Bay of Bengal Programme

Post-Harvest Fisheries

THE BY-CATCH FROM INDIAN SHRIMP TRAWLERS

IN THE BAY OF BENGAL: BOBP/WP/68

THE POTENTIAL FOR ITS IMPROVED UTILIZATION

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS

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BAY OF BENGAL PROGRAMME BOBP/WP/68
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THE BY-CATCH FROM INDIAN SHRIMP TRAWLERS IN THE BAY OF BENGAL: The potential for its improved utilization

By

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Shrimps are a major foreign exchange earner for India. But in the race for valuable shrimp, the considerable by-catch hauled up with it is, by and large, ignored in parts of the country. This by-catch is almost 90 per cent of the shrimp caught.

This report, based principally on work done in 1988, documents work on assessing the volume and composition of shrimp by-catch discarded by trawlers on India's east coast and identifies the constraints to its improved utilization. At the time this study was undertaken, the provisional estimate of by-catch discards was approximately 100,000 t/a year. Though the numbers have changed since, the loss of by-catch continues to be substantial off this coast. Consequently, more detailed work has followed in specific areas, using this work as a basis.

The study of shrimp by-catch and this report, which documents the work done, have been sponsored by the Bay of Bengal Programme's (BOBP's) Post-Harvest Fisheries Project. This project has been executed by the Natural Resources Institute (NRI), U.K. and has been funded by the Overseas Development Administration (ODA) of the United Kingdom.

During the work the best available experts were engaged and consulted. Besides the **BOBP** and NRI staff, they included counterparts and fishermen, A. Seetharamaswamy in Vishakhapatnam, and Roger Kullberg who provided invaluable assistance with data collection.

The Bay of Bengal Programme (BOBP) is a multi-agency regional fisheries programme which covers seven countries around the Bay of Bengal – Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka and Thailand. The Programme plays a catalytic and consultative role it develops, demonstrates and promotes new techniques, technologies or ideas to help improve the conditions of small-scale fisherfolk communities in member-countries. The BOBP is sponsored by the governments of Denniark, Sweden and the United Kingdom, by member-governments in the Bay of Bengal region, and also by UNFPA (United Nations Population Fund), AGFUND (Arab Gulf Fund for United Nations Development Organizations) and UNDP (United Nations Development Programme). The main executing agency is the FAO (Food and Agriculture Organization of the United Nations).

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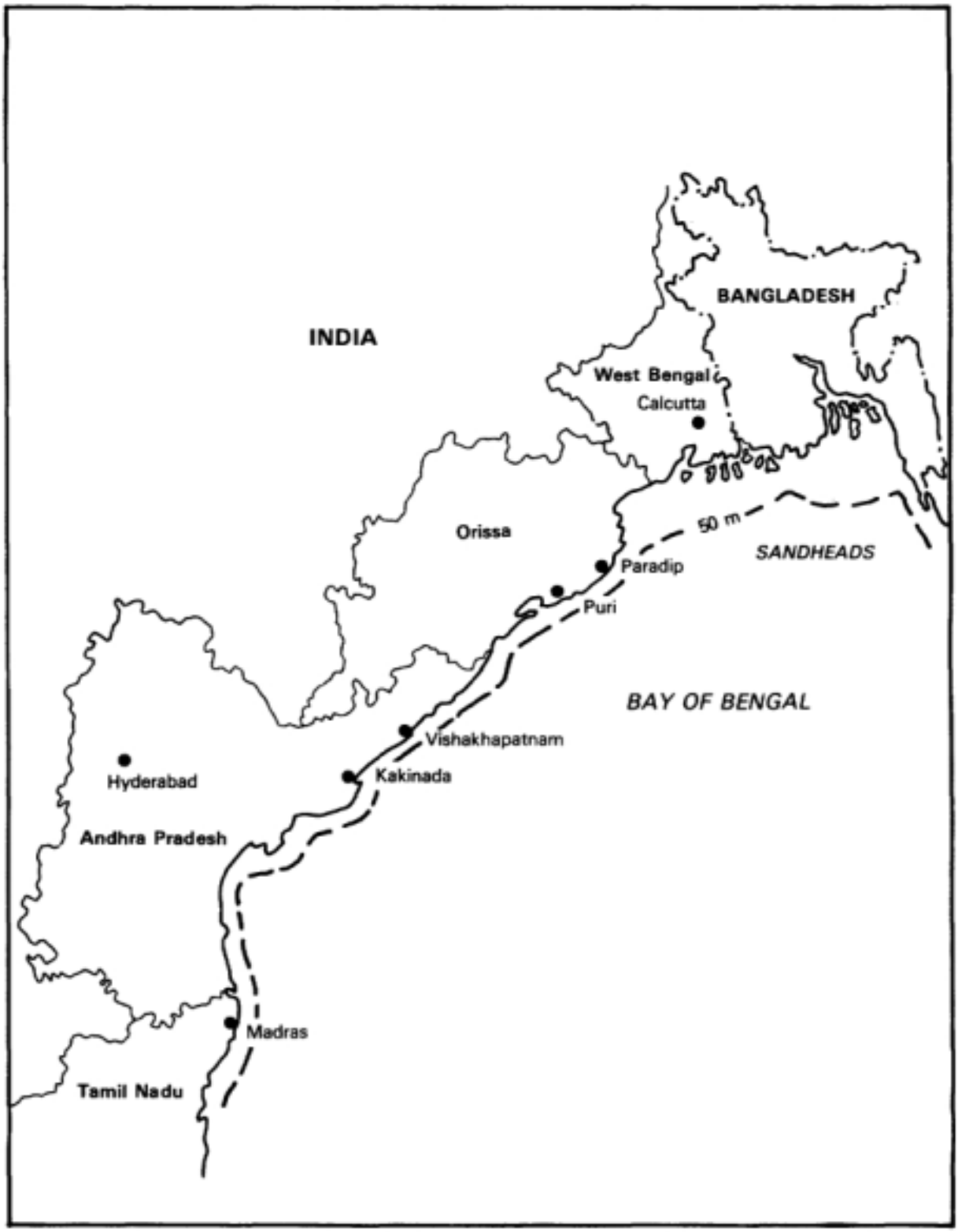

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1. INTRODUCTION

India exports approximately 60,000 t of frozen shrimp annually, accounting for export earnings of about £150 million (about Rs. 4,500 million). Its major markets are Japan and the USA. Marine capture shrimp comprises approximately 70-80 per cent of exports, although the prawn culture sector is now growing rapidly.

Seventy per cent of the shrimp is exported from west coast ports, even though some of this is harvested on the east coast and transferred by road. Small trawlers, going out each day, dominate the west coast industry. 'Voyage' fishing, with trawlers going out for 8-60 days, plays a more important role on the east coast. The long distance fleet is based at Vishakhapatnam, Andhra Pradesh. This is within 36 hours of Sandheads, the richest shrimp grounds in the area, located in the outflow of the Ganges south of Calcutta.

Shrimp trawling all over the world is associated with a large by-catch. In most shrimp fisheries the by-catch comprises 80-95 per cent of catch volume. Studies by Bostock* and others suggest that most of the fish caught with the shrimp on India's west coast is landed, albeit often in poor condition. In this particular case 'by-catch' is a misnomer since the 'trash' fish is an important part of the fishery. On the east coast, however, substantial quantities of by-catch are discarded at sea — a practice that results from the emphasis on voyage fishing.

High capital and operating costs mean that the operation is only profitable if revenues are high. The industry therefore focuses on shrimp and high value fish (and, latterly, deep sea lobster, which is seasonally trawled off the south-west coast when shrimp catches are low). Retaining large bulk catches of low value fish would necessitate an early return to port or divert labour or storage from shrimp, without yielding the high revenues associated with the latter.

The discard of fish has fuelled a growing debate over this wasted resource and the potential its utilization has for enhancing fishing incomes and the nutritional status of low income groups in India.

1.1 *Terms of reference*

In response to the growing concern over the discards of by-catch in India, a study was commissioned by the Bay of Bengal Programme Post-Harvest Project to focus on discards of by-catch by India's east coast trawling fleet. Its terms of reference were

(a) To develop a methodology for the assessment of shrimp by-catch, by volume and composition;

(b) To consider options for its use as food or feed;

(c) To investigate the options for landing the by-catch, including the use of collector vessels; and

(d) To investigate the costs and returns associated with landing the by-catch and identify technical, economic and financial constraints.

In considering possible utilization of by-catch, it was agreed that the main focus would be on 'low-tech' processing options.

1.2 *Methodology of study*

Six weeks fieldwork was undertaken during September and October 1988, Vishakhapatnam, the home port for India's east coast double-rig trawling fleet and where many of the commercial trawlers from Cochin were relocated in the l970s, was used as a base for the study. Other places visited were Kakinada, a smaller trawling port in Andhra Pradesh, the coastal areas of Orissa and West Bengal, and Cochin on the west coast, where several fisheries research institutes are located. An

* All figures are what were available in 1988 and, therefore, date upto a couple of years earlier.
Bostock, T.W. : *The marine fisherier of Gujaral, India* — Assessment *of posr-harvest losses and possibilities for development.* ODNRI Report L 75, London, U.K. (1987).

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economist worked with a national fisheries consultant and staff of the local fisheries departments. A minor field study, funded by the Swedish International Development Agency, was timed to coincide with this work. This work by Roger Kullberg provided valuable information about practices on board shrimp trawlers.

Although the work draws on published statistics and other studies available in 1988, and therefore dating to earlier years, it was necessary to conduct extensive interviews because information on by-catch in India has generally been poorly documented. People involved directly and indirectly in the shrimp sector, working for both the public and private sectors, were interviewed. Much of the information was collected through direct observation at landing sites and on board trawlers. The preliminary results of follow-up investigations undertaken in 1989 provided additional useful data. Studies of by-catch in other countries were used as background material.

2. ASSESSMENT *OF SHRIMP B V-CA TCH*

2.1 *Terminology used*

It was very important to clarify early in the study exactly what was meant by different terms. Discards, by-catch, trash fish, low value fish and miscellaneous fish are all mentioned in India when talking about by-catch. Separate sources use the same word in different senses.

In this study, by-catch means non-target species **caught with, and incidental to, the** target species. This definition of by-catch therefore includes landed by-catch and discards – **the latter being the** primary focus of the study. This definition is consistent with the use of the word in global estimates of by-catch, but differs from its use in India, where by-catch is frequently taken to mean landed by-catch only.

In India, trash fish, low value fish, and miscellaneous fish are often referred to synonymously with by-catch, though this study and others have shown this to be erroneous, since by-catch may include table fish. In India, trash fish and low value fish are so designated on account of species or size, and are usually dried for food use or fishmeal. The miscellaneous category is used in statistics to account for fish not specified elsewhere, but, strictly speaking, should not be used interchangeably with 'trash fish'. (For instance, at Vishakhapatnam, in the statistics kept by the Fisheries Terminal Organization, this category was given a value of 0.5-1 Re/kg, but included cuttlefish with a wharfside price of 30 Rs/kg).

2.2 *Sources of information*

Information on by-catch – especially in respect of that part discarded at sea – is particularly scant. Generally, no records are kept and the only people able to make observations are ships' crews. In India, the information problem is compounded by the sensitivity of the topic : the industry is cautious about fuelling the debate on discards, and fearful of measures that would further squeeze the industry (given the recent reduction in margins that resulted from increased effort but poorer production in the 1987/88 season).

Nevertheless, some information on the quantity and composition of discarded by-catch can be obtained from the following sources:

- Records kept by trawlers – but information on weight and quantities of discarded fish is not usually recorded;
- On-board survey – this can be costly and time-consuming, but provides the most comprehensive information;
- Interviews with trawler crew – generally an effective way of collecting information from the industry, although care and cross-checks are necessary to assess any bias in responses;
- Transfer of fish at sea – where this happens, good information may be available from "collecting" fishermen;

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- Landed by-catch – where some of the by-catch is landed (albeit the most valuable by-catch, or that from the end of the voyage),this can be monitored, and is particularly useful where practices are changing in response to environmental or economic pressures;
- Shrimp/fish ratio – may be known in some countries, though care is needed to interpret variability between seasons, locations etc.;
- Sampling fish that would be discarded – trawlers may agree to land samples of fish, though care is needed to avoid biased sampling;[2]
- Formal resource surveys – existing surveys may be a useful source of information, though attention to depths, mesh sizes etc. are needed;
- Miscellaneous studies – carried out by universities, marketing boards etc.;

2.3 *Methodology of assessment*

The methodology used in this study to assess by-catch involved the identification of separate trawling systems, and the use of multiple information sources to estimate volume and composition of discards. In general, it was found useful to pool information from different sources and cross-check.

Assuming that any attempt to assess discards will entail extrapolation from a sample, it is important to accurately identify different patterns of activity (described by, for example, length of voyage, home port, size of vessel, location of fishing ground, type of gear). Each trawling 'system' will be associated with by-catch that differs in quantity and/or composition or quality. For some fisheries it is quite possible that there will only be one 'system'. Where there is clearly a lack of information (as, for example, might be the case with a foreign fleet), then this should be stated too. Once separate systems have been identified, the next step is to determine the number of vessels falling in each system, and the volume and composition of by-catch associated with each.

2.4 *The East Coast fleet*

The practice of discarding shrimp by-catch in India is associated with 'voyage' (long distance) fishing, almost all of which is from Vishakhapatnam. Other east coast ports do not have adequate facilities for a large fishing fleet; a few are used in an emergency – *e.g.* Paradip in Orissa – while others, such as Kakinada, in Andhra Pradesh, and Dhamra, in Orissa, may be base for smaller trawlers if they can sell their catch.

The fleet at Vishakhapatnam has grown rapidly during the late 70s and 80s (it now has 2-3 times more trawlers than was originally envisaged). Shrimp processing facilities have also expanded here. One result of this is that some of the small vessels (10-11 m stern trawlers), previously engaged in fishing trips of less than 24 hours' duration, have now changed to voyage fishing to enable them to reach richer shrimp areas further north. Additionally, Vishakhapatnam became a second (seasonal) home for some small vessels from other places, such as Kakinada, 150 km to the south. More recently, it has become the base for a new type of stern trawler produced for smaller operators interested in voyage fishing but for whom double-rig trawlers are too expensive.

These different vessels constitute the following separate trawling 'systems'

(a) Double-rig trawlers of 20 m and over – approximately 150 based at Vishakhapatnam (twice the number in 1980), making voyages of 30-50 days in the Sandheads area (some may relocate on the west coast for deep sea lobster during the Sandheads off-season);

(b) Double-rig trawlers of 16-19 m – approximately 70 based at Vishakhapatnam (mostly brought into service since 1981), making voyages to Sandheads of about 3 weeks at a time and principally using ice;

(c) 14 m *Sona* single net stern trawlers – approximately 70 based at Vishakhapatnam, and increasing seasonally with boats from Kakinada, making voyages of about 15 days at a time to the area just north of Paradip and using ice; and

[2] Furnell D J: ***By-catch from shrimp trawling in Guyanese waters.*** In "Fish By-catch... Bonus from the Sea" (loc.cit) pp 43-50 (1981).

A scene typical of shrimp trawling operations throughout the world: Sorting the haul. Note, the better quality fish (e.g. pomfret) is separated for freezing along with the shrimp. The 'trash' is shovelled back into the sea through the scuppers.

(d) Mechanized fishing boats of 10-11 m — many of these very small vessels make voyages of 6-8 days, when weather permits, in the direction of Paradip.

2.5 The by-catch discarded

It has been estimated that, in 1988, approximately 100,000-130,000 t of shrimp by-catch was discarded by the East Coast fleet (see Table 1). The upper estimate is a conservative interpretation of information drawn from extensive interviews by the author in 1988, while the lower figure is more consistent with previous estimates of by-catch.

It seems that most of the discards are associated with the Vishakhapatnain-based fleet. This is because discards only occur with vessels that go to sea for more than one day. The total includes a nominal figure for the discards of the trawlers that go out daily, or engage in voyage fishing from ports other than Vishakhapatnam, but both these amounts are believed to be small. The by-catch associated with West Coast deep sea lobster fishing by the same vessels is also excluded because it fails outside the scope of this study.

Table 1

By-catch discards from India's East Coast trawlers

Vessel Group	*Gross Tonnage*	*Annual discards* ***In*** t
Double-rig trawlers of over 20 m	150	40-60,000
Double-rig trawlers of 16-19 m	40-50	21-32,000
Sona stern trawlers	20-25	14,000
10-11 m mechanized fishing boats	7-16	18,000
Non-'voyage' and non-Vishakhapatnam trawlers		6,000
Total		99-130,000

The by-catch discarded by each separate trawling 'system' is discussed below.

2.6 *Trawlers 20 m and over*

Information obtained from interviews with crews of doubling frames of 20 m and over, during September and October 1988, suggested that 2-4 t of by-catch per trawling day **were** discarded at sea. However, this figure is clearly very variable and it is possible that responses reflected experience immediately preceding the interview. A conservative 2-3 t (assuming that 4 t is an exceptional rather than average discarded amount) has been used in the calculations that follow.

Assuming 150 trawling days/year *(i.e.* excluding the 36-48 hours travel time between Sandheads and Vishakhapatnam, and the time spent at Vishakhapatnam or on the west coast), and assuming that at any one time 10 per cent of the 150 trawlers will be 'down', it would seem that 40-60,000t of by-catch is discarded annually by this category of East Coast shrimp trawlers.

A Sub-committee on Utilization of Trash Fish at Vishakhapatnam made some estimates of discards which were much lower (partly because of the assumptions made about the size of the fleet in 1983-1985). This was based on 2 t discarded per **day (until the** last days of the voyage); unfortunately, no information was given on how the figure of 2 t was arrived at, except that it applied only to trawlers of 23 m and above. (The same committee certainly underestimated discards by vessels smaller than 23 m, stating that the latter "do not throw fish into the sea").

Collection of by-catch from a large trawler at sea during f&shing operations: Fish is sometimes traded for victuals and other items of necessity during this somewhat hazardous liaison.

Women play the major role in purchasing, sorting, processing and marketing of the by-catch, especially from the smaller trawlers.

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Observations by Kullberg[3] on board one of the multi-purpose (four-net) trawlers during October and November 1988 (the last voyage of the season) suggested that 2.175 t of by-catch was discarded and 0.4 t retained daily, but that discards were higher earlier in the season, when shrimp (and fish) catches were more and the crew did not have the time to sort and retain so much fish. The observed shrimp/fish ratio (head-off weight for shrimp) was 1:15. (Note that this means the ratio would be approximately 1:9 for shrimp head-on.)

These on-board observations are very useful as indicators. The observed quantities fall within the range suggested by interviews with crews, tending to lend weight to the figures used. Any extrapolation, however, should be cautious and qualified, for the following reasons

- The relationship between volume of catch and number of nets pulled is probably not linear;
- The multi-purpose trawlers are better equipped to retain large quantities of fish than some of the other trawlers;
- Trawl nets are not rigged uniformly, and will therefore influence shrimp/fish ratios and absolute quantities; and
- Different skippers have different 'profit maximising' strategies, which relate to the balance between larger quantities of lower value shrimp and smaller quantities of higher value shrimp, these also affecting the patterns of by-catch.

Other estimates, although not directly applicable for various reasons, are consistent with the figures used above. *Fishing Chimes*[4] states that "the shrimp component of the catches (is) rarely over 6 per cent of the total catch". This percentage is also reported by the Fishery Survey of India[5] for the Calcutta/Paradip areas, though its results are from trawling with a larger mesh size and at a different depth to the commercial fleet. Six per cent corresponds to a shrimp/fish ratio of 1:7 (or 2.5t per day using Kullberg's shrimp catch data).

'Collecting' fishermen, when interviewed, gave estimates of 300-400 kg per haul *(i.e.* 1.5-2t per day), though this again is very variable, and applied to December and January (the off-season for shrimp, but when calm weather permits transfer of fish at sea). It appears that relatively small quantities of by-catch are informally transferred at sea to local boats rather than discarded, though it is difficult to ascertain the extent and scale of this type of transaction.

An additional point concerning the estimation of discards by this type of vessel deserves mention. From the foregoing discussion of ratios, these might appear to provide the most straightforward indicators of by-catch volumes. This would be true if there were reliable data on shrimp catch by vessel type, and home port. However, such data are not available. Official statistics exclude most of the industrial fleet's catch; since trawling companies are not obliged to supply this information, no estimates are made. Shrimp export data also do not help, since these include catch from all vessel types, in addition to cultured shrimp, and, even where broken down by port of export, the harvest may have come from an entirely different area.

2.7 *Trawlers of 16-19 m*

Interviews with crew of double-rig trawlers of 16-19 m suggested that their discards, per vessel, per day, were of a volume comparable to those of the larger trawlers. These trawlers pull two nets, like most of the larger trawlers, but most cannot stay at sea as long or retain as much fish because of their dependence on ice. Using the same assumptions as for the larger trawlers, the discards by this category of vessel, which numbered approximately 80 at Vishakhapatnam in 1988, amount to 21-32,000t per year. The same caveats apply to this estimate as to that for the larger trawlers.

[3] Kullberg, R. *Shrimp Trawler By-catch in Andhra Pradesh, India.* Unpublished report of work carried out in October/November 1988. Bay of Bengal Programme, Madras, India.

[4] 'Fishing Chimes' : *Illogical Report* (October 1988).

[5] Fishery Survey of India : *Comparative study of the demersal fishery resources of the Indian waters as assessed by /7.5 metre trawlers.* Bulletin 10 (December 1980).

This type of trawler has generally not received much attention in the by-catch debate, perhaps because it has only emerged in significant numbers in the Eighties. The sub-committee referred to earlier did not include this category in its calculations. These trawlers use the same, or slightly smaller, mesh size as the larger trawlers, and often trawl at the same depth, in the same areas; this would suggest that a similar shrimp/fish ratio applies.

As with the larger trawlers, the quantity of shrimp landed by this category of vessel is not known, so we cannot extrapolate from this. However, we can cross-check the figure above by taking the quantity of headless shrimp landed per vessel, per voyage, by a 16 m trawler, as 1-2 t or *1.5* t on average, and, assuming 12 voyages a year, apply the 1:15 ratio. This gives an annual by-catch of approximately 20,000 t (most of which is discarded). Kullberg observed a daily by-catch of nearly two tonnes on board a 16 m trawler; unfortunately this was on the return voyage, and therefore in an atypical area.

2.8 *Trawlers of 14m*

The *Sona* 14 m single-net stern trawler represents another category of trawler that is comparatively new, and has, therefore, not been included in the earlier debate on by-catch. As with all other vessel types, there was a high degree of variability in responses during interviews. However, 15 voyages per year, with discards of 1St per voyage, is taken as typical for this subsector. Given that there are currently 70 of these vessels operating at Vishakhapatnam, this would suggest that, as a group, they discard approximately 14,000 t per year.

Note that ten *Sona* crew questioned at Vishakhapatnam indicated that they were engaged in voyage fishing of 12-20 days in the area north of Paradip. Kakinada, to the south, is another base for voyage fishing *Sonas.*

2.9 *Mechanized fishing boats*

Interviews with crew of mechanized fishing boats at Vishakhapatnam, which traditionally were only used for day-fishing, suggested that those involved in voyage fishing of 6-8 days duration were discarding approximately one tonne of low value fish per trawling day. This was due to space constraints and restrictions on sale of fish by Andhra Pradesh fishermen in Orissa.

Assuming 130 trawling days per year, and that 150 of the 320 Vishakhapatnam-based mechanized fishing boats are engaged in this type of activity, (with ten per cent 'down' time), this gives a figure of 18,000 t of discards a year. Since this category of vessel was generally not considered sufficiently seaworthy for such long voyages, and day-fishing is not associated with discards, there is very little other information with which to cross-check this figure. The number of boats engaged in voyage fishing is particularly uncertain, partly because official statistics give catch per vessel per day, without indicating voyage length. Half the crew of Vishakhapatnam-based 10-11 m boats, questioned during September and October 1988, indicated that they were engaged in voyage fishing. A subsequent study at Kakinada (Van der Knaap)6 suggested that 10-25 per cent (depending on the time of year) of the boats there may also be involved in similar activity.

2.10 *The species of by-catch*

The information available on the species and size distribution of the discarded by-catch is general rather than specific, but nonetheless gives some indication of its value were it to be landed. The main selection criterion in retaining or discarding fish seems to be size, but the cut-off point is different for each type of trawler.

Most of the 20 m trawlers seem to have a policy of retaining large quality fish throughout the voyage. The rest of the catch is discarded. Some trawlers will retain more of the catch in the last few days of the voyage; some will not retain any catch until the end of the voyage. The mesh size (stretched) used by these trawlers is supposed to be 25-30 mm at cod end, though Van der Knapp reports.

6 **Van der Knaap** *By-catch and discards of the Indian shrimp fishery in the Bay of Bengal.* Unpublished report of the Bay **of Bengal Programme, Madras, India (1989).**

smaller meshes used by some trawlers. The most abundant species caught, observed by Kullberg on one of the multi-purpose trawlers in the Sandheads area during October and November 1988, were:

Sciaenidae (croakers or jewfish)
Leiognathidae (silverbellies/ponyfish)
Nemipteridae (threadfin bream)
Clupeidae (sardines, shads)
Trichiuridae (ribbonfish)
Carangidae (jacks, travallys)
Mu!!idae (goatfish)
Harpadontldae (Bombay duck)
Menidae

Everything less than 20 cm was discarded (80-90 per cent of the by-catch).

Van der Knaap also reports, on the basis of preliminary analysis of samples from two trawlers in November/December 1988, surprisingly large quantities of discarded shrimp of unspecified quality. This **indicated that 15-30 per cent of the discarded weight may be** shrimp. This deserves further investigation; there could possibly be some sampling error, and shrimp heads may be included in the figure. Van der Knapp lists discarded shrimp species as *Metapenaeus affinis, M. dobsoni, M. brevicornis, Parapenaeopsis hardwickii and P. stylifera.*

Retained fish (Kullberg's study) are listed below in order of abundance

Ariidae (catfish)
Sciaenidae (croakers or jewfish)
Stromateidae (pomfret)
Lutjanidae (snapper)
Polynemidae (threadfins or tasselfish)
Chirocentridae (wolf herring)
Muraenesocidae (eel)
Synodontidae (lizardfish)
Carangidae (queenfish)
Scombridae (seerfish, mackerel)

The species distribution of the by-catch varies through the year and with depth and location of trawl. In April 1989, Van der Knaap found *Nemipterus japonicus* to be the most abundant species in the by-catch landed at Vishakhapatnam. An earlier study by the same author cites croakers, threadfin breams, hairtails, ponyfish, Iizardfish, shads, sharks and rays as the most abundant by-catch species in Andhra Pradesh and Orissa. Other observers have noted landings of small cuttlefish and *Balisitidae* (filefish).

Fishermen in West Bengal 'collecting' discards from these trawlers reported that jewfish was the most abundant fish, but catfish was also significant. They considered that 20 per cent were of sufficiently high value to send on ice to fresh fish markets in Calcutta (average landed value of 3 Rs/kg) while the rest could be sold for use as fishmeal (landed value of 0.5-1 Re/kg Van der Knaap also notes "an overlap of sizes landed by stern trawlers as table fish and the discards of the double-rig trawlers..."

It is also interesting to note a similarity of abundant species reported with shrimp by-catch in other tropical areas by the FAO/IDRC7 and Canadian Institute of Fisheries Technology.8

FAO/International Development and Research Centre : *Fish by-catch.... Bonus from the Sea.* **Report of a technical** consultation on shrimp by-catch utilization held in Georgetown, Guyana, (27-30 October 1981) Ottawa, Canada, IDRC, 1982. 163 p.

Canadian Institute of Fisheries Technology of Mozambique. (1983) : *Retention of shrimp by-catch.* **A study for the** Government.

A better understanding of the size distribution of fish in the by-catch is very important, both for considering potential utilization, and for estimating the possible effects of this harvest on fish stocks. Samples of fish that would have been discarded by double-rig trawlers are now being collected and size distribution of different species recorded. Preliminary results from this exercise suggest that much of the discarded fish meet the size criterion for table fish (about 12 cm).

The double-rig trawlers of 16-19 m are discarding all by-catch except large quality fish. Some trawlers even discard these fish until the last few days of the voyage. In interviews, the stretched mesh size used was reported by crew to be 20-30 mm at cod end. The species distribution is probably similar to the catch of the larger trawlers.

The *Sona* vessels apparently discard most of the by-catch that is less than 15 cm, and the mechanized fishing boats discard by-catch of less than 10 cm. These trawlers differ from the double-rig trawlers in that they do attempt to land as much fish as possible (much of it salted or dried), subject to space constraints. The stretched mesh size (cod end) used by these trawlers is 10-20 mm. Small fish caught in this trawl is sold for less than Rs 5/kg if landed at Vishakhapatnam; much of it is sold at Re I/kg for use as fishmeal.

3. *OPTIONS FOR LANDING THE BY-CATCH FOR USE AS FOOD OR FEED*

3.1 *Reasons for discarding by-catch*

It is often said that fish is discarded by the trawlers because its value is insignificant relative to that of shrimp. This is partly true: the average wharfside price for shrimp (head off) at Vishakhapatnam (taking a weighted average for the three main varieties) was 117 Rs/kg during September and October 1988. The price for large, good quality fish, on the other hand, was around 10 Rs/kg (with the notable exception of cuttlefish, which is exported to Japan and is, therefore, sold at 30 Rs/kg). Much of the remaining catch is sold for fishmeal at only about 1 Re/kg.

This statement on its own overlooks the question of who benefits from the sale of fish. The income may be negligible to the trawling company, but is almost certainly not so to the crew. Until recently, and the practice still continues in some companies, the proceeds from fish sales were entirely the crew's. Even when a company took a share of this fish revenue, this was generally not as large as the shrimp revenue share.

The reality is that even if the additional income were small, it would be realistic to expect the industry to realize this income, particularly with the current situation of declining net revenues, unless it was perceived as jeopardising shrimp revenues in some way, or unless there were technical or institutional reasons for not doing so. This is, in fact, the case, as indicated by the reasons that crew gave for discarding fish.

Why 16 and 20 m double-rig trawlers discard fish

- Limited ice or freezing (storage) capacity;
- Lack of on-board processing or bulk reduction system (that is commercially viable);
- Possible contamination of shrimp;
- Labour already fully utilized;

  Large quantities of fish are difficult to sell and the trawler is therefore delayed in port; and
- Transfer to other boats perceived as risky if sea conditions are rough or management is opposed.

Why mechanized fishing boats and *Sonas* discard fish

- Insufficient space for drying or storing more fish; and
- Cannot sell fish in Orissa, or transfer to Orissa boats, because of ban on purchase of fish from Andhra Pradesh boats.

In order to land larger quantities of by-catch, the constraints mentioned above must be addressed and/or there has to be a change in the value of the by-catch relative to the shrimp. The identification of handling practices for fish and shrimp associated with an increase in total net returns would also result in increased landings.

CHILLING CAPACITY : Where trawlers are limited by their chilled storage capacity *(i.e.* by space or by chilling capacity), the only way to significantly increase the amount of by-catch landed is with major modifications to their chilling systems or with new vessels of different design. Most of these vessels do not have the deck space for storage of salted fish or fish in brine (nor would this be a popular option for operators of steel trawlers). However, although few vessels would have sufficient capacity to land all the by-catch caught, most of the 20 m trawlers currently have excess chilled storage capacity when they return to port. For the 16 m medium-sized trawlers, however, this seems to be a real constraint posed by small holds and dependence on the use of ice.

PROCESSING AT SEA : Some form of partial processing of fish at sea, to reduce bulk, has been suggested as a solution to space constraints. In assessing this, it should be noted that there has been virtually no installation of on-board mincing technologies in multi-species tropical fisheries. Most of the preparation of fish, by filleting and gutting, is probably unrealistic in view of labour constraints.

Partial processing at sea might be possible using a "meat/bone separator" to produce fish mince and reduce bulk. To the author's knowledge this has not been tried, but deserves investigation: What is the processing capacity of such machines? Is there sufficient space on the trawler? What would be the labour requirements? How would the fish mince be stored, and subsequently used? Would existing on-board storage be of sufficiently low temperature to preserve this more perishable raw material? Would this be a commercially attractive venture for trawling/processing companies?

Fish products may be developed from whole or minced fish. The former would use the fish already being landed, *i.e.* the larger fish, and experience in India and elsewhere suggests that this sort of operation can be commercially viable. The commercial potential in producing minced fish products is less certain. The end product is likely to be more perishable, but would make use of the small-sized, low-value, multi-species by-catch. (Indicative cost structures are provided in Section IV.)

The other alternative suggested is to make fish silage for use as animal feed. This avenue, however, has not been pursued as there appears to be several reasons why it is not likely to be successful

- The low value of the end product;
- The experience with fish silage elsewhere has not been encouraging;
- The problems in handling a liquid form of feed;
- The problems with handling acid needed in the process;
- The lack of knowledge about this in the fishing industry; and
- The lack of demand for (or knowledge of?) this in the domestic livestock industry.

SPOILAGE OF SHRIMP : There are two possible causes for this belief : one relates to chilling capacity *(i.e.* the temperature in the hold rising as a result of the addition of large quantities of fish); the other concerns slime on fish spreading to the shrimp. The latter is not really a technical constraint, but seems to stem from lack of information; fish and shrimp **can** be stored so that there is no contamination.

LABOUR SHORTAGE : Observations on board a 20 m trawler suggest that this is a binding constraint, at least during the peak shrimp season. This could be overcome if vessels were designed to accommodate more people (space is at a premium on all the trawlers), or if some of the sorting was done mechanically (all the catch is currently sorted manually). In order to overcome the labour constraint, mechanical on-board sorting could be used to separate shrimp from by-catch. On-board fish graders sort fish by size and would need to be adapted to accommodate the multi-species nature of shrimp by-catch in tropical waters. Selective trawl gear could also be used to pre-sort, or exclude, some species, though the multi-species nature of the fishery would pose special problems.

TRANSFERRING FISH AT SEA: Whilst this may currently be perceived as a prohibitive factor, of fishermen from West Bengal have demonstrated that it is possible for fish to be transferred at sea, even though it may require a 6-8 hour voyage to reach the shrimp trawlers. Moreover, more appropriate methods of transfer could be used (such as the use of floating net bags) that would not require small vessels to manoeuvre alongside the double-rig trawlers.

3.2 *Institutional constraints*

Two of the reasons given for discarding fish are essentially institutional constraints. Both are of a similar nature, and need to be recognized and addressed.

The first of these relates to the question of delay in port. Several people (crew and management) quite independently gave this as a reason for not landing more fish, and it seems likely that the delay partly reflects crew share arrangements. The crew share on fish is larger than on shrimp (sometimes 100 per cent) and there is usually no 'break-even' threshold. It would also seem that crew do not always declare the entire quantity of fish to their land-based managers. For these reasons there is an enhanced incentive for the crew to obtain the best price, which often involves clandestine deals and consequent secrecy in unloading – all of which is time-consuming.

The second instance of an institutional constraint is the adamant opposition of most of the trawling companies (but not their crew) to the idea of transferring fish at sea to local 'collecting' fishermen, presumably for fear of shrimp being transferred at the same time. The practice, nonetheless, occurs. Attempts to assess the extent of this practice have not been successful. However, several non-governmental organizations attending a BOBP workshop in Orissa in September 1989 confirmed the practice.

Although less obvious than the technical and economic constraints, these institutional constraints are very real. They can only be resolved through a thorough understanding and careful negotiation of the entire incentive system by crew and management.

3.3 *Problems of stern trawlers*

For smaller stern trawlers the principal technical constraint to increased by-catch landings is one of space, and there is probably very little that can be done about that. It may be possible to land slightly larger quantities of fish by making greater use of drums for storing salted fish on deck (if this does not adversely affect boat stability), or by some kind of tiered or extension system to give vessels more space for drying fish.

Smaller vessels would, however, land fish in Orissa if this were permitted. The original reason for this prohibition was apparently to reduce fishing effort off the Orissa coast, but the concern of Orissa fishermen today seems to relate purely to an alleged negative effect on prices when trawlers from other states offload their catch. Double-rig trawlers, putting into Paradip during bad weather and selling large quantities of fish, seem to have provoked the rigorous enforcement of this regulation.

A long-term view of this problem requires that marketing constraints in Orissa be tackled. Its relative proximity to Calcutta would suggest that if infrastructural bottlenecks could be removed there would be a market for increased quantities of fish from Orissa.

This does not, however, take account of any need to restrict fishing effort off the Orissa coast. Some clarification of this issue is required.

3.4 *Adding value to by-catch*

All the trawling companies and crew interviewed said that if fish prices were higher they would land more by-catch, or trawl for fish on the return journey. This suggests that the technical constraints discussed above are not actually binding, or, in some cases, could be relatively easily overcome.

The solution to this is perceived, by virtually the entire industry, to be the development of "value added products from trash fish" – basically, developing an up-market product with low cost inputs, most probably in frozen form. This idea is currently receiving attention from public agencies serving the sector *e.g.* the Integrated Fisheries Project, the Central Institute of Fisheries Technology, the Marine Products Export Development Authority and shrimp processors (both public and private corporations). The more ambitious technologies, however, are also the most risky, having no commercial track record in the context of tropical multi-species by-catch.

The distribution of any value-added frozen product depends on the efficient functioning of cold chains, and, in the case of India, would require significant inputs on the market development side. If these two obstacles can be overcome, India's urban middle class certainly represents a large market, and processors might best consider this market prior to venturing into the highly competitive international market.

If successful, the processor/trawler companies would have a greater incentive to land more fish; this incentive would not necessarily spill over to the trawler companies without downstream processing links. The effect here would depend on the level of demand for such products and, hence, the fish. If the development of such products brought about a real increase in wharfside prices of some fish, this would be beneficial to all fishermen, but could have negative employment, income and nutritional effects on traders, processors and consumers of fish diverted from traditional uses. Extra employment would be generated, however, in the minced fish processing industry.

Some companies have considered this type of product development in conjunction with a collector vessel system incorporating either a large 'mother ship' to process by-catch from a fleet of trawlers, transferred by purpose-built collector boats, or to supply a land-based plant. The 'mother ship' concept is very ambitious; one trawling company visited had considered it as a joint venture with a foreign company, producing value added products for the export market, but the proposal was not further developed. Another company was looking into the possibility of producing pet food from by-catch, again for export markets, using collector vessels to supply a land-based plant. Both declined to comment on their proposals.

3.5 The effect on fish prices

Even without the impetus that new products could inject into markets for fish in India, the ratio of shrimp to fish prices is likely to diminish over time. The price of fish in India has increased relative to other food items over the last two decades, while worldwide expansion in shrimp production is likely to result in stagnating, or falling, shrimp prices. Any change in this ratio is likely to have an effect on the margin. For instance, the delay in port necessary to sell fish was considered costly in terms of foregone trawling time. If we assume no real change or increase in voyage fixed costs, and a need to spend some time in port for other reasons, then any incremental increase in the price of fish relative to shrimp should result in increased landings of by-catch if the trawling companies are maximising profits. In reality, there is likely to be a lagged response to any change in price ratios, but this scenario is consistent with the current tendency to land increasing quantities of by-catch. (Note too, that this has been the experience in other countries; in Thailand, for instance, some trawlers, owned by the same company, stagger their return to port, with each trawler taking it in turns to collect fish from the others – a rational response to the decline in shrimp/fish price ratios that was triggered by depletion of fish resources).

Some of the problems in the marketing and distribution of fish in India (such as market development, transportation, communications, development of cold chains) will ease as India's infrastructural base is gradually developed. General population pressure and the growth of an urban middle- class will result in upward pressure on fish prices, and a change in fish handling practices. On the west coast, for instance, anecdotal evidence suggests that an increasing proportion of fish that was previously used as animal feed is now sold for food use.

Many trawling companies thought that cold storage for fish was the solution to the delay in port, consequent on their trying to sell large quantities of frozen fish during a brief spell in port and being obliged to accept low prices. Any such facility, however, would require careful management.

A build-up of supplies could be regulated by charging storage costs on a daily basis to the company concerned, and having an arrangement for auctioning fish after a certain time. This would enable day to day fluctuations in supply to be evened out, and assure supplies of fish to buyers at any time. If, however, trawlers are to land substantially larger quantities of fish as a result of this facility, simultaneous improvements in marketing and distribution of frozen fish would be needed. Without these, the cold storage would just result in a higher cost product being auctioned at, or below, existing low prices.

4. THE FINANCIAL INCENTIVE TO LAND MORE BY-CATCH

4.1 *Prices of wet fish*

Prices of wet fish are extremely variable and depend on fish size, species, quantity being sold, and quality. There is also seasonal and geographical price variations, which can be quite marked. Observed wharfside prices at Vishakhapatnam during September and October 1988 are given below (Table 2); prices for shrimp (head off) caught by double-rig trawlers are included for comparison.

Table 2

Wharfside fish prices, Vishakhapatnam, 1988

	Rs /kg*	
Tiger shrimp	270.00	(appx. 10 per cent of shrimp catch)
White shrimp	160.00	(appx. 30 per cent of shrimp catch)
Brown shrimp	70.00	(appx. 60 per cent of shrimp catch)
Cuttle fish	30.00	(sold for export)
Pomfret	7.75	
Eels	6.50	
Perch	6.00	
Red snapper	6.00	
Shad	4.00	
Shark, with fins	4.00)	small
Shark, without fins	2.75)	shark
Mackerel	3.00	
Mixed	1.50	

* *Note:* Rs 16 approximately equal US $ 1 (late 1988). Prices used throughout this report refer.to prices in late 1988.

These prices were quoted to one of the large trawlers at a time when there were many trawlers in port. They were considered low, but not untypical. Generally the fish listed would be the larger retained species in the by-catch; prices for such fish are generally 5-10 Rs/kg.

Most of the catch of the small trawlers would be smaller varieties (generally very little would have been discarded) and would sell at less than 5 Rs/kg. Very small mixed species would be sold for drying as fishmeal, and sometimes food use, at *0.5-1* Re/kg.

By-catch from the large trawlers would be landed frozen or, very occasionally, iced. Fish caught by the mechanized fishing boats and traditional craft would very rarely be iced at sea. (The price of ice in Vishakhapatnam at the time of the study was 375 Rs/t; at Kakinada, to the south, ice was 180-250 Rs/t).

4.2 *Prices of dried fish*

Price data on dried fish suggest that margins are very low for processors purchasing wet fish at the wharfside. Where fish is dried on board, or by fishing families — and the cost of the wet fish

Small-scale intermediaries, such as these 'barrow boys', play an important role in transporting the small, miscellaneous frozen fish from the large trawlers to local auctions.

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Most** women **processors rely on any availablespace, in this case the wharf, for drying their** purchases. Despite the apparent adverse conditions of work, profits can be good relative to many small-scale industries, as the demandfor low-cost fish, **both for direct and indirect human consumption, is very high and constant.

*The larger species are almost invariably salted and dried. Much of the **catch** could, **in** theory, **be enjoyed by** the **consumer in** fresh **fo#,n: However, lack of** knowledge, **poor** quality **and inadequate** infrastructure are **some of the factors which tend to restrid this at present.***

is, therefore, not a cash outlay — it is probably the most remunerative product form of fish that is small, un-iced, prone to rapid spoilage and, essentially, of low value. Fish is always sorted by species and some species may be salted prior to drying. If not dried on board, it is dried at the quay, or taken to nearby fishing communities.

Prices for some dried fish are given below, as reported at Vishakhapatnam wharf in October 1988. These prices are so low that they imply a negative return on the purchase of wet fish. A more realistic explanation may be that the fish drying is done by fisherfolk; **or,** fish processors depend on bulk purchases of very cheap, mixed species (available from all categories of trawlers), which are subsequently sorted; **or,** these wharfside prices recorded by the Fisheries Terminal Organisation are for better quality wet fish. Even very small fish are dried for food use, *e.g.* silverbellies of less than 5 cm in length.

Table 3

Prices of dried fish, wharfside, Vishakhapatnam 1988

Species	*Dried weight price, Rs/Kg*	*Implied break-even price for wet fish purchases'*	*Observed wet fish price*
Lactarius	*6.25*	*1.56*	3.00
Mackerel	5.00	*1.25*	3.00
Jewfish	4.30	1.08	2.00
Whitebait	16.00	4.00	
Ribbonfish	3.20	0.80	
Silverbellies	3.00	*0.75*	

* *Note:* Takes no account of other purchased inputs and assumes that dried weight is 25 per cent of wet weight. At break-even price the return to labour is, then, zero.

If we assume that fish takes two days to dry, and that the net return on dried fish is *0.5* Re/kg, then a processor would have to dry 250kg of wet fish every two days, in order to earn Rs 15 per day. This takes no account of salt costs (approximately 0.25 Re/kg) used in a saitfish ratio of 1:4-6.

The price information on dried fish was rather contradictory, so these data should be viewed cautiously. Some processors/traders at the quay reported much higher prices. Wholesale prices in Hyderabad (over 10 Rs/kg), for instance, would permit higher wharfside prices, since transport costs to Hyderabad should not be more than, say,. 2 Rs/kg. Fishing communities in Paradip, however, cited their on-selling price for small varieties of dried fish as 5 Rs/kg, which is consistent with the scenario of low returns but, nonetheless, indicates some returns for fishing families.

4.3 *Value addition by freezing*

Work by Rajendran and Seetharamaswamy[1] suggests that the cost of sending iced fish by train to Hyderabad from Vishakhapatnam was less than 2.5 Rs/kg. At the same time (Spring 1988), wholesale prices for wet fish in Hyderabad were 20-22 Rs/kg for pomfret, and Rs 12-13 for eel or perch. This appears to offer a significant margin to the broker/packer, though no mention is made of product losses. At least two of the trawling companies, distribute fish in this way to other major cities; together they account for approximately 1.5 t/week.

[1] Rajendran, **A.D.J.,** and Seetharamaswamy, A. *Study offish marketing systems in Andhra Pradesh.* Unpublished report of the Bay of Bengal **Programme, Madras, India. (1988)**

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This example is given to demonstrate the profit potential for value added products, as perceived by the processing companies. Information on cost structures for minced fish products, produced only on a pilot scale at the moment, was not available. The product described here is, therefore, a 500 g carton of pomfret 'steaks', making use of large, high value fish. This retails in Madras at about 44 Rs/kg, whereas the raw material price is about half that.

Table 4

Cost structure for packaged frozen pomfret 'steaks'

	Price Rs/kg
Pomfret, steak quality, sorted (wharfside price)	14.00
Yield for steaks @ 68 per cent; implied raw material price	20.60
Preparation/packing costs per 500g carton @ Rs 2.60 each	5.20
Bulk packaging for transfer to Madras	0.80
Transportation to Madras	1.50
C & f price, Madras (exclusive of capital/rent/management costs, but inclusive of labour costs)	28.10

Distribution costs, including wholesalers' and retailers' margins, have to be added to the c & f price before any conclusions can be drawn about the return to the manufacturer. Cold chain distribution costs and losses are likely to be high since this facility is not particularly well developed for retail products in India at the moment. Further, such 'new' products are aimed at the urban middle class market and consequently, require outlay on advertising.

The current interest being shown by processing companies in the development of minced fish products stems from the belief that, although the end-product would be more perishable, margins would be much higher because raw material costs would be significantly less *(i.e.* by using lower value, small fish).

At the time of this study, some trawling companies were interested in using by-catch to manufacture pet food, a relatively high value product in developed countries. Preliminary enquiries suggest that manufacturers in the UK use very low value raw material (£90-100/t for frozen blocks of fish 'offal' i.e. heads, backbones, tails) and would not pay more for, say, small whole fish, unless it contained "added shrimp" (trout, salmon etc). Unfortunately, companies interested in this in India were unwilling to discuss their proposals; the price information from the UK, however, suggests that export of raw material to the European industry is unlikely to be a viable proposition.

4.4 Voyage profitability

An attempt has been made here to model the cash flow associated with a 'typical' shrimp trawling voyage, and then to compare that with a situation where more by-catch is landed. Capital costs and other fixed costs are not included because it is assumed that there is no change in these.

There are obvious problems in defining 'typical', but the parameters broadly fall within those described by the crew of ten trawlers of this type. Each trawler is assumed to be manufactured in India, to stay at sea for five weeks, and to return to port for five days with 4t of frozen shrimp, and 4t of "quality" by-catch. Crew share arrangements vary between companies and over time; the assumptions made here are consistent with those that prevailed at Vishakhapatnam in late 1988.

Table 5

Cost structure for voyage by 20 m trawler
(35 day voyage/five days in port, operating costs only)

COSTS	**Rs.**
50,000 l of diesel @ 3.40 Rs/l (1988 subsidised rate for export industry)	170,000
15 t of water 37 Rs/t	555
Salaries (4 officers, 10 crew)	25,733
Mess money (for provisions)	10,544
	206,832
GROSS REVENUE	
4,000kg of shrimp @ 117 Rs/kg	468,000
4,000kg of fish @ 5 Rs/kg	20,000
	488,000
GROSS MARGIN (before crew share is paid)	**281,168**
CREW SHARE	
20 per cent of shrimp revenue exceeding Rs 225,000	48,600
40 per cent of all fish revenues	8,000
	56,600
Net revenue to trawler company/voyage (Net revenue to trawler company/day - Rs.5,6l4)	224,568
CREW EARNINGS	
Crew salary' and share/voyage	82,333
Crew salary' and share/day	2,058

Suppose this trawler were to retain an additional two tonnes of by-catch (valued at Rs 10,000 and shared in the same 40:60 ratio), and was delayed an extra day in port as a consequence of trying to sell **frozen** fish. If we assume that this day represents one day's lost trawling, then the extra by-catch results in extra gross revenue of Rs 10,000 and net revenue of slightly less when taking freezing costs into consideration. This amounts to a little less than cost of *not* trawling for that one day *(i.e.,* gross income foregone less fuel saved). In this case, the one day delay results in a small net loss.

During the course of this work much discussion focused on the question of whether selling by-catch really does cause trawlers to be delayed in port.

There seem to be two contributory factors here. The first relates to how the by-catch has been stored. It seems that iced fish can be unloaded without delay, provided it is re-iced, as necessary, prior to consumption. Off-loading frozen fish, however, might cause delays if it cannot be utilized straight away, or if no cold storage facilities are available.

The second point relates to conflict of interest between companies and crew. If the company management instructs the crew not to retain by-catch, or only to retain a certain amount, this could lead to still further delay in port if the crew opt to land the by-catch, without informing the company management, and sell it 'secretly'.

'Crew salaries and share arrangements changed subsequent to this, following industrial action taken by crew during a period of poor catches.

Although by no means true for all companies, it did appear, at the time of this study, that some of the managers had relatively little understanding of trawling and of the significant quantities of by-catch involved; people with no previous connection with the industry are attracted to it by expectations of high profits. With the rapid growth that the sector has undergone, many of the companies reported that trustworthy, experienced officers and crew are at a premium. (Note : In contrast to fish sales, it would be difficult to sell shrimp 'secretly', because of closer supervision by management and fewer outlets).

The figures used above serve to illustrate how incentives may be perceived by different parties. In reality, there may be a great deal of variation in expected income, such as with an optimistic view of the next voyage's shrimp catch, or a poor year when the crew receive no share on the shrimp. Additionally, crew shares differ between companies. It also appears that under current marketing arrangements in Vishakhapatnam, it is easy to glut the market, resulting in fairly volatile fish prices. It might be more appropriate to consider extra by-catch being landed at lower prices to reflect this, or a higher proportion of smaller fish in the by-catch. The following example illustrates the effect that increased landings of fish, and an associated fall in fish prices, could have on trawler revenues. There is assumed to be no change in costs or time spent in port.

Table 6

Trawler revenues and the effect of changes in fish price and quantity
(prices in rupees)

	I*	II**	III***
Gross Margin/voyage **(before crew share is paid)**	281,168	285,168	279,168
Company's net revenue/voyage	224,568	226,968	223,368
Company's net revenue/day	5,614	5,674	5,584
Crew salary and share/voyage	82,333	83,933	81,533
Crew salary and share/day	2,058	2,098	2,038

* **4t of fish landed at an average price of Rs 5/kg**

** **6** t **of fish landed at an average price of Rs 4/kg**

" 6t of fish landed at an average price of Rs 3/kg

Note: **Figures exclude cost of freezing additional fish, which would reduce the gross margin.**

In the example above, if prices fall to just over 3 Rs/kg as a result of landing more by-catch, both crew and company will lose. This is consistent with comments made by some trawling companies that 3 Rs/kg was the lowest price at which it was worth landing fish; this figure will change, though, depending on the assumptions made about quantities and reference prices. Although it may be argued whether one vessel could influence prices to this extent, it is conceivable that the by-catch retention strategy of a single company could have this effect if their trawlers were to put into Visakhapatnam simultaneously. Consider also the negative effect on fishing incomes for other categories of vessels, and the opposition by the Orissa fishing community to fish sales by Andhra Pradesh vessels in Orissa becomes understandable

As discussed earlier, the processing/trawling companies are all interested in the development of 'value added products' from so-called trash fish. Assuming that the 20 m trawlers have adequate freezing capacity (most do), and that the crew can handle increased amounts of by-catch (less certain), there is apparently no conflict of interest in this: there would be no cause for delay in port if the market was assured and the economic incentive to company and crew was clear.

4.5 'Collection' of by-catch

At the time of the study, several fishermen from West Bengal were engaged in informal 'collecting'. This involved a voyage of 6-7 hours, in 10 m gillnetters, to locate double-rig trawlers in the Sandheads

area. They would approach trawlers as the nets were hauled in, and, if the skipper agreed, would take the discards by going alongside, gathering fish in baskets or having it shovelled into their boat. This would be repeated four or five times during the day, with the same trawler or other trawlers. Payment, if made at all, would be in the form of fresh provisions.

This practice has gone on only for the last 4-6 years, and, apparently, followed poor inshore catches. This forced some gillnetters to go further until they reached the trawling grounds, where many trawlers operate within a relatively small area. During certain months these local vessels go to sea with the express purpose of 'collecting'; they carry no fishing gear at this time.

The costs and revenue from this activity, based on interviews with 'collectors' in Dhiga and Sankapur, are given in Table 7.

Table 7

Costs of collecting fish from trawlers off West Bengal
(operating costs only)

	Rs.
COSTS	
Fuel costs (150 litres)	*555*
Ice (700kg @ 0.5 Re/kg)	350
Provisions for barter trade	150
	1,055
GROSS REVENUE	
180 kg of fish @ 3 Rs/kg	540
1,020 kg of fish @ 1 Re/kg	1,020
	1,560
NET REVENUE PER DAY	*505*
Net revenue/crew member (crew = 8)*	63

* *Note*: No information was available on 'owner share' for this activity; shares from gillnetters in Andhra Pradesh are reported to be 60:40 (owner:crew).

Income from this activity is obviously not very great, but is on a par with normal fishing activity. Fishermen reported gross revenue from gillnetting as ranging from Rs 500-Rs 5,000 (with the high figure occurring perhaps two or three times a month). Observations on-board a 20 m trawler in 1988 indicated that there was no cost, or 'disbenefit', to donor trawlers (though trawler managers regard the practice with distrust).

An increase in this type of collection, within the context of a more appropriate method of transfer (for instance, using floating net bags), would appear to offer scope for increasing the utilization of by-catch. Any 'project' with this as its goal would need to build on existing practices. It is therefore important to clarify the extent and scale of existing informal transfer operations, so as to identify weaknesses and constraints. Analysis of existing operations would also indicate the value of transferred by-catch under current marketing arrangements, thereby setting cost parameters for new 'collection' technology.

4.6 *Pressure of numbers*

Any consideration of the economics of landing increased quantities of by-catch ultimately comes back to prices and marketing. Though a detailed analysis of marketing constraints was not part of this study, it might be useful to consider by-catch in the context of marine fish production in India.

The figures given below are based on information collected by the local fisheries departments for collation by the Central Marine Fisheries Research Institute. Overall, the figures probably underestimate landings, because of some notable exclusions, such as a part of the fish landed by double-rig trawlers (which information trawling companies are not obliged to supply). Nonetheless, these figures serve as broad indicators.

In 1986, estimated landings of marine fish and shrimp, for all India, were 1.7 million **t.** Marine landings in Andhra Pradesh alone were 141,038 t for the one year period 1986-1987. Marine landings in Orissa were 55,000t for the same period, and 40,000t in West Bengal in 1984. In 1987 the 10-11 m mechanized fishing boats (stern trawlers) based at Vishakhapatnam landed an estimated 4,000t of fish and shrimp.

Even when allowing for some underestimation in these figures, by-catch discards by the East Coast trawling fleet appear significant by comparison. At the same time, India's already large population (approximately 820 million) continues to grow, creating upward pressure on fish prices and an increasing fish deficit for use as food or feed.

As real prices for fish are pushed higher, trawling companies may look again at ways in which by-catch can be retained. But clearly there are many related problems of organization, distribution and market information that need to be overcome. In some cases, infrastructural development may be needed, but where public sector intervention is proposed, the distribution of benefits should be carefully assessed. The development of high value fish products, for instance, is unlikely to positively influence fish consumption by low income groups. The distribution of employment, income and foreign exchange benefits should also be carefully appraised.

5 CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

5.1 Conclusions

(a) ASSESSMENT OF BY-CATCH : The quantity of by-catch being discarded by the East Coast trawlers was estimated to be 100,000-130,000 tin 1988. These are mostly small fish, selling at the wharf for less than 5 Rs/kg, and, probably, at nearer 2-3 Rs/kg. The most abundant species in the by-catch are *Sciaenidae, Leiognathidae, Nemipteridae, Clupeidae, Trichiuridae, Carangidae, Mu/lidae, Harpadontidae and Menidae.*

These results are based principally on field work undertaken during a single trawling season in 1988/89, but are generally consistent with evidence from other sources. One major reason for differences between this and earlier estimates is the growth in the size of the fleet and the fact that smaller vessels are now involved in voyage fishing. These estimates should be regarded as provisional and subject to revision as more information becomes available.

(b) USE OF BY-CATCH AS FOOD OR FEED Although much of the by-catch is small, this in itself does not preclude its use as food. Fishermen in West Bengal, collecting discards from trawlers, reported that 10-20 per cent was of sufficiently high value to send on ice to retail markets in Calcutta; the remainder was sold locally for feed use.

The low landed value of this fish seems to preclude the use of ice in Vishakhapatnam; as a consequence, the process of spoilage is unabated, and much of the un-iced catch can only be used as fishmeal. When it is used as food, it is consumed locally as wet fish, or distributed in dried form. Observation of fish drying at Vishakhapatnam suggests that very small-sized low value fish could be sorted and dried for food use.

By-catch from the east coast is not generally distributed to the fish-scarce higher value urban markets elsewhere in India. However, there does appear to be a market for such fish, since at the time of the study, low value iced fish from the west coast was being retailed in Madras at 6 Rs/kg.

(c) *Landing more by-catch:* The greatest potential for landing more by-catch was considered to be through

- transfer of by-catch at sea to local fishing craft;
- greater retention of frozen by-catch by 20 m trawlers;
- direct landing of by-catch in Orissa and West Bengal by small stern trawlers based in Andhra Pradesh or by developing a fleet based in Orissa or West Bengal.

The quantity of fish currently discarded relative to other fish landings, and the tendency for the market to be glutted quickly, necessitates analysis of market systems to identify target markets and constraints. Communications, market information, and few suppliers of some key inputs, such as ice, are likely to be important factors.

(d) *Financial implications:* Under the current pricing scenario, it appears financially worthwhile for the 20 m trawlers to land more by-catch, assuming that this does not inhibit their shrimp activity. However, the overall effect on revenue is crucially dependent on whether trawling time is lost as a result of trying to sell frozen fish, which, in turn, depends on the level of demand, marketing and infrastructure.

The other trawlers face technical constraints, such as capacity, in retaining additional by-catch. 'Collecting' is apparently a viable option for local fishermen, with no apparent cost to the 'donor' trawler — though trawling companies may, in such cases, fear illegal transfer of the higher value shrimp.

5.2 Recommendations

(a) *Transfer of by-catch to local collector vessels:* A techno-economic study is required to determine the feasibility of increasing by-catch 'collection', and to identify possible problems at an early stage. The objective should be to improve on existing informal transfer operations, ensuring transfer of a larger proportion of the discarded by-catch to artisanal fisherfolk. Where possible, by-catch would be used as food, with options for use in feed explored only where quality and price render food use unviable.

This study would have two main components

(i) the transfer technology (floating net bags have been suggested, thus eliminating the need for manoeuvring alongside the double-rig trawler), and

(ii) the distribution/marketing of the fish.

The study should be undertaken in an area where collection already occurs and during the appropriate season. It should take account of the existing market systems, and identify any constraints to the distribution of a greater volume of fish. Care should be taken to assess the value of the fish *(i.e.* with attention to volume, species, size and quality), and whether, or how, 'donor' trawlers would find this activity attractive. The results of this could form the basis for a project proposal.

Prior to the study, there should be some desk research on 'collection' experiences in Bangladesh and Mozambiqu&0 (and possibly elsewhere). A preliminary survey in India should determine the extent of the current practice and describe as accurately as possible the by-catch landed **in** this way.

(b) *Increased retention of by-catch by 20 m trawlers:* A more detailed study of low value by-catch retained by 20 m trawlers, and existing patterns of processing and marketing, is also recommended. A thorough appraisal of existing supply and use in semi-traditional marketing systems (for wet fish, dried fish, and dried fish meal) would permit an assessment of qualitative and quantitative losses, and the potential to reduce these. If these could be reduced at low

cost, it might be possible to buy raw material (by-catch) at a price that would provide an incentive to trawlers to land more by- catch, but still permit processors to produce a product at a price both attractive to consumers and remunerative to processors. However, the overall effect on discards of by-catch is likely to be small: for example, if all 20 m trawlers retained an additional 2 t of by-catch per voyage, annual discards would be reduced only by approximately 1,000 t.

(c) THE EFFECT OF TRAWLING ON DEMERSAL FISH POPULATIONS: Estimates of by-catch volume have provoked debate on the possible effect this harvest has on key demersal fish populations. The by-catch (landed and unlanded) comprises a wide variety of fish species. Though some information on species and size distribution is available, it is insufficient to permit an accurate assessment of the population parameters. This is particularly true of groups such as sciaenids and perches which are incidentally caught during shrimp trawling in a largely unidentified mixture of large and small species. It is therefore recommended that a sampling programme be initiated to collect data on population parameters for selected species occurring regularly in the by-catch. These data may then be used to assess the effect of the shrimp fishery on key demersal fish populations. Such a study could be carried out in conjunction with on-going efforts to ensure optimum use of by-catch.

(d) SUPPLEMENTARY RECOMMENDATIONS: Other options that might have a marginal effect on the quantity of by-catch landed merit some investigation. These would include

- Financial analysis of the use of cold storage for fish at Vishakhapatnam to reduce delays in port on account of trawlers trying to sell frozen fish. This should take into consideration subsequent distribution also.
- Investigation of the use of mechanical sorters on trawlers to reduce labour requirements at peak periods.
- Trials using a meat/bone separator on board a trawler.
- Permitting stern trawlers from other states to land their catch in West Bengal or Orissa.
- Restructuring the industry in favour of smaller trawlers based nearer the fishing grounds (noting that the current level of fishing effort has already resulted in a decline in catch per unit of effort, rendering investment in industrial trawlers uneconomic)

(e) Finally, it is recommended that shrimp trawler operators be required to submit verifiable records of shrimp volumes landed.

PUBLICATIONS OF THE BAY OF BENGAL PROGRAMME (BOBP)

The BOBP brings out the following types of publications

Reports (BOBP/REP/...) which describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and subprojects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/...) which are progress reports that discuss the findings of ongoing BOBP work.

Manuals and Guides (BOBP/MAG/...) which are instructional documents for specific audiences.

Information Documents (BOBP/INF/...) which are bibliographies and descriptive documents on the fisheries of member-countries **in the region.**

Newsletters *(Bay of Bengal News)* which are issued quarterly and which contain illustrated articles and features in non-**technical style on BOBP work and related subjects.**

Other publications which include books and other miscellaneous reports.

A list of publications in **print follows. A complete list of publications** is available on request.

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21. *Income-Earning Activities for Women from Fishing Communities in Sri Lanka.* E. Drewes. (Madras, September 1985.)
22. *Report of the Ninth Meeting of the Advisory Committee.* Bangkok, Thailand, February 25-26, *1985.* (Madras, May 1985.)
23. *Summary Report of BOBP Fishing Trials and Demersal Resources Studies in Sri Lanka.* (Madras, March 1986.)
24. *Fisherwomen's Activities in Bangladesh . A Participatory Approach to Development.* **P. Natpracha. (Madras, May 1986.)**
25. *A ttempts to Stimulate Development A ctivities in Fishing Communities in Adirampattinam, India.* **P. Natpracha,** V. 1. C. Pietersz. (Madras, May 1986.)
26. *Report of the Tenth Meeting of the Advisory Committee.* Male, Maldives. 17-18 February 1986. (Madras, April 1986.)
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28. *Small-scale Aquaculture Development Project in South Thailand: Results and impact.* E. Drewes. (Madras, May 1986.)
29. *Towards Shared Learning: An Approach to Non-formal Adult Education for Marine Fisherfolk of Tamil Nadu, India* L. S. Saraswathi and P. Natpracha. (Madras, July 1986.)
30. *Summary Report of Fishing Trials with Large-mesh Dr,ftnets in Bangladesh.* (Madras, May 1986.)
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34. *The Coastal Set Bagnet Fishery of Bangladesh — Fishing Trials and Investigations.* S. E. Akerman. (Madras, November 1986.)
35. *Brackish water Shrimp Culture Demonstration in Bangladesh.* **M. Karim. (Madras, December 1986.)**
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40. *Tuna in the Andarnan Sea.* (Colombo, December 1987.)
41. *Studies of the Tuna Resource in the EEZs of Sri Lanka and Maldives.* (Colombo, May 1988.)
42. *Report of the Twelfth Meeting of the Advisory Committee.* Bhubaneswar, India, 12-15 January 1988. (Madras, April 1988.)
43. *Report of the Thirteenth Meeting of the Advisory Committee.* Penang, Malaysia, 26-28 January, 1989. (Madras, March 1989.)
44. *Report of the Fourteenth Meeting of the Advisory Com,niitee.* Medan, Indonesia, 22-25 January, 1990. (Madras, April l990.)
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46. *Exploratory Fishing for Large Pelagic Species in the Maldives.* **R.C. Anderson and A.** Waheed. (Madras, December 1990.)

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47. ***Exploratory Fishing for Large Pelagic*** *Species* ***in Sri Lanka.*** **R. Maldeniya** & S.L. Suraweera. (Madras, April 1991.)

48. ***Report of the Fifteenth Meeting of the Advisory Committee.*** Colombo, Sri Lanka, 28-30 January, 1991. (Madras, April 1991.)

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27. ***Reducing the Fuel Costs of Small Fishing Boats.*** O. Gulbrandsen. (Madras, July 1986.)

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