LINEFISH RESOURCES

ANNUAL REPORT FOR THE YEAR 2000

PART 1: FISHERIES ASSESSMENT

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ABSTRACT

These works reflects the activities of line and trap fishing in Southern Mozambique in 2000. In this report it was also included information of other sectors, which the catch composition includes line fishing species such us industrial trawling, recreational and artisanal. The catch in line fishing has been estimated at 441 mt, according to the DNAP records. The same sources indicated that 1767 days were spent at sea and the estimated catch rate was 250 Kg per boat/day. Most of the line fishing effort shifted away from Maputo and moved to Inhambane region. The species composition by number indicated that Sparidae continue to dominate the catch, accounting for more than 70% of the catch in 2000. The dominant species were *C. puniceus*, *C. nufar* and *P. coeruleopunctatus*. The monthly analysis of fishing vessels, stricter controls over catch and effort data submission, development of long-term research programme and the continuation of the on board sampling to improve the data collection are the recommendation for line fishing.

The catch of trap vessels increases from 30 mt in 1997 to 172 mt in 2000, during which the total number of traps increased from 25 to 300. During this time the number of fishing days has remained relatively constant, as well the soak time. These data sets are thus not compatible with each other, reflecting an increase in daily catch from 243 Kg to 791 kg. The species composition is mainly dominated by *P. coeruleopunctatus*, *C. puniceus*, *C. nufar* and *E. andersoni.*

RESUMO

Este trabalho retrata a actividade da pesca à linha e com covos no ano 2000 no sul de Moçambique. O mesmo trabalho também foca outro tipo de pescaria como é o caso da pesca industrial de arrasto, pesca desportiva e artesanal pelo facto das espécies capturadas também fazerem parte das espécies capturadas na pesca à linha. A captura da pesca à linha no ano 2000 foi estimada em 441 toneladas em 1767 dias de pesca de acordo com os registos da DNAP. No mesmo período, o rendimento foi de 250 kg dia. As embarcações de linha têm se movimentado de Maputo para a região de Inhambane. A composição especifica foi dominada pelas espécies da família Sparidae, nomeadamente *C. puniceus*, *C. nufar* e *P. coeruleopunctatus*, com cerca de 70 % da captura. As recomendações traçadas foram essencialmente ligadas à continuação da recolha mensal de dados de captura, esforço, assim como a bordo das embarcações e a elaboração de um programa de investigação a longo prazo.

A captura da embarcação com covos aumentou de 30 toneladas em 1997 para 172 toneladas em 2000. Durante o mesmo período o número de covos permitidos aumentou de 25 para 300. O esforço de pesca (dias de pesca e tempo de imersão), tem se mantido constante mas os dados referentes à captura e esforço não são compatíveis o que originou um aumento da captura diária de 243 Kg para 791 Kg. A composição específica foi na sua maioria dominada por *P. coeruleopunctatus*, *C. puniceus*, *C. nufar* e *E. andersoni.*

1. BACKGROUND & PURPOSE OF DOCUMENT

The long coastline of Mozambique, with its diverse ecosystems, offers many small- and medium-scale fishing opportunities. Prominent amongst these are linefish, defined as fish which are primarily a target of hook and line fishing, but which may also be taken in traps, nets, by spear etc. There are literally thousands of people engaged in one form of linefishing or another, thereby contributing significantly to food security and economic development of Mozambique.

The ichthyofauna of Mozambique is diverse (Fischer *et al* 1990) and this also contributes to the potential of linefishing, with more than 200 species eligible for capture. These linefish species can broadly be grouped into the following categories:

- Large pelagics such as the tunas, "serra" mackerels and billfishes,
- Soft substrate fishes such as the kobs and grunters
- Coral reef associated species such as parrotfishes, emperors and snappers
- Deep reef fishes, mostly belonging to the seabream and groupers
- Shoreline fishes such as pompanos, stonebream, bonefish
- Estuarine fishes such as mullets, grunters, pouters and perch
- Sharks and rays

The importance of linefishing in Mozambique is frequently underrated, partly because it is widely distributed and lacks obviously visible large-scale infrastructure and investment. This poses a serious threat to the fishery, not only in managing for sustainable use but also in the context of biodiversity conservation in Mozambique waters. Over the past decade, there have been substantial fluxes in the nature and intensity (effort) of linefish activities in Mozambique. These need to be understood and evaluated so as to assist in the management of this important resource. The Instituto Nacional de Investigacao Pesquiera (IIP) initiated studies on linefish in 1994 and each year since then, a status report has been produced. In 1995 a strategy for linefish research and monitoring was developed, which was designed to also function as a template for future monitoring.

This report reflects the assessment of the linefishery for the year 2000, and is produced in terms of the mandate vested in IIP. It is envisaged that this would:

- Contribute to the wise and sustainable management of Mozambique's linefish resources
- Represent a contribution to the IIP institutional annual report

- Provide decision support to the Ministry and National Directorate of Fisheries Administration (DNAP)
- Serve as a progress report to funding agencies
- Reflect on the activities and achievements of the linefish unit at IIP
- Create opportunities for feedback of information and discussion with users of the resource.

2. SECTORS OF THE LINEFISHERY

In terms of Mozambique fisheries legislation the fisheries are divided into three fishery components: artisanal, semi-industrial and industrial. However, the linefishery can in fact be divided into a total of five sectors, ranging from subsistence fishing to the industrial sector. It is important that these different sectors are properly identified and recognised in the overall assessment, as there is significant potential for user conflict and hence ineffective management. The basic elements and characteristics of these sectors have already been described (see Dengo *et al* 1991, van der Elst *et al* 1995). However, an update and summary review is given below.

Table 1. The basic elements and characteristics of the fisheries sectors

Sector	Gear	Average Crew	Main propulsion	Primary purpose
Subsistence				
Traditional traps	Natural materials	n/a	shore-based	food security
Shore linefishing	Hook & line	n/a	shore-based	food security
Artisanal				
Type 1	<3m canoe	1.3	paddle	food security
Type 2	3-8m boat	2.5	paddle/sail	food & trade
Type 3	2-10m boat	3	o/b motor	trade
Semi-industrial				
Hook & line	5-8 m skiboat			
Hook & line	10-20m port-based			
Industrial				
Hook & line	>20m port based	10-30	diesel:>200hp	trade/export
Trapfish	>20m port based	10-30	diesel:>200hp	export (iced)
Mid-water trawl	>20m port based	n/a	diesel:>200hp	export (frozen)
Recreational/ sport/ tourist				
Hook & line	3-6 m skiboats	4-6	outboard	leisure & tourism
Hook & line	shore-based	n/a	n/a	leisure & tourism
Spearfishing	shore & skiboat	n/a	n/a	leisure & tourism

3. MANAGEMENT OF THE LINEFISHERY

Fisheries management in Mozambique falls under the Ministry of Fisheries. The Mozambique Fisheries Master Plan as well as the Fishery Act (Lei No 3/90 of September 1990) are the enabling legislation that facilitate administration and management of the fishery and the promulgation of specific regulations in the form of articles. In terms of Decree No 16/96, dated 28 May 1996, extensive regulations pertaining to Mozambique fisheries were published. Periodically, regulations are issued dealing with fisheries management issues of the day.

While the fisheries are officially divided into three components, (artisanal, semi-industrial and industrial) there are no divisions into specific resource sectors such as linefish. Thus there are no specific regulations dealing with linefisheries so that there are no minimum size, daily bag or closed-area regulations in place. Two exceptions occur. The newly established trapfishery has a suite of rules that prohibit trapping in water less than 100 m and confines the total fishing effort to 300 traps. A second set of regulations deals with sport fishing, establishing total daily landings that can be made by individuals in this sector. These regulations are not made in terms of the Fisheries Act, but rather in terms of the tourism legislation.

A notable recent addition to the sectors which catch linefish is that of industrial trawling, permitted to operate south of 24 °. Initially seven licenses were requested for this zone, but only three were granted. These large vessels trawl in shallow water close to reefs and potentially catch similar species to those that make up the catch of linefishers. This fishery was initiated in 1999, apparently without prior information on catch rates, species compositions and hence sustainability. The three licences are held by foreign joint-venture candidates. The catch is frozen and packed on board and apparently most is exported. As far as can be established, these landings have not yet been properly monitored, nor is it certain that this technique is confined to only the three licensed vessels. However, it would appear that the rules were altered in 2000, so that this form of fishing is now supposed to be confined to midwater trawling north of 24 °. However, this appears to be ignored as a large midwater trawl vessel was observed offloading a 25 mt catch of fish during June 2001 that were confirmed to have been caught close to Maputo.

A further, rather poorly documented, sector in the linefishery is the skiboat sector. Introduced from South Africa, these boats can operate through the surf zone at almost any point along the coast and are capable of landing up to a ton of linefish per day. These operators are fully commercial in nature although no licences are issued for this sector, nor are catch and effort monitored. At present, there are such operators in Xai Xai, and it is probable that more such ventures will evolve, especially as lower input costs will make this fishery more economical than port based fishing. Clearly this requires monitoring and management.

A range of general fishing regulations exist that impact on linefishing. The capture of vulnerable animals such as turtles, dugong and dolphin is strictly forbidden. All semi-industrial and industrial fishers are obliged to submit operational records to the DNAP as well as catch statistics to the IIP. Vessel owners are also compelled to accommodate observers and samplers on fishing trips, if so requested.

Although participation in the linefishery is controlled by license issue, it remains essentially an open access fishery as no limits are placed on total effort and most licence applications are granted to the applicant.

The Fisheries Act recognised four distinct fishing zones in Mozambique waters as follows-

Zone 1: north of 10°	Rovuma to Namalunga
Zone 2: 10° to 21°	Namalunga to Bazaruto
Zone 3: 24.5° to 21°	Bazaruto to Cabo das Correntes
Zone 4: south of 24.5°	Cabo das Correntes to Ponta do Ouro

In the case of some fisheries, access is defined by zone. Thus, the shallow water shrimp fishery is confined to zone 2, 3 & 4, ranging from 3 nm out to 12 nm. In the case of semi-industrial linefishing, variable access is defined by zone, ranging from the entire coast to one of the primary fishing zones. Linefish access is from the shore to beyond 12 nm. As a result of logistic constraints at IIP, the assessment of linefishing contained in this report is confined to zones 3 and 4 – the southern parts of Mozambique.

Law enforcement and compliance takes place in terms of national legislation but implemented at Provincial level. No records were available to the study to establish the efficacy of compliance, although it is generally acknowledged to be an under-resourced activity.

4. RESEARCH AND SAMPLING PROGRAMME

Scientific investigations into the status and use of marine resources of Mozambique is primarily the responsibility of IIP, although a range of other agencies also undertake important marine resource research- such as IDPPE, MICOA, UEM etc.

This work can broadly be divided into two activities: (a) monitoring of fishing effort and resource use and (b) the investigation of biological reference points for primary species.

Several primary data sources are available.

1. The number of licenses issued by DNAP provides an indicator of fishing effort on an annual basis.
2. The compulsory catch returns submitted each month by each vessel to the DNAP provides estimates of total catch and fishing effort in terms of days fished.
3. Port control officials maintain a register of vessel movements that are related to fishing effort.

4. Port sampling undertaken by IIP throughout the year, excluding weekends and public holidays. This documents fishing effort, catch per boat, species composition and biological assessments. From January to July, the samples were provided by the fishers but after July the samples were selected by IIP staff to minimise bias in size and species composition.
5. On-board sampling undertaken by IIP throughout the year, by joining the fishing trips of various vessels. This documents fishing effort, locality, catch, species composition and biological assessments.
6. Specific research projects dealing with linefish, artisanal fisheries and the industrial sector all generate information of relevance to linefish assessment.

A summary of the 2000 sampling programme is tabulated below.

Table 2. A sampling programme for linefishery in 2000

	2000	1999	1998
Number of sampling trips to sea	1	0	3
Number of days at sea	10	0	23
Number of boats sampled	123	103	77
Number of sampling trips to Maputo Port	129	149	108
Number of fish measured	8361	9496	15270
Number of otoliths sectioned	167	160	0
Number of histology slides analised	160	0	0

5. DIFFERENT SECTORS THAT HARVEST LINEFISH

5.1. The Semi-Industrial Linefishery

5.1.1. Monitoring effort in 2000

The DNAP issues semi-industrial linefish licenses on an annual basis from a number of localities: Maputo, Inhambane, Beira, Vilankulos and sometimes other places. During the year, a total of 28 semi-industrial and industrial linefish licenses were issued from these localities combined. It is suggested that these two categories of vessel be combined for the purpose of calculating linefish effort, as long as the gear used is hook and line. Where

trawling for linefish occurs, then the vessels, and their fishing effort, need to be considered as separate entities in the linefishery.

The trend in licenses issued for linefishing over the years can be seen from the table below. It would appear that in the year 2000, the demand for, and hence the number of linefish permits issued, was the lowest for some time.

Table 3. Licences issued for linefish during the years 1996-2000

Year	Total semi-Industrial	Number of linefish permits issued					% Linefish permits
		Maputo	Inhambane	Beira	Other	Total	
1996	138	20	3	2	0	25	18.1
1997	119	24	9	1	1	35	21
1998	212	21	16	0	0	37	17.5
1999	173	22	10	2	0	34	20.8
2000	193	20	6	1	1	28	14.5

While the licenses are issued on an annual basis, operational and other constraints result in an uneven distribution of effort over the year. Furthermore, the licenses are valid for all zones of the Mozambique coast; hence it is not possible to allocate effort to any particular region.

Data collected by IIP from Maputo Port indicates a wide-ranging variance in monthly effort. Although 28 licenses were issued for the year, only an average of 8 per month were reflected to be operational, ranging from a minimum of 1 (in November) to a maximum of 15 boats in two months (June & July). Considering the actual days spent at sea, this also proved highly variable. Based on the sampling data from Maputo Port, for the year 2000, a total of 723 days were spent at sea by all boats combined. Considering that 52 weekend and 8 public holidays were not sampled, this would proportionately raise the total by 30% to 939 days. The average per month would then be 80 days, ranging from 66 to 128 days. Depending on how many vessels were actually operating (from 15 to 28?), this translates to a very low average-use pattern for individual boats during 2000, clearly not economically viable. Hence an explanation needs to be sought.

During 2000, there was compelling evidence that most of the linefishing effort shifted away from Maputo and moved primarily to the Inhambane region. Discussions with fishers suggest that no more than four vessels were operating in the southern region around Maputo. The port of Inhambane was in fact used extensively for discharge of the catch, partly because it saves costs in sea time not having to return to Maputo at the end of each trip. From this it is concluded that port statistics from Maputo alone reflect only a proportion of the real situation.

Unfortunately, no data collection took place at Inhambane, which means that the above Maputo data is only a part of the total assessment. However, vessels did submit monthly returns to DNAP that technically would include all Mozambique linefish effort in days at sea. These "national" records indicate that a total of 21 vessels actually submitted catch and effort data. The remaining seven vessels did not submit catch returns and presumably did not go fishing at all.

In total, the national data indicate that 1767 days were spent at sea. For three vessels, the Maputo port sampling in fact indicated a higher number of fishing days than was submitted by the vessel to the DNAP. If the maximum values were taken from either the national data or the Maputo data (whichever was highest), then the total days fished = 1883. It would thus appear that, while the national data is probably the best estimate, it is not necessarily complete and may thus be an underestimate.

These data indicate that an annual average of 81 days per vessel was spent at sea. This ranged from a minimum of 4 days to a maximum of 214 days. Considering these data on a monthly basis (Figure 1) indicates that the winter period May to July was the most intense fishing period in 2000.

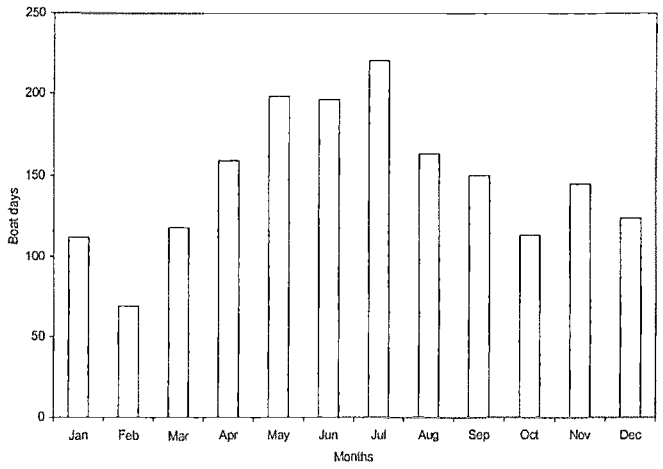

Figure 1. Annual average boat days per vessel spent at sea during the 2000.

This total figure for 2000 seems realistic and suggests that 39.5 % of the catches of 699 out of 1767 fishing days were monitored (i.e. offloaded) at Maputo. The Maputo data monthly effort trend is also similar to that of the DNAP data, with winter the main fishing period. (Figure 2).

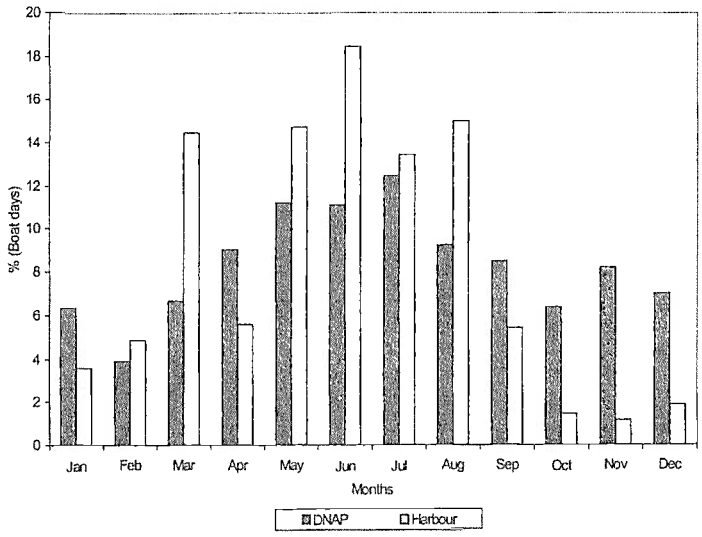

Figure 2. Percentage boat days monitored in the port of Maputo in 2000.

Discussions were also held with some members of the linefisher community. It was established that on average each vessel spent 16-20 days per month at sea, mostly comprising two trips of up to 10 days each. Actual fishing days would depend on travel time. For trips departing from Maputo, but fishing near Inhambane, this would result in a five-day travel time. On average, trips include about 7 days of actual fishing. When catch rates are very high, the trips are shortened in order to offload the catch. Similarly, when fishing close to the port of discharge, the travel time is shorter and a greater proportion of the trip is dedicated to actual fishing.

Clearly, the issues discussed above all have a major bearing on the nominal fishing effort, and hence on the interpretation of trends and assessment of the fishery.

Theoretically, there were 28x365 boat fishing days available in the year 2000- i.e. 10220 days. While days for rest, repair and travel are obviously required, the total of 1883 days represents only 18% of the potential total – a surprisingly low figure.

It is thus concluded that:

- Effort by semi industrial linefishing decreased considerably from 1999 to 2000. (see report for 1999; Lichucha *et al)*
- The main fishing activity has shifted significantly from Maputo to Inhambane i.e. from Zone 4 to Zone 3.

5.1.2. Catch Rates and Total Landings in 2000

There are three sets of information potentially useful in determining the linefish catch rates, namely

(1) The Maputo Port sample collected by IIP staff
(2) The national (DNAP) set of catch returns submitted by the fishers
(3) The personal records of a limited number of individual fishers given voluntarily during interviews with staff.

Based on the above sources of data, overall estimates of landings for 2000 can be established.

Table 4. Selected statistics in the linefishery for 2000

	DNAP records[2]	Port sample[1]	Fisherman Records[3]
Total catch (mt)	441	269	n/a
Total boat days	1767	723	n/a
Total fisher days	32248	12882	n/a
Thus CpUE/boat (kg)	250	372	350
Thus CpUE/fisher (kg)	13.7	20.9	29.1

These estimated catch rates are modest, ranging from 250 kg to 350 kg per boat-day. It is obvious that the voluntary reporting to DNAP is an underestimate of about 32%. This clearly represents a problem when it comes to using the national data and it suggests that the fishers are not reporting their full catch accurately. It also highlights the importance and value of the port sampling that is conducted by IIP- clearly a more reliable estimate of catch rates.

Considering that the total effort in boat days was calculated to be 1883 boat days, the total catch for the semi-industrial linefish catch in 2000 can be calculated as 700.5 mt. This is in fact 59 % higher than reflected in the official catch statistics.

The catch rates for individual species cannot be reliably calculated because individual species are not targeted and hence, effort cannot be proportioned to one species or another. However, the species composition of the catch will serve as an indicator of relative abundance.

5.1.3. Some Economic and Marketing Considerations

The linefishery, like most fisheries, is primarily driven by economic considerations. The only exception would be the subsistence and recreational sectors. There are different markets. In Maputo there is a modest domestic market demand, mostly for small fish. It is argued by some of the fishers that 4 to 6 vessels can adequately supply this local demand. A second and larger market is that of South Africa, especially in Johannesburg and Durban. This demand is for large fish and commands a higher price. In addition there is a variable export market, mostly to Portugal. This too demands high quality fish at a good price.

Based on the IIP sampled Port statistics, the catch per trip averaged over all vessels inspected is 2.13 mt, with a range from 0.9 mt to 6 mt per trip. The price of fish at first sale is variable, having increased from 28 Kmets/kg in 1999 to the following prices in 2000 reflected below-

Large fish per kg	=32 to 33 Kmets	= R 13.00
Small fish per kg	= 31 Kmets	= R 12.50
Large grouper etc for RSA	= 45 Kmets	= R 18.00
Serra per kg	= 25 Kmets	= R 10.00

In comparison, the first sale price of similar fish in South Africa = R 15 /kg. This would suggest that an average trip would generate approximately 150 Mmets (=R 60 000). Over the entire year 2000, the average number of trips per vessel (using 6 days as the mean trip length, 21 vessels and 1883 total boat days) can be calculated as 15 trips per annum. This would suggest that individual vessels generate revenue of 2250 Mmets each per annum (= R 900 000).

The operating costs of a vessel need to be considered. These will vary, not only due to its size, but also due to different levels of efficiency in operations. Operating costs of individual vessels will have to include such basic items as: ice, wages, food, diesel, bait and the fishing levy. Based on personal discussions with fishermen, these costs, for an average vessel, work out to about 60 Mmets per trip(= R 24 000). This equates to 900 Mmets (=R 360 000) per annum, hence leaving a pre-tax operating profit of 1350 Mmets. However, this excludes capital investment, maintenance and depreciation costs.

The total FOB value of semi-industrial caught linefish thus amounts to some 21 Bmets, equivalent to R 8.4 million. The number of people employed in the direct fishing operations is quite considerable, numbering more than 400 on a permanent basis. To this can be added the shore-based employees. Clearly these numbers confirm the importance of the linefishery as a significant socio-economic asset for Mozambique.

5.1.4. Catch Composition

IIP staff monitored most of the landings made in Maputo harbour. This was not only necessary to obtain catch and effort data, but also to investigate the species composition of the catch. Initially, fishers provided a sub-sample of the catch, which was taken to be proportional to the overall catch. However, it became evident that selection was taking place and that only the most common species were being selected. Subsequently, IIP modified this system and all recording was done through monitoring the entire catch discharged. This provided good information on numbers of fish but not for individual or total weights of the catch.

On-board sampling, conducted during six cruises, additionally provided information on species composition of the catch. There is good correlation between the two samples in terms of composition by number. However, weight compositions were somewhat different from each other.

The composition by number indicated that Sparidae continue to dominate the catch, accounting for more than 70 % of the catch in 2000. (see Table 5). Dominant species in this group were *C. puniceus, P. coeruleopunctatus* and *C. nufar.* It is noteworthy that the *P. coeruleopunctatus* proportion has progressively increased in the catch over the past eight years. This presents circumstantial evidence that the fishery has been operating at increasingly greater depths, a similar fact to that observed in KwaZulu-Natal. This progressive change in fishing behaviour needs to be recognised when assessing the trap fishery.

The groupers (Serranidae) remain relatively well represented in the catch, although their numbers were down in 2000. This group of fishes provides a good indicator of the level of fishing because they are often the first species to be eliminated. Thus the percentage of grouper in the catch should be monitored each year.

It is also noteworthy that *S. commerson* (serra) was very poorly represented in 2000 landings, while it ranged from 7% to 12% in past years. This reflects a poor year class, a relatively common phenomenon of fast growing pelagic species. However, more careful study and

assessment of this species may be justified in the light of potentially large harvests of juveniles made by the trawling sector.

The relative abundance of *Argyrosomus sp* is low in 2000, but did have a peak in 1997. The reason for this is unknown although it may have been due to selective targeting, possibly for squaretail kob (*A. thorpei),* thus proportionately elevating the catch of that species.

Sharks and rays are also caught in the linefishery, although they are not a normal target group. When caught, the fins are cut off and sold in Maputo, while the body is discarded. In discussions with IIP samplers and on review of the data, it is clear that the magnitude of the shark catch is modest, probably less than 1%.

Table 5. Percentage species composition by number of linefish catches sampled by IIP staff in the Port of Maputo.

	1993/94	1996	1997	1998	1999	2000
Sparidae	34.5	61.6	22	36.49	?	71.19
*C.puniceus**	11	37.2	6.9	9.11	?	24.4
C.nufar	14	18.7	8.2	10.7	?	7.43
*C.anglicus**	4.7			0.88	?	0.37
*A.spinifer**	3.22	3.2	2.5	4.3	?	0.79
*A.filamentosus**	1.55	1.5	2.5	2.6	?	2.4
P.coeruleopunctatus	0.03	1	1.9	8.9	?	35.8
Other Sparidae					?	
Serranidae	3.04	9.31	15.78	18.41		8.9
E.chlorostigma	0.02	2.5	4.4	0.43	?	0.02
E.andersoni *	?	0.9	1.6	0.94	?	0.57
E.rivulatus	0.08	0.8	1.4	4.72	?	1.2
C.sonnerati	1.82	2.2	3.4	2.6	?	1.68
*E.albomarginatus**	0.03	0.7	1.2	3.5	?	1.2
E.marginatus	?	0.6	0.97	1.1	?	0.69
E.tauvina	0	0.6	0.9	0.12	?	0.2
E.fasciatus	0.24	0	0	0	?	0.01
Other groupers	0.85	1.01	1.91	5	?	3.33
Lutjanidae	45.26	5.4	8	7.69	?	7.67
Pristipomoides spp	30.3	1.8	2	3.81	?	4.26
A.rutilans	0.04	1.7	2.8	2	?	0.11
L.sanguinensis	1.1	1.9	3.2	0.52	?	1.62
Other snappers	13.82			1.36	?	1.68
Other species						
C.sexfasciatus	0.24	3	5.1	0.06	?	0.16
*Argyrosomus spp**	?	1.2	20.4	1.8	?	0.27
L.crocineus	1.4	0.6	0.93	3.9	?	0.87
L.nebulosus	1.9	5.7	9.8	13.9	?	4.55
L.sanguineus	9.4				?	3
S.commerson	7.43	7.3	12.2	12.2	?	1.27

*= endemic

In 1999 there was not information on species composition as the linefishers denied researches access to their catches, becoming species composition difficult to be calculated for this year.

5.2. THE TRAP FISHERY

In July 1997, permission was granted by DNAP for two industrial vessels to undertake trap fishing for linefish. At that time, IIP recommended that initiation of such a new fishery should be on an experimental basis only and subjected to scientific investigation. By December 1997, one of the vessels had withdrawn from the fishery, apparently for economic reasons.

The nature of operations, as well as the preliminary study, of this fishery is fully discussed in the report by Abdula *et al* 2000. Initially, the total number of traps permitted was 25, but this increased progressively to 300 traps in total. The target species was to be the cachucho or blueskin, *Polysteganus coeruleopunctatus,* which were trapped in large steel-mesh traps in water deeper than 100m. Past data clearly demonstrated that at these depths there was only marginal overlap with other species in the linefish sector. The traps also proved size selective, a feature of the trap design itself as well as an optimal size for the export market in Portugal.

In September 2000, this fishery was changed from an experimental basis to a permanent fishery with the following permit conditions-

- Restricted to 300 traps
- Confined to south of 21° South
- Limited to depths 100m to 200m
- Bycatch of cava-cava *Scyllarides elisabethae,* permitted
- By-catch of turtles, dugong and dolphins prohibited.

5.2.1. Sampling Programme In 2000

The trapfish company submitted standard fishery catch return to DNAP on a monthly basis. These data include:

- Number of fishing days
- Number of fishermen
- Fishing area
- Depth at which traps are set
- Number of traps per haul (set)
- Soak time
- Total catch per haul.

IIP staff accompanied 13 cruises during the year, at which time biological sampling was conducted on cachucho, as well as robalo and marreco. This information included length (total and fork), weight of gutted fish, sex and maturity stages of a randomly selected sample. From May 99 to April 2000, it was also possible to collect otoliths, gonads and un-gutted weights of cachucho.

5.2.2. Effort In The Trap Fishery

The unit of effort in this fishery had earlier been defined as the "number of traps per haul multiplied by soak time" (Abdula *et al* 2000). As soak time was generally declared to be consistent around 23 hours, and as the number of traps was declared to be consistently around 50 per haul, the effort can also be expressed simply as hauls. Based on the records submitted to DNAP by the vessel, it deployed a total of 62 750 traps in approximately 1255 hauls during 218 days of fishing in the year 2000. This works out to an average of 18 days at sea per month and 288 traps (or 6 hauls) per day. The distribution of this effort, together with the declared catch, is depicted in Table 6.

Table 6. Distribution of estimated effort and total catch per month during 2000.

Year: 2000	Traps set	Average soak time (hours)	Effort (traps set* Avg. soak time	Days at sea	Catch (Kg)
January	6100	21.34	130174	24	17624
February	4900	22.42	109858	18	12670
March	5850	22.23	130045.5	21	17302
April	6660	23.57	156976.2	24	18107
May	6000	21.29	127740	20	16418.5
June	5700	21.54	122778	19	16816
July	5100	24.58	125358	17	13404
August	3300	24.17	79761	11	9151
September	4450	23.35	1039075	15	11504
October	5400	22.06	119124	18	13786
November	3600	23.35	84060	12	9541
December	5700	23.19	132183	19	16144
TOTAL	62750			218	172565.5

The catch, effort and CPUE values for each year are given in Table 7.

Table 7. The catch, effort and C.P.U.E. values during 1997-2000.

Year	Fishing Days	Traps set	Traps set per day	Avg. soak time (hrs)	Catch (kg)	Catch per trap(kg)	Catch per haul (kg)	Catch per day (kg)
1997	123	22525	183	24.5	29975	1.3	66.5	243.7
1998	191	19055	100	21.3	85600	4.5	224.6	448.2
1999	205	26614	130	22.2	81589	3.1	153.3	398.0
2000	218	62750	288	23.1	172566	2.8	137.5	791.6

Although a substantial amount of data has been collected, the results of analysis present many inconsistencies. This in turn casts considerable doubt on the validity of the data being submitted, a fact that was also noted with concern during the experimental phase of this project. Thus, a number of serious questions arise and are discussed below.

Overall Trend

The single vessel operating in this trap fishery has increased its total landings from 30 mt in 1997 to 172 mt in 2000, during which the total number of traps increased from 25 to 300. Yet, 1total of 218 days were spent fishing. Yet, through analysis of daily port statistics obtained from the Maputo maritime authorities it emerged that the trapfish vessel spent a total of 322 days at sea, 298 of them dedicated to fishing operations. (see Table 8) This leaves 80 days (22%) of the year unaccounted for.

Table 8. Data obtained from Maputo maritime authorities reflecting the trapfish vessel effort.

Total sea days	322
Total fishing days	298
Number of trips	31
Average trip	10.4 days
Average fish days	8.6

Once deployed, the traps are never brought back to shore. At the end of a fishing trip, the traps are again baited and deployed, so that on return from the port they will have caught fish. None of these "first of the trip" catches have been recorded in the catch returns. As there were 31 trips during 2000, with about 3 days between each trip, this would account for 90 days of undocumented fishing – equal to 41% of the declared fishing days. How can this be explained?

5.2.3. Fishing Depths

It was shown during the earlier report that the species selectivity is sensitive to depth, so that efficient targeting could occur, hence minimising potential user conflict. Comparing the depth data, submitted to DNAP, with that collected by IIP reveals very disturbing inconsistencies. Out of 277 trap hauls that were documented by IIP, only three (1%) corresponded in the depth data provided. Half of the depth data submitted by the company was incorrect by more than 30%, some were incorrect by as much as 80%, as seen in Table 9

Table 9. The difference in records submitted by the trapfish vessel compared with IIP data, expressed as a percentage distribution of the magnitude of the error.

Level of error (in %)	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	> 80%
% error in depth	22	10	19	19	14	10	3	2	0
% error in catch	13	15	8	14	14	12	7	9	7
% error in soak time	33	25	18	9	3	4	2	3	3

The above table is very disturbing and reveals serious flaws in the data being submitted. For example, it suggests that 19% of all data submitted, the error in depth data was in the range of 30%-40%. The same level of error in declaring catch was found in 14% of all data submitted and soak time was incorrect by 30% to 40% in 9% of all records submitted. These records can also be presented graphically as in Figures 3, 4 and 5.

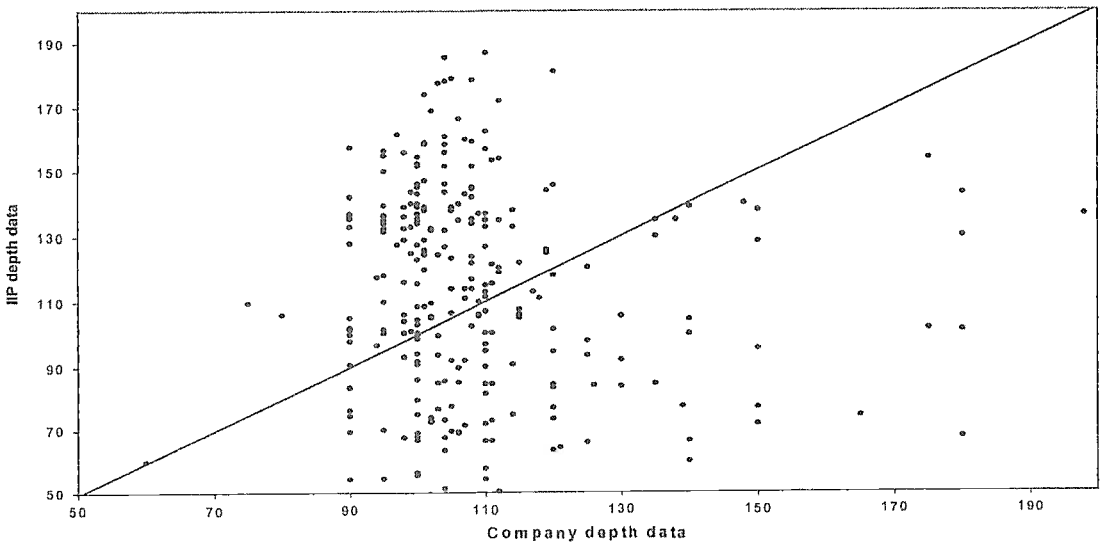

Figure 3. Depth comparison between IIP data and company data in 2000

From this scatter diagram of vessel reported depth vs IIP recorded depth, it is clear that there is very poor correlation. If the two sets of data had been reasonably similar, the scatter points would have fallen along the 45° axis. The fact that they fall both below as well as above the line suggests that there is no clear (or intentional) attempt to influence the data one way or another, but merely a case of extremely poor data recording. Closer analysis of the results also suggests that the permit conditions (of being confined to depths from 100 m to 200m) are not being adhered to. In 85 of 277 cases (31%) of IIP monitored hauls, the trapping took place in water shallower than 100m, even as close inshore as 35.7 m depth. This information was not reflected in the submitted data. Not only does it represent false data submission, but it impinges on the rights of the already established semi-industrial and artisanal linefish sectors. There is already growing user conflict between the trapfish and linefish sectors and breaking permit conditions is likely to aggravate these problems.

5.2.4. Daily Catch Rates

In a similar comparison it was noted that the catch reported by the vessel was also seriously flawed. Out of 258 corresponding daily samples, only 3 samples (1%) reflected the same catch. In some cases the reported catch varied by more than 90% from that recorded by IIP staff. Fig 3c reflects a scatter diagram of the under and over-reporting of catches. Once again there is no distinct pattern, except that it points to extremely poor record keeping and/or data submission by the company concerned.

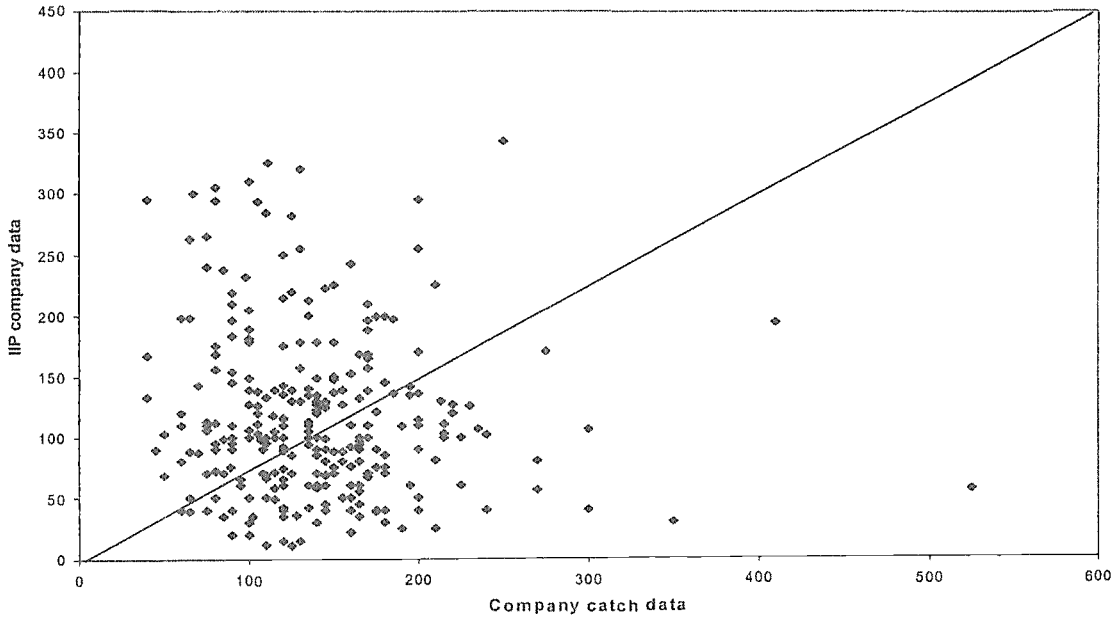

Figure 4. Catch comparison between IIP data and company data in 2000

5.2.5. Soak Time

Considering the fact that the first haul of any trip was initially deployed at the end of the previous trip, it seems reasonable to expect the first haul of such a trip to have the highest soak time. However, analysis of the catch returns do not support this at all. The mean soak time for all traps deployed in 2000, as reported by the vessel, was 22.9 hours (SD=2.1). The mean soak time of the first batch of each haul was calculated to be 22.6 hours (SD=2.3), less than the soak time for all remaining hauls (23.1 hrs; SD=2.1). Clearly, this confirms that the first haul was not documented. The analysis of the IIP data reveals that some of the first hauls of a trip were indeed longer, up to 96 hours in several cases.

A more detailed correlation analysis between the IIP and the vessel data sets further confounds the problem. Out of 249 corresponding hauls there were only seven (2.8%) occasions where the data corresponded. In table 9 above, the full range of errors is presented, revealing once again the highly questionable nature of the data submitted by the company. In the scatter diagram of Fig 5 the inconsistent data can further be assessed.

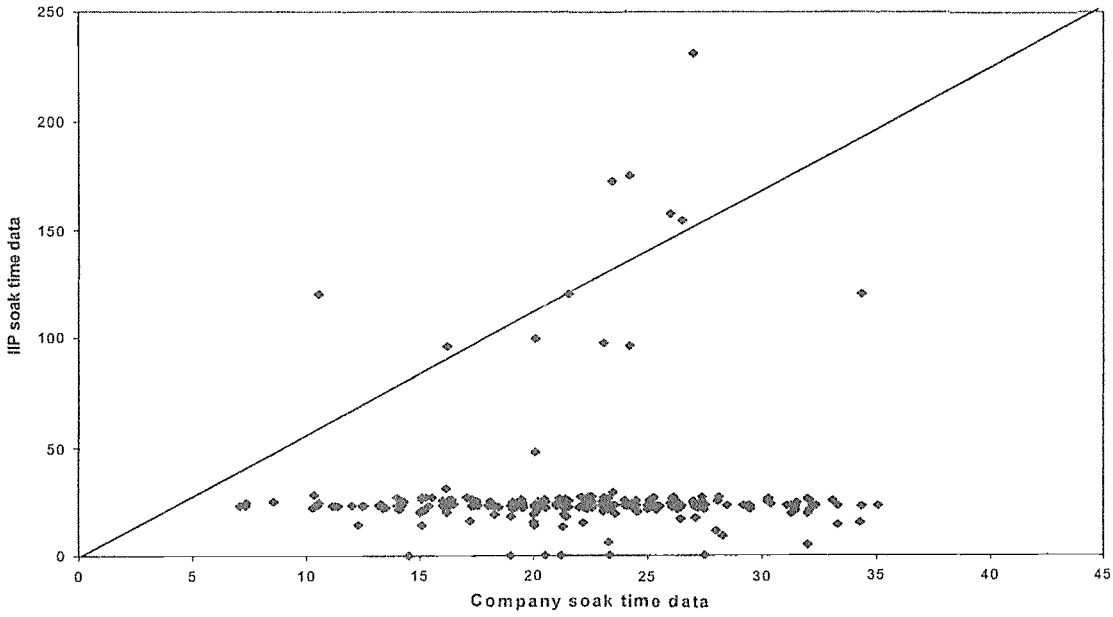

Figure 5. Soak comparison between IIP data and company data in 2000

5.2.6. Species Composition

Although this fishery was initially intended to target blueskin (*P.coeruleopunctatus)* at depths greater than 100m, there has been a progressive increase in by-catch of other species. By the year 2000, blueskin were no longer the main target and another 110 species were reported. See Table 10. This is a cause for serious concern because it reflects two

management problems. Firstly, it reveals that this fishery is not meeting its target and is impinging on other resources and the viability of their users and secondly it clearly indicates that the fishery is progressively shifting to shallower water, confirming the discrepancies in the depth analyses. Species such as *C. puniceus* and *E. andersoni*, occur primarily in water less than 100m.

Table 10. Main species composition for the trap fishery during the years 1997-2000

Species	Number				Weight			
	1997	1998	1999	2000	1997	1998	1999	2000
P. coeruleopunctatus	87.7	72.7	55.8	39.3	69.3	49.9	29.6	21.7
C. puniceus	2.2	6.5	12.6	11.4	1.5	3.8	8.8	6.8
C. nufar	1.5	14.4	10.6	10.1	2.2	15.6	6.8	6.1
E. andersoni	0.2	0.1	0.8	2.7	0.8	0.3	3.8	6.2
Other	8.4	6.3	20.2	36.5	26.2	30.4	51	59.2
Total species	29	20	59	110				

5.2.7. Total Landings

The total declared catch in 2000 was 173 mt. While this figure may be proximal to the real catch estimate, it cannot be related to the effort, so that further interpretation will be futile.

5.2.8. Conclusion

It is most unfortunate that the inevitable conclusion has to be drawn (once again) that the trapfish data submitted by the company is not reliable. Indeed, it could be asked if the submitted data has not been manipulated, either because of incompetence or to suit the company's interests at masking real facts and true information. In either case, this is not acceptable and contrary to the Fisheries Master Plan, international standards of responsible fisheries management and ultimately the people of Mozambique. Continued operations in this sector should be seriously reviewed if accurate data cannot be absolutely guaranteed.

More positive is the firm conclusion that the IIP samplers generated an outstanding and credible data set during these cruises. Considering the anomalous data situation, their continued monitoring of this fishery needs to be supported and their inevitably difficult position of being at sea on such a vessel needs to be recognised.

5.3. INDUSTRIAL TRAWLING FOR LINEFISH

In 2000, a total of 11 licenses were issued for trawling with fish (peixe) as the primary target. In the previous year, three of these licenses permitted fishing below the 24° S latitude. This allowed for capture of reef-associated linefish, because the southern region has considerable reef complexes. No detailed records are available for these 1999 industrial operations. In 2000, the permit conditions were modified so that fishing was confined to north of 24 °. As this now mostly includes the Sofala Bank region, these permits are clearly intended to target midwater fishes. This was confirmed by IIP staff samplers who noted that the gear on these vessels was midwater gear. The catch appears to be primarily for export to China.

Staff from IIP participated in some of these industrial fishing trips as monitors and obtained valuable statistics. Preliminary data indicates that much of the fishing takes place over soft substrates in water less than 50m. The catches recorded comprise the type of species normally associated with such substrata, notably small pelagics of the family Clupeidae. However, these landings do include one key linefish species, namely the serra *Scomberomorus commerson*. The limited IIP data indicates that the following species are caught with a frequency of capture per trawl as indicated (Table 11).

Table 11. Species caught in the industrial trawling for linefish

Species	Percentage by weight	Species	Percentage by weight
Carangoides malabaricus	11	*Rachycentron canadum*	11
Caranx sexfasciatus	4	*Scomberoides commersonianus*	7
Caranx ignobilis	4	*Scomberoides tol*	11
Carcharhinus limbatus	4	*Scomberomorus commerson*	79
Coryphaena hippurus	4	*Scomberomorus plurilineatus*	11
Drepane punctata	4	*Sphyraena sp*	11
Lutjanus sebae	4	*Sphyrna zygaena*	7
Manta birostris	4	*Thunnus albacares*	7
Pomadasys hasta	4	*Xiphias gladius*	4
Pomadasys maculatum	11		

Of some concern is the deduction that as much as 55% of the catch by weight may comprise *S.commerson*. Total landings of this fishery in 2000 were only declared by four of the 11 vessels and totalled 158 mt. In 1996 the total reflected for ten vessels was 2163 mt. If this is closer to the real tonnage landed, and the survey results are reasonably accurate, then as much as 7500 mt of serra could be taken in any one year.

5.4. RECREATIONAL, SPORT AND TOURIST FISHERY

There is a sizeable and growing recreational fishery in Mozambique. This was recognised by van der Elst *et al* (1995), with the influx of South African tourist anglers. More detailed analysis was presented by van der Elst *et* al (1997), based on the analysis of catch record cards and angling tournaments. The data presented at that time indicated that many, but not all, of the species targeted by the recreational sector were gamefish species. Unfortunately, no more data was collected from this sector during the year 2000, despite the considerable perceived growth in this sector.

The recreational sector comprises, skiboats, shore anglers and spearfishers. Also included should be the non-consumptive sector of divers, who depend on healthy reefs and fish resources to practice their form of recreation, much of it tourist related. Tourists from South Africa conduct most of the skiboat fishing, although at least three local clubs have active memberships and participation.

Ignoring the recreational sector could prove costly in the long term. Certainly the landings made by these fishers amounts to many tons per annum. It is now known that South Africa is on the verge of a major reduction (up to 70%) of the commercial linefish sector, one result of which is likely to direct South African fishing effort to Mozambique waters.

5.5. ARTISANAL FISHERY FOR LINEFISH SPECIES

This is a major and very important sector of the Mozambique linefishery. Although extensive studies into the artisanal fisheries are underway at Moma, Angoche, Zambezia, Inhambane and Maputo (for example), it is important to ensure that transfer of information takes place so as to ensure that different sectors of users do not threaten each other or the resource. Reports for this sector in 2000 are as follows:

In Maputo bay a total of 30 species was recorded where *Pomadasys maculatum*, *Otolithes ruber*, *Pomadasys kaakan*, *Sillago sihama*, *Priacanthus hamrur* was the group most abundant while the occurrence of sparide was only *Crenidens crenidens* with less percentage (Loureiro, personal communication). Data unprocessed from Inhaca Island indicates that the main species caught by artisanal linefishery is dominated by the genera *Lutjanus* and *Letrhinus* (Manuel, personal communication). The species from Family Sparidae namely *Chrysoblephus puniceus*, *Cheimeirus nufar*, *Rhabdosargus sarba*, *Acanthopagrus berda*, *Polysteganus coeruleopunctatus* and *Crenidens crenidens* are registered in low quantities (Manuel, personal communication).

In relation to Inhambane bay the data from 2000 are still processing and the main species *Crenidens crenidens*, *Lethrinus lentjan* and *Pelates quadrilineatus* (Halar, personal communication). In Vilanculos the occurrence of Sparidae was not notable and the most abundant species was *Carangoides gymnostethus* (Santana Afonso, personal communication).

Data from Angoche and Moma in Nampula province shows that the species most caught with line fishery is from families Serranidae, Lethrinidae, Lutjanus, Carangidae but there was also recorded *scomberomorus commerson* and *Acanthopagrus berda* (Masquine, personal communication). In Mogincual district also in Nampula province the species registered was mainly *Cephalopholis formosa*, *Lethrinus conchyliatus*, *Pomadasys kaakan*, *scomberomorus commerson and scomberomorus plurilineatus* (Masquine, personal communication)

6. CONCLUSIONS AND RECOMMENDATIONS

The linefishery in southern Mozambique is still generating productive catches that provide economic returns and social benefits. It is also clear that the harvesting of linefish in Mozambique waters has passed through several phases in recent years. Following years of low fishing pressure as a result of the war, there was a dramatic rise in fishing effort, largely brought about by South African lineboats (van der Elst *et al* 1997). The effects of this were noted in the assessment of several species, such as the marreco, and this subsequently resulted in the departure of many fishing vessels because the resource could not economically sustain such pressure. A second phase has now been detected, which involves the progressive extension of fishing grounds by Maputo based boats. Clearly, both phases have the same factor in common: namely the fact that linefish grounds closer to Maputo have been economically overfished. This trend is set to continue until such time that all the fishing

grounds south of the Sofala bank have been explored and exploited. It is anticipated that there would then be a sudden decline with potentially long-term consequences.

The results of 2000 and of previous years also clearly demonstrate that the linefish resource is harvested by a number of different fishing activities. One threatens the other, unless the management of each can be integrated and catch and effort statistics combined. It is not viable to have a large midwater catch of serra generating low returns potentially compromising a more lucrative linefishery for the same species. Similarly, it is not a good management practice to tolerate shallow water trap fishing when this impinges on well-established linefish activities – and so on.

Clearly, what is needed is a well-structured management plan for linefish that not only ensures sustainable use but also allocates the resource equitably to the diverse users. Recognition must also be taken of the fact that several of the prime species are shared with neighbouring countries and hence collaboration in their management is imperative.

The linefish research and monitoring programme at IIP needs to be strengthened. In particular the following actions are recommended-

- Monthly analysis of fishing vessel movements in and out of ports, including Inhambane.
- Much stricter controls over catch and effort submissions to the DNAP. Catch and effort information must reveal the locality where the fish are caught. The fishing zones of Mozambique are too large to allow for a single management zone.
- The on-board sampling programme should continue and especially to improve data collection at sea. It is recommended that a GPS be made available to the samplers so as to record fishing localities. VMS systems would also enhance the quality of data.
- A long-term management plan for linefish is urgently needed.
- There is an urgent need to develop a linefish database, possibly by using a modified version of some of the excellent databases already developed by IIP.
- Species-specific recommendations have been made in the report dealing with species profiles.

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