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REPORT ON A VISIT TO MOZAMBIQUE TO REVIEW
SHRIMP TRAWLER BY-CATCH UTILISATION

July - August 1985

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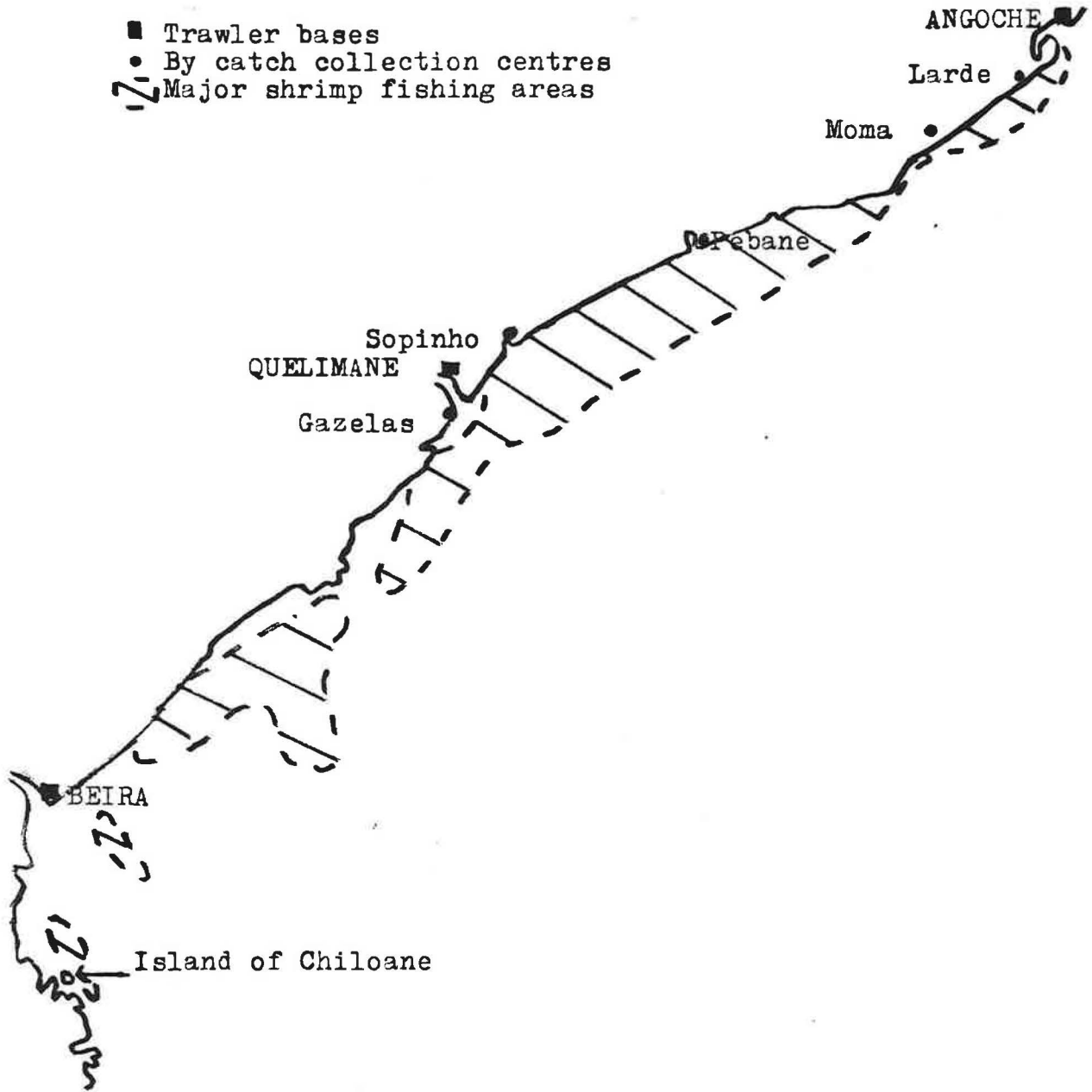
DANIDA	-	Danish International Development Agency
EFRIPEL	-	Entrepoto Frigorifico de Pesca de Mocambique (Japanese joint venture fishing company)
EMOPESCA	-	Mozambique state fishing company
MOSOPESCA	-	Russian joint venture fishing company
ODA	-	Overseas Development Administration (United Kingdom)
PAC	-	Posto de Apoio e Compras (fisheries support post)
PESCAMAR	-	Spanish joint venture fishing company
TDRI	-	Tropical Development and Research Institute
UDP	-	Unidade de Direccao de Pesca (regional fisheries administration)

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Map of the Sofala Bank Shrimp Fishery, Mozambique

- Trawler bases
- By catch collection centres
- ▨ Major shrimp fishing areas



Report on a visit to Mozambique to review shrimp trawler by-catch utilisation

(July - August 1985)

By Dr C D WOOD

1. Introduction

1.1 Purpose of Visit

It has been widely recognised that the fish caught during shrimp trawling operations represents a major potential source of fish for human food. At present much of this is discarded back into the sea as it is difficult to handle and process, particularly on vessels which freeze the shrimp on board and go for lengthy fishing trips. Also there may be little financial incentive for landing the fish which is of low commercial value relative to shrimp. In spite of these problems, however, progress has been made and in many places the landing of at least part of the by-catch is not uncommon. The problems and possibly solutions have been reviewed during a recent conference (FAO/IDRC, 1982) which describes among other projects the ODA sponsored work in Mexico.

In recent years Mozambique has established a shrimp trawling industry and the discarding of the by-catch became a usual operational practice. The scope of the problem and possible methods of handling and landing the by-catch have been reviewed recently (CIFT/CFCI, 1983). In this report it was concluded that probably more than 40,000 tonnes per year of by-catch fish was discarded in Mozambique waters, mainly by the freezer trawlers. Due to lack of data this figure was at best an educated guess, but clearly the quantity of fish is very considerable compared with the current fish landings, about 40,000 tonnes per year from all sources (marine and freshwater). The Government of Mozambique has been attempting to improve the level of by-catch utilisation in order to boost the supply of fish available for domestic consumption. During a recent visit to Mozambique Dr Tarbit, ODA Fisheries Adviser, discussed the problems which had been encountered during by-catch collection and processing. These included maintenance and organisational difficulties but also the collector boats in use could not operate in surf and had a limited carrying capacity. Secondly the salting and drying techniques in use, which are technically relatively simple, leave the product open to spoilage and insect

attack which can cause serious losses during processing. TDRI have considerable experience in countering losses in traditionally cured fish, and has successfully implemented a loss reduction programme in Malawi. Hence Dr Wood visited Mozambique to review by-catch utilisation with the following terms of reference.

1. Review current landing, handling and processing procedures at Chiloane Island.
2. Consider improvements in (fish curing) technique to avoid emphasis on fuel-costly methods.
3. Discuss various inputs with Danish and Mozambique officials to avoid duplication of effort and ensure that DANIDA and ODA approach to by-catch project is compatible.

Also ODA has supported the development of a catamaran which can operate in up to 3 metres of surf, a vessel which may be suitable as a collector boat. The opportunity was taken to consider how this vessel could be used in Mozambique.

The visit was timed to coincide with the visit of a four man appraisal mission from DANIDA who were investigating a project on the retention of shrimp by-catch and a request for technical assistance in connection with the construction of small transport boats for the small scale fishery sector. This enabled discussions to take place during the preparation of project proposals so that possible ODA and DANIDA inputs can be coordinated.

1.2 The Fishing Industry of Mozambique

The shrimp fishing region is predominantly the Sofala bank off central Mozambique from Chiloane in the South to Angoche in the North. About 10,000 tonnes of shrimp is caught, mainly by the freezer trawlers operated by the various fishing companies, and virtually all of it is exported. Frozen shrimp is a major source of foreign exchange for Mozambique. The shrimp trawling activities are conducted by privately owned trawlers, a state owned fishing company EMOPECA and by joint venture companies involving foreign and Mozambiquan inputs such as PESCAMAR, EFRIPEL and MOSOPECA. EMOPECA has fleets based at Beira, Quelimane and Angoche which are managed independently at the local level, the EFRIPEL fleet is based at Quelimane while the other fleets are based at Beira.

Small scale fisheries are conducted by private concerns and cooperatives, and may be assisted by the state organisation Combinado Pesquero which runs centres where fishing supplies can be obtained (called PACs, Posto de Apoio e Compras). All processed fisheries products are marketed by the state owned organisations PESCOM (dried fish for the domestic market) and PESCOM international (frozen shrimp for export). PESCOM has offices at most of the major fishing centres while PESCOM international exports the frozen shrimp through their main cold store in Beira. With the exception of EFRIPEL who ship their shrimp direct to Japan, all other exporters of shrimp bring the product to Beira for onward distribution.

The organisations involved in particular fisheries related activities varies from centre to centre with some overlapping of activities such as fishing companies being involved with on-shore processing: EMOPESCA is involved with fish processing at Angoche and EFRIPEL is managing a PAC at Pebane. The day to day management of the state owned concerns has become increasingly decentralised and they are to be coordinated locally by the Unidade de Direcção de Pesca (UDP). A UDP has been established for Maputo, one is being established in Beira for the Sofala region and further bodies will be started in Quelimane and Nampula. The fisheries industry is directed nationally by the Secretary of State for Fisheries.

1.3 Shrimp Trawler Operations

The operating practices of the freezer trawlers varies considerably from company to company. The EFRIPEL vessels fish for 25 days before returning to base to unload and refuel. PESCAMAR operate a mother ship system which enables the vessels to stay away from base for 20-30 days. The mother vessel, an old trawler, makes a rendezvous with a fishing vessel in sheltered waters to transfer fuel to the fishing vessel and frozen shrimp and some frozen by-catch to the mother ship. The fishing plan for the EMOPESCA vessels is that they fish for 15 days, returning briefly to base to refuel and unload shrimp before returning to sea for a further 15 days before making a longer break. In practice mechanical failures, poor weather and other factors often cause the EMOPESCA vessels to cease fishing after 2-3 days. The companies generally operate their ships in flotillas of 2-4 vessels rather than individually. Much of the trawling is conducted close to the shore, often within the sight of it. The vessels will alter the area in which they conduct their fishing in order to maximise the shrimp catch. The freezer trawlers generally land some fish, particularly large more commercially valuable species, but most of the by-catch is discarded.

Vessels which land fresh shrimp in ice are operated by private owners and make voyages of up to 3 days. On the occasions that ice is not available trips are reduced to a single day. During the longer trips the vessels lay up overnight close to the shore, the island of Chiloane being a particularly popular area for this. This enables some by-catch to be retained uniced on deck and landed in the evening at Chiloane. Similarly by-catch is retained and landed at Beira when the vessels return to their home port. By-catch fish which cannot be landed relatively quickly is normally discarded. The iced shrimp must be landed at Beira for processing and also it is common to ice the more valuable fish for sale at Beira.

1.4 By-Catch Utilisation in Mozambique

Most of the by-catch fish is small, in the range 50-100g. This can be consumed in a wet, unprocessed form but more usually is preserved by inexpensive methods such as salting and drying. As the freezer trawlers generally land the by-catch in a frozen form it may also be preserved by freezing if there are sufficient on-shore cold store facilities. There is, however, a considerable demand for salted dried fish in Mozambique probably well in excess of the 4,800 tonnes of cured fish which is produced per year (FAO, 1983).

1.5 Increasing the Shrimp By-Catch Retention in Mozambique

One of the major problems of by-catch utilisation is to devise methods whereby the fish can be landed in an edible condition without disrupting shrimp catching and processing. This is a major problem with the freezer trawlers as they have a very limited freezing capacity. At present some by-catch is put in boxes in the cold store to freeze slowly. In this way the trawlers are able to land a small proportion of the by-catch. The problem is much less severe with the ice carrying vessels which are able to land by-catch every day and can retain the by-catch from the final trawl on deck uniced. In order to increase the level of by-catch utilisation methods of retention and of transferring the fish to the shore have been suggested (CIFT/CFCL, 1983). Methods of by-catch retention suggested included transfer to shore by a small vessel (the so-called Moma transfer method), dry salting at sea on the trawlers, chilling at sea and transfer by pump to a collector vessel and freezing at sea.

To date the Moma transfer method, so-called because it was started at the Moma fish landing centre, has been the preferred method in Mozambique. It was

started in an unorganised way by small scale fishermen who took their canoes out to shrimp trawlers to exchange coconuts and other goods for by-catch. The practise still continues but only small quantities of fish can be landed in this way as the sea must be very calm and the trawlers must be close in shore for any transfer to take place. Also the capacity of the canoes is very low. As currently practised the method consists of taking a small motorised collector boat out to the trawlers and manoeuvring alongside. The two vessels are roped together and the fish transferred to the collector boat while trawling continues. The fish may be frozen in the trawler hold before transfer or may be transferred unfrozen. Ship to shore radio communication is essential for the arrangement of a transfer and in practice the trawlers radio a nearby shore base for a collector boat to come out to them at a convenient moment. After the transfer the collector boat carries the fish back to its base for processing. The transfer method has been described in more detail by Jensen (1985). The principal advantages of this method is that it is relatively simple and does not require much sophisticated equipment. Its disadvantages are that the collector vessel must be small to get under the trawl outriggers and alongside the trawler. This limits its carrying capacity and makes transfers difficult or impossible in anything other than fairly calm sea conditions. Also the by-catch may have to be preserved on the trawler if the transfer cannot take place within a few hours of raising the net.

Experimental trials on the bulk salting of by-catch fish have also been conducted but it was found that the larger fish spoil rapidly when salted intact at ambient temperatures (Jensen and Machava, 1985). Other techniques which involve chilling have not been attempted to date as they would require a significant investment in equipment which may not in any case physically fit onto the existing trawlers. Alternative transfer techniques such as the use of a bag made of netting which can be lowered from the trawler into the sea and collected by a collector boat have not so far been assessed under Mozambiquan conditions.

1.6 Losses Which Can Occur in Cured Fish

Very high levels of losses can occur during the production of cured fish. One estimate has suggested that on a global basis the equivalent of three million tonnes of wet fish is lost annually due to the deficiencies of the traditional processing practices (US National Academy of Sciences, 1978).

Some recent studies conducted by TDRI in Senegal have found that losses could be as high as 40% in some situations but that the levels of losses could vary very considerably from situation to situation (Wood and Walker, 1985). Based on these experiences it may be anticipated that for the type of processes in use in Mozambique major problems could occur during the processing of fish during the wet season when blow-fly infestation can be a very major cause of losses. TDRI has considerable experience in developing techniques aimed at preventing losses in cured fish. The Institute prepared an extensive literature review (FAO, 1981), and has also worked in many parts of Africa on the subject. Considerable success has been achieved in Malawi which experienced serious levels of losses due to blow-fly attack during the wet season drying of fish. After various experimental trials in which alternative countermeasures proved unsatisfactory an insecticidal treatment has been introduced commercially after receiving government approval and has enabled processing to continue throughout the wet season without heavy losses being suffered. Non-insecticidal countermeasures may also be used to advantage even though they may not be sufficient to prevent high levels of losses in some situations.

1.7 Current Levels of By-Catch Utilisation

Data on the fish landings of the major freezer trawler companies is given in Table 1. Much of the 314.3 tonnes of fish landed at Moma and Pebane was brought ashore by the Moma transfer method, the rest being landed by the trawlers themselves. Data on the amounts of fish landed by private trawlers was not available but purchases of dried fish by PESCO's Beira office gives some indications. As shown in Table 2, 1,182.3 tonnes of cured fish was purchased in 1984 indicating that about 3,500 tonnes of wet fish was cured (assuming 3 tonnes of wet fish is required to produce 1 ton of cured fish. Of this about 1,000 tonnes was supplied by freezer trawler companies to Beira and Chiloane. Therefore, assuming the fish landed by freezer trawlers was used for preparing cured fish, about 2,500 of wet fish was supplied from other sources principally the private trawlers.

Data was obtained on the monthly variations of dried fish purchases by PESCO in Beira to indicate the seasonal variations (Table 3). This indicated that the supply of fish was fairly steady except for a slack period in December (perhaps due to the Christmas holiday period) and peak periods in February to April and August at Chiloane and a month later (May and September to October) at Beira. It was said that May to December the period when fish

Table 1 By-Catch Landed by the Major Freezer Trawler Operators, 1984.

Company	Landing Centre	Quantity (tonnes wet weight)
EMOPESCA	Angoche	19.9
	Moma	63.6
	Pebane	150.7
	Beira	230.2
	Chiloane	<u>265.0</u>
	Total	<u>729.2</u>
	Shrimp landings	421
PESCAMAR	Beira	497.5
	Shrimp landings	2354.6
EFRIPEL (approximate data)	Pebane	100
	Quelimane	<u>1250</u>
	Total	<u>1350</u>
	Shrimp landings	1100
Total for all landing centres		2576.7

Table 2 Purchases of Dried Fish by PESCOM, Beira, 1984.

Source of fish	Quantity (tonnes, product weight)
Beira	116.5
Chiloane	534.8
Inhassoro	93.3
Machanga	207.5
Mainbone	111.2
Inharingue	118.0
Sofala	0.3
Massinga	0.7
Total	1,182.3

Table 3 Purchases of Dried Fish by Month by PESCOM, 1984

Month	PESCOM office	
	Chiloane	Beira
January	48.3	10.0
February	59.7	2.5
March	87.6	7.9
April	66.5	2.1
May	24.7	15.6
June	21.4	3.0
July	21.6	10.3
August	83.2	3.7
September	47.8	17.7
October	20.3	21.9
November	39.4	17.8
December	14.2	4.0
Total	534.8	116.5

supplies at Beira were at their highest levels. The shrimp trawler operators found that the peak shrimp production at the Southern end of the Sofala bank was during the October to December period and in the Northern part from January to March. The fishing vessels would change their fishing areas to maximise their shrimp production so by-catch availability will almost certainly mirror shrimp production to some extent.

2. Fish Landing and Processing Centres Visited

2.1 Maputo

Maputo is a minor base for shrimp trawling, with some ice carrying trawlers based here. Most of the vessels aim primarily to catch fish and there is a substantial gill net fishery for a pelagic hilsa species (known as magumba) which is dried or canned in Maputo. The PESCOM fish terminal at Maputo has a vertical plate freezer and cold store for storing magumba prior to canning.

The canning factory and its adjoining fish curing yard are operated by the state owned company PROPESCA. The drying yard was well laid out with raised dry racks and brining tanks. The process consisted of splitting and gutting the large fish, small fish being processed intact, brining in saturated brine for 24 hours and drying for 2-4 days depending on the weather. The fish on the racks was covered with plastic sheeting overnight and when it rained. The fish seen drying was in good condition. Blow-fly eggs had been laid on the fish but no larvae were seen, the eggs appearing to dry out before hatching. It was said that the cool season (ie. the time of the visit) was the period when blow-fly infestation was at its most severe as drying was slow at this time of year (4 days rather than the 2 needed during other times of the year). Damage and losses due to blow-fly attack were, however, said to be low even during the cool season.

The plant also had a big mechanical drier (made by Nansei in Japan) which was operated when the drying racks were full to increase the capacity of the plant. It had a 1½ tonne per day capacity and had a heater run on marine diesel and an electric fan. By-products such as shark fins, salted sharks skins (for leather manufacture), beche-de-mer and fish silage were also produced. The factory had a BP silage unit and used it to process their fish waste, fish heads been chopped in an old bowl chopper before being put into the unit. The silage was sold locally and fed to pigs.

The plant had a dried fish store where fish was kept for up to three months, 1 month being the usual storage period. Infestation by Dermestid beetles of dried fish was evident although it was not seen as a major problem.

2.2 Beira Harbour

Beira harbour has a section where the freezer trawlers of PESCAMAR and EMOPESCA are based as well as a public area where the privately owned ice carrying trawlers land their fish and transport boats operate. The transport vessels bring dried fish in from landing centres near Beira. At the time of the visit there was one ice plant owned by PESCOM in Beira from which private trawler companies can buy ice. This was out of order at the time of the visit forcing the trawlers to land their catch each day. The by-catch was retained uniced and sold by the box load to fish processors, which is the usual practice even when ice is available. The fish was transported by truck to processing yards some distance from the harbour.

2.3 Beira Fish Processing Centres

Two drying yards near Beira were visited both of which obtained their raw material from the harbour. They were well laid out with concrete brining tanks, raised drying racks and plastic sheeting to cover the fish overnight and during rain. The racks were made of old fishing nets supported on frames and posts. In one of the yards the insecticide Alfacron (Ciba-Geigy West Germany) was used underneath the racks to control insects, never it was said on the fish itself.

At the time of the visit (the cool, dry season) the fish being processed was of good quality with no signs of insect infestation or attack. Both yards were in a very clean condition, although it was said that this was not the case for all the curing yards around Beira. The processors said that there were no serious problems with insect attack even during the wet season in spite of the fact that the fish could take as long as a week to dry. At one yard it was said that more salt was using during the wet season, in the other the process was not altered at all. When it rains the fish were simply covered with plastic sheeting which is made locally (although at times it could be difficult to obtain) and as it did not rain for long periods in this region this was found to be adequate. Salt was produced locally in salt pans and was easy to obtain.

2.4 Dried Fish Store

The fish processors sell the dried fish to PESCOM who have several stores in the Beira region. Two stores were visited; in neither was the fish usually stored for an extended length of time, 2 days being the usual maximum. The fish appeared to be of good quality and there were no signs of insect infestation. These stores received fish from the curing yards near Beira and the outlying curing centres such as Chiloane Island (see below). It was said that dried fish transported by boat, especially from Chiloane could present problems if it became wet during storage at Chiloane (which could be for several months) or transport. In 1984 a batch of 100 tonnes of dried fish from Chiloane had become spoiled by halophilic bacteria by the time it arrived at Beira.

2.5 Chiloane Island

Chiloane is a small island separated from the mainland by a narrow channel and is located South-East of Beira, about 8 hours by motor boat away from it. At the time of the visit no trawlers were landing fish at Chiloane as the lack of ice had prevented them from operating this far from Beira, the trawlers having to return to Beira each day to land the shrimp. When the trawlers land by-catch here they anchor off the sheltered beach and the fish is transferred by small boats to the shore. As the water channel is fairly shallow and there are several sand bars, some trawlers moor off the unsheltered North shore. If the seas is rough it may be impossible to transfer the by-catch from trawlers moored here as the collector boats at Chiloane are small and unable to operate in heavy seas. EMOPECA freezer trawlers may also land by-catch at Chiloane if they stop here overnight.

At Chiloane there are several fish curing yards, four run by cooperatives and two privately owned, which process by-catch exclusively. Some fish is also landed by small scale fishermen and this is processed by the fishermen themselves rather than in these yards. Yards are equipped with brining tanks and raised drying racks of wood and reeds. Salt is produced locally in considerable quantities by the solar evaporation of sea water. The processors said that only good quality fish is bought for processing. It was said that insects were not a major problem even during the wet season; when it rains the fish is returned to the brining tanks with more salt. In the normal process fish is salted overnight using a salt to fish ratio of 1:1. Although not seen as a major problem the processors were clearly familiar with blow-fly infestation

indicating that it certainly did occur during the wet season to some extent. The peak season by-catch landing was said to be October to December, at the start of the wet season.

2.6 Chiloane Cold Store

At Vilhavelha on Chiloane Island is a now defunct cold store powered by a diesel generator. This was operated until recent years enabling shrimp trawlers to be based at Chiloane, landing shrimp here as well as fish and being refueled from diesel brought here from Beira. Four trawlers use to operate from here for up to 1 month periods. It is understood that the cold store is to be refurbished with assistance from the Nordic project (co-ordinated by SIDA, appraisal mission due in October 1985).

2.7 Quelimane Harbour

Quelimane is a major port located several miles up a river. It is the base for the largest single fishing enterprise in Mozambique, the Japanese joint venture company EFRIPEL. They operate seventeen large freezer trawlers, an onshore cold store and a freighter which carries the frozen shrimp direct to Japan and returns with fishing equipment, general supplies etc. EMOPESCA also has a fleet based here.

The EFRIPEL vessels stay out of port fishing for about 25 days and return with frozen shrimp and frozen by-catch. The holds of the vessels are large enough to store the frozen fish at the present levels of landing (at present EFRIPEL land slightly more fish than shrimp as shown in table 1) but there are problems in freezing it. The freezer capacity is only sufficient to freeze the shrimp so that the fish must be frozen slowly in the cold store. The vessels come in with their cold stores nearly full of fish and shrimp, about two-thirds full of shrimp in the peak season (the shrimp being given priority in the cold store due to its higher commercial value) and less in the off season for shrimp. The by-catch is sold frozen to PESCOM.

2.8 Sopinho

Located near the mouth of a river about 1½ hours drive from Quelimane, Sopinho has a PAC donated by the Japanese government and operated by Combinado Pesquero. The PAC has a chill store which at the time of the visit was being operated at

-10°C and used to freeze the by-catch. There were also some drying racks. The by-catch is landed by two collector boats operated from the PAC or during bad weather trawlers may come into the landing with the by-catch. The collector boats take about 40 minutes to get to the river mouth and a further 1½ hours to get out to the trawlers. During rough weather surf at the river mouth prevents the collector boats getting out, and frequent mechanical problems have also hampered collection operations. To date fish has been collected only from EMOPECSA boats although by-catch collection was only started in the previous month. In the first three weeks of operation 23 by-catch collection trips were made.

About 90% of the by-catch is salted and dried for distribution mainly to the plantation companies in the surrounding area. The rest is sold wet or frozen in the town. Salt is produced locally in adequate quantities but the curing yard lacks proper salting tanks, wooden boxes being used as a interim measure. The processing yard has not as yet operated during a wet season. As well as the by-catch landing there is a significant small scale fishing industry, the fishermen drying their own catch.

During the visit the ODA/DANIDA appraisal team was taken out by a collector boat and transferred to an EMOPECSA trawler to observe the trawl being drawn in. The sea was extremely calm (about 0.3 metres swell) and the manoeuvre to get alongside the trawler while it was trawling was accomplished without difficulty.

2.9 Gazelas

Gazelas is located down river from Quelimane, near its mouth, and 1 hours drive away from the town. It has a PAC, opened in March 1984, run by EMOPECSA. At the time of the visit the boats used to collect the by-catch were broken down. The curing yard was in the state of disrepair with many of the drying racks fallen down. There were some small brining tanks, but oil drums had had to be used as the tanks were too small. It was said that when it rains the fish was taken into the storage room, salted again and kept there or else buried in a hole in the sand with more salt. It was said that these procedures inhibited blow-fly infestation.

2.10 Pebane

Pebane is a small coastal town North of Quelimane. It has a PAC run by EFRIPEL which runs two collector boats for by-catch transfer and supports the local small scale fishing industry. No trawlers are based here. The collector boats can go up to about 15km from their base. During the transfer the trawlers can continue to trawl or else stop fishing for about 10 minutes as the transfer takes place. The constraints to the transfer operation were said to be the low carrying capacity of the collector boat and the heavy seas particularly in the May to July period.

At the time of the visit only EFRIPEL were transferring fish to Pebane as in September 1984 EMOPESCA had ceased the transfers after disagreements over prices and payments. The fish is sold wet, or more commonly is salted and dried (in 1984 135.5 tonnes was landed, 50.8 tonnes sold wet and the rest cured). Salt is prepared locally and the cured fish is sold quickly for transport to the interior by lorries operating in convoys. It was said that a fish to salt ratio of 10:1 was used, considerably less salt than at other curing yards. Blow-fly infestation was a major problem in the wet season even though the amount of salt used was increased as a preventative measure. It was said that it could rain continuously for as long as a week here. The fish observed on the drying racks were in good condition although adult Necrobia rufipes beetles were to be seen on the fish. During the visit a collector boat was observed landing frozen by-catch from an EFRIPEL trawler. The by-catch is transferred either fresh or frozen and Pebane has been found to be a convenient place for by-catch transfers as it is near the major trawling grounds.

2.11 Angoche

Angoche is a coastal port located at the Northern end of the Sofala bank and EMOPESCA have a trawler fleet based here. As it takes about 4-5 hours to travel by boat from Angoche to the shrimp trawling grounds Moma type transfers of by-catch are not possible from here. Pricing disputes between EMOPESCA and Combinado Pesquero had curtailed collection at Moma therefore EMOPESCA have recently established a transfer point at Larde midway between Angoche and Moma. This has one collector boat and a store house with a radio for ship/shore communications. It can be reached by road. The by-catch is usually transferred unfrozen, while trawling is in progress, and is salted and dried at Larde. Additionally, by-catch is frozen and landed at Angoche by the trawlers. PESCOM buy it all, storing it frozen in their cold store

or salting and drying it at their own drying yard at Angoche. During the wet season all the by-catch landed at Angoche goes to the cold store as curing is more difficult. As the Larde operation was established only recently it has yet to experience a wet season. The Larde curing yard cost about 80,000 MT to construct from locally available materials (excluding the radio).

3. Discussion

3.1 By-catch Handling On Board the Shrimp Trawlers

At present much of the by-catch landed is frozen in the trawler cold storage hold. However the boats have a limited capacity to freeze the by-catch and by placing unfrozen fish in these holds risk damaging the quality of the shrimp already in cold storage. There is a need to investigate these practices methodically to determine how much fish can be frozen in this way without impairing the shrimp quality and to assess alternative handling methods. As the different fleets are operating vessels with very different designs and equipment the practices for each type of vessel may differ. With the EMOPESCA fleets, for example, the South African built vessels based at Angoche and Beira have a hold with a powerful air circulation system which is used to freeze the shrimp. These probably have larger freezing capacities for by-catch than the Brazilian and French built vessels which have separate blast freezers on the deck and in the stern respectively.

CIFT/CFCL (1983) have suggested methods such as storage in refrigerated sea water or the use of an onboard vertical plate freezer for preserving the by-catch. Methods such as these would require the installation of more equipment on what are often already cramped vessels and hence their technical suitability is unclear. Such methods, however, could be considered in more detail if simpler methods prove inadequate.

3.2 Method of By-Catch Transfer

The Moma type of transfer of by-catch has many potential advantages for use in Mozambique. It does not require any major capital investment, the major equipment required being collector boats and a radio on-shore where these boats are based. Equipment and organisational problems have so far hampered the wider use of the Moma method in Mozambique but the technique has proved capable of landing significant quantities of by-catch.

A fundamental problem is that in order not to interrupt the shrimp trawling operations the collector boat must get along side the trawler while it is still fishing. This means that the boat must be able to pass under the outrigger booms which hold the trawl nets. These booms are about 3-4 metres above the sea on the EMOPESCA trawlers but even a slight swell would cause considerable movements of the booms relative to the water surface. Hence a collector boat for this type of operation should not rise more than about 1 metre above the water surface. This means that the boat will be fairly small limiting its carrying capacity. A capacity of about 10 tonnes would be desirable if the boat is to collect the by-catch from say three or four trawlers operating in a flotilla. This type of operation will not be possible under rough sea conditions because of the danger of the boats colliding and the collector boat being capsized. In practice how much this would limit the operation of the collector system is unclear as there is inadequate data on the prevailing sea conditions. CIFT/CFCL (1983) estimated that using this method it would be difficult to land more than about half of the by-catch potentially available.

An alternative transfer method maybe to put the by-catch in a net bag which the trawler can drop into the sea for collection by a collector vessel. This would avoid the need for the two vessels to come alongside, allowing (and probably necessitating) the use of a larger collector boat. The collector boat would have to be equipped with a lifting mechanism such as a block and tackle to raise the fish on board. Although it is understood that this method has been used in certain fisheries it is untried in Mozambique and problems could occur with the fish becoming spoiled or the bag net being attacked by sharks.

The transfer method will clearly play a major role in determining the optimal design of the collector boats and on-board handling procedures. More operational experience is required before a method can be unequivocally recommended.

3.3 By-Catch Processing and Distribution

Most of the by-catch is processed by salting and drying. This method is very well suited to Mozambique as it requires relatively simple onshore facilities for processing and distribution and gives a relatively inexpensive product.

During the dry season losses are apparently minimal, but wet season processing can cause problems. The wet season in Mozambique extends from October

to April but the rain is said to be more continuous in the North than the South. It appeared that blow-fly infestation, which can be a major problem during wet season processing, was particularly serious in the Northern part of the shrimp fishing region (eg. Pebane) and less serious in the Southerly areas (eg. Chiloane). There has not been a systematic survey of losses during the wet season and this should be done as a matter of priority. The wide use of salt may well reduce losses to levels lower than those found, for example, in Malawi. Walker (1983) found that losses during one wet season averaged 23% at one processing yard in Malawi, with losses ranging between 10 and 50% depending on the weather. Even though salt is known to give fish some protection from insect attack ODA sponsored studies in Indonesia have revealed that even heavily salted products can suffer from serious levels of losses (9% losses in edible solids being average, Esser *et al*, 1984). Further studies are needed to clarify how salt affects losses due to blow-fly infestation as this may depend on regionally specific factors such as climate and infesting insect species.

Other potential problems would be the losses of fish due to microbial spoilage and beetle infestation during storage and distribution. Spoilage did appear to be a problem when inadequate provision was made in the transport boats to keep the fish dry. The planned improvements in transport boats (DANIDA assisted) should greatly help in overcoming this problem. Beetle infestation did not appear to cause serious losses at present probably because the fish is salted and storage times are generally short. This should, however, be further investigated particularly as storage periods could lengthen due to the increased production of salted dried fish.

3.4 Possible Scale of Losses of Cured Fish

In the absence of any definitive data on the situation in Mozambique any estimate of possible levels of losses is at best an educated guess based on situations found in other countries. However, if 20,000 tonnes per year of by-catch is landed by the trawlers and an expanded collector boat system, and assuming half of this is processed during the wet season and is susceptible to blow-fly attack, then 10,000 tonnes per year of fish is susceptible to losses of this type. If losses average 10% throughout the wet season (about half the level of losses found in Malawi) then 1,000 tonnes per year of wet fish will be lost, worth at least MT 20 million or nearly 0.5 million US\$ per year.

3.5 Improvements in Fish Curing Techniques

A number of methods can be used to improve fish processing, particularly during the wet season when drying is a problem. One method is to keep the fish frozen rather than cure it, an approach used at Angoche. Cold store facilities in Mozambique are, however, limited and there is no realistic alternative to curing most of the by-catch landed, particularly as landings should rise considerably when by-catch collection is expanded. Mechanical driers such as the type in use at Propesca's plant in Maputo could be used but would involve a major capital investment and would incur running and maintenance costs. Previous studies conducted by TDRI in Malawi have shown that fish can be dried during wet seasons while incurring minimal levels of losses if the correct techniques are used. These techniques include the maintenance of high standards of hygiene in the curing yards, the use of drying racks and plastic sheeting to cover the fish and, if necessary, the use of a suitable safe and effective insecticidal treatment. The upgrading of the curing techniques appears to be the most suitable approach for Mozambique.

Although many of the yards were well equipped and organised, in some of the curing yards visited there was some scope for improving the facilities available. Modifications to the salting technique and the provision of plastic sheeting where it is not currently available may help to reduce insect attack. In spite of these improvements, however, it is probable that insecticidal treatments, such as the actellic treatments used in Malawi, will be required during the wet season if significant losses due to blow-fly infestation are to be avoided. It has been estimated that improvements of this type will lead to an additional 700 tonnes of fish per year being made available in Malawi. Further, in Malawi processors who used to suspend operations during the wet season because of the heavy losses are now able to continue to process fish. Details of the actellic treatment as used in Malawi are given in Appendix 1.

3.6 Coordination of ODA/DANIDA Inputs

DANIDA are to consider supporting by-catch utilisation in two ways: in the construction of collector and transport boats and in the organisation of a collection system. This will involve technical support to the boat yard in Maputo and the organisation of by-catch collection in the Quelimane region. The proposed DANIDA project would involve an initial research phase in which collection techniques are evaluated. It was agreed that the provision of a

post-harvest fish handling and processing expert by ODA would be very useful in augmenting this input without resulting in any duplication of effort. The ODA and DANIDA officers involved in the two projects would be expected to collaborate closely together and coordinate their activities.

4. Post Harvest Fish Handling and Processing Project

4.1 Areas Requiring Assistance

As discussed previously losses of cured fish during the wet season are probably high and will increase as more by-catch is landed. Improvements can be introduced to reduce these losses. Fish handling on board the trawlers is a second major post-harvest problem which requires a detailed investigation. As losses in cured fish are probably low during the dry season it should be possible for both of these post-harvest problems to be tackled by one officer on a long term assignment with appropriate short term inputs from other specialists. The emphasis would therefore be on fish curing during the wet season and fish handling at other times of the year. TDRI has considerable experience in fish handling and processing, and could provide an officer with experience of both aspects to undertake a long-term assignment and also provide short term specialist inputs which would be required for training courses on, for example, improved curing techniques such as the use of insecticides.

4.2 Location of By-Catch Handling and Processing Project

The work will need to be conducted on board the shrimp trawlers themselves and also onshore at the processing yards located between Angoche and Chiloane. Hence, wherever this project is based the officer involved must be mobile and able to work at the various locations where the fish is processed. In addition to the fieldwork some laboratory support will be required to analyse fish samples (eg. for salt content). If insecticides are used the laboratory facilities at TDRI could be used for conducting residue analyses. Laboratory facilities may also be required for the detailed investigation of various fish handling procedures. The Institute of Fisheries Research has its laboratories at Maputo and Beira; Beira would appear to be an appropriate base for this project as it would be relatively easy to obtain by-catch to work on and access to the fish processing centres such as Chiloane and Quelimane is possible by boat. Being based at the local UDP but collaborating with the Institute of Fisheries Research should allow a sufficient degree of flexibility to enable both the field work and laboratory work to be conducted.

4.3 Catfish Catamaran

In addition to the areas covered by the post harvest terms of reference it was also possible to discuss the possibility of using a catfish catamaran as a by-catch collector vessel following earlier discussions between Dr Tarbit and Mozambique officials. Vessels of this type are capable of operating through three metres of surf which mean that they could operate under conditions which may prevent the use of single hulled collector boats. Following a telephone discussion with the vessel designers it appears that a boat based on the conventional catfish catamaran can be designed for use as a collector vessel. The height above the water of an unladen catfish hull is about 0.8 metres so that it would fit under the trawler booms. It would, however, be potentially dangerous for the vessel to stay under the booms in a heavy sea so that it should be roped to the forward part of the trawler. The crew could stand in the well of the hulls as the craft is manouvered alongside the trawler. Also it would be possible to equip the boat with a mast which could be raised or lowered and lifting tackle for lifting a net bag from the sea if this method of transfer is in use. The catamaran has to date been constructed from aluminium or plywood, relatively strong materials. A plank vessel would need extra strengthening to withstand twisting forces on the hulls. The vessel designers consider it possible to construct a catamaran with sufficient strength. This would be advantageous as it would avoid the import of expensive boat building materials.

5. Conclusions and Recommendations

The currently high level of discarding of shrimp trawler by-catch and the need for more fish in the Mozambiquan diet justifies a project designed to improve the utilisation of this resource. The provision of a technical co-operation officer (fish handling and processing) with appropriate support would augment the possible DANIDA supported project on by-catch utilisation. It is recommended that the project proposed in appendix 2 is supported by ODA assuming that the prevailing security situation is appropriate for its implementation.

The catfish catamaran may be a suitable type of collector vessel to use, particularly if it can be constructed in Mozambique from locally available materials. It is recommended that ODA provide a vessel of this type and the necessary technical expertise so that experimental trials can be conducted. The results of the trials would be of great interest to the staff of the DANIDA project and they should be kept informed of developments.

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Appendix 1

USE OF INSECTICIDE TO CONTROL INSECT INFESTATION OF DRYING FISH IN MALAWI

The use of the organophosphate pirimiphos methyl to protect small whole fish from blowfly infestation during the early stages of sun-drying in the wet season (November to March) is now established practice in Malawi.

The insecticide may be applied to the drying fish as a spray or as a dip. The most popular method of application is to dip the fresh Cichlidae viz. Haplochromis spp. and Lethrinops spp. for one minute in an emulsion containing 0.06 per cent of active ingredient. This treatment has been demonstrated to give good control of blowflies and to produce residues of pirimiphos methyl on the final dried product which do not exceed 10 mg/kg. These residues have been accepted by the Government of Malawi as not constituting a hazard to consumers.

The spray procedure for the same type of fish involves an emulsion containing 0.15 per cent of active ingredient sprayed on the fish at a rate of 2.5 litres per 25 kg of fish. The fish need to be spread out so that all surfaces can be sprayed. The spray can be applied by any type of sprayers although in practice a knapsack hydraulic machine, e.g. CP3, is generally preferred.

Dipping is slightly cheaper than spraying because up to fifty boxes of fish can be treated in a single preparation of 100 litres. An additional advantage of immersion in a very dilute emulsion is that the fish are cleaned and take on a shinier and brighter appearance.

Appendix 2 Project Proposal: Technical Cooperation Officer (fish handling and processing).

Objectives. To improve the handling and processing of shrimp trawler by-catch in Mozambique.

Location. The officer will be based at the Unidade de Direcção de Pesca de Sofala in Beira.

Terms of Reference

1. To investigate losses during the processing and distribution of shrimp by-catch and to reduce them.

This will include -

- a) investigating the effect of salt in preventing blow-fly infestation
- b) improvements in processing technique and upgrading of processing facilities where required (eg. provision of salting tanks, plastic sheeting)
- c) use of a suitable insecticidal treatment if other improvements are inadequate
- d) train counterpart staff and fish processors in loss reduction techniques.

2. To investigate methods of improving by-catch handling at sea.

This will include -

- a) liaison with the Fisheries Research Institute and DANIDA staff with relevant experience
- b) surveys of handling practises (eg. cold store use)
- c) investigation of low cost improvements compatible with normal operations of the vessels
- d) introduction of improved procedures in collaboration with the DANIDA collection project.

Provisions for the Project

1. The fisheries department of Mozambique would be asked to provide the necessary office and supporting laboratory facilities at Beira and a counterpart officer plus appropriate local funds.

2. The TCO must be able to work in Portuguese language.
3. ODA would provide salary and other costs of the TCO, the vehicle (land-rover) for project use, working funds for laboratory chemicals, fish, fuel (diesel may be required for the electricity generator in the laboratory in Beira as the public electricity supply is unreliable), equipment (eg. temperature recording equipment).
4. The TCO should make a short liaison visit to DANIDA, Copenhagen before starting work in Mozambique.
5. An additional 2 month input on training local counterpart staff and fish processors on the use of insecticides will be required.
6. Backup laboratory facilities will be required for the monitoring of insecticide residues in treated fish. These can be provided by TDRI.
7. Mozambiquan staff may benefit from attending courses in the UK (eg the fisheries management and technology courses at Humberside College). English tuition may be necessary for some candidates. Suitable candidates could be identified as the programme proceeds.

Note

Depending on the conclusions of the research phase of the project further resources may be required particularly if any modifications to the trawlers is then envisaged (possibly the European Commission could be approached).