

Report On A Visit To Mozambique To

- i) To Assess The Economic Feasibility
Of By-Catch Collection Operation
- ii) Assess The Existing Post-Harvest
Losses In The Zambezia Region

January 21-February 16 1991

By A. GORDON and D. KING

EXECUTIVE SUMMARY

1. An ODA/DANIDA collaborative project in Mozambique is seeking to use collector boats to land and utilise shrimp by-catch usually discarded at sea by industrial trawlers. This resource is estimated to be 40,000 tonnes per year.
2. This report documents a preliminary survey of the Zambezia province fishery in early 1991, by an NRI fish technologist and economist. The study sought to assess the economic feasibility of the proposed by-catch operation in the changing circumstances of the country and also the extent and nature of post-harvest losses in the traditional fishery.
3. Delivery of the collection vessels has been delayed because of a problem with propeller design. Therefore, there are no operational data on the by-catch collection system, making it difficult to fully assess the economic feasibility. However, initial indications, based on data supplied by DANIDA, suggest that the collection and processing operation would show a very high rate of return. The need for further review is stressed as results are critically dependent on the validity of the operational assumptions.
4. Given the by-catch delay, the authors recommend that the TCO focus his efforts on loss reduction in the traditional artisanal fishery.
5. The most important source of loss observed during the visit was fragmentation caused by drying poor quality fish, bad handling and poor packaging/transportation of the product. Fish losses ("dust") varied considerably but were estimated to be in the region of 25%. (Note though that the dust can still be sold, in some instances, to low income groups for food use).
6. Significant levels of infestation of drying fish by blowfly larvae have been reported by other authors for the wet season. During this visit, the consultants noted that the insect problem appeared to be more significant in the freshwater fishery, where losses are likely to parallel those in neighbouring Malawi (23%, Walker 1983).
7. Recommendations are made for improving wet fish handling and curing techniques in the traditional fishery, using low cost technology and locally available materials. A participatory approach is needed if appropriate and sustainable ways of reducing post-harvest losses are to be developed.
8. Recommendations are also made on appropriate channels for extension and dissemination.
9. Finally, it is noted that the changing economic and political climate in Mozambique directly affects the institutional framework for proposed activities, and this should be reviewed in the light of emerging policies.

ACKNOWLEDGEMENTS

The authors wish to thank Mr Philip Ah-Weng for arranging our itinerary in Quelimane and for accompanying the authors on the field trips. Thanks are also due to Ms Francis MacLeod for her assistance during our stay in Maputo. The assistance of Mr. Paul Sorensen, the Danida adviser, who provided valuable background information to this visit was much appreciated.

Finally, the authors would like to thank all those people in Mozambique for their contribution to this study.

ABBREVIATIONS

CP	Combinado Pesqueiros
DANIDA	Danish International Development Agency
EC	European Community
FAO	Food and Agriculture Organisation
GNP	Gross National Product
IDPPE	Institute for Development of Small-Scale Fisheries
IIP	Institute of Fisheries Research
NORAD	Norwegian Agency for International Development
NRI	Natural Resources Institute
ODA	Overseas Development Administration
PAC	Support and Purchasing Sub-station
SFP	Fisheries Development Organisation
TCO	Technical Cooperation Officer

Currency £1 = 1004 meticaís at the official exchange
rate February 13, 1991

LIST OF TABLES

	Page
Table 1. Relative Importance of selected fishing centres	4
Table 2. Salt and water content of two species of fish	9
Table 3. Causes of losses of fish in Zambezia Province	12
Table 4. Possible countermeasures for reducing losses in wet and cured fish in Mozambique	13

CONTENTS

	Page
I. Introduction	1
1.1 Project Background	1
1.2 Terms of Reference	1
1.3 Visit Programme	2
1.4 Country Setting	2
1.5 Institutional Setting	3
II. Fish Handling And Distribution: The Traditional Fishery	4
2.1 Fish Production: Chinde to Angoche	4
2.2 Marketing Channels	5
2.3 Fish Handling and Preservation	8
2.4 Post-Harvest Losses In The Traditional Fishery	10
III Shrimp By-Catch	14
3.1 Shrimp By-Catch: Current Status	14
3.2 The DANIDA By-Catch Project	14
3.3 By-Catch Collection: Economic Feasibility	15
3.4 Processing and Marketing Of By-Catch: Economic Considerations	17
IV Conclusions And Recommendations	19
4.1 Conclusions Related To By-Catch Activities	19
4.2 Recommendations Relating To By-Catch (Post-Harvest)	19
4.3 Conclusions Related To The Traditional Fishery	20
4.4 A Strategy To Reduce Post-Harvest Losses In The Traditional Fishery	20
4.5 Specific Recommendations To Reduce Post-Harvest Losses	21
4.6 Draft Project Framework	22
Appendix 1 Map of Mozambique and project area	25
Appendix 2 Contact list	26
Appendix 3 Itinerary	33
Appendix 4 Salt Production	36
Appendix 5 References	37
Appendix 6 Financial Analysis	39

I. INTRODUCTION

1.1 Project Background

In 1988, the Mozambican Government, with assistance from DANIDA, initiated a shrimp by-catch project. This had two main components: a boat-building programme for transport and collection vessels; and a demonstration programme concerned with the operation of the vessels, and the retention of by-catch for human consumption. Since mid-1990, ODA has been funding a collaborative project, dealing with post-harvest aspects of the by-catch operation. In addition to the three year appointment of a fish technologist, based at Quelimane (Zambezia province), ODA funds complementary short-term consultancies. This report documents one such visit.

1.2 Terms of Reference

An NRI fish technologist and an economist were asked to conduct a survey of fishing centres on the coastline between Chinde (Zambezia province) and Angoche (southern Nampula), and visit important marketing centres. The purpose of this was two-fold:

- (i) to assess economic feasibility of the collection, processing and marketing of shrimp by-catch in relation to the ODA/DANIDA project based at Quelimane; and
- (ii) to assess existing post-harvest losses in region, and gain an appreciation of processing procedures, channels of distribution, and marketing practices.

The consultants were asked to consider the seasonal nature of the fishery, and the effect of this on traditional processing and marketing practices. They were asked to make recommendations concerning the handling and distribution of both by-catch and traditional fish products, to include proposals for reducing post-harvest losses. The need to reassess the economics of the by-catch operation was considered particularly important in the light of the changing economic situation in Mozambique.

The request to consider the traditional fishery as well as by-catch is largely due to a persistent problem with propeller design on the by-catch collection vessels, which has delayed the commencement of by-catch collection. (In early 1991, the estimated delivery date for the vessels was March 1991, although at the time of the visit the problem with the propeller had not been resolved and there was no revised delivery date).

1.3 Visit Programme

The consultants spent four weeks in Mozambique, from 21 January 1991 to 16 February 1991, working with the Quelimane-based ODA fish technologist. The first week and the last three days were spent in Maputo, visiting government departments, research institutes, aid agencies, non-governmental organisations, parastatal companies and fish markets. Ten days were spent based at Quelimane, from where day trips were made by road or air to fishing centres and interior markets, and another week was spent travelling by air to fish landings north of Quelimane, and to Nampula, an important inland market.

1.4 Country Setting

At the time of writing, the economy of Mozambique is subject to three main influences: a civil war that continues to cause widespread disruption of production and internal trade; a programme of structural adjustment and market liberalisation, which started in 1987, after more than a decade of central planning and regulated markets; and a drought, with accompanying predictions of widespread crop failure and famine. The result is that per capita GNP is one of the lowest in the world (US\$100-200 in 1988), and around 80% of total cereal supply is met from food aid.

The shrimp by-catch project is based in Quelimane, capital of Zambezia province, and home to part of Mozambique's important trawling fleet, responsible for 40% of export earnings (1989). The population of Zambezia is approximately three million (20% of the national total), of which an estimated 250,000 were displaced by the war in 1990. Many "deslocados" have fled to the coast, where they are dependent on relief supplies, and whatever meagre harvest can be reaped from the land or sea.

The severe food security situation explains the presence of the by-catch project. The project seeks to collect and utilise a food protein resource (estimated to total 30-40,000 tonnes per year), which is currently discarded at sea by industrial trawlers, interested only in lucrative shrimp for export.

1.5 Institutional setting

The by-catch project was set up in collaboration with the Institute for the Development of Small-scale Fisheries in Maputo (IDPPE). At the local level, IDPPE was responsible for the Combinados Pesqueiros ("fishing centres") which were located along the coast, to provide support to the artisanal fishery. These centres supplied inputs, purchased and processed fish, and were involved in some extension activities. They were, in turn, served by "fishing support and purchase stations", which were essentially satellites of the mother "combinado".

In 1987, Mozambique adopted open-market policies for the first time in more than a decade, and embarked on a programme of structural adjustment. This programme of economic rehabilitation emphasises the role of the private sector and free markets, and seeks to reduce public sector expenditure.

As a consequence, many public sector organisations have suffered budgetary cuts, and those performing quasi-commercial activities are considered candidates for privatisation. At the time of this study there was much debate concerning the future role, form and management of the CPs. Some change in their function appears inevitable.

II. FISH HANDLING AND DISTRIBUTION: THE TRADITIONAL FISHERY

2.1 Fish production: Chinde-Angoche

This 500 kilometre stretch of coast includes virtually the entire coastline of Zambezia province, and a further 100 kilometres in the southern part of Nampula province. The consultants visited important fishing centres in the vicinity of Quelimane, as well as Chinde, Pebane, Moma and Angoche.

Estimating fish production is extremely difficult. The war has resulted in abrupt changes in fishing patterns, and made it difficult to visit much of the coast. Moreover, fishing is very often a near subsistence activity, or trading is frequently "unseen" (and certainly unrecorded) and does not enter channels that can be easily monitored. 1981 registered catch data indicate that marine fish production in Zambezia province was about 3,000 tonnes per annum (and national production 22,000 tonnes). Taking into consideration reported growth in the artisanal sector, fish production along the stretch of coast studied is perhaps now in the region of 7-11,000 tonnes per annum. This seems broadly consistent with the consultants' estimate of fish traded annually through Quelimane's wholesale/retail market of 1-2,000 tonnes (wet fish equivalent). Note that Quelimane normally handles fish produced in the coastal areas roughly 50 kilometres to the north and south (and also handles some fish from Beira). The table below gives a rough indication of the importance of the main fishing centres in relation to Quelimane.

Table 1. Relative importance of selected fishing centres

Quelimane	1-2,000 tonnes per annum
Chinde	less than Quelimane
Pebane	less than Quelimane
Moma	less than Quelimane
Larde	this area probably more than Quelimane
Angoche	more than Quelimane

In 1981, approximately 20% of the country's artisanal fishermen were located in Zambezia. Extrapolating from this and NORAD's 1989 estimate of total artisanal fishermen, suggests that the state is now host to about 8,000 fishermen, with perhaps another 2-3,000 in the southern part of Nampula province. These figures indicate low labour productivity, and necessary dependence on additional sources of income and food.

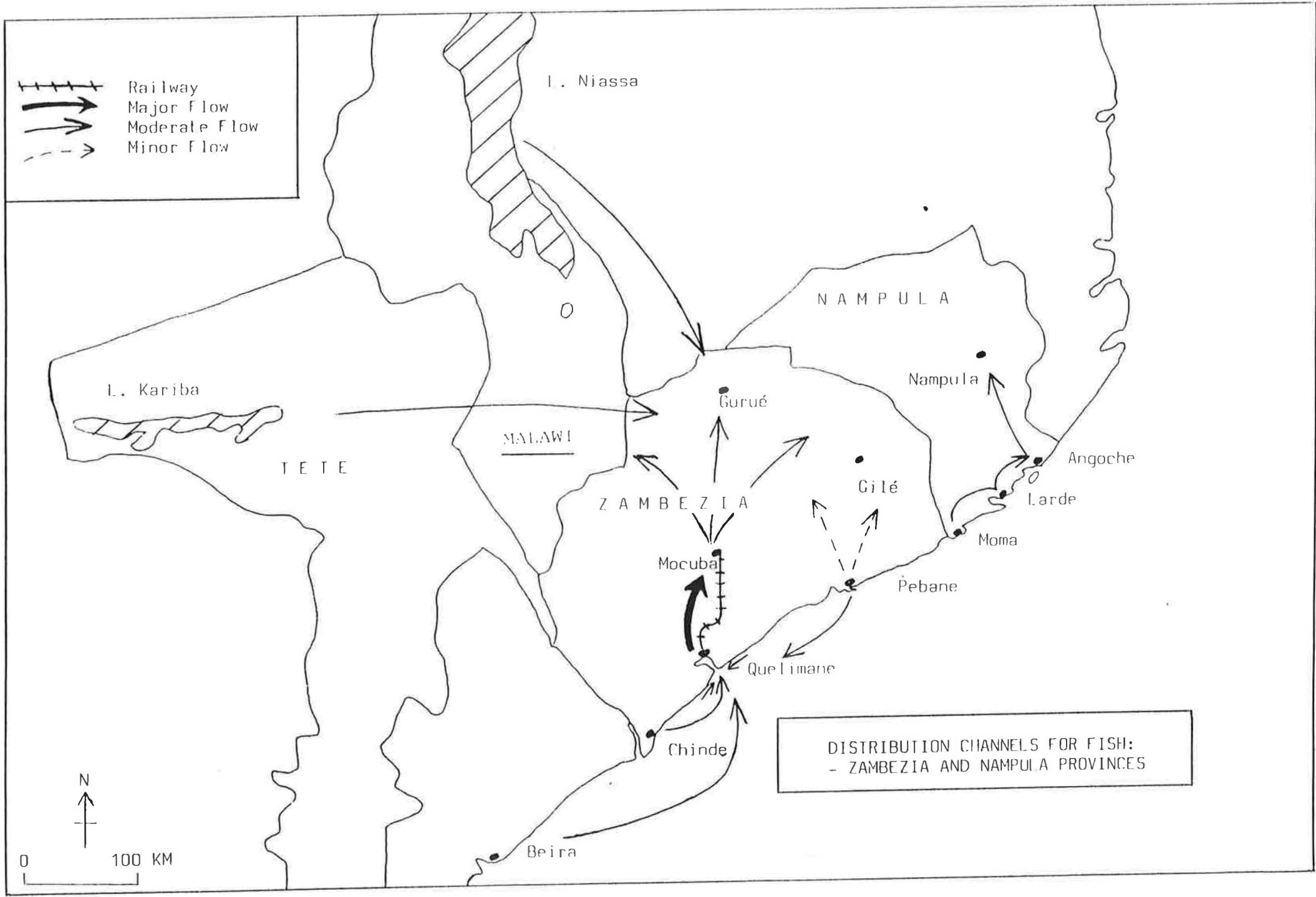
The most important marine and brackish water fish from this stretch of coast are hilsa, anchovy, shark, prawns, catfish, and mixed small pelagics. Additionally, inland production of tilapia and catfish may be important in some parts of the province. The fishing gear most commonly used are beach seines and handlines with some gillnets also in evidence. Additionally, some fishermen fish from the sea or estuary shore, and catch very small fish or shrimp (Acetes sp.) with extremely small mesh size "mosquito nets". The main fishing season is from September to April, though fishing continues year round. The rainy season usually is between November and April.

2.2 Marketing channels

In the areas visited, fishing communities were dispersed along remote areas of coast, and fishing was generally a disorganised activity undertaken by individuals or groups of individuals. In areas of particular importance, however, (such as Pebane, where marketing is a problem but fishing important to the traditional fishing population, whose numbers have been swollen by refugees), dried fish merchants finance some of the fishing. This is likely to be true too, of relatively inaccessible traditional fishing areas, such as the islands off Angoche.

Ice is not available for use on artisanal craft, or in distribution. Therefore wet fish is only marketed in the immediate hinterland (usually less than 40 kilometres away), which can be reached on foot, by bicycle, or occasionally by boat or vehicle. Very roughly, local sales probably account for 50% or more of the fish landed. All other fish is dried by the fishing communities themselves, and sold to merchants visiting the area, or taken by boat (or road, if the distance is short) to a more important marketing centre. In some areas, such as Gazelas near Quelimane, there are reported to be migrant communities engaged in fish processing.

The map below illustrates the direction of trade. Basically, two centres draw fish from the surrounding areas: Nampula, as an end market, attracts fish from Moma northwards; and Quelimane acts as an end market and a redistribution point for fish originating in Zambezia province. Both centres also handle dried fish shipped from Beira. From Quelimane, fish is redirected to local markets, or sent by rail or military convoy to Mocuba, thence markets in the northern interior. (The latter area is also supplied with freshwater fish from Tete province and Lake Niassa). It was observed that salted fish is an apparently preferred product in much of the interior of Zambezia. In Nampula the reverse was true, but some retailers reported a recent shift in favour of salted fish.



Transportation is a major constraint. Quelimane is supplied either from the immediate Gazelas-Sopinho area by road, or from other areas by over-subscribed boat services. Mocuba can then be reached several times per week by military convoy or train, but destinations beyond there are served less frequently by military convoy. With the exception of the road from Nampula to Alto Molocue, which is now reported to be open, no significant shipments are moved without military protection. In Gile, dried fish from Pebane was on sale in the market: traders had walked five days each way, carrying a sack of fish on the return journey. Although this type of small enterprise is probably widespread, the quantities of fish involved appear to be small.

Further north, transportation is a little easier. Although not entirely safe, private traders appear to be making more use of the road network linking Moma/Larde/Angoche with Nampula.

Most of the dried fish seen by the consultants during the study was traded in fairly small quantities (a few sacks of fifty kilograms or less) in a fairly disorganised ad hoc manner, renting freight space from larger concerns. However, from Moma northwards, there appeared to be more larger traders, some of whom had their own transport (probably reflecting both better security, and a greater concentration of fishing activity). There did not appear to be very many "links" in the chain: someone from Quelimane, for instance, may buy fish locally and transport it to Mocuba (usually travelling with the shipment). In Mocuba it would usually change hands, and either be retailed there or sent to a trader in a more distant market. Traders pay cash for fish purchases, frequently selling cassava from the interior in Quelimane, in order to finance their fish purchases. Marketing chains were similarly straightforward further north: traders from Angoche or Moma would take dried fish to Nampula where they would sell it directly to retailers.

In Pebane the consultants saw a well-organised dried fish operation, where good quality dried fish was produced. The merchant here financed fishing operations and employed people to process the fish. The fish was then packed in bundles of uniform size and weight, and stored prior to shipment by sea to Quelimane. This was quite unlike any other operation seen, but it seems likely that similar operations exist in the important fishing areas (particularly north of Moma).

The presence of many sellers and many buyers, as is the case with fish trade in Mozambique, would usually suggest that the industry should behave fairly competitively. This may not be the case in more remote areas, where fishermen perhaps have fewer people to sell to, or where they have entered into (relatively rare) contractual arrangements with fish merchants. However, it is perhaps worth mentioning that one large (general) wholesaler in Quelimane had stopped trading dried fish, because the advent of many small traders had reduced margins. Given acute food shortages in Mozambique, any wholesaler able to stay in business can probably expect a fairly high return on his investment. Trade in dried fish is presumably more accessible to smaller operators than other commodities traded (such as those originating out of the province).

Fishing in Mozambique is virtually exclusively a male activity, and unusually, in the areas visited, women were not generally involved in processing or marketing of fish either.

2.3 Fish handling and preservation

Most of the fishing communities have very limited facilities, and ice (which in any case is not generally available) is not used to preserve the catch. Generally, the first fishermen who return from fishing can sell their catch fresh but those arriving later are more likely to process their catch. Any fish unsold at the end of the day is processed.

Fish handling aboard the small canoes is very rudimentary. The fish are exposed to the direct sun and even the simple method of evaporative cooling by covering the catch with wet sacking is not carried out. Surprisingly, in some places, plastic fish containers were extensively used, suggesting that at some point these had been available at little or no cost. Once landed the fish is often placed directly onto the sand for sorting before being sold. In spite of these shortcomings the local fishing community has access to reasonably good quality fish since the time between capture and consumption is relatively short. The quality problem is more serious for dried fish being transported to larger population centres away from the immediate vicinity of the landing sites.

After the fresh fish is sold the remaining catch is usually sundried or salted and sundried by the fishermen. The climate is usually favourable for sundrying of fish with wind and continuous sunshine which reduces blowfly attack and increases the rate of drying. Usually no salt is used on very small fish although sometimes the bigger fish are salted. Salt was perceived as expensive by the majority of fishermen. It was difficult to determine the ratio of salt to fish used by the fishermen. However, a processor in Chinde stated that he used one bag of salt (about 25kg) to one tonne of fish which he weighed to ensure the correct proportions. These fish are normally left in the weak brine solution overnight and dried the following day. Salting before drying removes much of the water in the fish, accelerating drying, but the effect depends on the quantity used, in other countries it may be 1:3 salt to fish. However, in Mozambique it is apparent that the processors consider salt expensive, and therefore use it only when necessary and then only very sparingly. (Salt production is further discussed in Appendix 2).

The salt content and water contents of two species of salted, dried fish were determined in the laboratories of NRI.

Table 2: Salt and water content of salted, dried fish

Species	Moisture	Salt
Anchovy	30.4%	11.6%
Croaker	33.5%	11.2%

From details of the relationship between composition and storage life drawn up by Poulter in the FAO Fisheries Technical Paper No 219 (1981), the minimum "good quality" storage life can be predicted. This suggests a mould-free storage life of 6 weeks for anchovy and between 2-4 weeks for croaker. The results seem to confirm that dried fish is moved quickly through the distribution chain from processor to consumer as there was very little evidence of any moulds growing on dried fish in the local markets.

Most of the fishermen produce cured fish under very basic conditions with very little attention to quality. Fish is often placed on the ground exposed to contamination by flies, dust and dirt, and birds feed freely on the drying fish.

There was very little evidence of drying racks being used. In some cases fish were dried on sacks, fishing nets and coconut palm leaves, but this was relatively unusual. However, in Chinde the use of drying racks was observed and apparently there is a tradition of using racks in this region. The racks were well made from wood and old fishing nets.

Hot smoking and drying is another preservation method widely practiced by the fishermen. The fish are impaled on a small stick which is stuck into the ground over a fire. This method produces a hard cured product that was observed in many of the markets visited by the team. Species of fish that were smoked were predominantly shark, catfish and hilsa.

2.4 Post-harvest losses in the traditional fishery

Information gained during this visit was obtained by direct observation and discussions with fishermen and market traders, and should not be read as more than a preliminary indication of the extent of the problem. The distribution system should be monitored so that post-harvest losses in the traditional fishery might be more accurately assessed.

Physical losses of wet fish are considered to be minimal, since fish destined for wet consumption is distributed quickly to local retail markets, or consumed within the fishing community. Where losses might occur, fish is instead used for processing.

There is, however, scope for improved handling. After being landed, the catch is usually placed directly onto the sand to be sorted and sold. This applies to all species of fish and shrimp, regardless of value. They are prone to mishandling and physical damage, and as they are not chilled, are susceptible to bacterial spoilage. Simple methods of evaporative cooling would also extend the "shelf-life" of the wet fish (or improve the quality of the fish destined for processing).

Observed losses of cured fish were principally due to fragmentation caused by bacterial/autolytic spoilage that had taken place in the fish. This causes the fish to break up into small pieces or into a powder and, as a consequence, these pieces can be lost if the packaging is open. Fish that are partially spoiled before being dried are more susceptible to fragmentation. Also, the way in which the fish is packaged is important. Fish in Mozambique is generally packaged in hessian sacks which gives little protection to the fish. The sacks are roughly handled, and subject to compaction during transit by road and rail, which compounds the problem of fragmentation. Additionally, freight is paid on a volume basis, and not by weight, which encourages traders to tightly pack the sacks of fish. It was evident in some markets, however, that although there is a loss in value, even the fish "dust" can be sold for food use.

In the coastal areas visited by the team, infestation of drying fish by blowfly larvae did not appear to be a significant problem. Nor did dried marine fish seen in markets show signs of earlier infestation. However, it was stated by fishermen that losses due to larval infestation can be high during the wet season when the fish cannot be easily dried. Disney (1990), quoting local sources, reports a serious problem with blowfly in the Moma region, affecting large quantities of fish, and Wood (1985) refers to the same problem in the northern part of Mozambique.

Observations at markets in northern Zambezia and Nampula indicated that larval attack of freshwater fish from Lake Niassa appears to be a significant cause of loss. Damage to these fish is often severe and in some cases the whole fish is hollowed out leaving just skin and bone.

Causes of losses and suggested counter measures are given in Tables 3 and 4 below.

Table 3: Causes of losses of fish in Zambezia Province

Cause of Loss	Comment
1. Larval attack	May be a problem during periods of wet weather. Freshwater fish from Lake Niassa showed considerable damage due to larval attack
2. Fragmentation	Considered to be a significant problem and losses estimated to be in the region of 25%
3. Beetle infestation	Little sign of beetle damage observed during visit. Time dried fish is in the distribution chain and storage is very short.
4. Moulds/Bacteria	Little sign of mould or bacteria attack observed during the visits to local markets. A few cases of pink discolouration observed in the Central Market in Maputo.

Table 4 Possible Countermeasures For Reducing Losses
In Wet and Cured Fish In Mozambique

Causes of Losses	Counter measures
1. Spoilage of fish caused by bacterial and autolytic spoilage	Keep fish cool onboard, and throughout the distribution chain Improve the hygiene, sanitation and handling of catch
2. Blowfly infestation	Improve processing methods: -Using racks -Use of salt Improve quality of salt Improve hygiene and sanitation Reduce delays in processing the catch
3. Fragmentation	Improve storage conditions Improve packaging of fish Prevention of bacterial spoilage reduce delays in processing fish
4. Birds	Use of nets Raised drying racks

III. SHRIMP BY-CATCH

3.1 Shrimp by-catch: current status

DANIDA estimate that 66% of the industrial shrimp trawling occurs between Quelimane and Angoche, and that this is associated with roughly 27,000 tonnes of by-catch per annum. It should be noted that it is extremely difficult to accurately estimate the quantity of by-catch currently discarded at sea by the industrial fleet. DANIDA's estimates are consistent with with a national industrial prawn catch of approximately 8,000 tonnes, and a ratio of shrimp to fish of 1:5. Note though, that much lower shrimp to fish ratios have been observed (1:30 for instance, in November 1990, on a Quelimane-based trawler), which would suggest that the quantity of by-catch is much greater than 40,000 tonnes often quoted for Mozambique.

There is currently a closed season (for industrial trawlers only) in December and January. Some fishermen with canoes reported that they collect by-catch from the trawlers, without pre-arrangement, in exchange for fresh food, by going alongside when the nets are hauled. It should be stressed that if the trawlers are very distant, or the weather changeable, this is an arduous and potentially dangerous journey. Apart from this, only small quantities of by-catch are landed when the trawlers put into port--either the larger fish they have retained, or the by-catch from the last hauls.

3.2 The DANIDA by-catch project

The by-catch project was identified in 1983. It was proposed to construct new and better designed vessels for the collection of by-catch at sea, and at the same time organize the by-catch operation centrally from the headquarters in Quelimane. Ten by-catch collector vessels and 3 transport vessels are under construction at the boat yard in Pemba and upgrading of 5 by-catch collection stations is being undertaken between Quelimane and Angoche. The project seeks to establish a suitable retention system using these newly designed collector boats by bringing ashore by-catch throughout the fishing season. The project proposes to collect shrimp by-catch from industrial trawlers along the coast between Quelimane and Angoche. It is proposed that pairs of collector boats will be assigned to 5 by-catch "stations" and it aims to land 635 tonnes of fish per year at each by-catch collection station by the end of the pilot phase, due to end in August 1992. This represents 3,175 tonnes per annum in total for all 5 stations. The Mozambique government, through the IDPPE will supply qualified staff for the by-catch collection stations, collector vessels and transport boats together with qualified counterparts in the by-catch coordination office. This will be achieved through the service of the Combinado Pesqueiros which work within the auspices of the IDPPE and were set up to service the needs of the

small-scale fishermen. When the project was conceived they were flourishing and very active politically and economically reflecting the Government policy at that time. However, the changing political and economic climate in Mozambique has made their future uncertain.

The first two boats are to serve the processing stations at Zalala or Gazelas. The purpose-built boats will maintain radio contact with trawlers and, covering a thirty kilometre stretch of coast, collect by-catch from the trawlers. They are to go alongside when the nets are hauled, and transfer the catch using floating net bags. Inconvenience to trawlers is expected to be minimal (this is essential if they are to participate), and the by-catch will be paid for (with prices agreed in written contracts with each trawling company). The by-catch will then be landed at by-catch stations where it will be dried or salted and dried, prior to sale. Alternatively, some of it could be sold as wet fish.

As mentioned earlier, delivery of collection vessels has been delayed due to a problem with the propeller design. At the time of field work, delivery date was expected to be at the end of March 1991. This delay has meant that, contrary to earlier expectations, no operational data on the by-catch collection programme were available at the time of the consultants' visit.

3.3 By-catch collection: economic feasibility

The viability of the proposed by-catch collection, processing and marketing operation hinges on the costs of landing the by-catch. "Costs" here cover several factors which are crucial to the success of the programme; it is assumed that each of these factors affect costs in one way or another. So, for instance, if there are fewer trawlers than anticipated within reach of collector vessels, less by-catch will be landed and per unit landed costs will be higher.

The proposed activity is highly innovative. DANIDA's model suggests that by-catch collection would have an extremely high financial rate of return. This result is, however, clearly dependent on the validity of the assumptions which, in the absence of operational data, are difficult to assess.

The standard model, using DANIDA's assumptions, would suggest that by-catch could be landed at a cost of about 156 meticaïs/kg. This compares very favourably with current prices for similar fish of 250-300 meticaïs/kg. Appendix 1 contains the details of this calculation, along with several sensitivity analyses, using different assumptions (higher vessel cost, higher fuel costs, fewer days of operation, fewer transfers from trawler to collector, higher price paid to trawler for by-catch). Most of these result in relatively small increases in landed cost, but the analysis is quite sensitive to the price paid to the trawler for the by-catch. (Paying trawlers 200 meticaïs/kg rather than 100 meticaïs/kg would increase landed cost to 256 meticaïs/kg).

One collector boat is expected to land about 600 tonnes of fish per year, using the standard model assumptions. Given albeit crude estimates of the quantity of fish handled in Quelimane, of perhaps 1-2,000 tonnes per year, it seems likely that fish prices would fall if fish supply were to increase by 30-60%. In Appendix 1, the internal rate of return is calculated for each different scenario, assuming beach prices of 200, 250 and 300 meticaïs/kg. The price reduction reduces the high rates of return (from surprisingly high returns in excess of 100% to less than 100%), but does not appear critical unless higher prices are being paid to the trawlers, as an incentive to cooperate in the scheme. In the latter case an internal rate of return of only 20% (paying 200 meticaïs to the trawlers, but selling fish at the beach for 250 meticaïs) becomes negative when beach prices fall. Note too, that a return of 20% is extremely modest when compared with bank interest rates on loans of 27%, and the high return associated with the use of boats for passenger and cargo transport.

3.4 Processing and marketing of by-catch: economic considerations

The economics of processing and marketing is critically dependent on landed cost. This part of the operation should be assessed using "opportunity cost" values ie, the amount that the by-catch could be sold for if it were not processed at the by-catch station, even if landed cost is in fact lower. Separating the collection from the processing also enables us to assess the economic merit of each component. The processing and marketing, however, differs from by-catch collection, in the sense that it is not innovative. We know that fish can be processed and marketed economically, providing the cost of the raw material is not prohibitive. However, there are aspects of processing and marketing which deserve further consideration:

- * at the moment it is proposed that the by-catch will be processed at by-catch "stations"
- * the by-catch may differ significantly from other fish marketed, and
- * the quantity by-catch available may have a significant depressing effect on prices.

It is important that processing at well-equipped supervised by-catch stations does not become too expensive--important for the viability of the operation, and important for its demonstration value. At the beginning of 1991 the wholesale price for (small) salted dried fish in Quelimane was roughly 1,500 meticaís/kg. At this price, using traditional low capital processing methods, with wet fish costs of, say 300 meticaís/kg, fish drying is probably viable. (This assumes a weight reduction of 66% when dried, the use of salt, and local labour). Note that because refugees have moved onto land originally proposed for the Sopinho processing site, by-catch will be landed at Sopinho but taken by tractor nine kilometres along the beach to the processing area at Zalala, with obvious implications for cost and sustainability.

Dried by-catch is likely to be similar to other small low-value fish available currently, and is therefore likely to be sold at comparable prices. Fish processed at the by-catch station may in fact be of better quality, and could therefore conceivably command higher prices. Note, though, that it would be sensible to avoid dependence on a "false" high value market, such as selling to relief agencies prepared to pay elevated prices for fish to use in free food distribution programmes.

The price depressing effect of an increase in supply was discussed above, and it is difficult to gauge the magnitude of this effect. In the medium term, it is likely that the market would adjust to this: larger wholesalers only interested in large quantities of fish would probably become involved, and traders would attempt to send more fish to apparently under-supplied interior markets. Underemployed local communities (with big refugee populations) are likely to become (even) more involved in fish processing and marketing (security permitting). One wholesaler in Quelimane, interested in finding a bulk supplier of fish, claimed that he could sell 200 tonnes of fish per year without any problem at all. The most likely outcome is that prices would fall with the increase in supply, but probably not prohibitively (unless collection and processing costs are higher than predicted)--at least in the Quelimane area. In other areas, where marketing possibilities are fewer, or the security situation more restrictive, there might be more of a problem.

Given the price effect described above, it is useful to consider the possible distribution of benefits associated with this scenario. Consumers would be clear winners--with more fish available at lower prices. Existing artisanal fishermen would probably suffer a fall in income, receiving lower prices for their fish. The effect on traders and processors is less clear, though with increased turnover and employment there would probably be a net gain.

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions related to by-catch activities

Significant quantities of shrimp by-catch are discarded each year by industrial trawlers in Mozambique. DANIDA proposes to land large quantities of this underutilised food resource using collector vessels. If successful, this project could significantly increase the quantity of fish available in Zambezia, and help address the country's serious food security problem.

There are, however, several uncertainties surrounding the project. The following are particularly important:

- * the delivery date for by-catch collection boats is still uncertain
- * by-catch collection system has not been tested
- * it is not clear when the by-catch stations will be functional, and
- * the structure and role of the (host) Combinados Pesqueiros is likely to change.

Recommendations are made with these factors in mind.

4.2 Recommendations relating to by-catch (post-harvest)

In relation to the by-catch collection programme, the ODA post-harvest technologist should address certain issues:

- (i) collector vessels will be at sea for 12-14 hours; consideration should be given to appropriate on-board handling;
- (ii) it is important that processing at by-catch stations does not become expensive; in tackling this, the ODA fish technologist should consider the use of inexpensive locally available materials, and appraise proposed processing systems with regard to sustainability and replicability;
- (iii) the by-catch station managers should avoid dependence on NGOs prepared to pay elevated prices for fish for use in food distribution programmes;
- (iv) some by-catch may be sold directly for artisanal processing or local consumption; the ODA fish technologist should investigate ways of assisting artisanal processors; and
- (v) training of counterparts and sustainability of the systems established should be accorded the highest priority as soon as circumstances permit.

4.3 Conclusions related to the traditional fishery

The authors were able to make several observations on the traditional fishery:

- * fish passes through the distribution system very rapidly, and the market is undersupplied
- * even poor quality dried fish finds a market
- * coastal populations are largely underemployed, subsisting, and swollen with refugees
- * most people have very low purchasing power
- * the country is extremely dependent on food aid
- * dried fish is the most accessible animal protein source for low income groups
- * relatively small premia are paid for quality at consumer level
- * some dried fish in interior markets is subject to significant levels of loss
- * freshwater fish is more prone to larval attack, and
- * given dispersed production and markets, and current difficulties in transport, fish handling is dominated by small-scale enterprise.

This information provided the basic rationale for the strategy that follows.

4.4 A strategy to reduce post--harvest losses in the traditional fishery

The proposed strategy would target low income, nutritionally vulnerable groups, by concentrating on low value fish products. The main objective would be to reduce losses, thereby increasing the *quantity* of fish available (rather than specifically aiming to secure quality premia from consumers). For this approach to be successful, traders would have to be able to recognise and pay for improved products associated with less loss. If traders are to pay for the improvements, and fishermen are to adopt them, it is important to concentrate on low cost, "low tech" handling methods, using locally available materials, and a *participatory approach*. The fishing population is extremely dispersed and some form of extension is required if there is to be any impact. Activities should therefore be focussed wherever there is a structure through which to work, be it non-governmental, private, or governmental.

4.5 Specific recommendations to reduce post-harvest losses

The team recommends work in the following areas:

(i) the establishment of a system for collecting baseline data on the existing losses, and monitoring the effects of proposed changes in handling methods; this should explicitly take account of processors' and traders' responses

(ii) the identification of organisations with which the project could work, and a work plan showing how effort will be divided between different activities and places

(iii) improved handling methods should be developed using a participatory approach, seeking ideas and opinion from processors and traders; such methods are likely to be low cost, and use locally available materials; consideration should be given to suitable methods of wider dissemination of popular processes

(iv) for wet fish

- * improved handling of fish on board, on the shore, and in transit to markets
- * increasing shelf-life without using ice, on board, when landed, in transit to markets, and in the market

(v) for processed fish

- * making salt
- * salting and drying
- * using drying racks
- * salting fish on board
- * packing of dried fish
- * improving quality of wet fish for drying

Recommendations relating to the traditional fishery are summarised in the project framework that follows.

<u>Project Title:</u>	The reduction of post-harvest losses in the traditional fishery in Mozambique
<u>Project Structure:</u>	
Wider objectives	To effect a sustained increase in the supply of fish protein in Mozambique
Indicators of Achievement:	None appropriate
How Indicators can be quantified or assessed	None appropriate
Risk:	security situation disrupts internal trade
Immediate objectives:	<ul style="list-style-type: none"> a. To reduce post-harvest losses with particular reference to dried fish b. To set up a functioning network and appropriate methods for dissemination of information to people handling fish
Indicators of Achievement:	<ul style="list-style-type: none"> a. monitoring vs baseline data b. evidence of cooperation with other agencies
How Indicators Can Be Quantified Or Assessed:	a. techno-economic review of project progress by NRI staff
Risk:	<ul style="list-style-type: none"> a. inadequate local support to secure dissemination and uptake b. dispersed nature of processing and trading systems makes practices not susceptible to improvement

Outputs:

- a. System established for collection of baseline data and monitoring the effect of subsequent improvements
- b. Participatory approach used to develop appropriate cost-effective improved methods of fish handling
- c. Establishment of extension networks to work through
- d. Establishment of suitable dissemination methods

Indicators Of Achievement:

- a. Improved handling methods adopted by trade
- b. baseline data/monitoring system assessed by techno-economic NRI team

How Indicators Can Be Quantified Or Assessed:

- a. Regular project reports, stating progress & work plan
- b. trade survey and techno-economic evaluation by NRI staff of methods proposed/adopted
- c. management reviews, in-country monitoring by Embassy staff, review of project reports by NRI staff

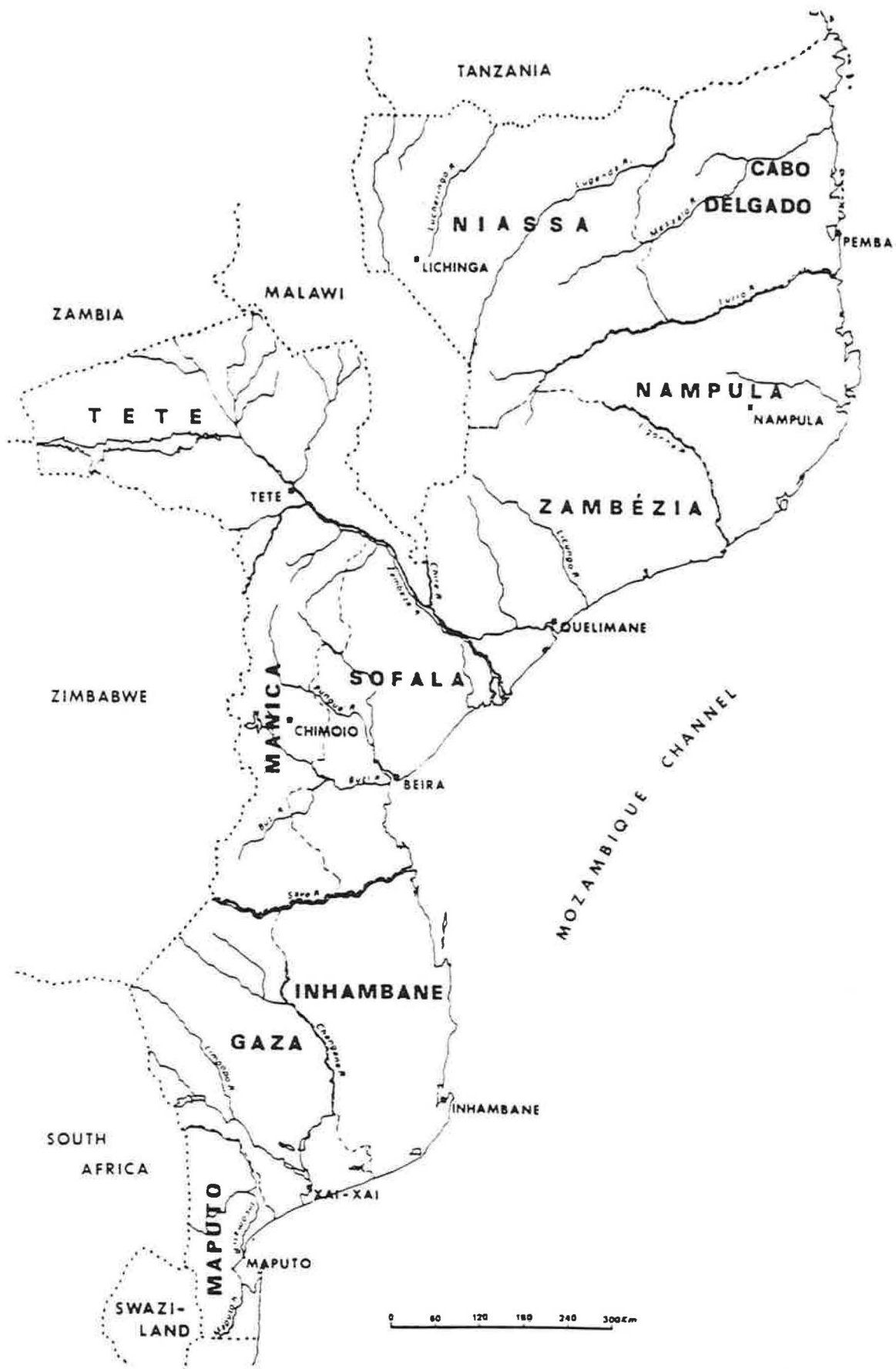
Risk:

- a. processing is already economically optimal, so no improvement possible
- b. trade too disrupted for benefits of improvements to be perceived, paid for, and therefore adopted
- c. networks inadequate or too weak for proposed work
- d. security situation disrupts proposed work
- e. outputs unobtainable within, say, 5 year project span

Inputs:

TCO, travel budget, cooperation of local

MAP OF MOZAMBIQUE AND PROJECT AREA



PEOPLE CONTACTED DURING VISIT TO MOZAMBIQUE

Abrão Pira Bau
Head of Department
Institute for Small-Scale Fisheries Development (IDPPE)
Maputo

Rui Falcão
Planning Officer
IDPPE
Maputo

Valiejos Alejandro
FAO Fisheries Expert,
IDPPE
Maputo

Oscar do Porto
FAO Fish Processing Export
IDPPE
Maputo

Philip Ah-weng
Technical Cooperation Officer
ODA Shrimp By-catch Utilisation Project
Quelimane

Maria Helena Motta Cruz
Formerly with PROPESCA, Maputo
(Currently studying in the UK)

Maria Imelda Sousa
Director
Institute for Fisheries Research (IIP)
Maputo

Frances MacLeod
Third Secretary (Aid)
British Embassy, Maputo

Vincent P Crockett
ODA Project to Rehabilitate Jetty at Angoche

Dr Heimo Mikkola
FAO Representative for Mozambique and Swaziland
Maputo

Peter Byrne
Consultant
UNCDF Rural Transport Project

Francisco Lulanga
Fisheries Supply and Purchasing Centre (PAC)
Inhaca

Cassímo Maraj
Director
PAC, Inhacca

Antonio Machava
Prawn Processing Plant
"Porta da Pesca" (fish handling company)
Maputo

Arão Zacarias
Head of Administration
Porta da Pesca
Maputo

Leonardo Garuglieri
Economist
EC Delegation
Maputo

Pierre Haftek
Economist
EC Delegation
Maputo

Michael K Kelleher
NORAD Consultant Fisheries Economist
Maputo

Virginia Kelleher
Consultant Economist
IDPPE
Maputo

André Valente Mondlane
Sales Department
Pescom International
Maputo

José Francisco Malunga
Commercial Director
Pescom EE
Maputo

Poul Sorensen
DANIDA By-catch Collection Programme Coordinator
Quelimane

Guy Mullin
Deputy Director
Action Aid
Quelimane

Maria Sorensen
Administrative Assistant
DANIDA By-catch Collection Programme
Quelimane

Amade Mussa
Director
Sopinho Combinado Pesqueiro (CP)

Avelino Buramugi
Fish Processor
Sopinho CP

Estêvão Andelepane
Fish Processor
Sopinho CP

Antonio Caminho
Accounts Officer
Zalala PAC

José Moleva
Manager
Gazelas PAC

Alves Bernardo
Provincial Director
Zambezia Directorate for Industry and Energy
Quelimane

Carlos Lopes
Regional Representative
Agricom (state-owned agricultural marketing & distribution co)
Mocuba

Baptista Emílio
Director of Internal Marketing
Mocuba

Anaudo Natívo
Cabinet Chief
District Administration
Mocuba

Manuel André Morais
DIPROZA (State Transport Company)
Mocuba

Jussab Aboo Bacar
Wholesaler, Safi Gulamo
Mocuba

Marcelino Janeira Donça Ferro
District Deputy Administrator
Gilé

João Fernandes Cabral
District Director of Health
Gilé

Carimo Juma
Department of Emergency Relief (DPCCN)
Gilé

Acacio Manuel
Local Government Officer
Gilé

Berto Nunes Malabo
District Administrator
Gilé

Abdul Sacoor Sidi
Wholesaler
Armazéns Safi
Quelimane

Luciano Pires
Station Master
Quelimane Railway Station

Bruce McWeeny
Consultant
EC Inhambane Fisheries Development Project

Pedro Rafael
District Administrator
Alto Molócue

Lourenço Paulo
Organizações Lôpa (Wholesaler)
Alto Molócue

Fernando Paulino Xavier
Wholesaler
Alto Molócue

Vasco Furéde
AGRICOM Representative
Alto Molócue

Horácio L Zigueiredo
Director of Marketing
Alto Molócue

Rosario Memande
Deputy District Administrator
Gurué

Adalberto Janeiro
District Director of Agriculture
Gurué

Luís Armazia
District Director of Health
Gurué

Ibrahim Hosseine
Wholesaler
Gurué

O Sr Mussa
Fisheries Officer
Provincial Fisheries Service
Quelimane

Antonio Serra
Technician
DANIDA By-catch Project
Quelimane

Antonio Pedro Cardozo
Action Aid Project Manager
Pebane

Tony Aboo Bacar
Dried Fish Processor/Trader
Pebane

Aristides Coahlo
District Administrator
Pebane

Regalado Boné
Departamento de Prevenção e Combate às Calamidades Naturais
Pebane

Matias João Morais Machava
Director of Combinado Peisquero
Moma

Ernesto José Namagoa
Deputy District Administrator
Moma

António Maurício
Administrative Assistant
Moma

Fernando Bernardo
Dried Fish Merchant
Moma

Uzini Nota
Dried Fish Merchant
Moma

Sualé Abudo
Fisherman
Moma

Luís Altino de Sousa
Extension Officer
Combinado Peisquero
Moma

Eugenia Mupota
PAC Director
Moma

Manuel Saide
PAC Director
Moma District

Palagio Ali
Technician
Combinado Peisquero
Moma

Jamnadás Parsotamo
Fisheries Technician
SIDAC (Portuguese Aid) Project
Moma

Joaquim Mohilapa
Director of Emopesca
Angoche

Talio Braimo
Maritime Administration
Angoche

Américo Rosa
Maritime Administration
Angoche

António José Chande
District Administrator
Angoche

Ezequiel Monjane
Station Master
Nampula

Jacinto Tonhiua
Director of Department of Industry and Energy
Nampula

Joaquim Alves
Director of Department of Industry
Nampula

Pedro Juma Mawawa
Deputy District Administrator
Chinde

Carlos Moisé Muchanga
Harbour Master
Chinde

Joaquim Bivar Segurado
Country Director
Action Aid
Quelimane

Wibe Johnsen
Socio-economist
IDPPE
Maputo

Stig Barlyng
Head of Mission
DANIDA
Maputo

Eusebio Siquela
Director of Economics
State Secretariat for Fisheries
Maputo

Mr Cruz
Director
Sociedade de Fomento Peisquero
Maputo

Agostinho Pontes
Economist
Sociedade de Fomento Peisquero
Maputo

Amilo Faria
Fisheries Technologist
Sociedade de Fomento Peisquero
Maputo

Visit Programme : Duncan King and Ann Gordon

- 21/1 Arrive Maputo
- 21/1 Meeting with Philip Ah-weng
Meeting at IDPPE
- 22/1 Meetings: IIP
British Embassy
FAO
Visit fish landings
- 23/1 Meetings: EC
NORAD Consultant
IDPPE Economist
Visit to Central Market, Maputo
- 24/1 Visit to Inhaca Fisheries Supply and Purchasing
Centre
Meeting: Peter Byrne UNCDF Consultant
- 25/1 Visit to "Porto da Pesca" fish handling plant
Meetings: PESCOM International
Bruce McWeeny (EEC Fisheries Project)
Oscar do Porto (FAO/IDPPE)
British Embassy
Visit to Dried fish market, Maputo
- 26/1 Visit to Pescom EE
- 27/1 Travel by air to Quelimane
- 28/1/ Meetings: Paul Sorensen (DANIDA)
Action Aid
Visit to main market in Quelimane
Visit to ODA Project fish processing laboratory
- 29/1 Visit by car to CP at Sopinho and proposed by-catch
processing sites at Gazelas and Zalala

- 30/1 Visit by air to internal marketing centres of Mocuba and Gilé
- 31/1 Visit to market in Quelimane
Meeting with Provincial Director, Industry and Energy
Visit to railway cargo handling yard
Meeting with Wholesaler
- 1/2 Visit by air to internal marketing centres of Alto Molócue and Gurué
- 2/2 Visit by car to markets at Nicoadala and Likuare
- 4/2 Fly to Pebane to survey production, processing and marketing in area
- 6/2 Fly from Pebane to Moma to continue fish landings survey
- 7/2 Fly from Moma to Angoche (fish landings survey)
- 8/2 Fly from Angoche to Nampula (market survey)
- 9/2 Return flight to Quelimane
- 11/2 Visit by air to Chinde (fish landings survey)
- 12/2 Duncan King to Sopinho fish processing area
Wind-up meeting with Poul Sorensen
Meeting with Action Aid
Wind-up meeting with Philip Ah-weng
- 13/2 Flight to Maputo
Meeting with Frances MacLeod, British Embassy

- 14/2 Wind-up meeting at IDPPE
 Meeting with DANIDA Head of Mission
 Meeting with Economics Director, State Secretariat
 for Fisheries
- 15/2 Wind-up meeting at British Embassy
 Meeting at the Sociedade de Fomento Pesqueiro
 Market visits in Maputo
- 16/2 Departure from Mozambique

APPENDIX 4: Salt Production

Salt is available in the larger centres of population such as Quelimane. Salt is produced by the evaporation of seawater using the action of the wind and sun to produce solar salt. Figures for the amount of salt produced in Quelimane are given in the table below.

Table 1. Production of Salt in Quelimane

Year	Amount in tonnes
1985	1,181
1986	2,816
1987	12,885
1988	1,921
1989	1,886

Source: Dept. of Industry and Energy

The class of salt varies in price depending on its grade. There are three grades of salt with first class salt being the purest, this is taken from the top layer which would generally have less contaminants, mainly sand and dirt. The price for first class salt is roughly double that of third class salt.

Commercial salts vary in their composition depending on the sodium chloride content. Analysis of salt obtained from the market in Quelimane showed a sodium chloride content of 86% which indicates a fairly low quality salt.

APPENDIX 5: References

1. Ah-Weng, P.(1990). Shrimp by-catch utilisation: Progress report, May-September.
2. Ah-Weng, P.(1990). Shrimp by-catch utilisation: Progress report, September-December.
3. DANIDA(1988) Fish distribution project: Part 1. Study of the small-scale fishery in Sofala: Part 2. Study of markets for dried fish. Report prepared by short term DANIDA consultants.
4. DANIDA(1990). Support to small-scale fisheries of Mozambique. Final report of project review mission: Volume 1-3 and Annexes.
5. DANIDA(1990). Shrimp by-catch project: Socio-economic study of small scale fisheries in Quelimane zone. Report prepared by V. Johnsen.
6. Danida(1990). Draft report on viability of the Combinado Pesqueros. Report prepared by Centre for Alternative Social Analysis.
7. Debeauvais, R., Vauclare, C., Campbell, J. and Roullot, C. Study of small-scale fisheries in Mozambique(1990). Report prepared for Centre d'etude et d' action sociales maritimes (CEASM), Paris, France.
8. Disney, J.(1990) Shrimp by-catch utilisation project.
9. Donato, J.(1990). Report prepared for Action Aid on the artisanal fishing sector in Pebane.
10. Donato, J.(1990) Basic information about the artisanal fishery in the districts of Maganga. Report prepared for Action Aid
11. Economist(1990) Mozambique gets sympathy but cannot sell its tea, March 31 1990
12. FAO.(1981) The prevention of losses in cured fish. FAO Fish. Tech. Pap. (219): 87p
13. FAO.(1990) Angoche fisheries development project. Report prepared on behalf of the United Nations Capital Development Fund.
- 14a. Financial Times(1991). Wilting in the shadow of war, January 15, 1991
- 14b Financial Times(1991). The prawn Industry: Rare sucess for the state, January 15,1991.
15. Krantz, L., Sorensen, N. K., Olesen, J. and Katalova, J.(1989). The fisheries in Mozambique: A sector study. Report prepared for NORAD.

16. Silva, C. and Sousa, M. I.(1986) Summary description of the marine fisheries and resources for Mozambique. Instituto de Investigacao Pesqueira.

17. Sorensen, P.(1990) Shrimp by-catch and construction of transport vessels(Quelimane and Pemba, Mozambique). Progress report(June 30-December 15 1990) prepared by P. Sorensen, Coordinator by-catch collection programme.

18. Wood, C. report on a visit to Mozambique to review shrimp trawler by-catch utilisation. Report prepared for Tropical Development and Research Institute (TDRI), London, UK.

19. World Bank(1990). Mozambique: Economic Policy Framework, 1990-1992

APPENDIX 6 FINANCIAL ANALYSES

VIABILITY OF BY-CATCH COLLECTION VESSELS

Example 1. Standard model

Cost of vessel (estimate Feb. 1991 in '000 meticaïs)	60,000.00
Life of vessel (low maintenance) in years (zero salvage value)	5.00
Interest rate	27%
Annualised capital cost in '000 meticaïs (A)	23,231.75
Annual maintenance charges (8% of A) '000 meticaïs (B)	1,858.54
Crew salaries, annual basis, in '000 meticaïs (C)	2,160.00
ANNUAL FIXED COSTS in '000 meticaïs (A + B + C)	27,250.29
Days/year weather permits operation of vessels (& open season)	214.00
"Down" time	5%
Hours of engine use per day (but 12-14 hours at sea)	10.00
Litres of diesel used per hour	7.20
Cost of diesel per litre in meticaïs	450.00
Annual fuel costs in '000 meticaïs	6,586.92
TOTAL FIXED AND FUEL COSTS in '000 meticaïs	33,837.21
Number of transfers per day	12.00
Volume of fish per transfer (kgs)	250.00
Fish collected per year (kgs, 100% utilisation assumed)	609,900.00
Price paid to trawler (meticaïs/kg)	100.00
Total landed cost of by-catch (meticaïs/kg)	155.48

FIVE YEAR CASH FLOW MODELS (zero salvage value for vessel assumed)

Value of fish at landing (meticaïs/kg)	200.00 (1)
	250.00 (2)
	300.00 (3)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	60,000.00	71,595.46	71,595.46	71,595.46	71,595.46	71,595.46
Income (1)		121,980.00	121,980.00	121,980.00	121,980.00	121,980.00
Income (2)		152,475.00	152,475.00	152,475.00	152,475.00	152,475.00
Income (3)		182,970.00	182,970.00	182,970.00	182,970.00	182,970.00
Net income (1) (	60,000.00)	50,384.54	50,384.54	50,384.54	50,384.54	50,384.54
Net income (2) (	60,000.00)	80,879.54	80,879.54	80,879.54	80,879.54	80,879.54
Net income (3) (	60,000.00)	111,374.54	111,374.54	111,374.54	111,374.54	111,374.54
IRR (1)	79%					
IRR (2)	133%					
IRR (3)	185%					

Example 2. Sensitivity analysis: higher vessel cost

Cost of vessel (estimate Feb. 1991 in '000 meticaïs)	75,000.00
Life of vessel (low maintenance) in years (zero salvage value)	5.00
Interest rate	27%
Annualised capital cost in '000 meticaïs (A)	29,039.68
Annual maintenance charges (8% of A) '000 meticaïs (B)	2,323.17
Crew salaries, annual basis, in '000 meticaïs (C)	2,160.00
ANNUAL FIXED COSTS in '000 meticaïs (A + B + C)	33,522.86

Days/year weather permits operation of vessels (& open season)	214.00
"Down" time	5%
Hours of engine use per day (but 12-14 hours at sea)	10.00
Litres of diesel used per hour	7.20
Cost of diesel per litre in meticaïs	450.00
Annual fuel costs in '000 meticaïs	6,586.92

TOTAL FIXED AND FUEL COSTS in '000 meticaïs 40,109.78

Number of transfers per day	12.00
Volume of fish per transfer (kgs)	250.00
Fish collected per year (kgs, 100% utilisation assumed)	609,900.00
Price paid to trawler (meticaïs/kg)	100.00
Total landed cost of by-catch (meticaïs/kg)	165.76

Value of fish at landing (meticaïs/kg)	200.00 (1)
	250.00 (2)
	300.00 (3)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	75,000.00	72,060.09	72,060.09	72,060.09	72,060.09	72,060.0
Income (1)		121,980.00	121,980.00	121,980.00	121,980.00	121,980.0
Income (2)		152,475.00	152,475.00	152,475.00	152,475.00	152,475.0
Income (3)		182,970.00	182,970.00	182,970.00	182,970.00	182,970.0
Net income (1) (	75,000.00)	49,919.91	49,919.91	49,919.91	49,919.91	49,919.9
Net income (2) (	75,000.00)	80,414.91	80,414.91	80,414.91	80,414.91	80,414.9
Net income (3) (	75,000.00)	110,909.91	110,909.91	110,909.91	110,909.91	110,909.9
IRR (1)	60%					
IRR (2)	104%					
IRR (3)	146%					

Example 3. Sensitivity analysis: increased cost of diesel fuel

Cost of vessel (estimate Feb. 1991 in '000 meticaïs)	60,000.00					
Life of vessel (low maintenance) in years (zero salvage value)	5.00					
Interest rate	27%					
Annualised capital cost in '000 meticaïs (A)	23,231.75					
Annual maintenance charges (8% of A) '000 meticaïs (B)	1,858.54					
Crew salaries, annual basis, in '000 meticaïs (C)	2,160.00					
ANNUAL FIXED COSTS in '000 meticaïs (A + B + C)	27,250.29					
Days/year weather permits operation of vessels (& open season)	214.00					
"Down" time	5%					
Hours of engine use per day (but 12-14 hours at sea)	10.00					
Litres of diesel used per hour	7.20					
Cost of diesel per litre in meticaïs	540.00					
Annual fuel costs in '000 meticaïs	7,904.30					
TOTAL FIXED AND FUEL COSTS in '000 meticaïs	35,154.59					
Number of transfers per day	12.00					
Volume of fish per transfer (kgs)	250.00					
Fish collected per year (kgs, 100% utilisation assumed)	609,900.00					
Price paid to trawler (meticaïs/kg)	100.00					
Total landed cost of by-catch (meticaïs/kg)	157.64					
Value of fish at landing (meticaïs/kg)	200.00 (1)					
	250.00 (2)					
	300.00 (3)					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	60,000.00	72,912.84	72,912.84	72,912.84	72,912.84	72,912.84
Income (1)		121,980.00	121,980.00	121,980.00	121,980.00	121,980.00
Income (2)		152,475.00	152,475.00	152,475.00	152,475.00	152,475.00
Income (3)		182,970.00	182,970.00	182,970.00	182,970.00	182,970.00
Net income (1) (60,000.00)	49,067.16	49,067.16	49,067.16	49,067.16	49,067.16
Net income (2) (60,000.00)	79,562.16	79,562.16	79,562.16	79,562.16	79,562.16
Net income (3) (60,000.00)	110,057.16	110,057.16	110,057.16	110,057.16	110,057.16
IRR (1)	77%					
IRR (2)	131%					
IRR (3)	182%					

Example 4. Sensitivity analysis: fewer days of vessel operation

Cost of vessel (estimate Feb. 1991 in '000 meticaïs)	60,000.00					
Life of vessel (low maintenance) in years (zero salvage value)	5.00					
Interest rate	27%					
Annualised capital cost in '000 meticaïs (A)	23,231.75					
Annual maintenance charges (8% of A) '000 meticaïs (B)	1,858.54					
Crew salaries, annual basis, in '000 meticaïs (C)	2,160.00					
ANNUAL FIXED COSTS in '000 meticaïs (A + B + C)	27,250.29					
Days/year weather permits operation of vessels (& open season)	214.00					
"Down" time	15%					
Hours of engine use per day (but 12-14 hours at sea)	10.00					
Litres of diesel used per hour	7.20					
Cost of diesel per litre in meticaïs	450.00					
Annual fuel costs in '000 meticaïs	5,893.56					
TOTAL FIXED AND FUEL COSTS in '000 meticaïs	33,143.85					
Number of transfers per day	12.00					
Volume of fish per transfer (kgs)	250.00					
Fish collected per year (kgs, 100% utilisation assumed)	545,700.00					
Price paid to trawler (meticaïs/kg)	100.00					
Total landed cost of by-catch (meticaïs/kg)	160.74					
Value of fish at landing (meticaïs/kg)	200.00 (1)					
	250.00 (2)					
	300.00 (3)					
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	60,000.00	64,482.10	64,482.10	64,482.10	64,482.10	64,482.10
Income (1)		109,140.00	109,140.00	109,140.00	109,140.00	109,140.00
Income (2)		136,425.00	136,425.00	136,425.00	136,425.00	136,425.00
Income (3)		163,710.00	163,710.00	163,710.00	163,710.00	163,710.00
Net income (1) (60,000.00)	44,657.90	44,657.90	44,657.90	44,657.90	44,657.90
Net income (2) (60,000.00)	71,942.90	71,942.90	71,942.90	71,942.90	71,942.90
Net income (3) (60,000.00)	99,227.90	99,227.90	99,227.90	99,227.90	99,227.90
IRR (1)	69%					
IRR (2)	117%					
IRR (3)	164%					

Example 5. Sensitivity analysis: fewer transfers

Cost of vessel (estimate Feb. 1991 in '000 meticaïs)	60,000.00
Life of vessel (low maintenance) in years (zero salvage value)	5.00
Interest rate	27%
Annualised capital cost in '000 meticaïs (A)	23,231.75
Annual maintenance charges (8% of A) '000 meticaïs (B)	1,858.54
Crew salaries, annual basis, in '000 meticaïs (C)	2,160.00
ANNUAL FIXED COSTS in '000 meticaïs (A + B + C)	27,250.29

Days/year weather permits operation of vessels (& open season)	214.00
"Down" time	5%
Hours of engine use per day (but 12-14 hours at sea)	10.00
Litres of diesel used per hour	7.20
Cost of diesel per litre in meticaïs	450.00
Annual fuel costs in '000 meticaïs	6,586.92

TOTAL FIXED AND FUEL COSTS in '000 meticaïs 33,837.21

Number of transfers per day	8.00
Volume of fish per transfer (kgs)	250.00
Fish collected per year (kgs, 100% utilisation assumed)	406,600.00
Price paid to trawler (meticaïs/kg)	100.00
Total landed cost of by-catch (meticaïs/kg)	183.22

Value of fish at landing (meticaïs/kg)	200.00 (1)
	250.00 (2)
	300.00 (3)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	60,000.00	51,265.46	51,265.46	51,265.46	51,265.46	51,265.46
Income (1)		81,320.00	81,320.00	81,320.00	81,320.00	81,320.00
Income (2)		101,650.00	101,650.00	101,650.00	101,650.00	101,650.00
Income (3)		121,980.00	121,980.00	121,980.00	121,980.00	121,980.00
Net income (1) (	60,000.00)	30,054.54	30,054.54	30,054.54	30,054.54	30,054.54
Net income (2) (	60,000.00)	50,384.54	50,384.54	50,384.54	50,384.54	50,384.54
Net income (3) (	60,000.00)	70,714.54	70,714.54	70,714.54	70,714.54	70,714.54
IRR (1)	41%					
IRR (2)	79%					
IRR (3)	115%					

Example 6. Sensitivity analysis: higher price paid to trawler for by-catch

Cost of vessel (estimate Feb. 1991 in '000 meticaïs)	60,000.00
Life of vessel (low maintenance) in years (zero salvage value)	5.00
Interest rate	27%
Annualised capital cost in '000 meticaïs (A)	23,231.75
Annual maintenance charges (8% of A) '000 meticaïs (B)	1,858.54
Crew salaries, annual basis, in '000 meticaïs (C)	2,160.00
ANNUAL FIXED COSTS in '000 meticaïs (A + B + C)	27,250.29

Days/year weather permits operation of vessels (& open season)	214.00
"Down" time	5%
Hours of engine use per day (but 12-14 hours at sea)	10.00
Litres of diesel used per hour	7.20
Cost of diesel per litre in meticaïs	450.00
Annual fuel costs in '000 meticaïs	6,586.92

TOTAL FIXED AND FUEL COSTS in '000 meticaïs 33,837.21

Number of transfers per day	12.00
Volume of fish per transfer (kgs)	250.00
Fish collected per year (kgs, 100% utilisation assumed)	609,900.00
Price paid to trawler (meticaïs/kg)	200.00
Total landed cost of by-catch (meticaïs/kg)	255.48

Value of fish at landing (meticaïs/kg)	200.00 (1)
	250.00 (2)
	300.00 (3)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	60,000.00	132,585.46	132,585.46	132,585.46	132,585.46	132,585.46
Income (1)		121,980.00	121,980.00	121,980.00	121,980.00	121,980.00
Income (2)		152,475.00	152,475.00	152,475.00	152,475.00	152,475.00
Income (3)		182,970.00	182,970.00	182,970.00	182,970.00	182,970.00
Net income (1) (	60,000.00) (	10,605.46) (	10,605.46) (	10,605.46) (	10,605.46) (	10,605.46)
Net income (2) (	60,000.00)	19,889.54	19,889.54	19,889.54	19,889.54	19,889.54
Net income (3) (	60,000.00)	50,384.54	50,384.54	50,384.54	50,384.54	50,384.54
IRR (1)	large negative					
IRR (2)	20%					
IRR (3)	79%					

Example 7. Sensitivity analysis: fewer transfers,

Cost of vessel (estimate Feb. 1991 in '000 meticaiss)	60,000.00
Life of vessel (low maintenance) in years (zero salvage value)	5.00
Interest rate	27%
Annualised capital cost in '000 meticaiss (A)	23,231.75
Annual maintenance charges (8% of A) '000 meticaiss (B)	1,858.54
Crew salaries, annual basis, in '000 meticaiss (C)	2,160.00
ANNUAL FIXED COSTS in '000 meticaiss (A + B + C)	27,250.29

Days/year weather permits operation of vessels (& open season)	214.00
"Down" time	5%
Hours of engine use per day (but 12-14 hours at sea)	10.00
Litres of diesel used per hour	7.20
Cost of diesel per litre in meticaiss	540.00
Annual fuel costs in '000 meticaiss	7,904.30

TOTAL FIXED AND FUEL COSTS in '000 meticaiss 35,154.59

Number of transfers per day	8.00
Volume of fish per transfer (kgs)	250.00
Fish collected per year (kgs, 100% utilisation assumed)	406,600.00
Price paid to trawler (meticaiss/kg)	200.00
Total landed cost of by-catch (meticaiss/kg)	286.46

Value of fish at landing (meticaiss/kg)	200.00 (1)
	250.00 (2)
	300.00 (3)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Costs	60,000.00	93,242.84	93,242.84	93,242.84	93,242.84	93,242.84
Income (1)		81,320.00	81,320.00	81,320.00	81,320.00	81,320.00
Income (2)		101,650.00	101,650.00	101,650.00	101,650.00	101,650.00
Income (3)		121,980.00	121,980.00	121,980.00	121,980.00	121,980.00
Net income (1) (	60,000.00) (	11,922.84) (	11,922.84) (	11,922.84) (	11,922.84) (	11,922.84)
Net income (2) (	60,000.00)	8,407.16	8,407.16	8,407.16	8,407.16	8,407.16
Net income (3) (	60,000.00)	28,737.16	28,737.16	28,737.16	28,737.16	28,737.16
IRR (1)	large negative					
IRR (2)	(11%)					
IRR (3)	38%					