift in order to catch small pelagics. They can be used in the open sea in calm waters or, when the weather is rough, within estuaries. Vessels used for these nets are either the almadia or the moma canoe and, in some cases, dual-prow sailing canoes. The nets generally extend from 100 to 200 meters, with a mesh size of 1.5 to 2.5 inches.

The deep-water gillnets are used in Angoche, in the Angoche-Sede, N´guri, Kwirikwige and Sangage regions. These nets are anchored in waters between 10 and 15 meters in depth. They can remain submerged for 24 hours, leaving them vulnerable to theft and damage from industrial trawling nets. These gillnets, ranging from 100 to 200 meters in length, are used to capture sharks and other demersal species. The mesh size for capturing sharks varies from 5 to 12 inches (Baloi *et al*, 2002). No more than two or three fishermen employ this rare technique.

Because of its low cost and simplicity, the technique of longline fishing is very widespread, especially along the canals and estuaries. Longline fishermen generally operate at night, traveling in dugout or small plank canoes with crews of no more than three per vessel. This fishing method, which utilizes a line with a single hook, can be practiced either on the open sea or in the vicinity of the Primeiras and Segundas Islands (Fig.13), but most commonly near the Ilha do Fogo (Baloi *et al*., 2002) and similar areas where, because of rocky sea floors, the use of nets presents difficulties. N'guri fishermen in the Angoche area prefer to fish and process their catch on the Island of Mafamede.

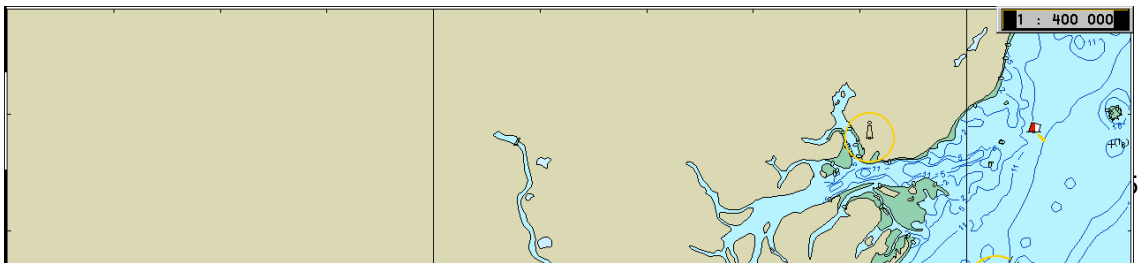


Figure 13: Location of the Primeiras and Segundas Islands (from Kelleher, 2002)

The fish weir (Fig. 14) is a stationary, passive trap in a "V" shape, with its opening positioned in the direction of the bank. These traps, placed in intertidal areas, are constructed of fixed stakes and reeds. The length of each arm varies from 20 to 100 meters, with one always shorter so as to allow fish to enter at high tide. When the tide ebbs, the fish within the enclosure are corralled at the vertex, where there is a depressed compartment. When the tide is at its lowest point, the weir's owner collects the fish from the compartment using a reed basket. During steady tides the catch is greatly reduced and the reed covering is removed to keep it from rotting.

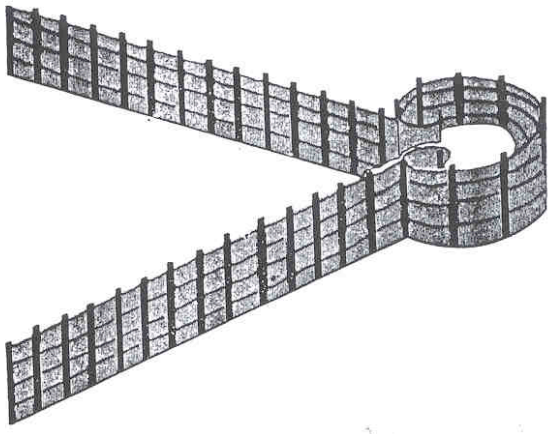


Figure 14: Gamboa, or fish weir (from FAO)

Other fishing implements, such as those employing cages, are made of local materials and utilized along the entire coast and in the rivers and canals. Some artisenal fishermen practice underwater fishing, especially for lobster and demersal fish.

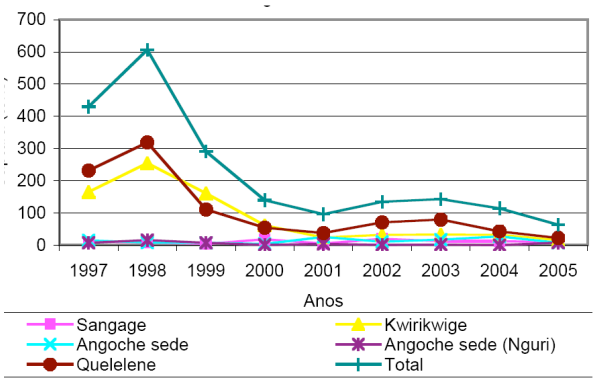
Throughout the three surveyed districts, fish gathering at low tide as well as hauling mosquito nets to the beach are activities of some importance. These methods are commonly the province of women and youngsters who gather mollusks and small fish and prawns for daily consumption.

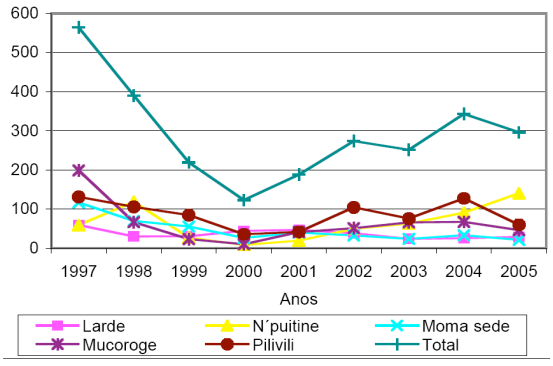
Yet another faunal gathering activity occurs as a by-product of industrial prawn fishing. Fishermen in this case row their artisenal vessels alongside industrial trawls, from which they collect the overflow of fish that often occurs. This gathering technique is currently most common in the Moma and Pebane districts.

Angoche, Moma and Pebane rely upon distribution companies for fisheries implements and material (Wilson & Zitha, 2007).

2.4. Fisheries Effort, Yields and Earnings

The Fisheries Ministry has collected yield and effort data for Angoche and Moma since 1997. The total 1997 catch was 7,944 tons in Angoche and 7,909 tons in Moma. These figures can be considered high for a 200 km tropical coast (Baloi *et al.*, 1998). One notes (Fig. 15) that these amounts have declined over the years, especially in the Angoche district.





Catches in Angoche (1997-2005) Catches in Moma (1997-2005)

Fig. 15: Catches in the Angoche and Moma Districts between 1997 and 2005
(From Wilson & Zitha, 2007)

Drag netting (beach seines) is the technique responsible for capturing the greatest quantity of fish, mostly pelagic species, and accounts for approximately 70% of the total haul. From the year 2000 to 2005, approximately 28,604 tons of fish were caught in Angoche by means of this technique (IIP, 2007, unpublished data). Figure 16 illustrates the monthly capture variation from beach seines in the same district from 2003 to 2005. One notes a decline in the yield from 6,482 tons in 2003 to approximately 2,044 tons in 2005 (IIP, 2007, unpublished data). These data do not reveal any generalized seasonal pattern in the monthly variation of the catch.

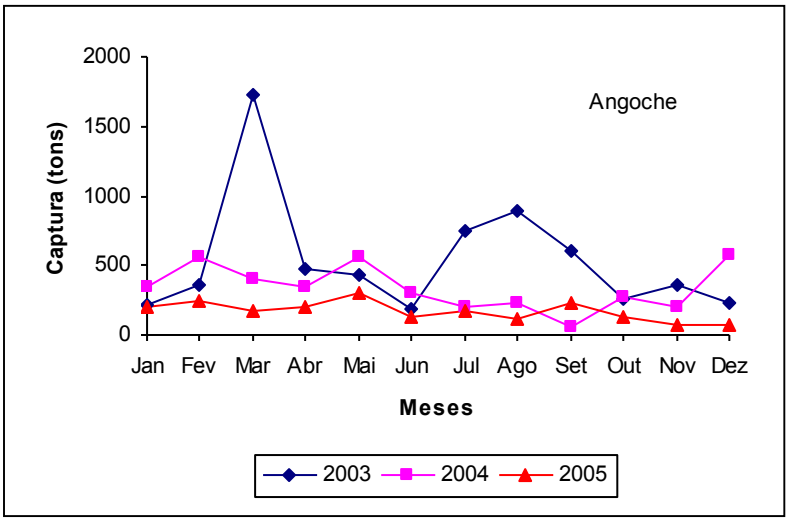


Figure 16: Monthly variation catches from beach seines from 2003 to 2005 in Angoche
(From IIP, 2007, unpublished data)

In the Moma district, approximately 25,870 tons of fish were caught from 2003 to 2005 by means of the beach seine technique. A catch decrease, similar to that of Angoche, occurred between 2003 and 2005 with a decline from 10, 367 tons to 6,872 tons (IIP, 2007, unpublished data). Figure 17 illustrates the monthly yield variation from 2003 to 2005 in Moma district.

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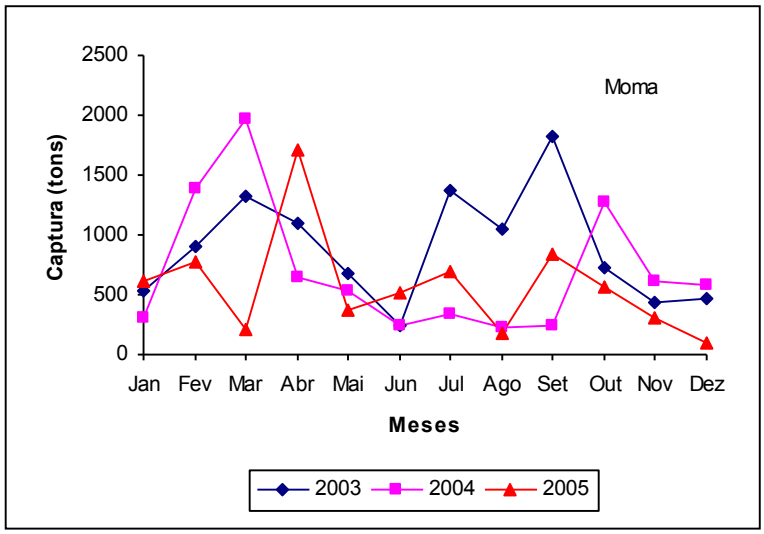


Figure 17: Monthly variation catches from beach seines from 2003 to 2005 in Moma
(From IIP, 2007, unpublished data)

Approximately 36,937 tons of fish were caught in the Pebane district from 2003 to 2005 using beach seines. As in Angoche, the district witnessed a yield decline, from 10,367 tons in 2003 to 6,872 tons in 2005 (IIP, 2007, unpublished data). Figure 18 illustrates the monthly catch variation from 2003 to 2005 in Pebane district.

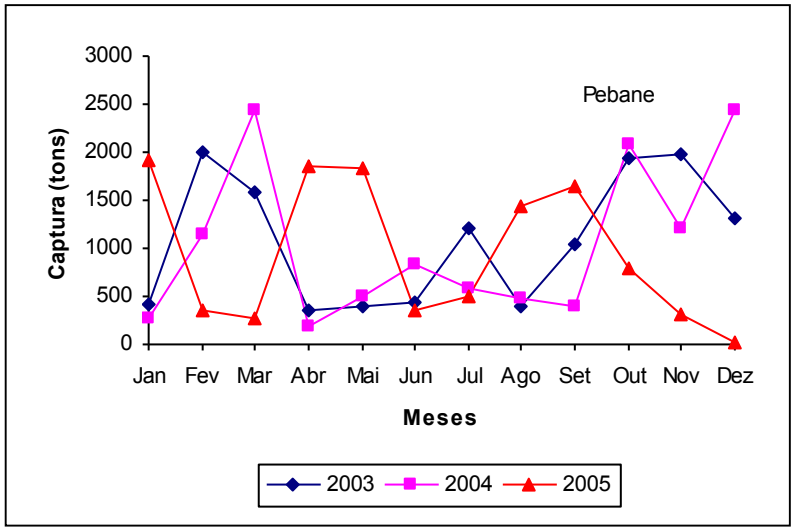
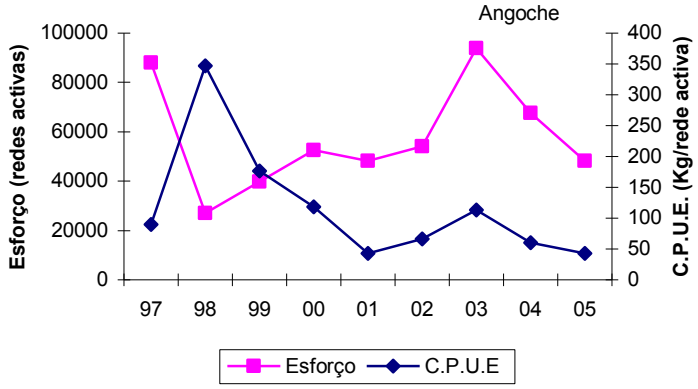
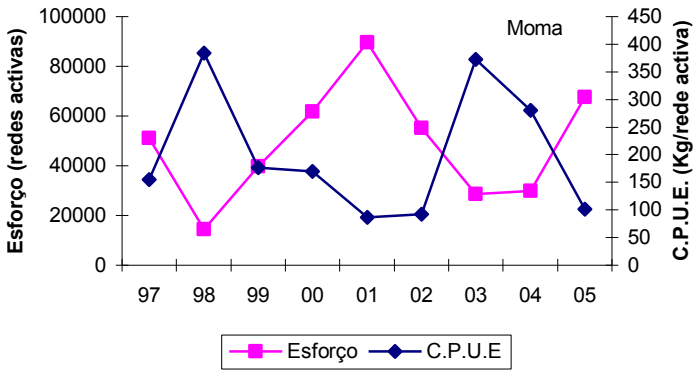


Figure 18: Monthly variation catches from beach seines from 2003 to 2005 in Pebane
(From IIP, 2007, unpublished data)

Effort and Yield per Unit of Labor (YPUL) data have varied in these three districts over the years. Effort fluctuations may be a function of the dynamic quality of artisenal fishing itself, such as the migration of its fishermen (Baloi *et al*, 1998). The YPUL, which represents average yield per day and fishing method (kg/method.day), has suffered a general decline in the three districts over the past few years. Figure 19 illustrates effort trends and YPUL in Angoche, Moma and Pebane between 1997 and 2005. Pebane was the district that recorded the greatest effort input for 2005, followed by Moma and Angoche. The most favourable results (YPUL's) were measured in Pebane, followed by Moma and Angoche.





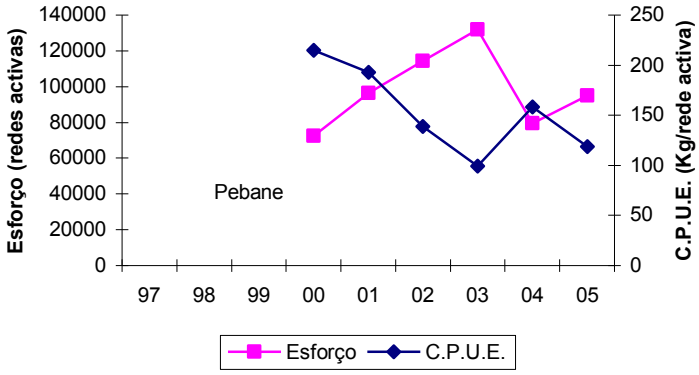


Figure 19: Effort (active nets) and YPUL (kg/net.day) for beach seines between 1997 and 2005 in Angoche, Moma and Pebane (from IIP, 2007, unpublished data)

Analysis of the monthly fishing effort variation data for Angoche in 2005 (Fig. 20) shows a higher degree of effort during the months of February and October. The greatest recorded YPUL was 67 kg/net.day for May. The effort distribution was far different in Moma, where the greatest values were recorded for the month of September. The highest YPUL was recorded for April. Data for effort in Pebane is most closely related to that of Moma, and September was likewise the month with the greatest values. The highest YPLU figure was for the month of January (462 kg/net.day). In previous years, fisheries effort intensified during the first months of the year (Baloi *et al*., 1998).

Figure 20: Effort (active nets) and YPUL (kg/net.day) for beach seines in 2005 in Angoche, Moma and Pebane (from IIP, 2007, unpublished data)

The Beach seine yield (YPUL) in Moma was calculated at 154 kg/net.day in 1997, when data collecting began (Baloi *et al*, 1998). Yield data between 2003 and 2005 reveal a 30% decline despite seasonal peaks (Fig. 21). Average YPUL was calculated at 167 kg/net.day (Wilson & Zitha, 2007).

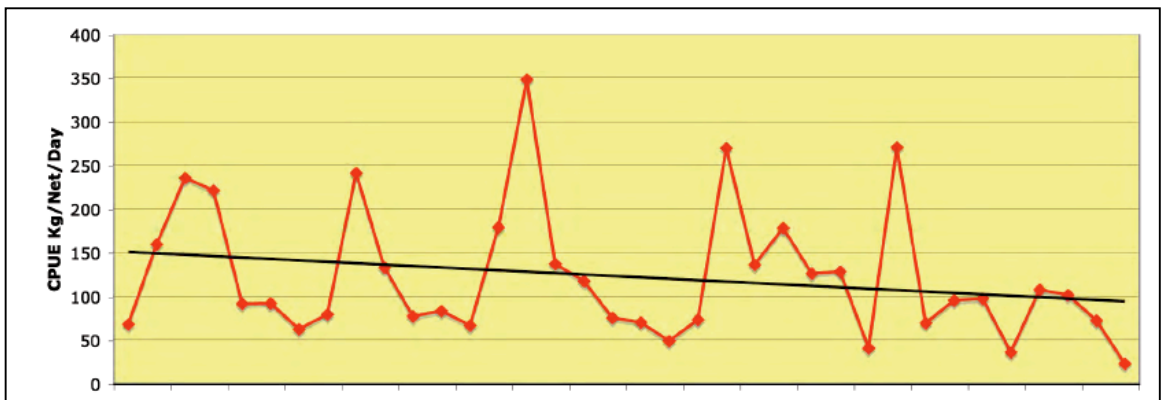


Figure 21: Yields per Unit of Labor in Moma from January 2003 to December 2005 (from Wilson & Zitha, 2007)

Yields (YPUL) obtained in these three districts are relatively high when compared to other regions of the country. The average YPUL in Baia de Inhambane, for example, was 103 kg/net.day in 1998 (Santana Afonso, 1999). When drawing these comparisons, one must keep in mind differences in terms of species, environment and fishing technique. Still, average YPUL serves as an important productivity indicator for the various regions.

Longline fishing is the second most common fishing technique employed in the surveyed area. Yields have diminished in Angoche and in Moma from 2003 to 2005. Only in Pebane was an increase in yield recorded from 2003 to 2005 (Fig. 22). Yields recorded in Angoche during the period of 2000 to 2005 were 5,515 tons and, over the same period, 1,587 in Moma. From 2003 to 2005 1,589 tons was the recorded catch in Pebane (IIP, 2007, unpublished data).

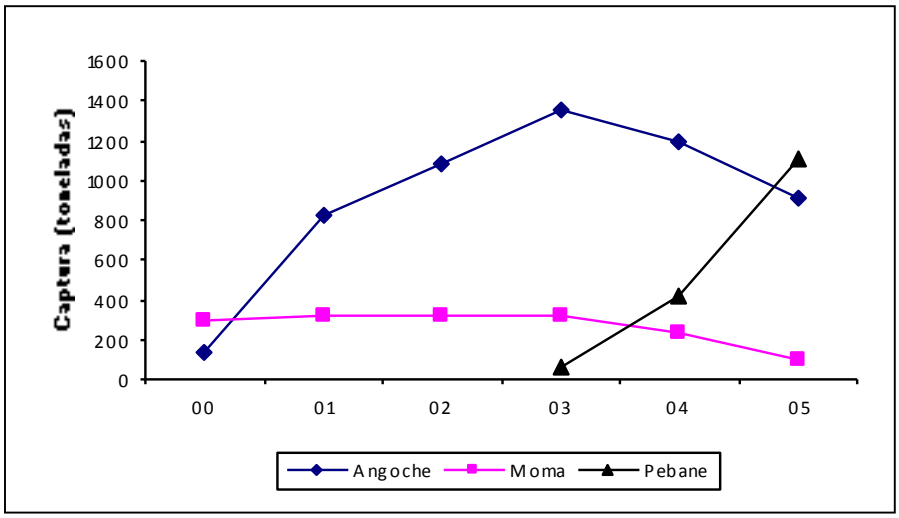


Figure 22: Longline yields in Angoche, Moma and Pebane from 2000 to 2005. (From IIP, 2007, unpublished data)

Figure 23 shows the monthly variation in longline fishing yields for the three districts in 2005. In Angoche, March was the most productive month; in Moma it was November and, in Pabane, June.

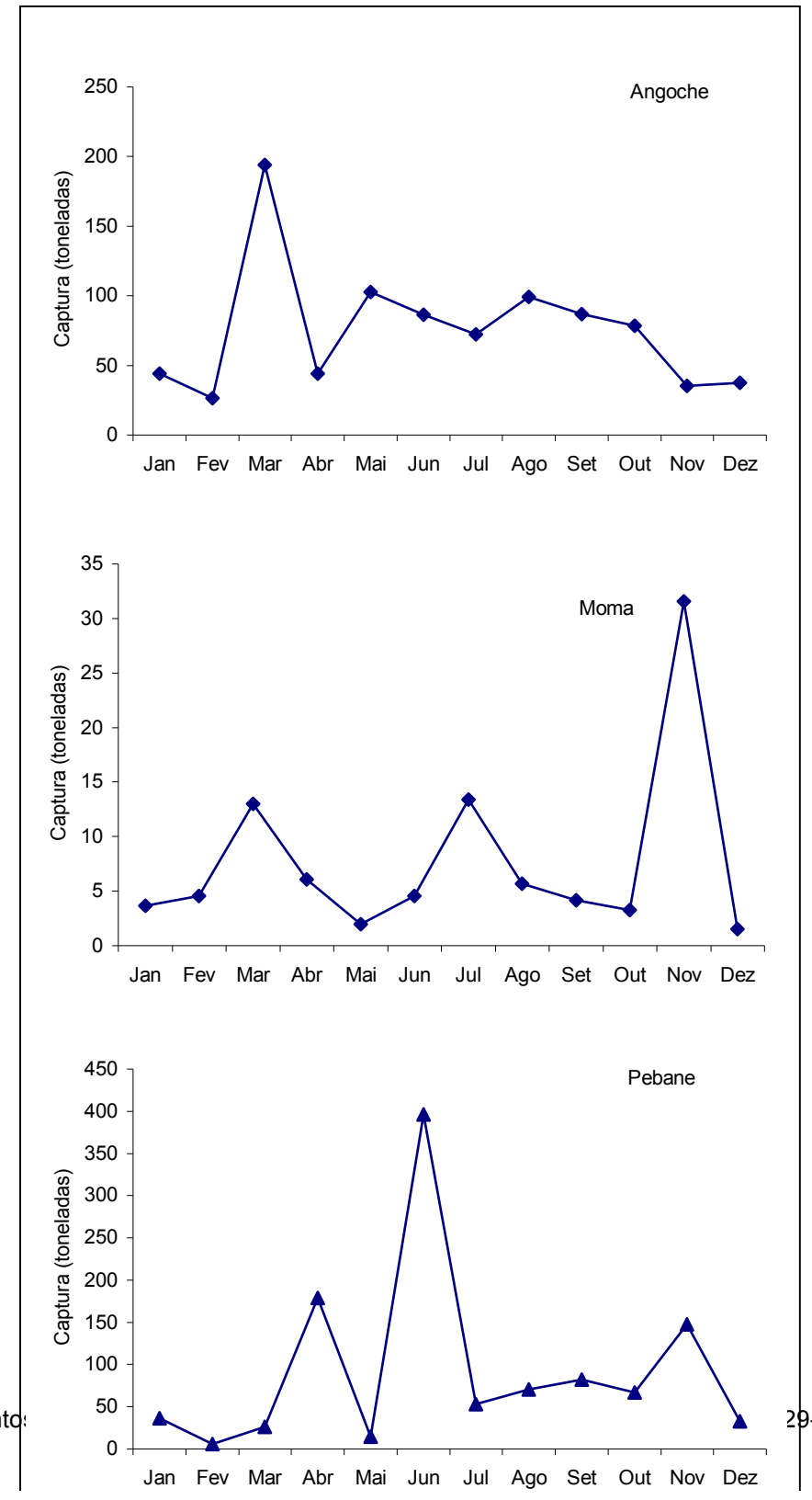
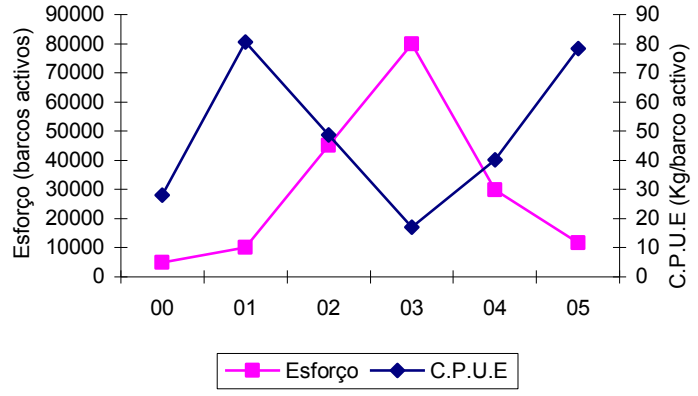
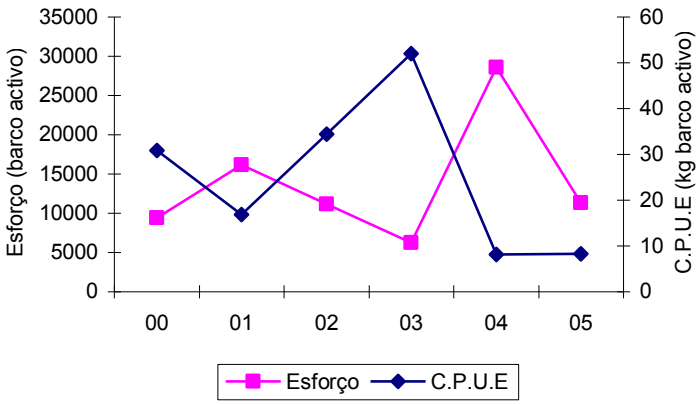


Figure 23: Monthly variation of longline yields in Angoche, Moma and Pebane for the year 2005 (from IIP, 2007, unpublished data)

Figure 4 illustrates effort trends (number of active vessels) and yields per unit of labor (kg/active vessel.day) for longline fishing in Angone, Moma and Pebane from 2000 to 2005. In Pebane, where effort data were the highest, both effort and yields increased from 2003 to 2005. The greatest yields were recorded in Angoche, which enjoyed growth between 2003 and 2005. Yields in Moma declined during the same period, however.





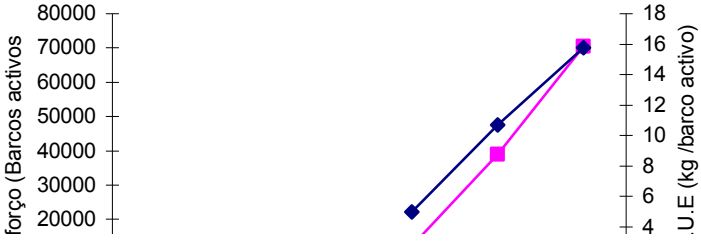


Figure 24: Effort (number of active vessels) and Yield per unit of labor (kg/vessel.day) for longline fishing in Angoche, Moma and Pebane between 200 and 2005 (from IIP, 2007, unpublished data)

As regards surface gillnets, approximately 1,574 tons of fish were caught in Angoche from 2004 to 2005 using this technique (IIP, 2007, unpublished data). Figure 25 illustrates monthly yield variations from 2004 to 2005 in Angoche.

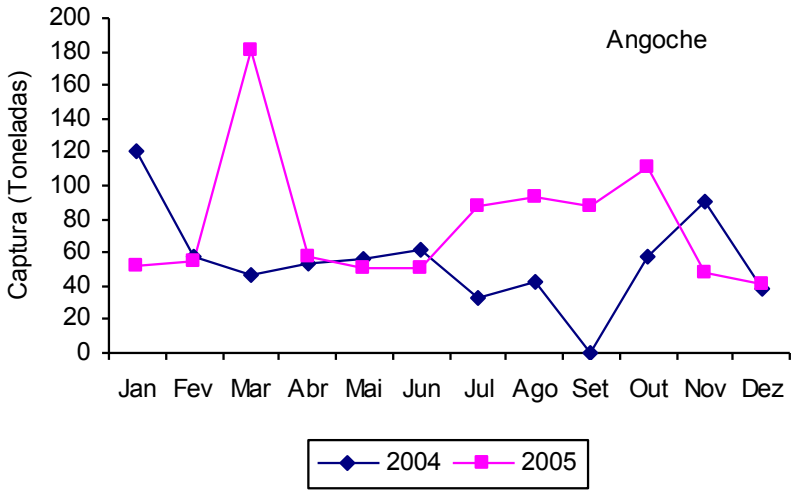


Figure 25: Monthly yield variation from surface gillnets in Angoche, 2004 and 2005 (from IIP, 2007, unpublished data)

In Moma, 786 tons of fish were caught from 2004 to 2005 using this method (IIP, 2007, unpublished data). Figure 26 illustrates the monthly yield variation for this district.

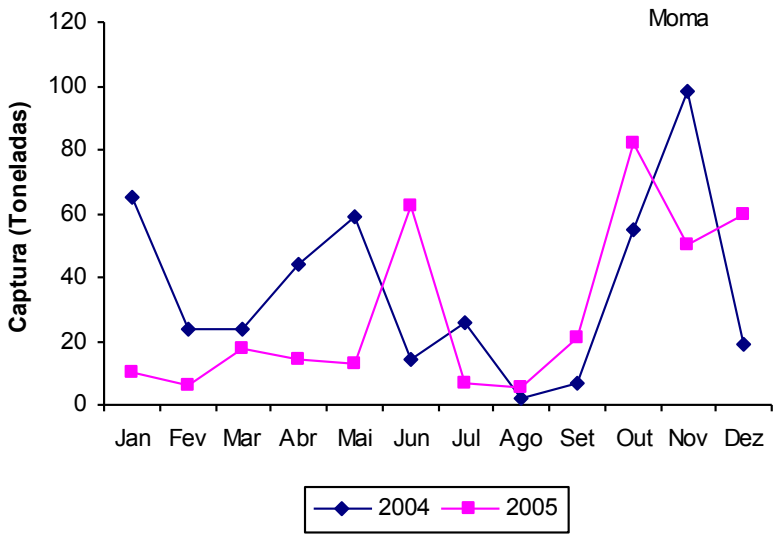


Figure 26: Monthly yield variation from surface gillnets in Moma, 2004 and 2005 (from IIP, 2007, unpublished data)

In Pebane, approximately 3,803 tons of fish were caught from 2004 to 2005 by means of surface gillnets (IIP, 2007, unpublished data). Figure 27 illustrates the monthly yield variation for this district.

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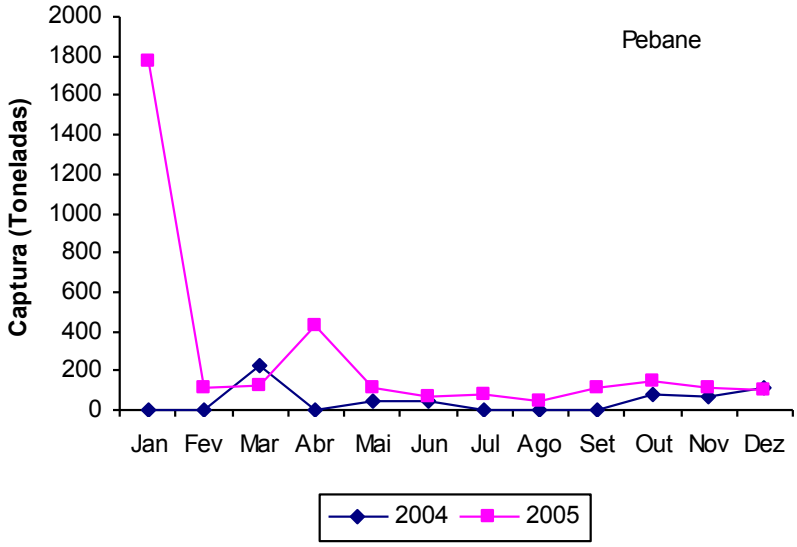


Figure 27: Monthly yield variation from surface gillnets in Pebane, 2004 and 2005 (from IIP, 2007, unpublished data)

Figure 28 illustrates yields (YPUL) and fisheries effort trends in the three districts for the years 2004 and 2005.

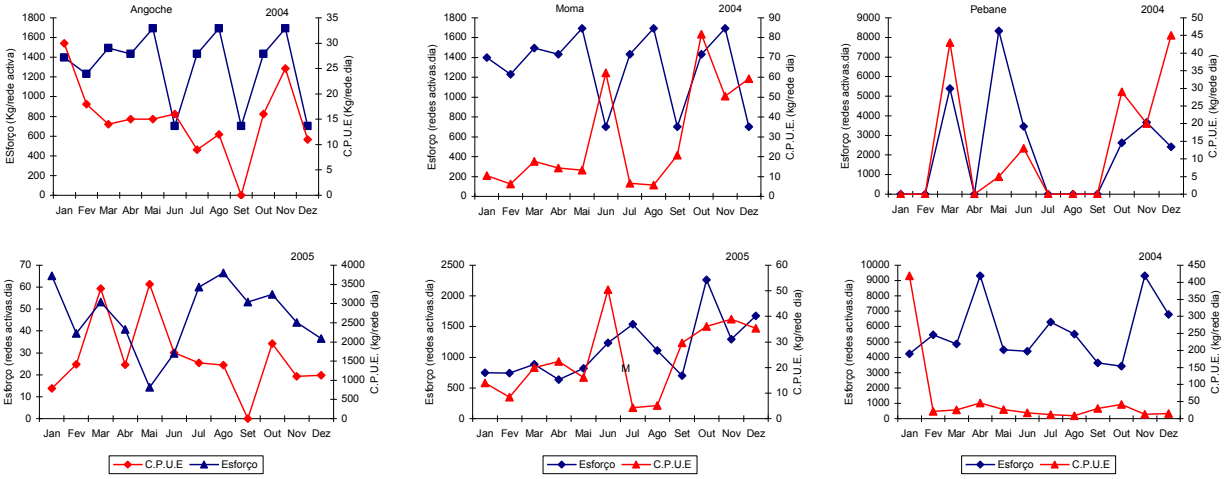


Figure 28: Effort and Yield per unit of labor from surface gillnets in Angoche, Moma and Pebane during the years 2004 and 2005 (from IIP, 2007, unpublished data)

2.5. Faunal Composition of the Catches

Tropical coastal waters normally yield at once a great number of fish species and few specimens of each. Species diversity is even greater in the estuary zones, as many of these species utilize the estuary either as a permanent habitat or as a temporary ground for feeding and spawning (King, 1995). Beach seines in Angoche and Moma collect 233 species of demersal fish, 113 pelagics and 22 separate species of crustaceans (IFAD 2000). The yields, though normally not very abundant, include a large proportion of young fish. The yield frequency per species in the region is recorded for beach seine, gillnet and longline methods.

The species caught in beach seines are usually small pelagics, such as *Thryssa spp* (Anchovy), *Rastrelliger spp* (Mackerel) and *Trichiurus*, along with peneideos shrimp (Wilson & Zitha, 2007). According to data obtained in 2005 by Uetimane & Mualeque (2006) in Angoche and Moma (Tab. 7), the most abundant species caught in beach seines was *Thryssa vitrirostris* (Orangemouth anchovy), followed by *Trichiurus lepturus* (Cutlass fish), *Scomberomorus commerson* (Kingfish), *Upeneus vittatus* (Yellowstriped goatfish), *Gaza minuta* (Toothpony), *Alepes djedaba* (Shrimp scad) and *Secutor insidiator* (Barred ponyfish), among others. In a 1997 study, species of the *Engraulidae* (Anchovy) family were dominant, accounting for 26% of the total catch by weight in the Angoche and Moma districts (Baloi *et al*., 1998). In another study published by Wilson & Zitha (2007), in Mponha, in 2007, the faunal composition of the catch was *Thryssa spp* (Anchovy) (41%), *Trichiurus lepturus* (Cutlass fish) (18%), *Pomadasys stridens* (Striped piggy) (10%), *Otolithes ruber* (Tiger-toothed croaker), *Fenneropenaeus indicus* (Indian prawn) (4%), *Stolephorus indicus* (Indian anchovy) (3%) and others (16%).

Longline fishing is the most selective of all of the methods. The principal species caught are from the families Haemulidae (Stonefish, Striped Piggy), Scombridae (Kingfish), Carangidae (Shrimp scad, Queenfish), Lethrinidae (Porgies), Serranidae (Groupers), Lutjanidae (Snappers) and others such as catfish, hake and whitetip sharks. In the district of Angoche, the most common species captured by means of longline were *Pomadasys kaakan* (Stonefish), *Epinephelus malabaricus (*Malabar grouper*)*, *Carangoides malabaricus (*Malabar trevelly*), Chirocentrus dorab* (Dorab wolf-herring*)* and *Lutjanus gibbus* (Humpback snapper).

Table 7: Specific composition of beach seine catches in the Angoche and Moma districts for the year 2005 (from Uetimane & Mualeque, 2006)

Group	**Family**	**Species**	**Angoche** (tons)	**Moma** (tons)	**Total** (tons)
Orangemoth anchovies	Engraulidae	*Thryssa vitrirostris*	2,1	1.124,9	1127
		Thryssa setirostris	16,8	175,2	192
Anchovies		*Encrasicolina sp e Stolephoros sp*	1,1	0	1,1
Cutlassfish	Trichiuridae	*Trichiurus lepturus*	9,2	484,0	493,1
Kingfish	Scombridae	*Scomberomorus commerson*	34,7	407,4	442,1
Goatfish	Mullidae	*Upeneus vitatus*	66,3	342,1	408.4
Ponyfish	Leiognathidae	*Gaza minuta*	79,3	171,5	250.8
		Secutor insidiator	65,8	268,5	334.3
Shrimp scad	Carangidae	*Alepes djedaba*	1.2	355.5	356.7
Queenfish	Carangidae	*Scomberoides tol*	76.7	80.6	157.3
Indian white shrimp	Penaeidae	*Feneropenaeus indicus e Penaeus monodon*	130,7	119,0	249.7
tsivakihini paste shrimp	Sergestidae	*Acetes erythraeus*	41,3	3,3	44.6
Kelee shad	Clupeidae	*Hilsa keele*	90	204,2	294.2
Sardines		*Sardinella albella*	41,9	110,0	225,5
Corvinas	Sciaenidae	*Otolithes ruber*	2,3	299	301.6
Common asohos	Sillaginidae	*Sillago sihama*	57	132.2	202.7
Javelinfishes	Haemulidae	*Pomadasys maculatum*	38,6	143.2	192.3
Larvas	larvas	Larvas	48,7	0,8	102,2
Outros	Outras	Outras	1.301	2.451,9	4.282,5

In Moma, the 2005 catch brought in *Gerres filamentosus* (Melanúria filamentosa), *Pomadasys kaakan* (Peixe pedra) and *Scomberomorus commerson* (Serra) (Uetimane & Mualeque, 2006). Table 8 illustrates the specific composition of the longline catch for Moma and Angoche in 2005.

Table 8: Specific composition of longline catches in the Angoche and Moma districts for the year 2005 (from de Uetimane & Mualeque, 2006)

Species	**Angoche** (tons)	**Moma** (tons)	**Total** (tons)
Pomadasys kaakan	130,9	6,5	137,4
Epinephelus malabaricus	91,6	0,0	91,6
Carangoides malabaricus	51,5	0,1	51,6
Chirocentrus dorab	49,8	0,0	49,8
Scomberomorus commerson	0,0	1,0	1,0
Lutjanus gibbus	47,3	0,0	47,3
Scomberoides lysan	42,3	0,0	42,3
Epinephelus microdom	41,4	0,0	41,4
Lethrinus crocineus	0,0	0,0	38,8
Epinephelus caeruleopunctauts	36,7	0,0	36,7
Megalaspis cordyla	36,5	0,0	36,5
Sphyraena barracuda	35,5	0,0	35,5
Valamugil sp.	31,9	0,0	31,9
Gerres filamentosus	3,1	30,1	33,5
Caranx sexfasciatus	29,1	0,0	29,1

Decapterus kurroides	24,9	0,0	24,9

Stonefish, catfish, croakers, sharks and rays formed the majority of the longline catch in Pebane in 2004. The Haemulidae family was represented by the *Pomadays kaaakan* (stonefish) and *Pmadasys commersonni* (spotfin croaker) species; the Ariidae family by the *Arius dussumieri* (catfish) species and, the Sciaenidae, by the *Ottolithes rubber* of the Dasyatidae family are composed of the *Himantura uarnak* (marbled stingray) and *Himantura gerrardi*, or sharpnose stingray (Sulemane *et al*., 2005).

Table 9: Specific composition of longline catches in the Pebane district for the year 2004 (from Sulemane *et al*., 2005)

Family	**Pebane** (tons)
Ariidae	56
Belonidae	19
Carangidae	24
Dasyatidae	12
Haemulidae	169
Lobotidae	10
Muranesocidae	29
Sciaenidae	47
Scyliorhinidae	21
Outras	28
Total	415

Surface gillnet capture mostly pelagic fish. Table 10 illustrates the specific composition of the species haul from this type of net in Angoche and Moma, for 2005.

Table 10: Specific composition of species caught in surface gillnets in Angoche and Moma districts, 2005 (from Uetimane & Mualeque, 2006)

Species	Angoche (Tons)	Moma (Tons)	Total (Tons)
Chirocentrus dorab	104,7	38,5	143.2
Sardinella albella	42,1	136,5	178.6
Valamugil sp.	115,1	3,0	118,1
Chirocentrus nudus	16,7	38,6	55,3
Hilsa kelee	32,5	46,7	79,2
Gerres filamentosus	38,4	17,2	55,6
Sillago sihama	47,9	8,9	56.8
Herklotsichthys quadrimculatus	47,4	0,3	49,7
Decapterus russelli	33,5	0,0	46,9
Scomberoides tol	29,7	4,7	34.4
Atule mate	31,9	0,4	32.3
Carangoides malabaricus	22,8	7,7	30,5
Sphyraena qenie	7,6	0,0	7.6
Pomadasys kaakan	23,4	1,3	24,7
Other	31,1	0,0	31,1

The most commonly caught species in Angoche were Valamugil sp. (White mullet), Chirocentrus dorab (Dorab wolf-herring), Sillago sihama (common asohos), Herklotsichthys quadrimculatus (blue-stripe sardine) and Sardinella albella (White sardine). In Moma, the predominant species are Sardinella albella (white sardine), Hilsa kelee (Kelee shad), Chirocentrus nudus (Whitefin wolf-herring), Chirocentrus dorab (Dorab wolf-herring) and Gerres filamentosus, or Whipfin silverbiddy (Uetimane & Mualeque, 2006). The predominant species in Pebane in 2004 were the Hilsa kelee (Kelee shad), Arius dussumieri (Blacktip sea catfish), Otolithes ruber (Tiger-tootherd croaker) and the Trichiurus lepturus (Cutlass fish). Table 11 shows the specific species profile for this district.

Table 11: Specific composition of captures in surface gillnets in Pebane, 2004 (from Sulemane *et a*l., 2005)

Family/group	**Pebane** (toneladas)
Ariidae (Catfish)	32
Carangidae (Scads)	21
Chironcentridae (herrings)	50
Clupeidae (Shad)	324
Sciaenidae (Croakers)	31
Teraponidae (Tigerfishes)	34
Trichiuridae (Cutlassfish)	52
Other	31
Total	575

The shrimp catch is highly important to the artisenal fishermen, but this importance stems more from the species' high commercial value than from the quantities caught. The portion that shrimp represented of the total haul in Angoche, Moma and Nicoadala varied between 0.6 % and 5.9% from 2000 to 2004 (Masquine *et al*., 2006).

In Angoche, between 2001 and 2005 approximately 30% of the total shrimp yield in weight was from artisenal fishing. In the region extending from Moma to Nicoadala, this figure is approximately 15% (Palha de Sousa *et al*., 2006). Figure 30 illustrates the artisenal shrimp yield trends in Angoche, Moma and Nicoadala from 1997 to 2005.

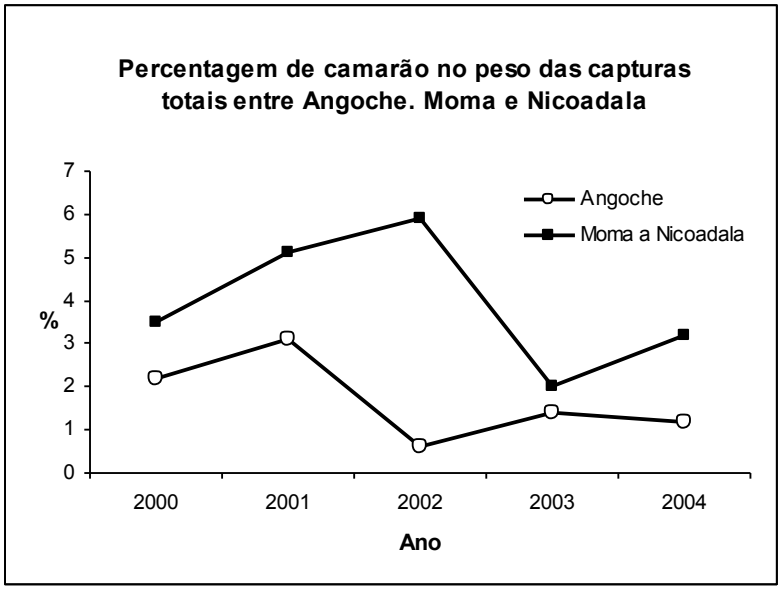


Figure 29. Shrimp yields, as percentage of total catch weight, in Angoche, Moma and Nicoadala, 2000 to 2004 (from Masquine *et al*., 2006)

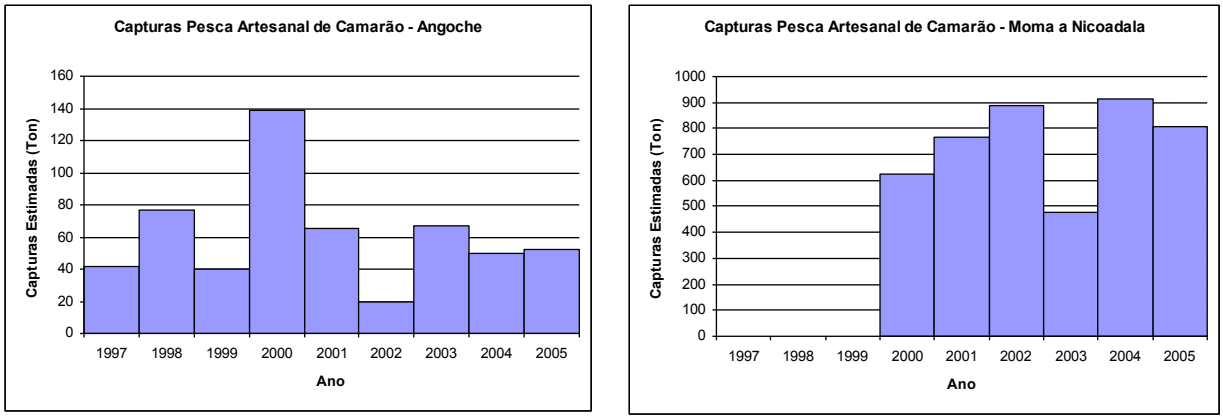


Figure 30: Trends in artisenal shrimp catch in Angoche, Moma and Nicoadala, 1997 to 2005 (from Masquine *et al*., 2006)

The principal shrimp species caught is the white prawn (*Fenneropenaeus indicus*), which accounts for between 60 to 98% of the total yield by weight in the regions between Angoche and Moma and Pebane to Nicoadala. The secondary species caught include *Metapenaeus monoceros, Penaeus monodon* e *Penaeus semisulcatus* (Baloi *et al*., 1998; Masquine *et al*., 2006) (Fig. 31). Among other secondary catch species are considerable numbers of *Acetes erythraeus,* of the Sergestidae family, known locally as camarão *fino* or *liwapa*, together with Palaemonid shrimps of the Pandalidae family.

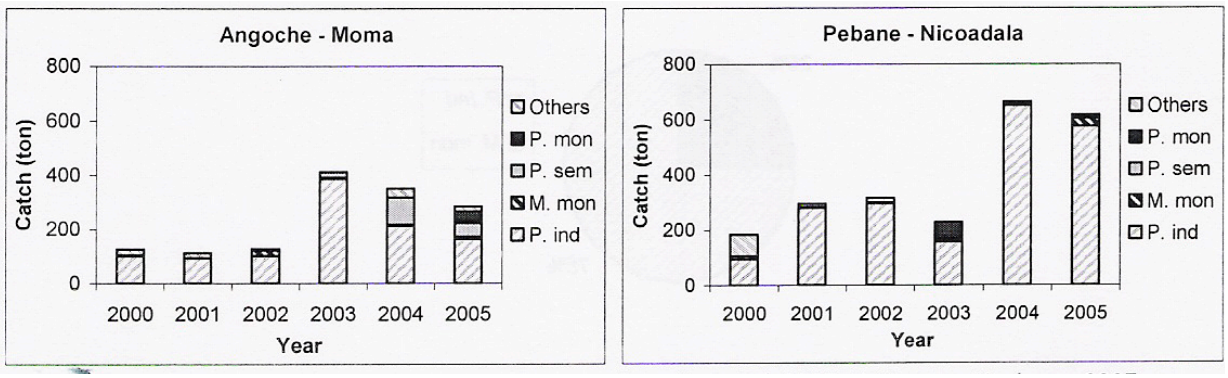


Figure 31: Shrimp yields and their specific compositions in the regions from Angoche to Moma and Pebane to Nicoadala, 2000 to 2005
(from Uetimane & Mualeque, 2005; Masquine *et al*., 2006)

The number of shrimp caught by means of artisenal fishing is great despite the species' small contribution in terms of total annual catch by weight. The great majority of shrimp caught are young spawns. An analysis of the various lengths of the *F. indicus* species caught by means of artisenal fishing in 2003 in Angoche reveals that 63% of the specimens has a carapace length (CL) of between 15 e 22 mm. The average CL calculated was 20,6 mm (Masquine *et al*., 2003) (Fig. 32).

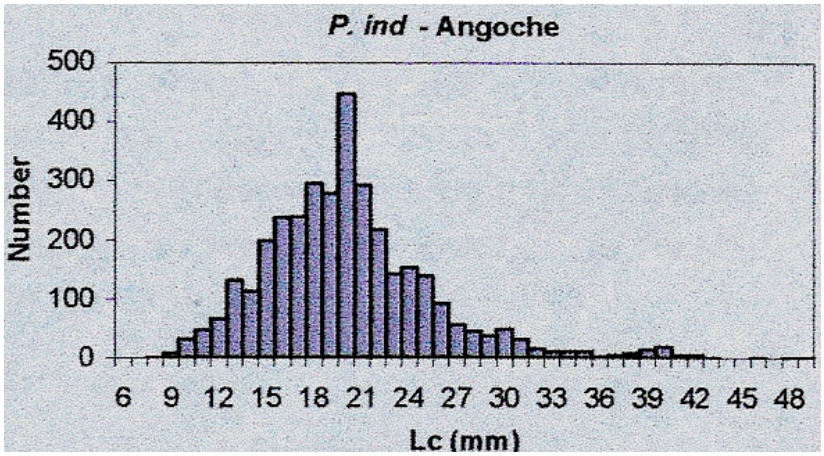


Figure 32: Distribution of lengths of both sexes of *F. indicus* in Angoche (from Masquine *et al.*, 2003)

2.6. Fish selling and processing

Nowhere throughout Mozambique's artisenal fishing industry will one encounter the practice of rejecting or returning certain fish to the sea (by-catch). Practically the entire catch is sold or consumed. The most valuable species (first quality fish) and the larger prawns, at times packed in ice, are sent to urban markets. In cities such as Beira and Angoche, where one finds processing stations, the fish (mostly shrimp) might be frozen and transported to even larger urban centers or exported. The most common processing technique is that of sun drying and salting. In areas such as Matadane, in Moma's northeast region, sun drying is practiced without salting on account of the mineral's scarcity (Fig. 33). Certain fish species call for smoking as a preservation method. All of these preservation techniques, however, can be interrupted during the rainy season, when product loss is frequent. Processed fish is transported to inland urban centers, especially in the country's central and northern regions (Wilson & Zitha, 2007).

Figure33: Drying of fish in Topuito (photo Camila de Sousa)

Beach seine catches are divided between the owner of the nets and boats and the fishermen. It is common practice for the owner to keep half of the catch while the other half is dived among the fishermen. Fishermen generally earn little from their trade, which is first and foremost one of subsistence. Beach seine fishing may be viewed as at once a commercial and subsistence endeavor, which employs a great number of fishermen, requires a degree of financial investment and which permits the sale of the excess catch. Still, the distribution of the catch is such as to provide for no more than the crew's subsistence (Wilson & Zitha, 2007). A study conducted in Nampula province by Muchave (2000) concluded that average earnings of a crewmember were approximately 120 to 400 dollars per year. For fishing net owners, average earnings range from 700 to 1,800 US dollars per year. Those owning both nets and vessels had average annual incomes from 1,200 to 3,300 US dollars.

2.7. Management strategies, impacts and concerns

The principal management strategy applied to artisenal fishing is the prohibition period, which varies in terms of duration and season throughout the regions. The veda, or prohibition period, requires an interruption in fishing for a certain period in a given area. The purpose of the prohibition is to control the reduction in the numbers of young fish. These periods normally last three to four months where shrimp are known to grow and spawn. Fishermen, however, do not always welcome these periods of forced stoppage.

In the surveyed region, beach seine fishing is subject to a prohibition period of the same duration as industrial fishing at the Sofala Bank: usually from November 15 to March 1. Beach seines in Angoche and in Moma have been exempt from this restriction since 1997. Because of pressure from industrial fishing interests that called attention to the impact of these fisheries on shrimp resources as well as the Sofala Bank neighboring communities, the prohibition was once again applied in 2006 (Wilson & Zitha, 2007).

The reinstitution of the prohibition period in Angoche and Moma is relatively recent and has not yet proved efficacious. In Mponha during 2006 and 2007, widespread disregard of the rule was observed among fishermen and vessel owners alike, who insist that fishing is their sole source of subsistence throughout the year and evince an ignorance of the penalties they might face for their infractions. The authorities,

however, are unprepared to properly monitor the beaches and community councils have yet to take the needed measures to help impose these restrictions (Wilson & Zitha, 2007).

The reasons for the failure to impose the prohibition period in this region are many. Wilson & Zitha (2007) point to the following:

- Fishermen fail to see themselves as direct beneficiaries of the measure;
- No alternative income-generating activities exist, nor is there an attempt to coordinate the period with the annual agricultural cycle, which is indeed at its least favorable stage during the period;
- The fishermen have no say or participation in decisions surrounding the prohibition;
- The financial and/or administrative penalties fail in their ability to force fishermen to abide by the restrictions, and oversight is non-existent;
- The fishermen argue that the period is determined by biological criteria reflecting more the economic interests of Sofala Bank industrial fisheries than their own.

The average catch during the prohibition period (November to February) in Moma was estimated for 2003 to 2005 at 2,024 tons of fish (93%) and 75 tons of shrimp (4%). Estimates of the shrimp catch during the restriction period represent 8% of the district's annual shrimp catch (Wilson & Zitha, 2007).

According to Wilson & Zitha (2007), the most unfortunate impact of beach seine fishing during the prohibition period has been the depletion of young shrimp from the use of mosquito nets or those having a mesh smaller than 38 mm. Of the 473 nets registered in Angoche, 67% employ mosquito nets. Likewise, in a study of Kwirikwidge, to the north of Angoche City, 73 of the 90 beach seines had mosquito net sacs (Lopes & Gervásio, 2000). In the Angoche district there is a demand for two smaller species – the *Stolephorus* anchovy and the *Acetes* prawn. The fishermen claim that they must use mosquito nets to catch these species measuring an average of 4 cm. Many other species are also caught at a very young stage of development (Lopes & Gervásio, 2000; Wilson & Zitha, 2007). In effect, many species are caught before the

stage of sexual maturity and first spawning, thereby posing a threat to species replenishment and compromising the sustainability of the fisheries (Baloi *et al*., 1998).

Co-management committees have instituted incentives in an effort to discourage the utilization of mosquito nets. Fishermen in turn argue that, by employing nets of greater mesh sizes, their catches would be limited to large, first-quality species beyond the means of the local population that can only afford small quantities of the smaller, second and third-quality fish. Local conditions, then, and market realities argue against the employment of more sustainable fishing practices. A solution may be to market the large, first-quality fish in areas that enjoy greater purchasing power, such as the large cities. This would, however, require efficient means of access to ice or refrigeration equipment to ensure preservation, as well as improved access to roads leading to these markets.

No study measuring the impact of these nets on floral seabeds exists. Nonetheless, the impact will in the end be a function of the technical characteristics of each net (Wilson & Zitha, 2007).

Yet another consequence to consider is that of the elevated fishing effort; namely, the depletion of spawning fish stocks. Both fishermen and local authorities agree that the catch has diminished in recent years because of over fishing (Wilson & Zitha, 2007).

The fishermen may be able to migrate to neighboring areas and set up camp. Such a migration would be an important factor to consider when measuring fishing effort (Baloi *et al*., 1998; Wilson & Zitha, 2007). At the Kwirikwidge fisheries center the community limits the number of migrant fishermen to 40 (Lopes & Gervásio, 2000).

3. Semi-industrial Fisheries at the Sofala Bank

The semi-industrial sector has operated from Angoche since 2001 and from South Beira (from Dondo to Machanga) since 1992. Figure 34 shows trends in the numbers of vessels in operation from 1992 to 2005. Angoche today relies upon eight vessels and South Beira a fleet of nineteen (Palha de Sousa *et al*. 2005).

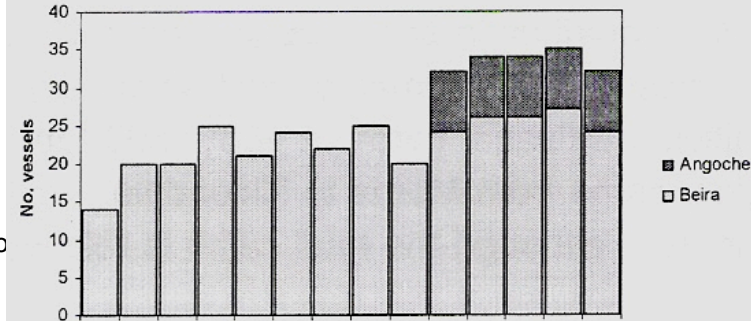


Figure 34: Number of semi-industrial vessels in South Beira and Angoche, from 1992 to 2005 (from Palha de Sousa *et al*., 2006)

The chief catch at this fishery is shrimp, which increased considerably in Angoche and South Beira. The catch in Angoche began at 25 tons, reaching 105 tons in 2005. In South Beira, the catch has varied between 150 tons in 2000 to a maximum of 319 tons in 2004. The 2005 catch diminished slightly to 308 tons (Palha de Sousa *et al*., 2006).

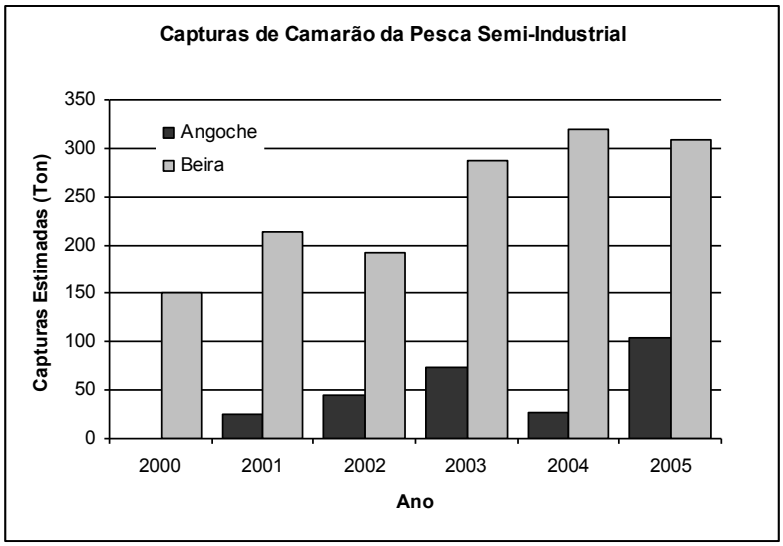


Figure 35: Semi-industrial shrimp fleet catch, South Beira and Angoche, 2000 to 2005 (from Palha de Sousa *et al*., 2006)

The predominant shrimp species caught by semi-industrial fisheries fleets based in Chiloane is the *F. indicus* (75%), followed by *M. monoceros* (25%) (Palha de Sousa *et al*., 2006).

A study of the species size was conducted using data from this very fleet. . The range in size for the predominant species, *F. indicus*, indicated an average CL of 40.1 mm for the females and 30.3 mm for males. CL lengths varied from 20 to 58 mm. In the case of *M. Monoceros*, average CL was calculated at 34 for females and 27 mm for males. Lengths varied between 20 and 44 mm (Palha de Sousa *et al*., 2006) (Fig. 36).

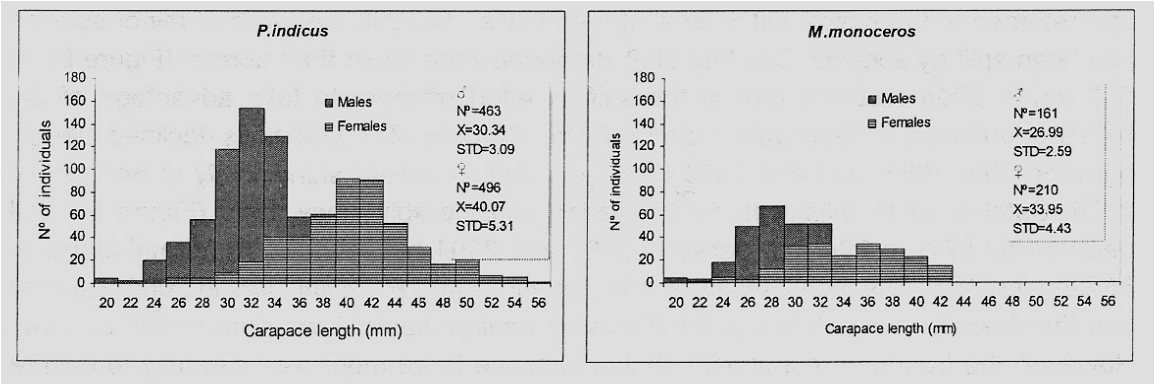


Figure 36: Length profiles for *F. indicus* and *M. monoceros* by sex, from the semi-industrial fleet catch in 2005 (from Palha de Sousa *et al*., 2006)

In addition, a longline semi-industrial fishing vessel operates from its base in Pebane.

4. Industrial Fishing at the Sofala Bank

4.1. Fisheries Effort, Catches and Yields

Though enjoying any real level of development only as of 1974, 1964 marked the beginning of industrial shrimp fishing in the Sofala Bank.

The industrial fleet operating at the Sofala Bank (including semi-industrial vessels with on board refrigeration equipment) comprised 75 vessels in 2005. This number has remained relatively constant since 2001 (Palha de Sousa *et al*., 2006). Figure 37 illustrates trends in the numbers of vessels in recent years in terms of gross registered tonnage (GRT).

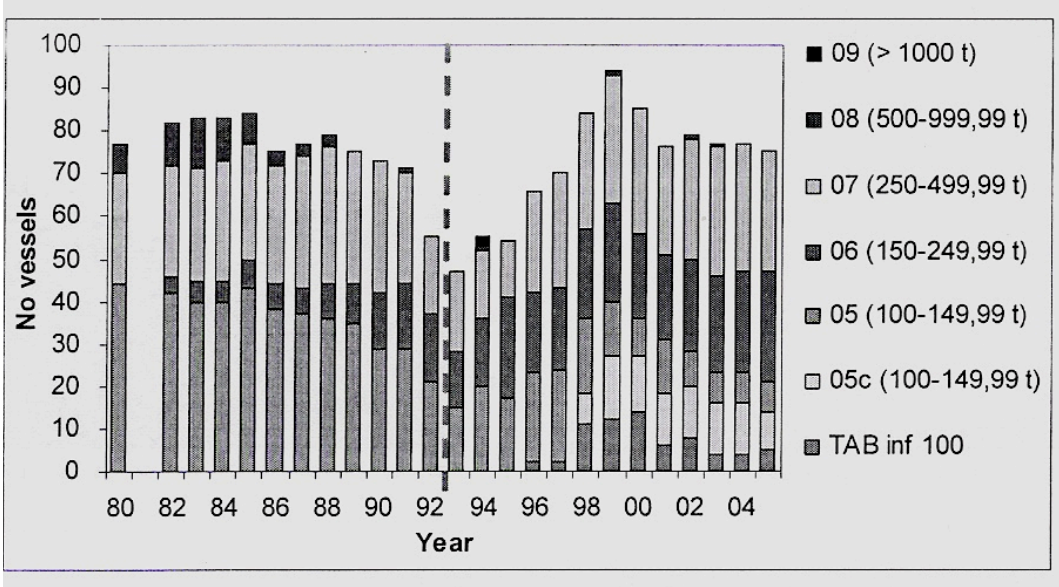


Figure 37: Composition of the Sofala Bank fleet per Gross Registered Tonnage (GRT), 1980 to 2005 (from Palha de Sousa *et al*., 2006).

Three mixed national and international companies dominate the industrial fleet, namely Pescamar, Efripel and Krustamoz. Two of these companies, Pescamar and Efripel, rely on capital inputs from two shrimping companies, Pescabom and Copoic. These five companies represent 40% of the fishing fleet possessing refrigeration capacity and, among them, account for 47% (4,400 tons) of the annual shrimp catch (Tembe, 2005).

The total yield for the industrial shrimping fleet and semi-industrial vessels outfitted with refrigeration in the Sofala Bank was, in 2005, 7,715 tons. This catch was somewhat greater (3%) than that of the previous year, which had a recorded yield of 7, 456 tons. Figure 38 illustrates yield trends since 1980. The 2003 catch was 7, 117 tons, or 15% below 2002 and the lowest since 1994 (Palha de Sousa *et al*., 2006).

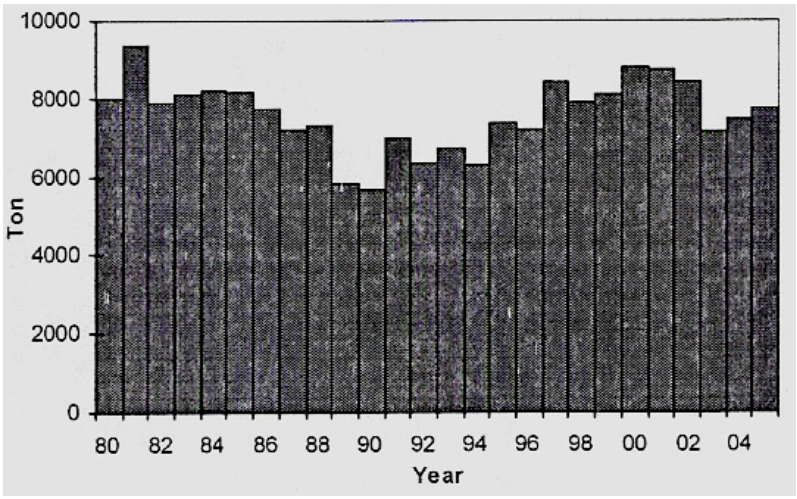


Figure 38: Total catch of the industrial fleet and refrigerated, semi-industrial vessels, Sofala Bank, 1980 to 2005 (from Palha de Sousa *et al*., 2006).

As regards the region being surveyed, we have data for Angoche as of 1997 (Fig. 39) for Moma to Nicoadala as of 2000 (Fig. 40).

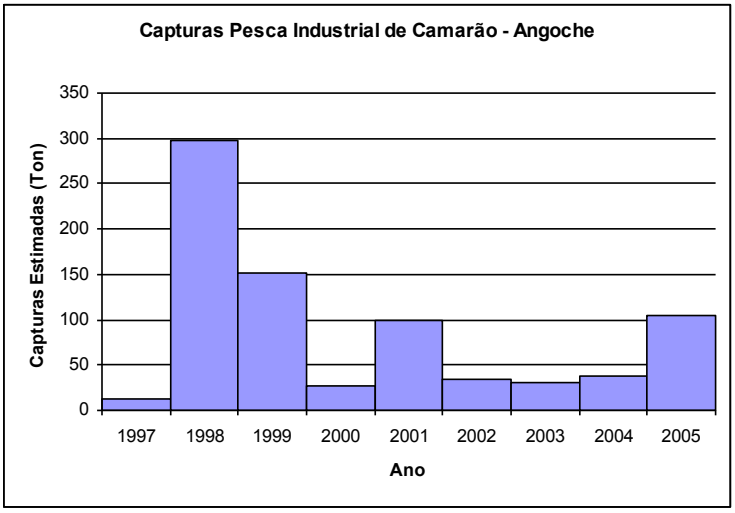


Figure 39: Industrial shrimp catch in Angoche and from Moma to Nicoadala from 1997 to 2005 (from Palha de Sousa *et al*., 2006).

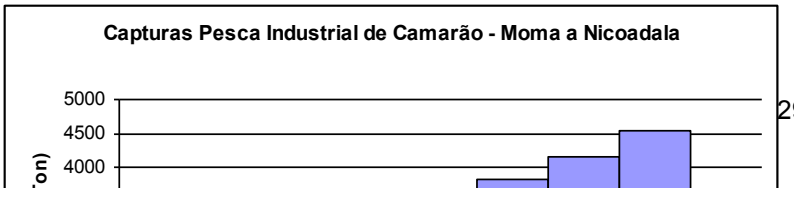
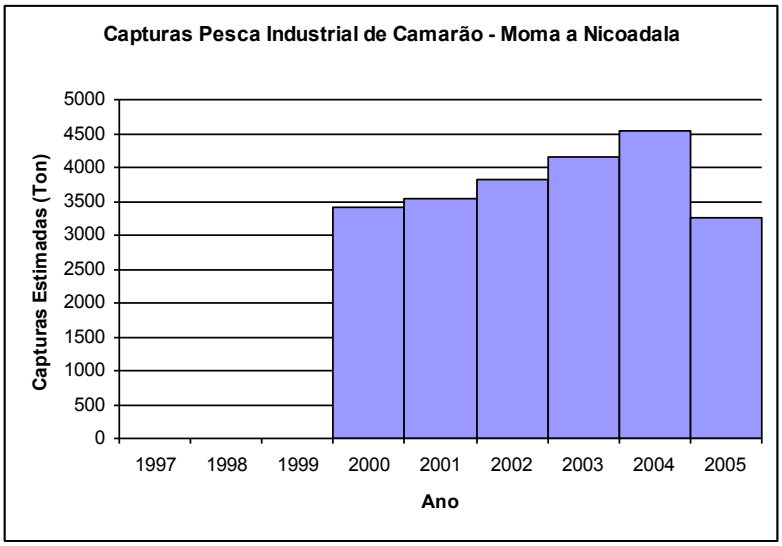


Figure 40: Industrial shrimp catch in Angoche and from Moma to Nicoadala from 1997 to 2005 (from Palha de Sousa *et al*., 2006).



Throughout the year, the greatest catch levels are achieved immediately after the prohibition period, usually fixed for January and February. Following this spate of hauls during the first few months, a period of accentuated decline sets in, declining to the lowest catch levels during October and November. The haul will then increase ttowards the end of the year, determining the following year's recruitment. In response to the prohibition period, companies attempt to cover their losses by increasing the number of fishing hours per day and engaging in nocturnal fishing (Palha de Sousa *et al*., 2005).

Measuring the effort level is a very complex undertaking because of the variety of fishing techniques that the vessels employ (Fig. 41). In view of this complexity, the IIP adopted a single vessel (the VEGA) as the standard of comparison for data pertaining to effort (Tembe, 2005)

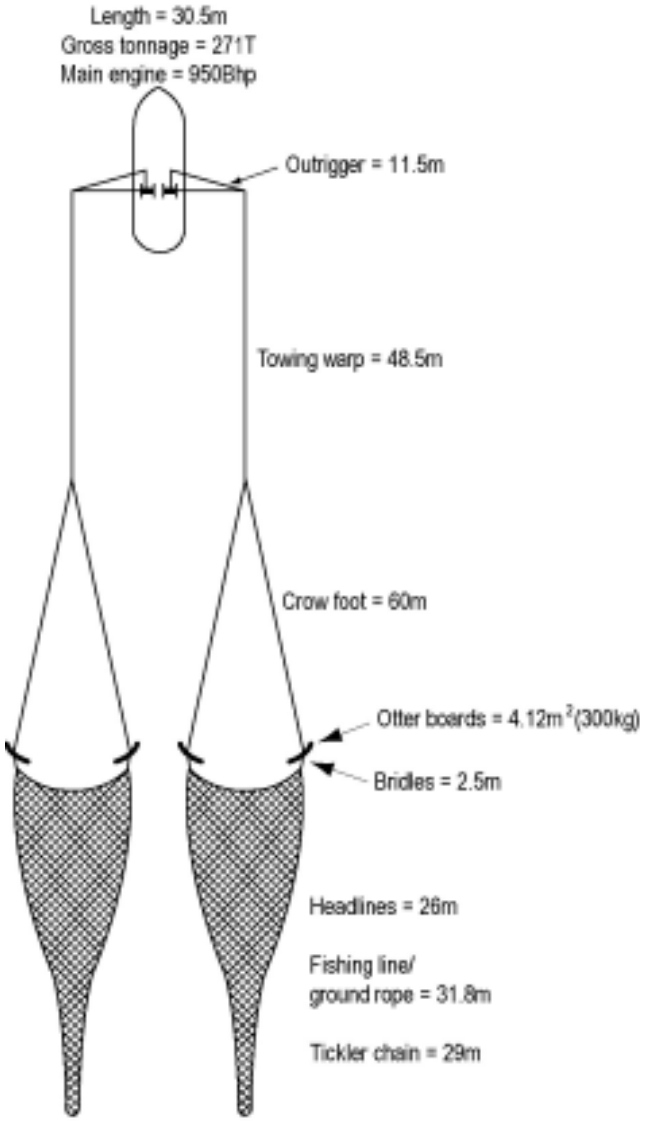


Figure 41: Schematic diagram of a shrimp trawling net from the Sofala Bank (from Pinto, 2000)

Fishing effort has been on the rise, with its highest level recorded in 2004 (Fig. 42). For the same year, it was calculated that the fleet exceeded its fishing effort capacity by 40% (Palha de Sousa *et al*., 2005).

Along with this higher effort data one must take into account greater fishing efficiencies obtained with the introduction, for example, of global positioning systems (GPS) and the introduction of nocturnal fishing. These elevated levels can contribute to stock depletion and other consequences of over fishing (Palha de Sousa *et al*., 2006).

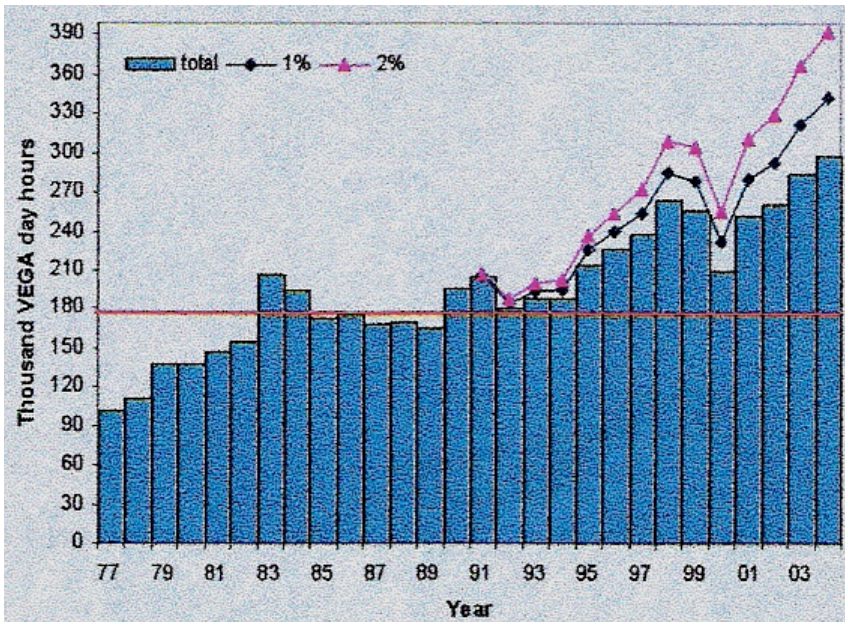


Figure 42: Total annual effort at the Sofala Bank, 1977 to 2004 (from Palha de Sousa *et al*, 2005).

As measured by average annual yield per hour, Sofala Bank yields have declined. (Palha de Sousa *et al*., 2006). A study of these yields, catch rate per hour in this case, points to a decline over the years (Fig. 43). Since 1989 this rate has been affected by the prohibition period as well as the practice of nocturnal fishing (Palha de Sousa *et al*, 2006).

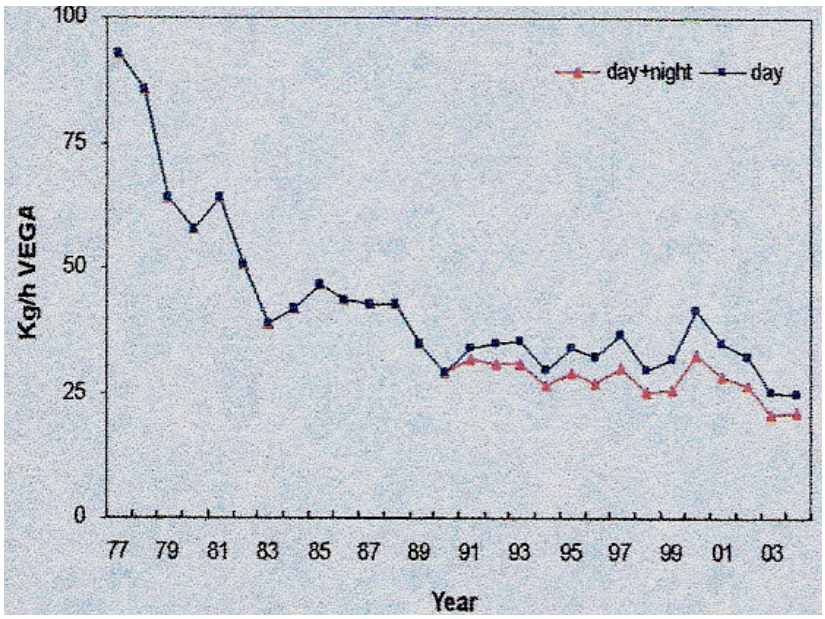


Figure 43: Annual measurement of hourly yields, Sofala Bank, 1977 to 2004, with 53.2 m master cable as reference (from Palha de Sousa *et al*., 2005).

Relating yield and fishing effort data for all shrimp species over the course of several years, we find that increased effort levels since 1998 have not resulted in greater yields (Fig 44). Increases in other words, whether of vessels or number of fishing hours per day, have not yielded a larger catch despite the greater investment (Palha de Sousa *et al*., 2005).

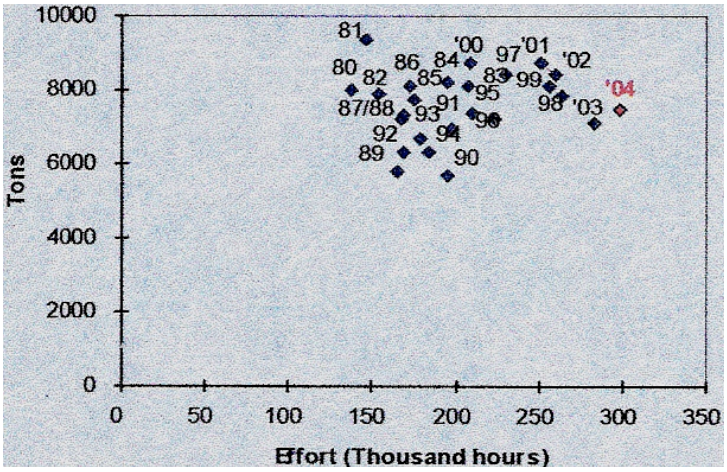


Figure 44: Relationship between yields and effort in the Sofala Bank fishery, 1981 to 2004 (from Palha de Sousa *et al*, 2005).

Another, bio economic study of this fishery was conducted analysing yield and effort relationships and production inputs, especially fuel costs. This study concludes that a similar shrimp yield can be achieved with less fishing effort, thereby allowing for more efficient profit maximization. A 40% effort reduction relative to 2005 levels is recommended for the long run. Such a reduction would result in a significant increase in profits for the industrial fleet and protect the spawning fish stock (Palha de Sousa *et al*., 2006).

Fish effort distribution by region for 2003 and 2004 is illustrated in figures 45 and 46, respectively. This data was compiled on the basis of diaries from fishing company vessels operating in the Sofala Bank. In 2004, the industrial fisheries exclusion zone was extended from one to three nautical miles from the coast, to a depth of up to 10 meters. Notwithstanding this change, patterns of fishing effort distribution have changed little (Palha de Sousa *et al*., 2005).

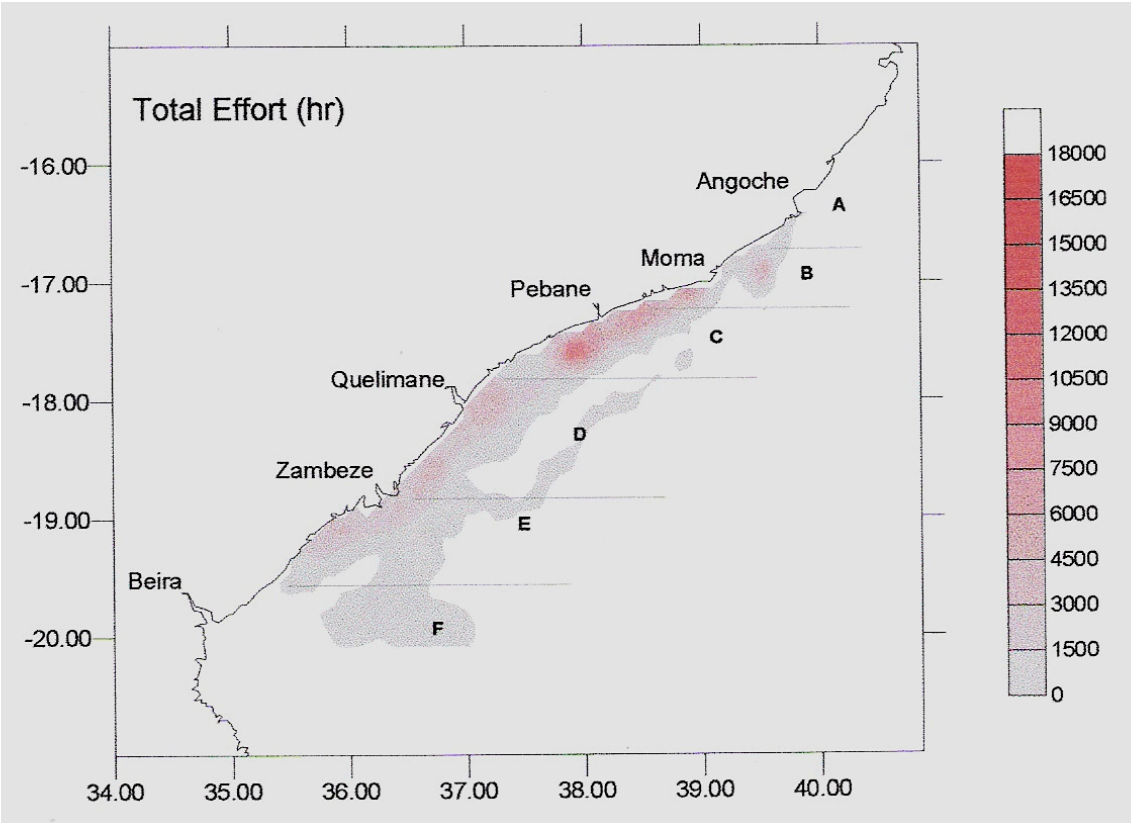


Figure 45: Regional distribution of fishing effort of vessels of majority of companies during 2004 (from Palha de Sousa *et al*, 2005).

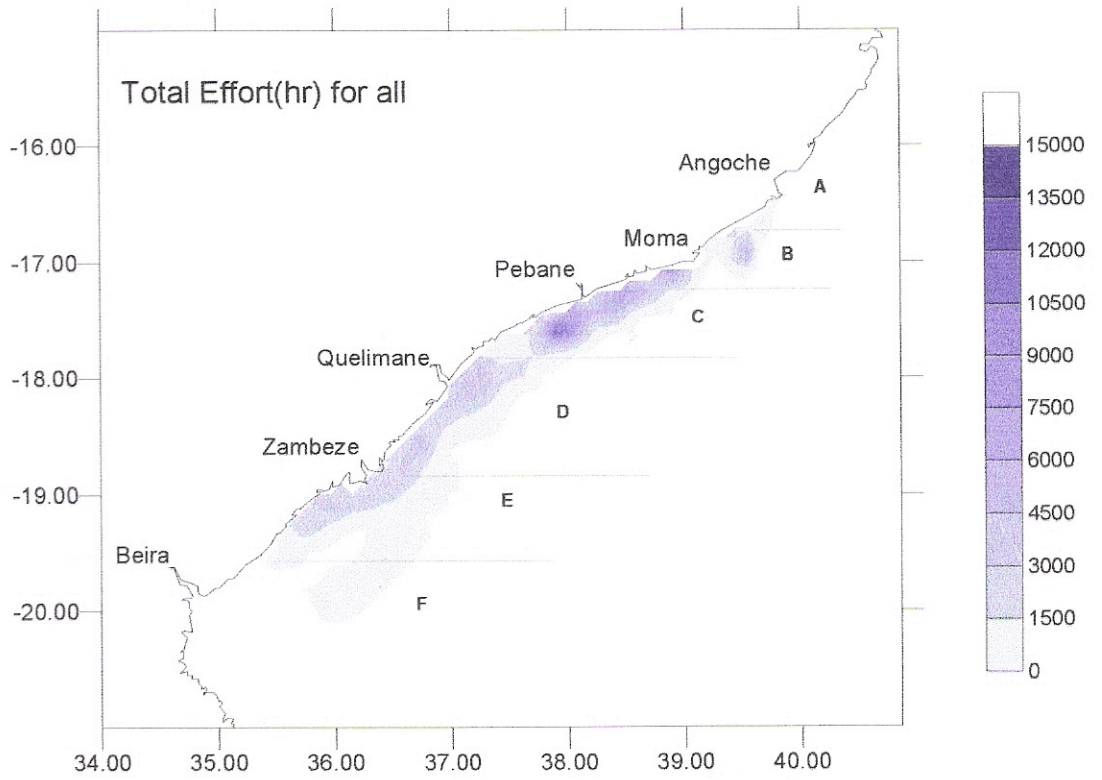


Figure 46: Regional distribution of fishing effort of vessels of majority of companies during 2003 (from Palha de Sousa *et al*, 2005)

4.2. Faunal Composition of the Catches

The primary species caught are *F. indicus* and *M. monoceros*, which account for 95% of the yield. It must be emphasized that, as of 1989, the practice of nocturnal fishing has introduced other species yields, such as *P. japonicus*, *P. latisulcatus* and *P. monodon* (Palha de Sousa *et al*, 2004). Figure 47 shows the trends in yields per species in the Sofala Bank.

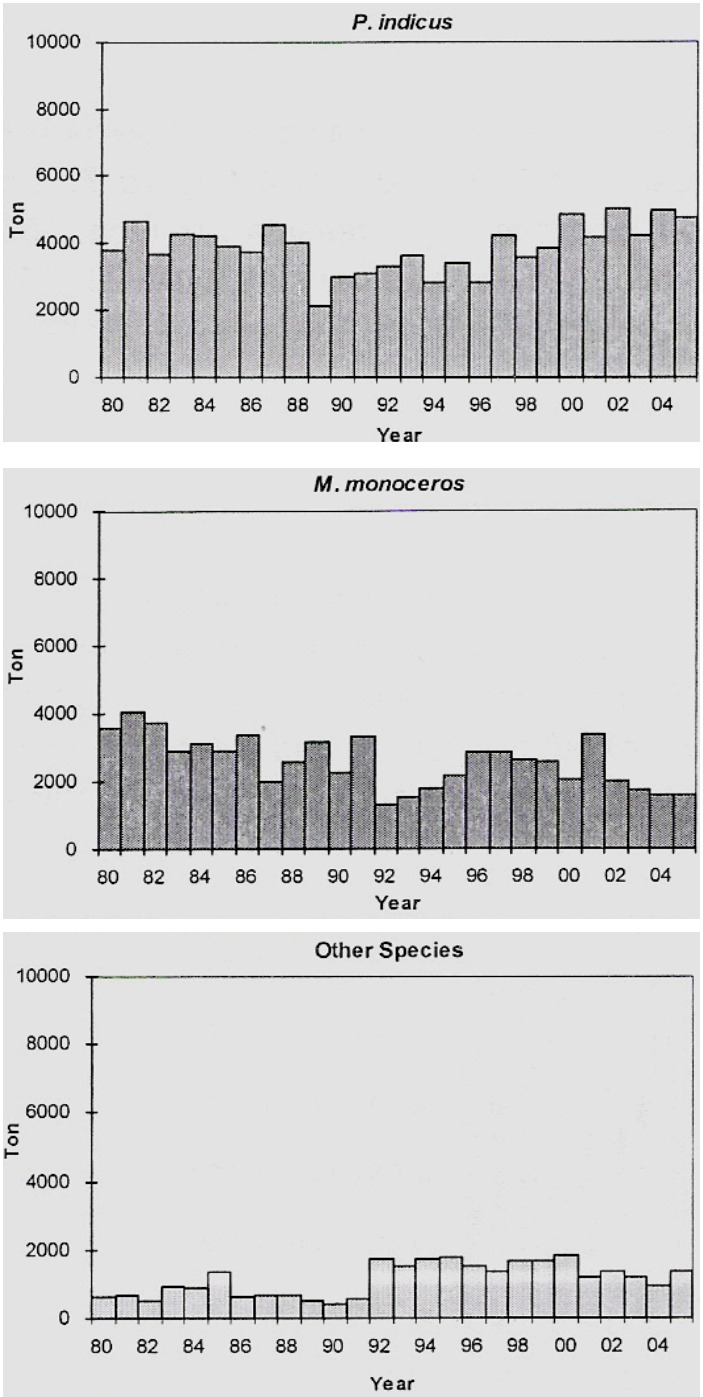


Figure 47: Chief shrimp species yields from the Sofala Bank industrial fleet, 1980 to 2005 (from Palha de Sousa *et al*., 2005).

The total estimated catch for *F. indicus* in 2005 was 4,754 tons; slightly bellow the figure for 2004. The *M. monoceros* catch in 2005 was 1,592 tons, similar to the 2004 catch and approximately 50% bellow the maximum 3, 389 tons obtained in 2001. From 1992 to 2000, catches of other, less important species (*P. japonicus, P. latisulcatus e P. monodon*) increased relative to previous years because of intensified nocturnal fishing. These species represented a total of 1,369 tons in 2005, which was 45% above the previous year's tonnage (Palha de Sousa *et al*., 2006).

The principal species, *F. indicus* and *M. Monoceros,* are of different lengths, a factor that has a bearing yield rates. *M. monoceros* is found in deeper waters and *F. indicus* at all depth up to 45 meters, though usually at lower depths. Artisenal catches are also influenced by these characteristics, as these fishermen must limit themselves to the relatively shallow coastal waters of the *F. indicus*. Both species are difficult to find at night. Nocturnal species, such as *P. latisulcatus* and *P. japonicus* abound, however (Palha de Sousa *et al*., 2006).

The per kilo price of shrimp increases in proportion to the species' size. Greater effort expended in fisheries has resulted in the catching of shrimp that are ever smaller and therefore of lower commercial value. An analysis of variations in the price and size of shrimp concluded that, had the 2005 fishing effort been less intensive, yields would have been commercially more favorable. Indeed, company profits would have been greater as a more efficient distribution in fishing effort would have reduced operating costs. Such optimization would have also served to better protect stocks (Palha de Sousa *et al*, 2005).

Average weight for specimens of the principal shrimp species was 18 to 29% greater in those years when the prohibition period was extended to March 12. This increased weight contributed significantly to the price of the shrimp (Palha de Sousa *et al*., 2005).

Distribution of the *F. indicus* species according to average weight during the first months (March and April) of the fishing campaign suggests that spawning and growth occurs along the coast, although the pattern is not a static one (Fig. 48). Evidence furthermore suggests that spawning can occur later, or even last longer, and that new spawn can take place during the same year (Palha de Sousa *et al*., 2005).

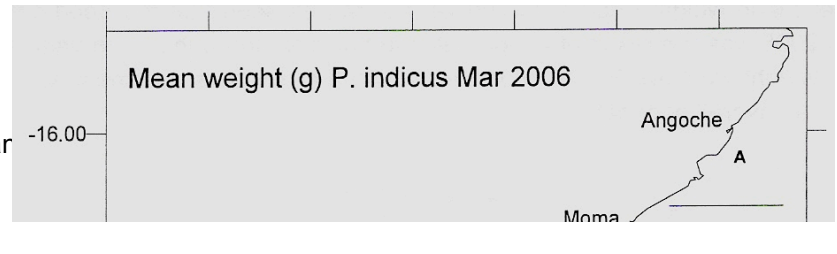


Figure 48: Regional distribution by individual average weight of *F. Indicus* in the Sofala Bank, March and April, 2006 (from Palha de Sousa *et al*., 2005)

A great variety and abundance of fish inhabit the Sofala Bank as well. In shallower waters, one finds demersal species of the Sciaeneidae, Mullidae, Synodontidae, Nemipteridae and Haemulidae families Species belonging to these families usually form large shoals and adapt well the Sofala Bank's rough waters. Small pelagic species, which also form shoals, are represented by the Carangidae, Scombridae, Engraulidae, Clupeidae, Sphyraenidae and Leiognathidae families. Tuna and mackerel are the most abundant of the large pelagics (Palha de Sousa *et al*., 2005).

These fish species of the Sofala Bank are also caught by industrial trawlers seeking shrimp. Industrial fishing is usually responsible for the greatest catches by quantity, accounting for 80% of the fish and 20% of the shrimp. A portion of the fish yield may be for on board consumption, but the greater part is rejected. These species hold little value for industrial fishermen as thy command slight returns in comparison to shrimp (Palha de Sousa *et al*., 2005).

The principal by-catch of the Sofala Bank industrial fisheries are demersals (63%), chiefly those of the Sciaenida family, followed by pelagics of the Engraulidae family (17.6%), crabs (14%), molluscs (3,5%) and crustaceans (2,6%) (Palha de Sousa *et al*., 2005). The most abundant families are the Sciaenidae, Trichiuridae, Brachyura, Engraulidae, Haemulidae and Synodontidae (Fig. 49). The most common species includes *Otolithes ruber*, *Johnius amblycephalus*, *J. dussumieri*, *Trichiurus lepturus*, *Arius dussumieri*, *Pellona ditchela*, *Thryssa vitrirostris* and *Pomadasys maculatum* (FAO, 2003).

At times these species are collected by artisenal fishermen who follow the trawlers. In Pebane in 2004, 47 tons of fish were gathered from industrial shrimping vessels in this fashion. The by-catch was composed mostly of the species *Otolithes rubber*, *Jhonius dussumieri*, *Arius dussumieri*, *Trichiurus lepturs* and *Acetes erythraeus* (camarão fino) (Sulemane *et al.*, 2005).

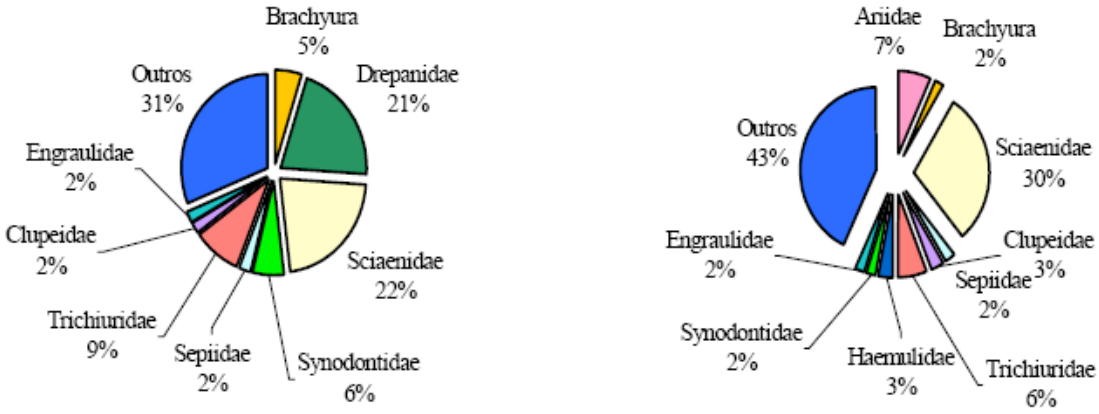


Figure 49: Industrial shrimping by-catch composition at Sofala Bank in 2000 (left) and in 2001 (right) (from Palha de Sousa & Baltazar, 2002 *in* FAO, 2003)

4.3. Industrial gamba fishing at the Sofala Bank

Gamba fishing also occurs at the Sofala Bank, particularly in its deeper waters. From 2003 to 2005, 29 companies were reportedly involved in this enterprise. Some of these companies alternate between surface shrimping and fishing for gamba from the same vessels. Twenty-two licenses were issued for fishing in 2005, although an average of but 13 vessels were in operation during the first semester. Almost the entire fleet must be outfitted abroad (Tembe, 2005).

Annual average production has yielded between 1,200 and 1,500 tons, representing underproduction of a resource able to yield in excess of 5,000 annual tons. As gambas inhabit deep waters (200 meters, on average), their exploration requires industrial-scale equipment of greater cost. In addition, the gamba's relatively low commercial value discourages many fishing companies (Tembe, 2005).

4.4. Administrative Measures, Impacts and Concerns

As has been demonstrated, maximum average shrimp yields in the Sofala Bank can be achieved while reducing effort by 30% to 40% from the 2005 level. In view of the industrial fleet's excessive effort, it is important to ensure the survival of adequate numbers within all shrimp species for these to reach the spawning season, Such management is critical to the survival of the less abundant shrimp species whose stocks can reach very low levels while target species remain abundant.

Palha de Sousa *et al*. (2005) propose a number of management suggestions for this resource, all based upon the principle of effort reduction and changes to the prohibition period:

- Extension of the prohibition period to four months;
- Addition of a prohibition period during July and August, a practice that would benefit the resource and increase fishing companies' profits;
- Added protection for small specimens, particularly those of the *F. indicus* species. One measure would be the introduction of special prohibition periods in areas along the coast with the greatest numbers of young spawns, especially during the beginning of the fishing campaign and within depths of 25 meters. Thus protecting smaller shrimp species would optimize the biomass (capture rate per specimen);
- Improvements to the licensing system so as to properly manage fisheries effort and establish annual catch quotas. Shrimp-fishing licenses must reflect the fishing capacity of the vessels for which they are issued.

Analyses of the fishing industries' economic performance leaves plain the current excesses in the fleet's capacity contribute to unnecessary costs. The results from the model that was generated demonstrates the economic benefits from the introduction of additional prohibition periods, thanks primarily to savings in fuel on the order of US$ 4,000,000.00 (Palha de Sousa *et al*., 2006).

All of these measures demand a great degree of oversight of the industrial fleet by means of naval patrol of the entire region. These means, however, are costly and Mozambique possesses little of this technical and operational capacity.

One of the measures underway for fisheries monitoring and oversight is the introduction of VMS, or Vessel Monitoring Systems for ship identification and location via satellite, on board all vessels operating in the Sofala Bank. This system allows for the control and monitoring of vessels, thereby ensuring compliance with the three nautical mile exclusion zone. The zone is critical in the effort to protect smaller shrimp species and maximization of yield efficiencies. The system furthermore would permit the temporary imposition of prohibition periods in response to unusually high concentrations of smaller shrimp in a given area (Palha de Sousa *et al*., 2005).

According to the 2005 EC/SADC report, the most common infraction in Sofala Bank industrial fisheries is the practice of fishing during prohibition periods and within the three-mile exclusion zone. Such practices give rise to countless conflicts with the region's artisenal fishermen, particularly when industrial trawlers interfere with or destroy the latter's fishing supplies and provisions.

It has been pointed out that such infractions have come to a halt in Moma district, where no transgressions on the part of the industrial fleet have been recorded in recent years (Wilson & Zitha, 2007). This felicitous situation owes itself, in part, to the introduction of VMS systems in the area.

Another negative consequence of industrial fishing has been the large-scale depletion of species sought by artisenal fishermen. This yield, usually the by-catch of shrimping trawlers, can reach 85% of the total catch for the species (Baloi *et al*., 1998).

Industrial fishing operators view artisenal fisheries as one more obstacle in the way of their target catch, which occur in reduced numbers along coastal areas and in estuaries (Palha de Sousa *et al*., 2006). Yield rates for young spawns are, indeed, quite high on account of diminutive mesh-sizes employed in net sacs (Baloi *et al*., 1998).

Yet another unfortunate consequence of industrial fishing has been the fate of marine turtles. Gove *et al*. (2001), estimate that between 1,932 and 5,436 such turtles are inadvertently caught every year by Sofala Bank shrimp trawlers. Although not all are killed, many in fact are as they are made into meals for the crews. With the implementation of General Marine Fisheries Regulation, TED - Turtle Excluder

Devices have become mandatory on motorized trawlers. These devises in no way interfere with the shrimp catch, while protecting other marine organisms, such as rays and stonefish, in addition to the turtles (Gove *et al.,* 2001).

Shrimp fishing in the Sofala Bank, as well as all the world's shrimp fisheries, face grave problems such as rising fuel costs and competition from aquaculture that reduces the price for shrimp on the world market (Palha de Sousa *et al*., 2006).

Fuel costs for fishing vessels in Mozambique has risen by more than 100% in the past two years. At the moment, fuel accounts for 40% of the exploration costs for the average industrial shrimping company and 56% for one of semi-industrial scale. Rises in fuel costs, coupled with lower world prices for many fisheries products, have rendered Mozambique's companies less competitive. In an era of ever rising oil prices, this companies will find it ever more difficult to compete on a global scale (Yussuf & Biquiza, 2007).

5. Final Considerations and Recommendations

Fisheries activities and industries figure prominently at both economic and social levels in Mozambique. The region being surveyed, furthermore, is of particular interest in a nationwide context. Artisenal fishing is well entrenched in the Angoche, Moma and Pebane districts. The numbers and varieties of fishermen, fisheries centers, vessels and fishing methods are substantial when compared to other coastal districts. Yields (YPUE) are also great in comparison to these other districts, suggesting the region's resource abundance of fisheries resources. Artisenal fishing is vital to the district communities for the jobs, income and animal protein it provides. Important industrial and semi-industrial shrimp and gamba fishing operations are in place in the region as well. These operations play a crucial role in the county's export economy.

Shrimp, the region's most important fisheries resource, is harvested by all three types of fishing operations, namely, artisenal, industrial and semi-industrial. Industrial and semi-industrial fleets equipped with refrigeration target adult species in the Sofala Bank. Artisenal fisheries are limited to coastal and estuary zones (up to three nautical miles from the coast) and target primarily the young spawn. These activities are in keeping with the life cycles of most shrimp species, those that migrate between ocean and estuary zones (Appendix I). The adults live and spawn in the open sea and the larvae are transported to the coast by the current. Young spawns then migrate to areas of low salinity, such as estuaries and mangroves. The young spawn remain in these areas until they attain sufficient maturity to migrate to the ocean, where lower temperatures and salinity draw them. These various fisheries are, then, interconnected as artisenal fishing, by targeting young spawns, affects adult shoal populations. Industrial fishing, in turn, targets adult species during their reproductive phases of development. Indeed, the industrial fleet is responsible for a degree of over fishing that compromise the ability of shrimp shoals to renew them. Artisenal methods lead, on the other hand, to young spawn over fishing.

This interrelationship between the young spawn population inhabiting the estuaries and the adult at sea is not sufficiently understood. Urgent studies are called for to elaborate the means of managing the various fisheries that rely upon the same resource. A young shrimp population may be subject to an artisenal fishing effort within and estuary and, at the adult stage, which population will migrate to the sea and again be targeted by the

industrial trawling effort. This dynamic is misunderstood inasmuch as larvae, and even adult shrimp, are driven at random by prevailing currents. It then becomes difficult to determine an adult population's estuary of origin and, later, the estuary to which the current will carry their larvae.

Even in the Sofala Bank, where the currents are more carefully studied, this dynamic remains largely a mystery. Future studies strive to determine the sources of the shrimp populations. Such studies are even more difficult when applied to crustaceans. Other techniques, however, such as molecular biology, can help distinguish the various populations.

A monitoring of artisenal fisheries in the three districts is underway, led by the Fisheries Ministry through its IIP and IDPPE programs. The primary references for fisheries biology are collected in the form of catches, effort, yields (YPUE), and faunal composition and specimen length. This research is conducted in terms of the principal fishing methods and fisheries centers. Beyond this, an artisenal fisheries development program is underway in the region known as the PPABS, or the Sofala Bank Artisenal Fisheries Project, expected to last until 2008.

Projects in the region have played a key role in the creation of fishermen's associations and administrative models through which fishermen are empowered through co management. Such arrangements allow, for example, for the implementation of micro credit programs, conflict resolution methods and management supervision.

The IIP, which every year conducts fisheries cruises employing observers who gather crucial data, monitors industrial and semi-industrial fisheries. The VMS system has been partially instituted and will also contribute to monitoring and oversight.

As regards artisenal fisheries throughout the three districts, the following can be stressed:

- Many artisenal fishermen operate intensely in the region of the three districts.
- The people of this region depend entirely upon fisheries and agriculture for their livelihood.
- Beach seine is the most commonly employed fishing technique and the one responsible for the greatest catch.

- The catches and yields (YPUE) have generally decreased over the past few years.

The primary repercussions and problems facing artisenal fisheries in the three districts are:

- Fishermen, in general, earn little from this activity, which is primarily one of subsistence.
- Great numbers of young shrimp are caught in nets having very small mesh sizes (mosquito nets).
- Fish selling and processing are limited enterprises. Highest-quality fish are difficult to sell to the most important markets. Smaller fish are preserved more easily, are cheaper and therefore in higher demand; thus the use of mosquito nets.
- The primary management strategy – prohibition periods – is often ignored. Most fishermen claim that the prohibition coincides with the least promising phase for agriculture and that no other income-generating alternatives exist.

As regards industrial and semi-industrial fisheries in the Sofala Bank, the following can be stressed:

- Fishing effort has been ever on the rise. Effort has been carried out through nocturnal fishing as well for the past few years.
- Yearly catches have been relatively stable.
- Fisheries yields have decreased over the years. Calculating catches in terms of effort since 1998, we can conclude that increased effort has not given rise to catch increases.
- A bio-economic study of fisheries calculating catches, effort, production costs (primarily fuel), concluded that a similar catch could be achieved with the employment of less effort, and result then in greater profits.
- The IIP recommends reducing effort by approximately 40% below 2005 levels.
- Greater effort has led to the harvesting of ever smaller, less expensive shrimp. A study of the link between species size and price variations concluded that reduced effort would give rise to more valuable catches of larger shrimp. These efficiencies was additionally serve to protect the shoals.

- Fish trawling in this area is multi-targeted, with each species characterized by its individual season, behavior and catch technique.
- Industrial fishing is usually subject to a three-month prohibition period.
- The by-catch is common and very large, representing up to 80-85% of the total catch. These species are of little value to industrial fishermen who have little incentive but to discard them. The by-catch is either returned to the sea or retrieved by artisenal fishermen.
- Deep-sea gamba fishing is uncommon given the species' low commercial value.

The primary repercussions and problems facing Sofala Bank industrial and semi-industrial fisheries are:

- Heightened effort has given rise to lower earnings, rendering the fishing industry less economically efficient and posing risks to the shoals of various Sofala Bank shrimp species.
- The IIP recommends a management plan that calls for a reduction in levels of effort, an increase in the prohibition period and the introduction of new prohibition periods for specific areas.
- Industrial trawlers often disregard the prohibition and the three-mile exclusion zone. This situation creates conflict with the artisenal fishermen whose equipment is often damaged or lost. Violations have lessened with the introduction of VMS systems.
- The huge volume of by-catches creates hardship for industrial fishing interests. Studies that consider improvements in netting and other equipment have not come up with much in the way of practical solutions. Perhaps alternative uses of the by-catch can be considered.
- Industrial shrimp trawlers currently face stiff competition from aquaculture concerns. Higher fuel costs have, in addition, rendered these shrimping companies less competitive in the world market.
- Illegal fishing affects industrial as well as artisenal fisheries. The most common of these practices in the region is the use of bottom lines that target tuna and sharks. The authorities lack the means to combat these illegal practices.

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Appendix I

Peneideos Shrimp and their Life Cycle

Despite the occurrence of variations, the life cycles of most peneideos shrimp is divided between the ocean and estuary zones. The adults live and spawn in the open sea. The larvae circulate from the ocean to the coastal estuary and mangrove areas. Once these shrimp reach maturity they migrate to the ocean, thereby completing the cycle of normally one year (Fig. 50) (De Freitas, 1984; King, 1995).

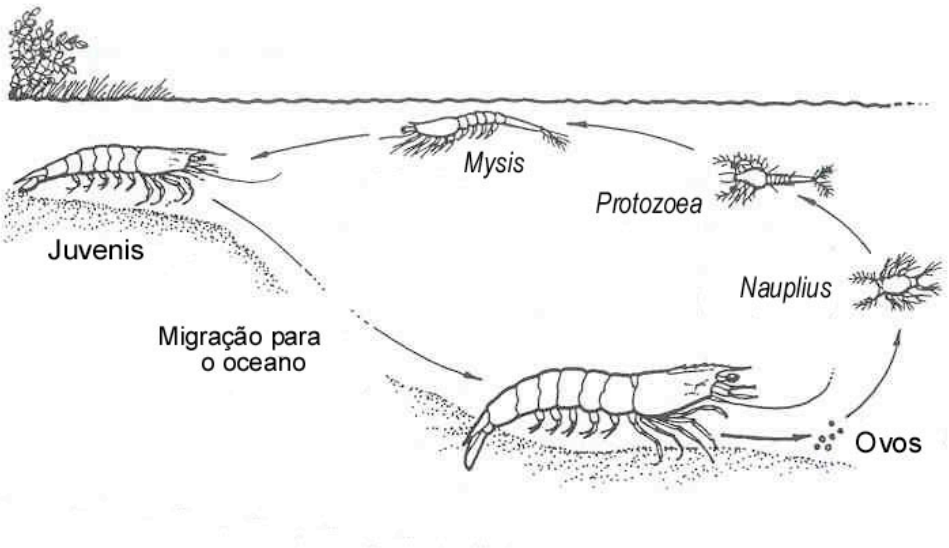

Figure 50: Life cycle of peneideos (from King, 1995)