

## **Fisheries Co-management in Inhassoro A license Limitation Programme**

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### **ABSTRACT**

The Inhassoro region has over-exploited the fisheries resource in inshore waters while the offshore fisheries are under-exploited. In order to alleviate the excess fishing effort inshore and taking into account the property rights regime on fishery, this paper proposes a License Limitation Programme such as licensed access. Such a programme is based on an existing production structure, which shows indications of a excessive number of fishing units in the inshore fisheries, represented by less share catch and their fishing conditions are very poor. The standard of living of the fishing communities that the 1996 Fishery Policy establishes for improvement will not be achieved with current characteristics of these fisheries. An improvement of the income directly from fishing will pass necessarily by definition of the property rights of exploitation of the resource. This paper suggests a gradual reduction of beach seines and increasing number of fishing units, which operate handlines (traditional fishing methods) in offshore waters in the region. A financial analysis of the operation of such fishing units has been carried out and there is evidence of an increase in individual income from fishing. A fisheries co-management system is suggested for implementation of the programme while the public management agencies will provide the scientific information and other relevant studies. The proposed studies include, among others, upgraded socio-economic surveys, marketing and processing, boat building feasibility and biological studies/stock assessment.

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## 1. INTRODUCTION

The Republic of Mozambique has a coastline of about 2 700 km, along which there is a considerable number of inhabitants who depend on fisheries for a living. There are three categories of fisheries: industrial, semi-industrial, and artisanal. The industrial and semi-industrial fisheries mainly exploit crustaceans and high value fish, which are 40% of the total Mozambican foreign exchange earnings. The number of employees in both fisheries together is estimated at 8,500 people. The artisanal fisheries play an important role as alternative employment for most coastal communities and supply the domestic market.

According to the current frame survey of the Institute for Development of Small Scale Fisheries, there are more than 80 000 artisanal fishermen with 787 landing sites and their fleet numbers about 12 740 vessels. The artisanal fisheries exploit the coastal and onshore zones using seine, handline, gillnets and fishtraps. The vessels are usually 3 to 10 m (for example lancha, chata and casquinha). It is estimated that artisanal fishers catch about 100 000 tons of fish although there is no available statistical information to support this.

Although there is well-documented biological information on some fish stocks (e.g. shrimp) that are targeted by the industrial fleet, little information is available on the stocks targeted by artisanal fisheries. The fishery policy carried out by the Government of Mozambique (Decreto 16/96) defines research priorities on resources, which have economic importance in terms of income or social impact (food security or subsistence).

Furthermore the 1996 Fishery Policy defines, as priority areas for research on artisanal resources, Maputo Bay, Inhambane Bay, Inhassoro, Mozambique Island and Pemba Bay, which currently show indications of overfishing. In some of these areas, including the Angoche Region, the collection of biological and economic data based on random sampling of catches and fishing effort has begun. Currently the collection of fisheries statistics in the Inhassoro Region is co-funded by the French Bilateral Development Cooperation. This program will continue for the next two years.

It has been estimated that the Inhassoro Region has renewable marine resources of considerable potential. Despite this, as mentioned earlier, the artisanal resources are currently being overexploited which of course lowers the benefits from the fisheries both for the fishermen and the consumers. Current management measures introduced by the former Colonial Administration, including minimum mesh size, closed seasons, and limits on the number of mechanised seines, do not appear to be sufficient in controlling the exploitation rate.

The 1996 Fishery Policy Act established that the management of the artisanal fisheries would involve the communities. It is clear that the state will provide scientific information to help with decision-making regarding the exploitation of those resources. There have been attempts to establish organisations of fishermen, taking into account their social structure. The key issue is how to establish and maintain a sustainable fisheries research and management system, given the budget constraints of the Government. This project will try to address the lack of funds by recommending measures to deal with that particular problem.

The introduction and administration of a resource rent charge involves costs and so its collection is only justified if the expected value of the rent exceeds the cost of collecting rent by a significant margin. Such a margin is necessary because of the uncertainties inherent in assessing the size of the rent. Rents in most existing fisheries are low or non-existent because the property right of fishermen, under the common, input-based management schemes, are poorly defined, and as such fishermen competitively increase their fishing effort. Thus the total costs of fishing increases and the rent is subsequently lost. A resource rent is created when the access to the resource in question is limited in some way and therefore it is important to define property rights as clearly as possible.

The commercial fisheries in Mozambique consist of both industrial and small-scale (artisanal) sectors. There is evidence that the industrial fishery is more profitable and that income from the small-scale fisheries is low because of the technological inefficiency of traditional fishing methods. Under open access small-scale fisheries, some fisheries resources are overexploited as a consequence of a high fishing effort. Several authors have documented the optimal level of fishing effort and the cost of fishing, based on the Cobb-Douglas Production function, and others developing owner models. Both methods focus on the marginal cost, such as fishing input cost, which must be equal to the marginal revenues. That indicates the level where maximum rents are obtained (economic concepts). These attempts are better documented in industrial fisheries and very few cases are reported regarding small-scale fisheries. One reason for the lack of research is that there is almost no available financial cost data on artisanal fisheries. Another is that the small-scale fisheries employ less capital and the fishing effort is directly related to the number of fishers involved in the fishery, which can be very hard to determine. Small-scale fleets are often homogeneous and even if individual fishermen generate small amounts of fishing effort, the whole group together can produce an unsustainable level of fishing effort. It follows that the sum of the number of participants in a small-scale fishery determines the level of fishing effort. There is ample evidence that limiting the entry will minimise the current overexploitation. The most obvious way to do that is through a fishing license limitation system. Following the principle that artisanal fisheries can generate a net social surplus, this paper proposes a license limitation program for Inhassoro, a district of the Inhambane province. The analysis is based on characteristic of production and it assumes fixed-cost of inputs. The lack of financial resources from the Government of Mozambique for scientific research and statistical sampling of the small-scale fisheries has limited the extent of management plan recommendations. There have been developed data collection programs for the sampling of small-scale fisheries but they do not allow for overtime working. An attempt has been made to establish an artisanal fisheries data collection system sampling catches. The funding of the program is uncertain even if it has been considered cost effective. Experience gained in other small-scale fisheries has shown the difficulty in gathering data in overtime because of the financial limitations on monitoring programs. All public investments have time limits and the few data collection programs currently being run are no exceptions (only three provinces). It is therefore most important to attempt to continue the programs already in place, so as to have a temporal perspective on the data. Finally it is important to note that the extent of scientific information limits the ability of the public management agencies in providing sustainable management advice to the artisanal fishermen. The artisanal fishermen have informal agreements among themselves on closed seasons and other conservation measures. The Government through the Fisheries Administration Service at the provincial level ratifies and enforces the agreements. The main issue examined in this paper is how to recover management cost at minimum total operations cost, taking into account the rents created by the artisanal fisheries.

## **2. INHASSORO REGION: FISHERIES CHARACTERISTICS**

The District of Inhassoro is located in the northeast part of the Inhambane province, Mozambique, and covers an area of 6 300 km<sup>2</sup>. Lopes (1995) estimated that there were approximately 60 000 inhabitants, based on a survey of the local administration authority. This is contrary to the 33 748 inhabitants cited by Falcao (1993) based on the census carried out in 1989. However, the current number of inhabitants is bound to change according to the

census carried out by the National Statistic Institute in 1997, whose results have not yet been published.

Although not mentioned much in the literature, it is well known that most people live in the coastal area and on the islands of the Bazaruto archipelago, and depend on fisheries. As Falcao (1993) and Lopes (1995) observed, the fishery was the principal economic activity in terms of cash income. Agriculture is mostly subsistence with a small surplus for commercialisation. Between 1980 and 1990, war and drought were singled out as the major development constraints in the region.

Falcao (1993) concluded that the income level of most households, in general, was low. There was a considerable difference in income between, permanent employees (skipper and crewmembers) and individual fishermen.

Presently, the consensus for development in the region in the medium-term indicates fisheries and tourism as key sectors, mainly on the coastline. The District of Inhassoro has a considerable potential for tourism. There is the Bazaruto archipelago that has appeal for tourists from South Africa and from Zimbabwe. The Inhassoro Village is closer to Bazaruto archipelago than Vilankulos, but presently the tourists have preferred the latter since it has infrastructure such as an airport, hotel accommodation and other services.

## 2.1 Fisheries Resources

Since March 1997, R/V Fengur has been conducting intensive bottom trawl surveys on the shelf area of Mozambique. The main purpose of the survey has been to determine distribution, abundance, length distributions, and species composition of the marine resource (Almada and Brito 1998). The survey report for the 1997 survey estimated a total biomass of 1 363 749 tons. The 1997 survey covered 80% of the total coastal area, i.e. between the coordinates 16 20'-17 00' and 25 58'-26 51'. The 1998 survey revised the previous estimate to a total of 534 889 tons, less than half of the total biomass index for 1997. For the sub-area that includes Inhassoro, the biomass index estimate was 6 483 tons in 1998 and 1 559 tons in 1997. Table 1 shows the main species in the survey in the sub-area between Macau and Magaruque Islands, which covers the Inhassoro region.

Table 1: Catch rates (kg/h), distribution indices (tons) (Almada and Brito 1998 and 1999).

	Survey 1997		Survey 1998	
	Biomass	Catch rate	Biomass	Catch rate
<i>Lutjanidae</i>	532,2	14,8	3 221	89,3
<i>Lethrinidae</i>	431	12,0	1768	49,2
<i>Deperidae</i>	1 018	28,2		
<i>Synodontidae</i>	383	15,7	5	0,4

Kristiansen et al. (1995) mentioned that the species composition of the catches of the seines surveyed by a team of biologists, during the case study on fishery co-management in Inhassoro, had been mostly represented by the following species: *Lutjanus fulvus*, *Lethrinus lentjan*, *Lethrinus mahsena*, *Lethrinus nebulosus*. This confirms that the resources surveyed in the 1997 and 1998 surveys of R/V Fengur can be considered to be accessible to the artisanal fisheries.

The total catch is not known. It has however been estimated from 2 000 to 3 685 tons in the early 1990's. These estimates are based on several assumptions regarding the number of licensed fishing units, daily catch rates, and number of fishing days (Falcao 1993).

The number of licenses may be including the total number of applicants during two or more past years. In the meantime some fishermen could have left the fishery or gone to other areas. The fishing unit criteria assumed that a boat was a fishing gear while a boat can operate more than a single fishing gear, although that is rare. Falcao (1993) suggested that the potential catches could be between 4 000 and 5 000 tons.

Earlier in this paper it was argued that biological research and fisheries statistics are as yet insufficient. This suggests that future management actions, at least in the short-term, must be based on conservative harvest allocations.

## 2.2 Fleet Composition

According to the census of artisanal fishery undertaken by the Institute for the Development of Small Scale Fisheries (Instituto de Desenvolvimento da Pesca de Pequena Escala - IDPPE), in 1998, the most predominant fishing units are seine/boat (about 45% of total fishing gear), followed by handline/boat (about 32%). The rest of the fleet is composed of gillnets, fish traps, fishing spear and other fishing gear. According to Falcao (1993), the composition of the artisanal fleet in 1991 was 54% seines, 29% handline, and 27% other fishing gear. It is believed that the whole fleet has declined from 257 units in 1991 to 213 in 1998, based on two censuses. Table 2 shows fishing gear distribution and number of fishermen associated with each gear type, in 1998.

Table 2: Number of fishing units and associated fishermen in 1998 (IDPPE 1998)

Type of Fishing Unit	Registered Fishing Units		Registered Fishermen	
	Number	%	Number	%
Seine	95	45	1229	72
Handline	68	32	349	20
Gill nets	28	13	69	4
Fishing Spear	14	7	37	2
Others	8	4	28	2
Total	213		1712	

Most of the seines are 50-100 m long and are pulled by 9-12 persons. The largest seines can be up to 180 m long and require about 24 persons to operate.

Inhassoro is the only the area in Mozambique where mechanised seines are used for fishing (so-called semi-industrial fishing). The nets are connected to cables, which are pulled by a tractor with a winch. There are five such mechanised seines active in the fishery.

The handline boats between 6 to 9 m in length employ at least five fishermen while the smallest boats (2 to 4 m) employ 1 or 2 fishermen.

In general, the boats are made of wood and the main means of propulsion are oars and sails. There are only 18 motorised boats and most of them are equipped with handline.

It is assumed that the average lifetime of a wooden boat is five years. Table 3 indicates that most boats are older than five years, 51% of the chata and 78% of the lancha. The chata operate mainly seine and most lancha use handline.

Table 3: Age distribution of boat type in the Inhassoro region (IDPPE 1998).

Types of boat	0 to 5 years old	< 5 to 10 years old
Chata	49%	51%
Lancha	22%	78%
Total Average	40%	60%

Traditionally fishermen do not carry ice to sea, although there is at least one ice plant in the Inhassoro region.

Given the age of the fishing vessels, the fishermen spend considerable time on maintenance and repair. Owners in the commercial fishery, contract the services of the local artisanal carpenters. A subsistence fisherman usually does the repairs himself and only resorts to external services when the repairs become complicated.

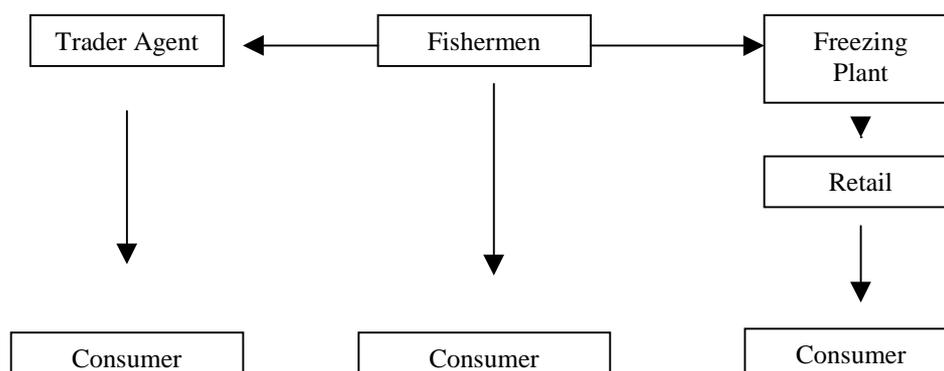
### 2.3 Processing and Marketing

The region has a long tradition of salted sun dried fish as means of preservation. Until the end of the 1950's the means of communication with the outside world was through a transport boat running through the cities of Vilankulos and Beira and all the dried fish was marketed in the cities. In the early 1960's, Inhassoro became connected to the national road system and thus markets for fresh fish become accessible (Kristiansen et al. 1995).

Presently, both dried and fresh fish products are marketed and the main domestic markets for fresh fish include the cities of Maputo (about 800 km from Inhassoro), Inhambane (about 350 km from Inhassoro) and Beira (about 400 km from Inhassoro). In these markets, the prices are two or three times higher than the production cost. At least two owners of mechanised seines have infrastructures for preservation of the product and they also buy surplus production from others commercial fishermen.

As a result of reduced competitiveness between buyers, the ex-vessel price has remained low. Nevertheless, there are numerous small buyers of dried fish but their presence in Inhassoro is not regular and consequently fishermen are sometimes forced to keep their product for a long time.

Following are the distribution channels for the fish and fish products:



### 3. THE CURRENT MANAGEMENT REGIME IN MOZAMBIQUE

#### 3.1 Fishery Policy

Overall objectives for the fisheries sector in Mozambique are based on the Government program for development. These are typical for a developing country, such as reduction of unemployment, reduction of the deficit in food supply for domestic markets and increased economic growth. Given the economic importance of the fisheries sector, which generates 40% of foreign exchange earnings, employment and supply of animal protein is relatively cheap compared to substitute products. These aspects were taken into consideration regarding the specific objectives for each fisheries sector in Mozambique.

There is evidence that the current fisheries policy was based on cost benefit analysis and it is expected that a net social surplus for society will be attained by its implementation. The 1994 Fisheries Master Plan, which was based on the fisheries policy, indicated an increase in social and economic benefit for the nation from utilisation of the fisheries resources. The strategy adopted for each objective theoretically shows that a net social and economic benefit would be achieved (appendix 1).

There are three main objectives for the fisheries sector:

- Improvement of the domestic supply of fish in order to alleviate a part of the country's food deficit by:
  1. Increasing the quantities of fish landed
  2. Reducing post harvest losses
  3. Increasing net foreign exchange earnings through increased landings for export
  4. Increasing the value added to the fish for export through onshore processing
- Maximising the viability of stock exploitation, in particular the chief product – the shrimp – transforming the present structure of the shrimp trawling fleet
- Raising the standard of living of the fishing communities, maximising the levels of employment in fishing and associated activities

It follows that the industrial fisheries should be oriented towards the export market and the small-scale sub-sector should supply the local market. The present assumption in fishery policy is that the main targeted resources are relatively different for the two sectors. The industrial fleet mainly targets the shallow water resources (shrimps) such as *Metaponaeus momoceros*, *Peneaus indus*, *peneaus*, *Penaeus semisulcatus*, *Peneaus laticulucatus* and *Penaus japonicus* while the small-scale fisheries (artisanal fisheries) catch mainly small pelagics, large pelagics and demersal species. The demersal species are reported to be under-exploited and over the past five years the semi-industrial fleet has increasingly been targeting these species.

According to the 1994 Fishery Master Plan, the improvement of the production capacity for artisanal fisheries should prioritise the fishing and collecting activities that show the best productivity and most favourable cost-benefit ratio. And fishing effort should concentrate on areas where the logistics and market conditions are favourable to transport and marketing of products.

It has been pointed out that the desire for the population to have access to cheap fish while at the same time wanting to increase employment or income in the fisheries sector are two conflicting objectives. The 1994 Fishery Master Plan is careful in that aspect, because it states that the increase of income should be achieved with increasing production or promoting activities that tend to realise the value of fisheries products that have a high commercial value and can be exported.

### 3.2 The Institutional Framework of Fisheries Management

According to the 1997 Marine Fisheries Regulation established by the Government of Mozambique (Decreto [Decree] 16/96), the Fisheries Administration Commission is to discuss issues regarding fisheries management and make recommendations regarding management measures to be adopted by the Ministry of Agriculture and Fisheries. It is a consultative group (organisation), involving representatives from public fisheries institutions (National Directorate for Fisheries, Fisheries Research Institute, Institute for the Development of Small-Scale Fisheries), fisheries industry, semi-industrial and artisanal fisheries associations.

The Ministry of Agriculture and Fisheries is in charge of the overall fisheries policy, development, and management in Mozambique. Fisheries administration (regulation and enforcement) is the responsibility of the National Directorate for Fisheries, which the Fisheries Administration Services operate under at the provincial. These ensure the observance of the fisheries law (licensing, fish quality inspection, etc.) principally with regard to industrial and semi-industrial fishing activities. However, as far as artisanal fisheries are concerned, the responsibility was delegated to the Maritime Administration, an institution under the Ministry of Transport and Communications.

In Inhassoro there is a fishermen's organisation, which has gained experience in the decision making process on fisheries management. It determines the closed season and the public fisheries administration ratifies and enforces. Over the past 5 years there have been discussions of its integration into the formal co-management that the government of Mozambique can use as an option to manage artisanal fisheries. In this perspective, the Institute for Development for Small-Scale Fisheries carried out a case study on co-management in 1995 (Kristiansen et al. 1995) and is attempting to strengthen the area to establish a so-called committee of co-management.

### 3.3 Laws and Regulations

Judicially, the fisheries resources in Mozambican waters are national property. The State, as the representative of the nation, is the owner and guardian of the fishery resource. The State is thus responsible for ensuring that fishing activities do not threaten the long term sustainability of the natural resources and that the benefits gained from these activities for the communities and for the country, as whole, are maximised (SEP 1994).

The principal fishery law is “*Lei 3/90*” which defines the role and responsibilities of the fishery administration and principles which orient fishing activities. It also defines the fisheries, namely subsistence, artisanal, semi-industrial, industrial, recreational and sport. The Fisheries Regulation (*Regulamento da Pesca Marítima, Decreto 16/96*) establishes the technical specifics for those fisheries and it appears that it clarifies the ambiguity between the subsistence fisheries and the artisanal fisheries because it takes into consideration the commercial aspect. Article 2 (1) defines the artisanal fisheries as a fishery that is carried out locally, producing surplus for commercialisation, with or without a boat that does not normally exceed a total length of 10 m, moved by means such as sails, oar and outboard or inboard engines (less than 74 kW). The fishing operations do not usually take more than 24 hours; ice or other means to preserve the catches on board is seldom used.

The fisheries licensing procedures are stated in chapter IV (sections I, II, III) of the 1996 Regulation of Maritime Fisheries. Section II (article 115) states that it is the Ministers authority to issue fishing licenses. Article 115 (4) states that artisanal fisheries are licensed under the Maritime's authority, which will represent the Ministry of Agriculture and Fisheries or if it is

lacking the District Administration or Locality. This article also empowers the Minister of Agriculture and Fisheries to execute the alteration of the organisational framework of the fishing licenses for management purposes.

Article 116 (2) states the legal conditions for the fishing license, such as inspection certification of fishing gear and vessel according to the specifications corresponding to the particular fisheries. For example, registration of a boat through the Maritime Authority and under limited length and minimum mesh size.

Chapter III, Section I, article 6 describes the fishing gears authorised to all fisheries. Article 29 (1) of this section defines the minimum mesh size for seines. It (e) establishes 38 mm for seine as minimum mesh size. Article 38 states minimum distance for a seine shelter to others fishing gear, ¼ miles. Other fishing areas for seines and point 4 states that seine, using mechanical means to set net.

Chapter V, section 2, article 73 fixes the limit on distance for artisanal boats at 3, 6, and 12 miles according to safety at sea. Only boats with motors can operate at 6 and 12 miles.

Any interpretation of the rules mentioned above is solely the responsibility of the author of this paper. The regulation is originally written in Portuguese.

## **4. ANALYSIS OF THE STUDY AREA**

### **4.1 Seine**

As mentioned in Chapter 2, the fleet in Inhassoro is constituted mostly by manual seine boats, which are exerting a major fishing effort. It is described by Kristiansen et al. (1995) that the management goal of the plan carried out in 1974 was to rebuild prediction models and it has been assumed that mechanised seines that capture juveniles increased the fishing effort substantially. The artisanal fisheries in Mozambique at the moment are characterised by open access, from the 1980's the number of fishermen has increased and as the seine is considered more productive than the handline, new entrants preferred to invest in seines which are similar to the mechanised seines. Because the manual seines catch (operate) in the same fishing grounds as mechanised seines, excess effort was to be avoided by restricting the use of mechanised seines. As for achieving that goal there are currently 90 manual seines in operation compared to 9 in 1974.

Assuming that the length of boat determines the length of the seine net (to be confirmed) and based on the frame survey of the artisanal fisheries, it is concluded that more than 70% of seines are less than 150 m long, using boats between 3 and 7,5 m where investment capital is relatively low compared with owners of large nets. The average age of those boats is 6 years. Consequently the fishing operations decline corresponding to diminished returns because of excess fishing effort. There is no reposition of investment, given uncertainty of the catches and the income from the fishery does not cover fishing gear cost, which is considered expensive by fishermen. The only variable for these fisheries is labour and its cost is proportional to catch. The opportunity cost for employment is not applicable because they are rare in this case. However, it is common that the fishermen earn annually less than the minimum salary established by the Government, including their catch share for their own consumption.

The user group with long nets has less variable conditions. The few fishers who use long rope (2000-3000 m) to set seine employ at least 20 people to pull the net and their catch levels are relatively great because they are fishing on grounds further out. It is common that they catch at least 1,5 tons per throw, which is similar to what is captured by mechanised seine.

The characteristics of the net of manual and mechanised seines are not considerably different. However, these two user groups differ in that the manual seine employ many people while the mechanised employ relatively few people, especially to set net at sea and they both use the same labour for required assistance on beach and support fuel cost. As fisheries are overexploited, the marginal cost for mechanised seines were increased even if there is no fishing effort cost data.

Some owners of mechanised seines are involved in others business such as tourism, commerce, etc. Their permanence on fishery is historical, although no specific study has been carried out, with some reservation it can be said that they are subsidizing the fishery with rent from others activities. For example, they are fish wholesales and their production is sold to the markets, which pay relatively high prices.

Table 4 shows distribution of seines, based on length of boats. It is assumed that seines between 50 and 90 m use boats 3 to 5 m, seine between 100 and 140 m use boats 6 to 7,5 m, and seines between 150 and 180 m use boats over 7,5 m.

Table 4: Distribution of seines by length (IDPPE 1998).

Type of boats	Seine length		
	50 – 90 m	100 – 140 m	150 – 180 m
Chata	2	6	13
Lancha	23	31	12
Canoa	3		
Total	28	37	25

Though there is no data on fished stocks, it appears that by itself closed seasons are not achieving a reduced level of fishing effort. It has been argued that closed seasons do not effectively regulate the seine fishery because of an increased fishing pressure in open seasons. This means that the largest part of the vulnerable stock can be harvested very early in the fishing season and consequently the catches decline over the remainder of the season. Attempts made by the fishermen to extend the closed season from 3 to 4 months in 1992 and to 5 months in 1993 supports this assumption (Kristiansen et al. 1995). From 1994 the fishermen have observed a 4 month closed season.

There is no data on stock age distribution. The additional conservation measure of minimum mesh size is helpful to protect juveniles. The main issue for these fisheries is stock reproduction and with the current excess level of exploitation, where seine is the main culprit, effort control is required.

## 4.2 Handline

Handline boats operate both inshore and offshore. There are no data on target species composition either for seines or for this fishery but it is believed that the species composition is similar. From a biological and management perspective, this means that both fisheries are exploiting the same stock. Nevertheless, experience gained in the region suggests that the handline boats that are fishing inshore catch medium size and large fish and its price is relatively high, thus raising the income of these fishermen. Additionally, by selecting the correct hook size the fishermen can avoid juveniles in catches and it appears to be more effective than minimum mesh size measures, if the management goal is the protection of the stock. However, it is not one of the management purposes taken into consideration in this paper.

Handline boats fishing inshore use motors and employ between 8 and 10 people. It is estimated that each fisherman catches at least 7 kg per day. This results in average daily catches of at least 50 kg. The variable inputs are fuel, bait, and labour. The major constraint of these fisheries is that there is no tradition in the use of ice, which limits the duration of fishing. Since its fishing operations are usually far from port the variable fuel costs are high. This fishery is thus vulnerable to marginal production cost as opposed to manual seines, where investment in fishing gear is of main concern. To lower fuel and bait costs, handline fishermen only use the motor when weather conditions are not favourable for sail or oar and often catch the bait themselves.

There are also handline boats that operate offshore. These have usually sails and oars and prefer fishing in areas closer to landing sites (near to where they live).

Table 5 shows the distribution of boats by type and propulsion system. The propulsion system predominant in these fisheries is sail/oar and, although the table does show it, most of the sailboats are less 7 m long. The lancha, chata and canoe are made by local carpenters and two others, namely NP FV, NP MD were introduced by a company (NAVIPESCA) resulting from a program for the development of small-scale fisheries.

Table 5: distribution of boats by type and by propulsion system

Type of boats	Propulsion System		Total
	Motorised	Sail and Oar	
Lancha	12	31	43
Chata		22	22
NP FV	7		7
NP MD	2		2
Canoa		7	7
	21	60	81

More recently, five vessels were rebuilt for fishing inshore through a funding program by Irish aid and implemented by the Institute for Development of Small Scale Fisheries whose aim is to promote these fisheries. It is believed that in the short and medium term any development for fisheries must focus on the near shore fishing.

However, the semi-industrial fleet is also developing the near shore fishing and fishing licenses are issued by the Provincial Fisheries Services and the next district is also issuing licenses. This suggests that a license limitation program must be coordinated between different users. The development option for local fishery needs to focus on the offshore fisheries.

## 5. ASSESSMENT OF CO-MANAGEMENT

The conditions for successful co-management are defined as the sharing of responsibilities of resource management between a government and organisation(s) of fishermen and their communities (Harrington 1997). This is further described as follows:

- Legalise the community government structure so they are recognised government bodies

- Bring together the managing agencies with community and regional governments and non-government organisations (NGOs) to create a co-management body and devise how the co-management will be structured and how duties will be shared and divided
- Create institutional design of a co-management system
- Devise how to incorporate all stakeholders into co-management
- Create and implement a management plan and mechanism, feedback and information gathering, and identify success criteria
- Adapt a management plan using feedback and new scientific information

This chapter analyses the current fisheries resource management regime and identifies the conditions that suggest that a co-management system for Inhassoro would be appropriate. From the 1980's, the fisheries in Inhassoro have been under local management, based on fishermen's agreements. The fishermen involved are mainly owners of seines, and determine the closed season and enforcement commitment. The ultimate goal of the co-management system is to try to cover and involve other fisheries and representatives from other local institutions. The committee for co-management suggests this in a recent proposal, which still has to be approved by the provincial government.

However, the current co-management system is only a forum. It should function in an advisory capacity towards fisheries management and be answerable to the fisheries administration. The first step mentioned above assumes the establishment of a local co-management authority that has the legal authority to manage the resource on a local level. Harrington (1997) argued that creating a co-management system requires a clear legal definition of local powers.

Several authors assessing co-management of small-scale fisheries have reported that socio-cultural aspects are more important than the economic aspect. Lopes (1995) reported that the fishing communities in Inhassoro need license fees and other tax payments but do not trust the Marine Administration to collect these payments for them. In 1991 representatives of fishermen were allowed to collect the taxes with good results.

The social structure of fishermen in Inhassoro was described by Lopes (1995). The structure was basically composed of semi-industrial stakeholders (mechanised seines) and artisanal stakeholders (carpenters, net makers and artisanal fishermen). The structure has not changed to the present day. Lopes (1995) and Kristiansen et al. (1995) reported that there were conflicts of interests between the semi-industrial and artisanal fisheries. Furthermore, Kristiansen et al. (1995) advocated a co-management system of fisheries management, because of its flexibility and ability to come up with a balanced decision making situation. These studies suggest that to establish a legal institutional framework in Inhassoro, there is a need to strengthen existing social structures, in which the communities feel that they are playing a part in the co-management process. This arrangement is currently being carried out through the Institute for Development of Small Scale Fisheries.

Under the 1996 Marine Fisheries Act, the Minister of Agriculture and Fisheries has power to make alterations on the institutional framework. However, it does not make clear the legal grounds of the local aspect of the fisheries management. The 1996 Fisheries Regulation prescribes the representation of the Ministry of Agriculture and Fisheries at the local level in the artisanal fisheries.

The local government consists of an aggregation of the existing bodies of the different local government institutions supposedly under Local Administration. However, they are not directly subordinate to the administration, they only collaborate and coordinate activities at the district level. Therefore, the establishment of local management agencies appears to be, at least in the short term, impossible because first the various legal aspects must be cleared up and may delay the co-management implementation process. On the other hand, the

institutional arrangement that is described below offers advantages to the co-management system.

The second step refers to the need for coordination between all user groups (government agencies, NGO's and direct participants in the fishery). The existing social structure needs strengthening. Central Government programs allow researchers in the area regularly and at the local level there is a Directorate of Agriculture and Fisheries, a Marine Administration and more recently fisheries statistics enumerators, which are employed to gather fisheries statistic through the national statistical program. There is connection between the government and the informal fishermen's organisation.

However, there is a lack of infrastructure, furniture, communication equipment, means of transport, etc. A national program should provide these. The infrastructure will serve the government employees, representatives of fishermen (chairman elected by fishermen) and the fisheries statistics team. The government should employ only one officer at the local level who will coordinate all activities. Any specific program must employ local people with periodic technical assistance from the national technical staff.

These assumptions will be helpful in the third step, which will entail the institutional design of a co-management system. First it will be necessary to create community committees, following a model adopted by the Institution for Development of Small Scale Fisheries which encourages fishermen to form associations based on geographic areas. However, given the difference of interest, it would be necessary to ensure "equality" in the composition of representatives of associations and the validation of their opinions.

"It is often that the decision makers carry out programs based strictly on ideology and economic values without taking into account the social-cultural aspect of the target group" (Lopes 1995 p.76). This implies that if the differences between fishermen organisations are not considered, the social structures will be destroyed and consequently the co-management will be unsuccessful because of social pressure.

In the Inhassoro region the artisanal fishermen are characterised by low income from fisheries, operating defective fishing units. The availability of credit facilities, for artisanal fishers in general is rare or non-existent. It appears that the situation has not changed from how it was previously described, "actual accumulation of capital is, in general, far from sufficient for major replacement and even less for investment in new units" (Falcao 1993 p.76). It follows that the motivation of this social group to participate in co-management will depend on the improvement of their fishing conditions. The collective action must have at least one specific objective and for this group it should be to improve their income from the fisheries. For example "since the introduction of the ITQ system in New Zealand, associations of quota holder have begun to develop. These associations have sought and obtained agreements restricting harvest, spread the catch out over time, and redefined management areas in a more operational manner so that investment can be undertaken" (Johnson 1995 p.338).

If we assume that the artisanal fisheries are over-exploited, as the evidence suggests, how can the income of artisanal fishermen increase? Fisheries revenue is expressed as being a function of harvest and price. If actual catches remain the same or decline, as price is constant that means that income will at most remain the same or decrease. It therefore appears that if fishermen make community associations and decide to lower the effort their income will increase, but they do not have the incentive to do so.

We suggest that the needed incentive for the fishermen to establish a co-management system is the opportunity to exploit the open sea resources, which are apparently of high commercial value. To do that, they need sufficient capital investment to invest in motorised boats. To address this issue a credit component must be incorporated, which should also include a sub-component for training in business management.

Lopes (1995) also described the credit opportunities for this group as limited. He reported that there was no indication of this group becoming competitive on the market that focuses on maximising utility, i.e. maximum rent. It has been argued that it was rather that they were closer to a traditional economy than it was a reflection of “cultural variables (family and relatives, magic-traditional practices)” (Lopes 1995 p.70).

The fisheries management regime incorporates a fisheries management system, monitoring, control and surveillance, and a fisheries judicial system. Management systems usually controlled by the central government and a co-management system, have been two options for governments in managing their fisheries resources. The judicial part of the fisheries management system is integrated into the national judicial system. Local institutions should have the function of monitoring, controlling, and surveillance. To enforce the agreed management measures of a co-management regime the decisions have to be ratified by the Provincial Services of the Fisheries Administration. The Minister of Agriculture and Fisheries should approve any substantial alterations of the management system.

The local institutions can also have the function of a credit facilitator and community development. Associating these functions with monitoring, control, and surveillance, the institution will be composed of:

- One officer under Provincial Services of the fisheries administration who should represent the three public institutions
- Two extension workers (data collector and biologist) under the Institute for Development of Small-Scale Fisheries.

The communities should, at least in the medium term, provide the data collectors themselves. The office should also serve as a representative of the fishing associations. Fishermen’s associations with supervision of the officer should agree upon the framework for credit facilities and community development. As has been illustrated above, the staff of the central institutions should observe the time frame of the assistance. Technical staff of the institutes should ensure the availability of information for biological and socio-economic research. Therefore, duties should be divided as follows:

<b>Institutions:</b>	<b>Responsibilities<sup>1</sup>:</b>
Fisheries National Directorate	• Carry out regulations
IDPPE	• Socio-economic study, extension activities
IIP	• Biological study
SPAP	• Fisheries administration (rules, collection of license fees)
Local institutions	• Fisheries statistics, fisheries program implementation
Fishermen's Organisations	• Enforcement, control, credit application
FFP	• Credit funds
NGOs	• Community development projects

Participants should be organised in associations and name their own representatives. Representatives of all associations should participate in the debate on the management system. It is necessary to ensure that their members agree upon the management resolutions

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<sup>1</sup> To be developed further in a management plan

coming out of the debate. The region also has a traditional structure, which could participate in the decision making process at the community level. However, that would require a specific study because the traditional power structure functions as an authority. Co-management makes partners of the stakeholders, both of the stakeholder representatives and of the fishermen themselves.

Another element that must be taken into account is language, “[the co-management system] can also utilise Xitsua, as the basis for the development actions, i.e. extension, training, etc.” (Lopes 1995 p.77).

## 6. MANAGEMENT PLAN

The current management of marine resources accessible to the artisanal fisheries has quite exclusively concentrated on the registration of artisanal fishing units in an annually renewable fishing license system. There has been no clear policy regarding limitations on the number of licenses. The access licenses are mostly limited to the industrial and semi-industrial sector, which exploits fisheries resources that have a known harvesting potential. The estimates of exploitation potential are supplied through surveys conducted by the Fisheries Research Institute. However, there is a general consensus that the degree of excess fishing effort in the artisanal fisheries is high, at least in some areas. These areas are indicated in the 1996 Fishery Policy and research into management solutions for the areas have the highest priority. To alleviate the over-exploitation, artisanal fishermen have been encouraged to exploit offshore resources under the assumption that these are under-exploited. The optimal exploitation rate for the offshore resources is not currently known and research results are pending.

One of the major problems in world fisheries today is the over-capacity of fishing fleets resulting from fisheries management failure. Various studies have been carried out that point out these failures and have suggested that the solution lies in clearer property rights. Each kind of property right has its advantages and limitations. An Individual Transferable Quota Systems is more successful in managing fisheries but it can bring a monopoly situation on fishery because it assumes the existence of a market system for the transfer of quota. In most developing countries the national industrial fisheries are not yet competitive. For example, in Mozambique, the shrimp fisheries were dominated by two joint venture companies (Government of Mozambique and a Japanese company and Government of Mozambique and a Spanish company). Most national private entrepreneurs carried out the fishing with the semi-industrial fleet. Obviously, if an ITQ system were introduced, the joint venture companies would not have any competitors, unless special measures were taken.

The recent shrimp strategy carried out by the Government of Mozambique introduces a change to an Individual Quota Regime (IQ). This substantial change in management limits the access to fishing by introducing a limited amount of standardised fishing effort. Thus, the IQ is exclusively a reference point for statistical purposes and for fisheries licensing. It is implicit that vessels, which operate in excess of the standard fishing effort, will lose the opportunity to maximise its initial allocation of quota shares. It is evident that those operations that are willing and able to adapt their strategies will become profitable. It is also clear that operational management cost will be recovered by collection of license fee revenues in the industrial fishery.

It has been documented that for the artisanal fisheries resources any changes will have to be extensions on the current co-management system. However, it is not clear if management operational costs will be recovered by collecting license fees from the fishermen. It is also not clear that the artisanal fleet will move to the offshore fisheries grounds as intended.

The management plan presented here involves a license limitation program for the Inhassoro region. It is an empirical project that can be adjusted with the availability of reliable data. This initial attempt defines a model for the cost recovery of artisanal fisheries management. The following assumptions are used to structure the management plan:

- Maximum catches of a motorised boat (local construction), using handline is 40 tons per year
- Maximum catches of a motorised vessel (built by NAVIPESCA) is 100 tons per year
- Maximum catches of a rebuilt motorised vessel by the project “development for open sea fishery” implemented by IDPPE is 75 tons per year.
- Maximum catches of a non-motorised boat with handline is 30 tons per year
- Limit the number of mechanised seines (5) and set limit by fishing season estimated at 90 per year.
- Set of the longest manual seine is equilibrated to mechanised seine at 50 tons per year.
- Other seines (less than 100 m) catch 20 tons per year.

### **Opportunities and Limitations**

#### *Opportunities*

- The existence of a Fisheries policy
- The existence of a Marine Fishery Regulation
- The existence of public institutions dealing with fisheries co-management
- The existence of a Co-management Program
- Existing credit funds
- The existence of an informal social structure
- Experience of resource management by the fishermen themselves
- Fisheries statistics system

#### *Limitations*

- Lack of landing infrastructure
- Non-existence of credit institutions
- Difficult to have formal access to credit
- Weakness in marketing fish
- Performance in business management weak
- Competition in the offshore fisheries
- Political incentive to promote semi-industrial fisheries
- Fishing License concession system in the semi-industrial by SPAP
- Fishing License concession system of the industrial fisheries by the Minister of Fisheries
- Exploitation of fisheries resources with other management regimes
- Lack of proper jurisdiction

## **6.1 Objectives and Goals**

#### *Objectives:*

Sustainable utilisation of fisheries resources through the participation of the local community in order to optimise physical yields and improve the socio-economic returns from the fishery. Sustaining the fisheries statistics system for artisanal fisheries through the recovery of management costs.

### Goals

- To reduce excess fishing effort in the coastal area through limiting the number of seines
- To reduce the amount of juvenile and small size fish in artisanal catches
- To obtain a net social surplus from fisheries both for consumers, producers, processors and for society in general
- Self-sufficiency of operational management cost

## 7. STRATEGIES

### 7.1 The Production Sector

The decline of the catches in the inshore fisheries has resulted in an excess number of active fishing units. The participants in the inshore fishery include a considerable number of small boats operating mechanical handline as well as manually operated seines. The scenario has not changed much at the present moment. The increase of catch will fundamentally result in the exclusion of a predetermined number of operators. The strategy will be oriented towards a gradual reduction in the number of fishing units, represented by seines, which are the major source of fishing effort. At the same time the capacity of the offshore fleet will be increased. In general, the smallest boats produce lower quantity of fish with consequential lower incomes. Strategies in this area will not be aimed at replacing these boats. Fishing opportunities will be offered through their integration into the medium boat category, which will operate offshore and onshore employment in other fishing activities (e.g. fish processing).

The fisheries in the offshore waters are accessible to other fishers outside the region such as the licensed semi-industrial fleet at the provincial level and the artisanal fleet of the Viankulo district. The strategy will establish a reference point of quota for each fisheries management system, based on a relatively conservative fishing mortality rate for instance  $F_{0.1}$  of survey cruise stock assessment while the research is still in progress thereby adhering to the precautionary principle.

The number of artisanal fishers is not regulated and there is a considerable number of unlicensed boats, which are fishing in the area. The strategy will be to establish criteria, which identifies the historical dependence on fisheries and the priorities of fishing allocation rights and terms of conditions.

Dried and fresh artisanal fish has potential markets, however the actual wholesale sector shows weak marketing capacity. A strategy will be adopted to encourage potential investors in the region to expand their means of transport, cold storage network, and other facilities (e.g. ice plants and dried fish infrastructure).

The access to bank credit is limited for artisanal fishermen and there are few alternatives. The monetary policy of the Government is restrictive and the commercial banks lend the sub-sectors, which offer high return in the short-term such as goods traders. The artisanal fisheries are still not a priority. The reinvestment in the sector for rents from industrial fishery has been reduced. The adopted financial strategy of the Government consists of retaining 50% of the license fee revenue, but has not as yet shown significant progress. Only a low margin is applied to the production sector and high percentage covers the current expenditure of public institutions. The strategy to be adopted to address the lack of credit for artisanal fisheries should be to create a special fund. Its application should be negotiated with the local commercial banks as a medium term credit to be lent to the applicants who have been deemed eligible by the co-management committee.

## 7.2 Research

Not much known about the abundance of fisheries resources in the offshore waters and access to them is currently limited. In contrast, the fisheries resources in the inshore waters are accessible but again stock status is barely known. The research strategy must be based on a clear definition of the objectives and choice of appropriate methods for the short-term, advice on a reference point of range of species and availability for harvest. The biological data collection will be carried out through a national program to determine distribution, abundance, age-structure and species composition of the marine resources accessible to the small-scale fisheries. The current survey cruises carried out by the Fisheries Research Institute should continue with the support of government investment funds and donor funds. The license fee revenues used to cover the costs for landing site fisheries data collection *should be reduced* in this system. There must be a formal agreement with legal institutions whereby a part of the revenue from the license fee collected in the artisanal fisheries goes towards the data collection program. The remainder should be covered by tax revenue from the industrial fisheries.

## 7.3 Monitoring

There are about fifteen evenly distributed landing sites. The distance between the furthest of them, Ngovane/Bartolomeu Dias and Nhagondzene, is 33 km. There are two islands in the region, namely Bazaruto and Santa Carolina. There are estimated to be 100 active fishing units per day in both the inshore and offshore fisheries. The number of vessels in the Vilankulo and Inhambane fleets is not known. Currently, trained personnel carry out the monitoring of the catches in the coastal area, including Vilankulo. The monitoring is based on random sampling, catch amount, fishing trip duration, species length and size and active fishing gear. The semi-industrial fleet reports the catches and fishing effort to the Fisheries Administration at the provincial level. The monitoring strategy should be to collect data from the two sources. It will be necessary to carry out the design of data collection for the semi-industrial fleet in order to integrate the data processing on fishing effort. This is fully justified if it is confirmed that the two fisheries exploit the same stocks.

The region has management measures such as closed seasons and minimum mesh size. Additionally, surveys will be planned for the closed seasons. Surveys will also be carried out in the offshore waters, using fishing techniques such as longlines and other fishing methods to determine catch per unit effort in order to recommend feasible fishery exploitation rates in the start up phase of the offshore fisheries.

## 7.4 Control

There are numerous landing sites, but the fishers know the identity of all participants in fisheries in their respective communities. The control strategy will focus on participation of fishermen who should report infractions to the local co-management committee for consensual decision. Local institutions should resolve any disputes and/or lawsuits. The members of the community shall be responsible for all activities and should report to the local institution. A monthly meeting will be organised to evaluate the efficiency of the control process. The meetings will become quarterly depending on the progress of the management system.

## 7.5 Enforcement

Fisheries Directorate under Minister of Agriculture and Fisheries carries out the regulatory measures of the Fisheries Act. Its observance and enforcement are delegated to the Fisheries Administration and Marine Authorities. For instance, the local institution will be empowered under Agriculture and Fishery's Minister Diploma.

Because the current process of regulation shows less flexibility, it is suggested Fisheries Administration at the provincial level would formalise that decision-making, based on consensual agreements between fishing communities and local institutions.

### 7.5.1 Rights Allocation or License Concessions

The fishing licenses are issued on annual basis and last until 31 of December of the same year. The licenses should normally be continued. Additionally in the offshore fishery the rights should be allocated for at least three years for new investors. This means that some kind of property right should be introduced connected to the fishing license, entitling the license holder to participate in the fishery. Nevertheless it has to be kept in mind that if the property right is weak then the common-property problem is not eliminated. This is because the investment capital can expand with the associated overcapitalisation and over-exploitation (Arnason 1995). The license system is very useful as a short to medium term solution of the current management issues in the Inhassoro fisheries where it is important to increase the production capacity of the offshore fisheries, while the effort is being decreased in the inshore fisheries. The monitoring system advises on the capacity of the fleet.

Strategically, the property rights or access licenses will be allocated to participants with historical participation in the fisheries, such as vessel owners or others with proven ability of fishing. Furthermore, property rights are associated with the fishing vessel or unit and thus the object of transfer is the fishing unit.

The fishing unit that operates seines will not have the long-term access license, but will still be regulated on an annual basis. Same criteria will be applied to boats under 7 m long for any specifically regulated fishing gear.

New entrants in the fishery will be limited according to the results of the abundance estimates of the fisheries resources. When the resource increases the number of local license holders can increase. It may appear that these assumptions do not take the market system into account but that it is not case. A collective action that brings about suitable fishing activity is helpful for the management system. There is evidence that a co-management system presupposes the existence of coherent groups of fishermen and it appears that existing groups show a relatively high level of cooperation, although their interests differ.

## 7.6 Collection of License Fees

Currently, the Marine authority collects the license fees. Only half of the current number of participants pays the license fee. In order to abate this situation, the collection of the license fee should be delegated to the local co-management committee. The license fees should then go to the local institution, which issues the fishing licenses. Based on the financial capacity of some of the local fishers the license fees should be paid in three equal instalments during the license year.

## 7.7 Distribution of the Revenue from License Fees

Currently the revenue from the license fee program is sent directly to the National Directorate of Fisheries. The Directorate splits the license fee revenue between the Fisheries Administration (10%), the Fisheries Development Fund (50%), and the Ministry of Finance and Planning (40%). But none of the fisheries management operational costs are covered. The revenue from the license fees should go to the operational management (at least 60%), to the local co-management institutional framework and the remainder should be sent to the National Directorate of Fisheries. The legal basis of the fee distribution has to be secured before the implementation of the license limitation system.

## 8. IMPLEMENTATION OF THE LICENSE LIMITATION PROGRAM

Under open access conditions and decreasing stock abundance, some fisheries will be more affected than others. Generally those vessels with high autonomy and economic rent will tend to increase harvest rates by exerting their fishing effort on distant fishing grounds (FAO 1999). For example, in the inshore fishery in the Inhassoro region, the mechanical and manually operated seines with 2000-3000 meters of rope to set the net reduce the catch rates of other fishers using smaller nets.

In general, the income for all groups of participants in the inshore fishery is low. There is an excess fishing capacity in the region. This chapter examines the current estimated catches by fishing unit and attempts to infer, from the changes of fishing grounds to the offshore and limits on the number of fishing units in the inshore grounds. It follows that the future income should improve and projected catches should increase. Such results are essentially speculative in nature.

### 8.1 Current fishing conditions

As a result of open access, the catch rate has declined. In fact, the number of participants is high and the fish stocks seem to be overexploited. Assuming that  $x$  is fishable stock biomass and  $q_1, q_2, q_3, \dots, q_n$  are catch per unit effort (CPUEs) of different fishing units. The number of fishing units by type is represented by  $N_1, N_2, N_3 \dots N_n$ . If total catch is the sum of the CPUE times the number of the homogeneous fishing unit, it follows that:

$$\text{Catch} = q_1 * N_1 + q_2 * N_2 + q_3 * N_3 + \dots + q_n * N_n$$

In Inhassoro there are seven types of fishing units. The daily catch rates by type of fishing unit tend to be reduced due to the high pressure of exploitation at the same time. Thus, production possibilities are limited by the fishable stock, consequently the productivity of the fishing units are affected greatly by the number of participants. It follows that the catch rate corresponding to each participant remains below the maximum catch that can be achieved with a limited number of competitors.

Table 6 shows the catch rates by type of fishing unit in the Inhassoro region. The lowest catches are by canoe and highest catches are by mechanised seines. Although the daily catch rates of manually operated seines with net of 100 to 140 m and oar and sailboat with handline are the same, they differ in catch composition and the value of caught fish. The catch composition of the seine (pelagic fish, small-size and medium of demersal fish) is mainly high value fish. Obviously the incomes are different, being best for oar and sailboat with handline.

Table 6: Distribution of catches by fishing unit (IDPPE 1998).

	Number of Fishing Units	Daily Catch Rates (kg)	No. of days Fished Annually	Unit Catch Annually (tons)	Total annual catch (tons)
Manually operated seines (150 – 180 m)	25	150	181	27,15	678,75
Manually operated seines (100 – 140 m)	37	100	181	18,1	669,70
Manually operated seines (50 – 90 m)	28	50	181	9,05	253,40
Mechanised seines (150 – 180 m)	5	200	181	36,2	181,00
Motorised boat with handlines	21	100	224	22,4	470,40
Oar and sail boat with handline	53	40	224	8,96	474,88
Canoes with handlines	11	8	224	8,96	98,56
Trap/Gamboa	3	40	156	0,62	1,86
Total	183				2828,55

Contrarily in the industrial fisheries it has been argued that dissipated rents focuses the incentives on the catch rates in order to obtain a profit from the fishery. Often these catch rates are not sustainable and when the fishermen compare the historical catches on an empirical basis their perception is that the harvest is decreasing. As they often exploit pelagic species, which can be migratory, it is obvious that the annual production is not evenly distributed probably due to their limited fishing area. Thus, it appears that the losses from fishing activity for artisanal fishermen might be supported by the knowledge of the status of the artisanal stock.

However, in this study it is suggested that independent of the status of the fish stocks, the number of participants in the inshore fisheries exceed the level corresponding to cost-effectiveness. This is demonstrated by individual income in the fishery. The income is proportional to the catches because the income is mainly based on a catch share system. According to the survey on artisanal fisheries carried out by IDPPE in 1998, at least 90% of the fishing units paid in share of production (money and/or fish, individual/household). Only 17 fishing units paid in remuneration on salary basis, corresponding to less than 10%. The estimated annual catch by fishing unit from Table 6 is compared with the composition of crew in Table 7. The table shows that manually operated seines with share-individual fishermen is below the minimum salaries established by the government in 1998 (3,8 million tons per year). While the fishing unit with handline are considerably over the minimum salaries. There is no available data on the salaries paid to the crew employed in mechanised seines and motorised boats with handline.

Table 7: Distribution of catches by fishing unit (IDPPE 1998).

	Number of Fishermen per unit	Total Individual Catch (kg per day)	Total Revenue of Catch (MZM)	Share-Ownership (MZM)	Share-Individual Fishermen (MZM)
Manually operated seines (150 – 180 m)	20	27,15	230 755	190 389	2 019, 28
Manually operated seines (100 – 140 m)	15	18,10	135 750	88 237	3 167, 50
Manually operated seines (50 – 90 m)	10	9,05	67 875	44 118	2 375, 63
Mechanised seines (150 – 180 m)	15	36,20	307 700	235 700	4 800, 00
Motorised boat with handlines	10	22,40	212 800	164 800	7 200, 00
Oar and sail boat with handline	5	8,96	80 640	52 416	5 644, 80
Canoes with handlines	2	1,79	14 336	4 300	5 017, 60
Trap/Gamboa	5	6,24	40 560	12 168	5 678, 40

Although the income of the owner of manually operated seines will be reduced; the fishermen employed in these seines will be much more affected. Additionally, this group is less educated and 40% of the fishermen are part-time.

Assuming a reduction in fishing effort. The productivity of mechanised seine is given to be 1 metric ton per set and the largest manually operated seines are 0.8 metric tons per set and the fishing season has the duration as previously described when the catches were calculated. As a result of the distribution of catch rates by fishing unit type, the reported catch can be caught by only 5 manually operated seines and 3 mechanised seines. If this were the case then the catch rate per unit would increase considerably.

Figure 1 shows the difference between limited number of fishing units and open access scenarios for seines (manually operated and mechanised seines).

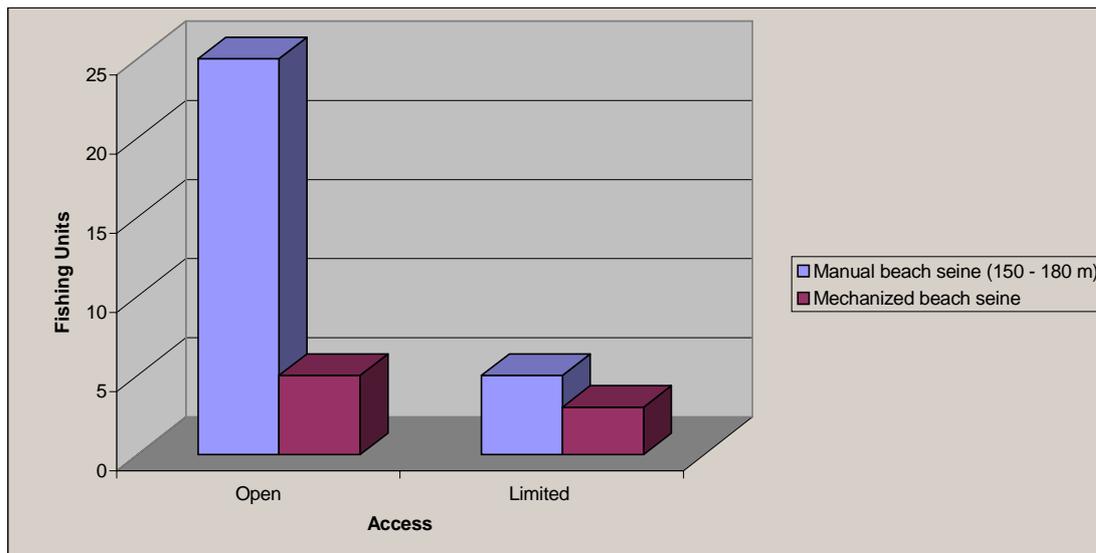


Figure 1: Fleet composition according to access to the resource.

Obviously, if we want to explore the limited access option it is implicit that some of the current participants will be excluded. Since those participants employ people and possess assets (boats and nets), the losses by a policy option like that tend to be increased social cost since the return from the fishery does not bring direct benefits to the actual participants. The opportunity capital cost and opportunity of labour cost are very low. Although it is possible to obtain a surplus for consumers with the low price of fish as a result of decrease of fishing effort cost, the losses for producers and employees are significant.

## 8.2 Improvement of income from the fisheries

Management alternatives hinge around how to promote a particular fishing method without damaging others and how to increase at least proportionately the net benefits of all fishers involved. Fisheries co-management when used to improve the living standard of fishermen ensures an adoption of fishery management strategy that is satisfactory to the fishers (FAO, 1999).

A gradual reduction of the small boats and increase of the medium vessels, which will operate in the offshore waters, is recommended. The number of fishing units in operation must be reduced and it is also recommended to convert the effort exerted in seines to handline boats.

Alterations of fleet composition will occur without a government buy-back program. For that, there will be created a mechanism of incentives for building medium size vessels with the option of fishing the offshore fishing grounds. The reduction of the fleet should occur mostly through the replacement of older, smaller vessels with larger newer ones, suitable for offshore fishing. It is expected that the number of offshore vessels will increase in the first three years. In the fourth year, the plan will be adjusted according to the status of the stocks. During the implementation phase of the program a significant increase in catch is not projected (Appendix 3).

Figure 2 demonstrates that the number of boats over 6.5 m will increase and less than 6.4 m will decrease. Further it is assumed that some boats currently operating with seines will be adapted for fishing with handline and the increase in income will result from improvement in the composition of fish caught. The handline fish has a considerably higher commercial value than the fish from seines. Certainly the access to fishing will be limited, resulting in the

reduction in participants but many of the fishermen affected are not employed full time in the fisheries and do not receive most of their income from fishing. Identification of fishermen that are not professional will occur with the collaboration of fishers who know the situation of their crew.

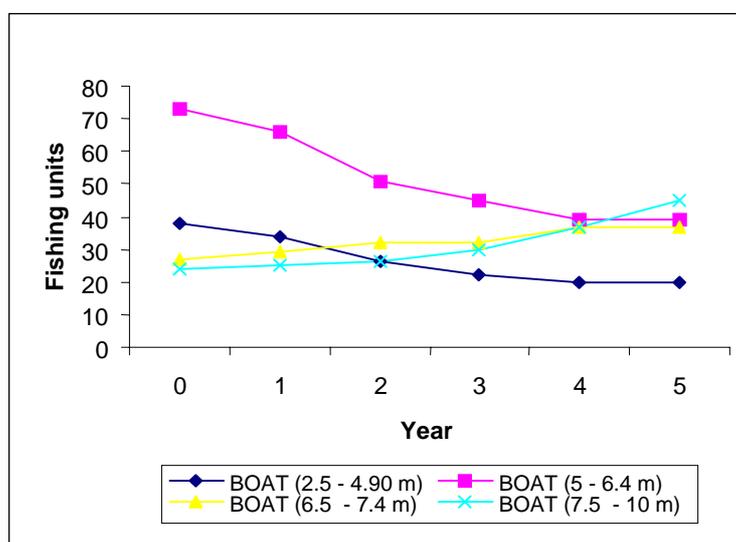


Figure 2: Projected fleet composition.

During the implementation phase of the license limitation program an increase of fisheries revenue is expected, resulting from the change of composition of the catch from smaller to larger sizes. This will contribute to increased income because the medium and large sizes of these species are of a higher commercial value. Actual marketing operators will carry out its commercialisation, initially, and at the same time will develop an information system of the market that can help the decision making of trade operators as well as producers.

Thus, income from fisheries activities will improve for all participants (traders, producers, employees, and taxation of government). Table 8 shows the projected revenue for five years.

Table 8: Projected revenues of the fisheries in USD (IDPPE 1998).

	Year 1	Year 2	Year 3	Year 4	Year 5
Manually operated seine	7 250	6 552	4 637	4 405	5 209
Mechanised operated seine	1 037	991	803	465	551
Motorised boat with handlines	4 855	8 868	13 106	22 863	31 112
Non-motorised boats with handline	4 699	7 067	9 126	14 496	5 209
<b>Total</b>	<b>17 841</b>	<b>23 487</b>	<b>27 672</b>	<b>42 229</b>	<b>42 081</b>

Although the catches do not increase during the first three years, the total revenue from the fishery will increase because of improvement of the productivity capacity due to capture of species of high commercial value. The boats fishing handline will contribute about 70% of the total revenues. Catch levels in the inshore waters will be reduced by half. In these three years it is expected that the offshore fleet will operate at least 90% of its maximum capacity.

The license limitation program assumes the reduction of inshore fishing effort. But there will still be an opportunity to exploit the inshore resources with a limited number of 100-140 m seines. Obviously, the current management measures will be complementary to this program.

### 8.3 Other fisheries

Other fishing fleets such as the semi-industrial fleet of Inhambane and the artisanal fleet of Vilankulos also exploit the offshore fisheries. The registered licenses for those two fleets do not specify or limit the fishing areas they can exploit. Anyone with a fishing license can exploit both the inshore and offshore resources. The specification of the operational area of particular types of boats will be based on the characteristic of the fishing unit (size/length of boat and fishing gear). There will also be coordination with the Marine Administration regarding safety requirement for offshore fishing.

For the co-management license limitation program, there will be coordination between management agencies to limit entry into offshore water. For instance, an allocation reference point should be established for each management system. A proposal for the distribution of allocations is presented in Table 9. The area for this suggested allocation is between coordinates 21°00′-22°00 and 22°55′-23°48.

Table 9: Distribution of quota in the offshore water for different management systems

Management System	Share	Scenario I	Scenario II
Inhassoro – artisanal fishers	25%	2500	5000
Vilankulo – artisanal fishers	25%	2500	5000
Inhambane – Semi-industrial	50%	5000	1000
Total		10000	20000

The scenarios presented above are only intended to be indicators since they ignore the actual capacity of the semi-industrial fleet operating in the area. According to the artisanal survey carried out by IDPPE in 1998, there were estimated to be about 50 boats operating handline capable of exploiting offshore fisheries in Vilankulo.

### 8.4 License fees

For the co-management license limitation program presented here the estimate of the applicable license fee is 1% of the estimated total value of catch by type of fishing unit. However, the projected total revenue from license fees does not cover the projected expenditures of operational management of Inhassoro, due perhaps to an underestimate of catches for the first year of the program. It is clear that the license limitation program is based on a more conservative measurement. This deficit must be covered by other government financial sources. Yet the license limitation program presupposes a return at long term when it is determined that the harvest potential of the region and adjustment of taxpayer levy. Attempts to show the returns are presented in Appendix 1. Note that these are hypothetical values. If actual numbers do not confirm the hypothesis, the management regime will be adjusted in order to reflect cost-effectiveness.

It is suggested that the future development of the offshore fisheries is through a semi-industrial fleet, being the actual fishing license concession of a limited period corresponding to the return of investment employed. This will alleviate the constraints of license buy back, at least for the artisanal fisheries. It can clearly be questioned whether boats will leave the

fishery. It should be pointed out that there are technically specific requirements regarding the construction and age of motor vessels built into the license limitation program. Implicit is the total replacement of fishing units. Over-capitalisation is always a concern when developing a new fishery and has to be taken carefully into account with the development of the semi-industrial fishery.

Appendix 2 shows the projected revenues from license fees based on 1% of total individual catch and it is assumed that the recovery of the fee will be at least 90%. The reason for this high recovery rate is the involvement of the communities in collecting the license fee.

The variability of revenue from the license fees is explained by changes of fleet composition that is encouraged by the management system, i.e. an increase in offshore fishing.

## 8.5 Fisheries Statistics

The lack of available fisheries statistics has been the major limitation for the present approach on the license limitation program. This constraint has not been relevant for theoretical development, e.g. principles of licensed access, but it is crucial when dealing with operational fisheries management. It is usually the first step of the management plan to have knowledge of the state of the fisheries resources, otherwise the management plans become unreliable. The availability of information on the state of the fisheries resources could be useful as a guide for the successful implementation of a new fisheries management system. However, it is believed that it usually takes more time (e.g. 3-7 years) to determine the biological and environmental conditions for tropical multi-species fisheries. Because there is no existing data on the historical catches in the region, the fishing effort being exerted by artisanal fisheries will need at least two years of data so that comparisons can be made. Collection of catch and landings data started in July 1999, this implies that a comparison would only be possible at the end of 2001.

The current management objectives in the region focus on raising the income of the participants. Thus effort costs and the sustainable level of living of fishermen, based on earnings from employment in fisheries, must be established.

## 8.6 Economic and social impacts

In order to analyse the economic and social impact of the implementation of the co-management license limitation program the necessary data would include such typical variables as earnings, employment, and contribution to food security and resource rent. As has been suggested special care must be taken in defining and measuring income and profitability indicators for small-scale fisheries (FAO 1998). There is available secondary information of the region (e.g. Falcao, 1993. Lopes, 1995) and this data will be updated through participatory assessment surveys.

Such studies might be carried out on the basis of a multidisciplinary team composed of a socio-economist and a fishery scientist. It might be possible to fund such a study through the French Cooperation Program that is already in place.

The complementary studies could identify conflicts between artisanal fisheries and the semi-industrial sector. Additional studies are needed that focus on upstream sectors (e.g. boat-building) related with downstream sectors (e.g. marketing and processing).

A report, which summarises all features, is carried out and submitted to the social institutions of the region. Meetings should be scheduled to occur before the annual meeting of fishermen (1<sup>st</sup> September). The recommendations and comments from these meetings should be incorporated into the final document, which will be presented to the management committee for decision-making on the feasibility of a license limitation program.

## 8.7 Social and economic environment

More generally, the fishery sector has interactions with other sectors. There is evidence that tourism plays an important role in the region. The Bazaruto archipelago has been declared a National Park and measures have been taken for its conservation. At the same time the tourism authorities have declared their intention of infrastructure development in the coastal area. The nature of the links between the tourism and fisheries sectors needs to be clarified. For instance, the employment opportunities for local people, recreational and sport fisheries for tourists could be estimated.

A consultation process between the two sectors might be established through respective bodies. The major output of this cooperation might be offered to the central institutions that make strategic plans.

The analysis of alternative employment opportunities should follow the studies suggested above. This would be intended to determine the opportunity cost of labour. This will be useful in the restriction of fishing practices, which will bring a net economic benefit in the form of income for the participants in the fishery.

In addition, research on the service suppliers (e.g. fuel, fishing inputs, spare parts) and tax regimes on outputs (e.g. taxation system) might be carried out.

In this context, the above-mentioned socio-economic studies should cover all fisheries related sectors. It should be possible to obtain information in the form of secondary data from legal and administrative sources and various existing documents concerning the information needs (FAO 1998).

It should be noted that the time frame should not exceed 6 months and there should be staff dedicated to the Inhassoro issue.

## 8.8 Regulatory aspects

At the legislative level it is important that the regulatory entity (National Directorate of Fishery) understands what the primary objectives of the license limitation program are for the artisanal fisheries. It is usually this entity that takes management measures based on advice from the Fisheries Research Institute regarding the state of the resources. However, the current informal organisational framework on fisheries co-management involves mainly the Fisheries Research Institute and the Institute for the Development of Small-Scale Fisheries. In fact the formation of fishermen's organisation is still in progress. The Institute for the Development of Small-Scale Fisheries has documented the nature of the management problem in artisanal fisheries and at the same time developed the role of the consolidation of these organisations. Fishermen themselves often report such problems to the Institute.

The co-management system proposed in this paper suggests the direct involvement of the National Directorate of Fisheries which would evaluate the regulatory context of the license limitation program and whether it is possible to undertake the required regulation that have to be approved by the Minister of Agriculture and Fisheries.

For the activities laid out above to be successfully implemented, coordination among public institutions is essential. Such coordination avoids unnecessary waste of financial and human resources during the implementation of the program.

## 8.9 Biological information

The state of the fisheries resources exploited by the local fishers is unknown. However, some point estimates can be calculated, based on preliminary trawl surveys of the area. Studies of

the same or similar species in other areas can be used to get some idea about biological parameters such as growth. Research should also be conducted on the predator-prey relationship and other species interaction as well as environmental conditions.

Where it is not possible to base biological or bio-economic models on scientific information it is important to utilise the local knowledge of the fishermen.

It is extremely important for the sustainable basis of this co-management system to gather the biological data that is essential for stock assessment models. Among the information needed is the length-weight relationship, length distribution, the sex ratio and the gonado-somatic index of the main commercial species. Also the catch composition in the fisheries, the distribution of the main species and information on the species diversity and species richness of the fished habitat, needs to be collected.

Assessment of fish stocks should be discussed with the co-management committee in order to evaluate the parameters and give the local community an opportunity to be involved in and understand the assessment process and the importance of biological data.

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## APPENDIX I

## Fleet Composition

Fishing Unity Type	Existing	Year 1	Year 2	Year 3	Year 4	Year 5
<i>BOAT (2.5 - 4.90 m)</i>						
seine	26	22	16	12	10	10
handline	12	12	10	10	10	10
<i>BOAT (5 - 6.4 m)</i>						
seine	0	0	0	0	0	0
handline	42	35	25	19	13	13
handline	31	31	26	26	26	26
<i>BOAT (6.5 - 7.4 m)</i>						
seine	0	0	0	0	0	0
seine	15	13	11	6	6	6
handline	12	16	21	26	31	31
<i>BOAT (7.5 - 10 m)</i>						
seine	0	0	0	0	0	0
seine	11	8	4	1	1	1
handline	13	17	22	29	36	44
	162	153	135	128	132	140

## Assumptions

Whole seine reduce

Boats (2,5 to 6,4 m) reduce

Boats (6,5 to 10 m) increase

## Production

Fishing Unity Type	Existing	Year 1	Year 2	Year 3	Year 4	Year 5
<i>BOAT (2.5 - 4.90 m)</i>						
seine	235	73	59	50	42	46
handline	22	16	15	16	16	18
<i>BOAT (5 - 6.4 m)</i>						
seine	-	-	-	-	-	-
seine	760	346	287	242	162	180
handline	278	206	200	225	225	250
<i>BOAT (6.5 - 7.4 m)</i>						
seine	-	-	-	-	-	-
seine	407	254	239	154	154	171
handline	108	207	319	441	534	593
<i>BOAT (7.5 - 10 m)</i>						
seine	-	-	-	-	-	-
seine	398	256	167	47	47	52
handline	291	450	672	978	1 223	1 655
Total	2 499	1 809	1 959	2 154	2 402	2 965

## Revenue

Fishing Units	Existing	Year 1	Year 2	Year 3	Year 4	Year 5
<i>BOAT (2.5 - 4.90 m)</i>						
seine		573	516	470	454	537
handline		232	211	196	307	309
<i>BOAT (5 - 6.4 m)</i>						
seine		-	-	-	-	-
seine		2 696	2 499	2 278	1 761	2 083
handline		2 226	2 643	3 019	4 213	4 706
<i>BOAT (6.5 - 7.4 m)</i>						
seine		-	-	-	-	-
seine		1 984	2 083	1 447	1 678	1 984
handline		2 241	4 213	5 912	9 977	11 145
<i>BOAT (7.5 - 10 m)</i>						
seine		-	-	-	-	-
seine		1 997	1 455	442	513	606
handline		4 855	8 868	13 107	22 864	31 112
Total		16 805	22 488	26 870	41 766	52 481

**APPENDIX 2**

## License Revenue

Fishing Units	Existing	Year 1	Year 2	Year 3	Year 4	Year 5
<i>BOAT (2.5 - 4.90 m)</i>						
seine		10	7	5	4	4
handline		2	2	2	2	2
<i>BOAT (5 - 6.4 m)</i>						
seine		0	0	0	0	0
handline		32	23	17	12	12
<i>BOAT (6.5 - 7.4 m)</i>						
seine		0	0	0	0	0
handline		18	14	8	8	8
handline		16	22	27	32	32
<i>BOAT (7.5 - 10 m)</i>						
seine		0	0	0	0	0
seine		30	17	4	4	4
handline		52	69	89	111	135
Total		173	165	163	184	209

## Operational Management Cost

	Existing	Year 1	Year 2	Year 3	Year 4	Year 5
fisheries biologist		78	78	94	108	125
field enumerators		52	52	63	72	83
Observers*		7	7	9	10	11
administrative cost		60	60	72	83	96
maintenance and repair		1	1	1	2	2
Travel		22	22	27	31	36
		220	220	266	306	352
Total (excluding biologist and travel)		120	120	126	126	126

\* From fishermen group

Excluded are fisheries biologist and travel expenses These will be provided by Central Budget, fisheries biologist covers whole province.

**APPENDIX 3**

	Year 1	Year 2	Year 3	Year 4	Year 5
<b><u>Manual seine (150 - 180 m)</u></b>					
Capital Costs	79		42		
Operational Cost	84	91	99	106	115
Total Cost	163	91	141	106	115
Revenue	182	231	281	326	386
Cash Flow	18	140	141	220	271
	15%	20%	30%	45%	
Net Present Value (NPV)	475	409	311	218	
<b><u>Manual seine (100 - 140 m)</u></b>					
Capital Costs	40	-	30	-	-
Operational Cost	50	54	58	63	68
Revenue	78	99	121	140	165
Cash Flow	- 13	45	32	77	97
	15%	20%	30%	45%	
Net Present Value	137	116	85	56	
<b><u>Manual seine (100 - 140 m)</u></b>					
Capital Costs	27	-	18	-	-
Operational Cost	26	28	30	32	35
Revenue	- 27	5	- 8	14	20
Cash Flow	- 27	5	- 8	14	20
	15%	20%	30%	45%	
Net Present Value	- 31	- 23	- 21	- 19	
<b><u>Motorised boat with handline</u></b>					
Capital Costs	78				
Operational Cost	93	100	107	114	122
Total	171	100	107	114	122
Revenue	373	525	593	799	870
Cash Flow	202	425	486	685	748
	15%	20%	30%	45%	
Net Present Value	<b>1 580</b>	<b>1 376</b>	<b>1 070</b>	<b>773</b>	