FI:DP/BGD/72/016
Field Document 3
September 1982

BANGLADESH

THE CURRENT STATUS OF OFF SHORE MARINE FISH STOCKS IN BANGLADESH WATERS WITH SPECIAL REFERENCE TO PENAEID SHRIMP STOCKS

A repprt prepared for the
Fisheries Advisory Service, Planning, Processing and Appraisal Project

by

J.W. Penn
Fishery Consultant

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1982

W/P9708

This report is one of a series of reports prepared during the course of the UNDP/FAO project identified on the title page. The conclusions and recommendations given in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the United Nations or the Food and Agriculture Organization of the United Nations concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

TABLE OF CONTENTS

	Page
INTRODUCTION AND TERMS OF REFERENCE	1
HISTORY OF COMMERCIAL OFFSHORE TRAWLING	3
PREVIOUS ASSESSMENT OF BANGLADESH MARINE STOCKS	4
a. West (1973): Fishery Resources of the Upper Bay of Bengal IOFC/DEV/73/28	4
b. Rashid(MS): Mitsui-Taiyo Shrimp Survey 1976-77 by M.V. SANTAMONICA and M.V. ORION - 8 in the Marine Waters of Bangladesh	6
c. Saetre (1981): Surveys on the Marine Fish Resources of Bangladesh: November/December, 1979 and May 1980	7
OFFSHORE MARINE FISHERY DATA	9
a. BFDC Production Statistics	9
b. Bangladesh Shrimp Trawlers	10
c. Kuwait Joint Venture Shrimp Trawlers	11
d. Thai Joint Venture Trawlers	11
e. RV ANUSANDHANI	12
CURRENT ASSESSMENT OF MARINE STOCKS	12
a. Offshore Marine Demersal Fish	12
b. Offshore Marine Shrimp Stocks	18
GENERAL DISCUSSION	24
RECOMMENDATIONS	27
SUMMARY	29
ACKNOWLEDGEMENTS	30
LITERATURE CITED	32

LIST OF TABLES

1. Approximate landings and catches of marine demersal fish in Bangladesh waters for 1978/79 and 1979/80	35
2. Offshore trawl catches of marine shrimp by Bangladesh trawlers and "guesstimates" of the production by Kuwait and Thailand joint venture trawlers for 1978/79, 1979/80 and 1980/81	36

LIST OF FIGURES

1(a) Marine Fisheries Production Proforma	37
1(b) The reverse side of the Marine Fisheries Production Proforma showing the major subdivisions of the offshore trawl grounds used in the collection and analysis of the catch and effort data	38
2. Total catches of shrimp and landings of fish by month for Bangladesh shrimp trawlers in the years 1978/79, 1979/80 and 1980/81	39
3. Monthly catches of tiger, white and brown shrimp by Bangladesh shrimp trawlers in 1979/80 and 1980/81 (Data for individual species was not available for 1978/79)	40

		Page
4.	Catch rate for shrimp and fish landings per day by Bangladesh shrimp trawlers in the years 1978/79, 1979/80 and 1980/81	41
5.	Catch rates (kg/day) of tiger, white and brown shrimp by Bangladesh shrimp trawlers in the years 1979/80 and 1980/81	42
6.	Records of days fished in each of the four major sections of the trawl ground from selected Thai trawler logbooks for the period January to October 1980	43
7.	Catch rates of shrimp and landings per day of small fish and large fish	44
8.	Catch (t) plotted against days of fishing by BFDC trawlers in the years 1972/3, 1973/4, 1974/5, 1978/9 and 1979/80	45
9.	Approximate boundaries for the productive marine demersal fish and shrimp trawl grounds in Bangladesh waters	46
10.	Catch in number per hour (histogram) of the four major marine shrimp species and hours of trawling	47

THE CURRENT STATUS OF OFF SHORE MARINE FISH STOCKS IN BANGLADESH WATERS WITH SPECIAL REFERENCE TO PENAEID SHRIMP STOCKS

BY

J.W. PENN, FISHERY CONSULTANT TO BGD/72/016

INTRODUCTION AND TERMS OF REFERENCE

The extensive fresh and brackish water fisheries of Bangladesh supply a major proportion of the animal protein consumed in the country but are considered to be fully exploited and possibly on the verge of decline (Mohiuddin *et al*, 1980). In contrast the marine off shore fish stocks, at least up to 1979, appeared to be only lightly exploited, and thus represented a potential source of food which should be developed.

The existence of considerable off shore marine fish and crustacean stocks has been indicated by a series of surveys carried out by both National and International Agencies (Mohiuddin *et al*, 1980) and one Bangladesh/Japanese (private) feasibility fishing experiment (Rashid MS). From these surveys, various standing stock and potential yield estimates have been made, West (1973), Karim (1978), Saetre (1981) and Rashid (MS). Standing stocks as high as 373,000 tons of demersal fish and 9,000 tons of shrimp (West,1973), and 200,000 tons of pelagic fish (Karim,1978) have been suggested. However, annual production of marine fish and crustaceans has been estimated to be only 99,000 tons in 1967/68 (Anon, 1972a) and 85,000 tons (Anon, 1973). These catches are largely taken by the in shore small scale fishery, and are composed mostly of estuarine species such as Hilsa, rather than marine species. Landings from off shore marine stocks have been suggested to be about 5% of the marine production.

Although data suggesting the existence of significant but largely unexploited off shore marine stocks had been available since the late 1960's, the only off shore demersal trawl fishing up to 1976 was by the Bangladesh Fisheries Development Corporation (BFDC) trawlers. The first major commitment of private funds to exploitation of these off shore resources occured in 1976 (Rashid, MS) when test fishing for marine shrimps was carried out. The results of this feasibility study encouraged the entry of four privately owned shrimp trawlers which began fishing in 1978. To generate more rapid development of both the marine shrimp and fish resources, the Government of Bangladesh entered into joint venture agreements with Kuwait and Thailand for 1980, (Antony Raja, 1980). The resulting sudden influx of large number of vessels under these agreements, not only created practical difficulties in terms of policing their activities, but also reportedly caused decline in catches inconsistant with the previously estimated potential yields of fish and shrimp. As a consequence of these problems, the Government of Bangladesh terminated the joint venture agreements (Oct. 1980) and requested through FAO, that a reassessment of the potential for marine fish should be made. For this purpose, a consultant was engaged for 3 months (1 month Feb/Mar. 1981, 2 months Oct/Nov, 1981) by FAO/UNDP Fishery Advisory Services Project, BGD/72/016 under the following terms of reference:

> "To reassess off shore marine fisheries potential and advise on optimum levels of exploitation with special reference to marine shrimp stocks, so as to avoid overcapitalization in vessels and shore facilities and depletion of the stocks".

This study, in addition to reviewing previous stock estimates was to assess the current stocks on the basis of catch records from recent commercial trawling operations including the discontinued Thai-Bangladesh joint venture vessels.

Secondary objectives of the consultancy were to instigate a practical system of collection and storage of fishing data from the off shore

trawler fleet including BFDC vessels and to provide basic training for three assigned Bangladesh national counterpart scientists in methods of:

a. Fisheries data collection, storage, processing and reporting
b. Simple stock assessment techniques suitable for providing practical management advice for Government.

HISTORY OF COMMERCIAL OFFSHORE TRAWLING

Following the extensive pre-investment survey under project FAO/UN/PAK/522 (Anon, 1972b) commercial offshore trawling was started by the Bangladesh Fisheries Development Corporation. During the 1972/73 year, 11 vessels were available to fish, however only 7 were fully operational. This fleet has continued to operate to the present time (October 1981) although in recent years the number of fully operational trawlers was decreased. At present four vessels are in service and a fifth is being recommissioned. Specifications for the BFDC vessels, both operating and unservicable, have been given recently by Mohiuddin *et al* (1980).

In addition to the BFDC fleet, a small number of privately owned Bangladesh registered trawlers began operating after the Mitsui-Taiyo test fishing survey (Rashid, MS) of 1976 and 1977, showed commercial catches of shrimps were available. Four shrimp trawlers began fishing in 1978, and now a fleet of 18 vessels exists, of which 10 to 15 are operational. Details of the sizes of these vessels and their nets are given in the following table which also include similar data for the presently operational BFDC vessels:

Vessel type	No. of vessels	Average length	Range of vessel lengths	Average net size	Range of net sizes
Shrimp trawlers	15	27.07m	23-28.4m	25.8m (x 2)	16-35m (x 2)
Fish trawlers	5	25.2m	18-30m	42.8m	39.2-45.2m

In 1980, two additional groups of trawlers from Kuwait and Thailand began operating in Bangladesh waters under joint venture agreements. The small Kuwait fleet consisted of five identical shrimp trawlers, 24 metres in length, which used conventional twin shrimp trawls of 21 metres headrope length. The Thailand fleet of 113 trawlers were reported to be smaller general purpose single trawl vessels. These vessels were generally of wooden construction, about 20 metres length and used nets of 18 to 30 metres in headrope length.

PREVIOUS ASSESSMENT OF BANGLADESH MARINE STOCKS

A number of estimates of standing stock size and potential yields for Bangladesh waters have been made in the past. These estimates, particularly those of West (1973), were made at a time when information on the hydrology of the area was sparse and the responses of tropical fish stocks to fishing pressure were poorly known. For this reason, a review of these previous estimates in the light of new information, has been carried out here.

a. West (1973): Fishery Resources of the Upper Bay of Bengal-IOFC/DEV/73/28.

This desk study utilising the survey and test fishing data from the Research Vessels SAGAR SANDHANI and MEEN SANDHANI, (Anon 1969, 1972b) estimated the standing stock of demersal fish on the Bangladesh continental shelf, to be approximately 264,000 to 373,000 tons. From this, West (1973) suggested that an annual yield of 175,000 tons of demersal fish could be expected. In addition, he suggested that a yield of 9,000 tons of marine shrimp was available, and that pelagic fish resources although not surveyed, were promising. West (1973) did note however that "clearly further studies are needed in the Bay of Bengal to assess the size of stocks more precisely" and "that a cautious approach to development be adopted until the stocks were better known".

More recent information on the distribution of fish in Bangladesh waters from the R.V. FRIDTJOF NANSEN surveys (Saetre, 1981) and a short survey of the shrimp ground by the author aboard R.V. ANUSANDHANI suggests that some of the assumptions underlying West's estimates may not now be valid. For example, the assumption of uniform density of demersal fish and shrimps over the entire continental shelf has proven to be incorrect. Demersal fish catch rates have been shown to vary significantly with depth, resulting in particularly low catch rates at more than 100m depth (Saetre, 1981). Secondly, the inshore zone is heavily influenced by the fresh water and contains mostly estuarine, rather than marine species. Since this zone is largely occupied by other than marine stocks and the waters deeper than 100m do not provide catch rates as high as in the surveyed area, the total ground occupied by the stock must be reduced accordingly. For this reason it is suggested that the standing stock estimates given by West (1973) may have been over-estimated by a factor of about 2.4 (the ratio of area surveyed to the total shelf area to 200m depth).

A second assumption involved in West's estimates, has also been challenged by Saetre (1981), who suggests that the width swept by the net, i.e. the distance between the swivels, used by West (1973) was incorrect, and that the distance between the wings of the net should have been used. Saetre (1981) suggests that this makes West's stock sizes under estimates by a factor of 1.5 or 2. However, the use of the distance between the wings of the net ignores the herding effect of the otter boards and bridles which is a design feature of fish trawls and should be considered when calculating area swept (Saville, 1977). This effect would be expected to cause the opposite bias to that suggested by Saetre (1981).

A further assumption made in West's swept area calculation was that effort was uniformly distributed to all grid squares surveyed. However, the purpose of the survey upon which the estimates was based was to prove up commercial trawl grounds (Anon, 1969) and as a consequence, much of the fishing, which produced the average catchrates used

by West, was semi-commercial and appears to have been concentrated in areas of high abundance, e.g., the South Patches Ground. Because this bias was not taken into account, the values for stock size produced were again considerably overestimated.

These problems, caused by a breakdown of the basic assumption underlying the calculation methods, together with a number of errors in relation to the use of statute/nautical miles suggests that the estimates of standing stock and potential yields given by West (1973) are gross overestimates, and should now be disregarded.

b. Rashid (MS) - Mitsui-Taiyo Shrimp Survey 1976-77 by M.V. SANTAMONICA and M.V. ORION - 8 in the Marine Waters of Bangladesh.

The catch and effort data from this test fishing survey has been used to make a series of estimates of the standing stock of marine penaeid shrimp in Bangladesh waters. The first estimate of approximately 4400 tons was calculated by a conventional swept area technique and based on average annual catchrates for each grid square (10 minutes latitude x 10 minutes longitude) fished during the 12 month survey. However, in recognition that this method involves a number of assumptions (particularly in relation to the random distribution of effort) which are unlikely to be fully valid in a test fishing survey, the author has also calculated a second set of standing stock estimates using only the catchrates and the area fished in each month. By this method, some of the bias caused by the non-random distribution of effort interacting with intrayear changes in distribution and abundance, typical of these short lived species, may have been reduced. From this set of monthly estimates, Rashid suggests that the standing stock varied considerably during the year, (as did the area surveyed) with maximum stock size occuring in March 1977 at 3939 tons over an area of 21 grid squares. Rashid further suggested (using the method of Gulland, 1971) that a stock of this size might provide a yield of between 2000 and 4000 tons annually, depending on the mortality rate and net efficiency

Although the estimates given are unlikely to be very precise they are probably under estimates, because of the assumptions that the entire stock is contained within the area surveyed and that the net used was 100% efficient. However, an opposite bias, due to the effect of concentration of effort in the areas of high catchrate would appear to offset this tendency to some extent.

c. Sætre (1981): Surveys on the Marine Fish Resources of Bangladesh: November/December, 1979 and May 1980:

These two surveys provide a valuable description of the hydrology of the Bangladesh shelf area, both at the end of the monsoon when the maximum river outflow occurs, and in late winter when river outflow is at a minimum. In addition, trawl catches have been used to make estimates of the standing stock of demersal fish. The standing stock of pelagic fish has also been estimated from acoustic data.

The hydrological data suggests that the river outflow from the Ganges delta may be influencing the distribution of demersal fish (from trawl data) and pelagic fish (from acoustic records). When the river outflow was high in November-December 1979, the major concentrations of demersal fish were found further offshore in depths of 50-99 metres compared with 10 to 24m in May, when the fresh water effect on inshore salinity was less. The movements of pelagic fish as shown by the acoustic data followed a similar onshore/offshore movement. The second significant feature of the hydrological regime described, was the apparently variable movement of low oxygen water on and off the shelf which appears to be related to the very low catchrates of demersal fish in depths over 100m. The demersal trawl data was also useful in showing that the catches contained a high proportion of pelagic species. During November/December, 1979, pelagic species ranged from 18 to 41% of the demersal catch, while in May 1980, they varied from 2% to 92% depending on depth zone. This feature of

the bottom trawl catches,which was taken into account in estimating stock sizes, however highlights a further problem in the West (1973) demersal standing stock estimates which were based on gross catchrates, but which undoubtly also contained a significant percentage of pelagic species.

From the depth stratified average catchrates, Saetre (1981) has estimated the standing stock of demersal fish in depths from 10 to 150m to be 160,000 tonnes and 92,000 tonnes in November/December 1979 and May 1980 respectively. It is further suggested that if the 0-9m area contains the same catchrate as that in the 10-24m zone, then the total stock would be approximately 250,000-245,000 tonnes, from which a yield of 100,000 tonnes might be expected. This suggestion however, again raises the issue of whether the 0-9 metre zone, which is more estuarine (brackish) than marine, should be included as a marine habitat, when the stocks in the two areas are apparently quite different. If it is accepted that the 0-9m area should not be included, then Saetre's (1981) standing stock estimate of 160,000 tonnes (from before the Thai fishing occured) could be expected to allow an annual yield of about 40,000 tonnes of demersal marine fish, separate from the existing "marine" catch. This however assumes that the bulk of the present "marine" catch taken by the small scale fishery is from an independent (estuarine) stock.

A further point for consideration before accepting these standing stock and potential yield estimates, is that the variability in the basic catchrate data was quite high due to the low number of hauls undertaken in each depth zone. This variability indicates that the confidence limits for the stock estimates, if calculated, would be very wide.

Finally, the pelagic fish standing stock estimates of 60,000 tonnes and 120,000 tonnes given in the report are useful in that they represent the first estimates of the pelagic stocks in Bangladesh

waters based on scientific observation. However, Saetre's inclusion of the inshore 0-9m zone as an area containing marine pelagic stocks contributing to the potential yield, raises the same issues as previously discussed for the demersal stock. Further work is therefore required to determine the relationship between the species groups occuring in the two zones, before the estimates given by Saetre (1981) are accepted.

OFFSHORE MARINE FISHERY DATA:

Since there has not previously been a regular collection of fishery data in Bangladesh, the available estimates of production from freshwater, estuarine and marine stocks are largely conjectural. However, some data on production from the offshore marine sector, collected for other than research purposes is available. In addition, the newly set up Marine Fisheries data collection system for offshore trawlers has provided useful catch and effort statistics. (Note: Throughout this report the term "catch" has been used to describe the quantity of fish taken by the trawl and therefore removed from the population. The term "landings" refers to that part of the catch retained aboard the vessel for later sale).

a. <u>BFDC Production Statistics</u>

Annual production for the BFDC trawlers for the period 1972/73 to 1979/80 has been presented and analysed by Mohiuddin *et al* (1980). In addition, internal BFDC reports giving detailed annual catch and effort data for individual BFDC trawlers for the years 1972/73, 1974/75, 1978/79 and 1979/80 has been made available to the Author. Since March 1981, detailed catch and effort data has been collected from the operational BFDC trawlers using the Marine Fisheries Production Proforma (Figure 1a and 1b)

b. Bangladesh Shrimp Trawlers

Landings and trawling effort statistics for these vessels have been collected via Marine Fisheries Production Proforma since March 1981. In addition, the Fishing Companies involved voluntarily supplied back data for these vessels, which in some cases extends back to 1978, when the commercial marine shrimp fishery began. This landings per trip data from the proformas, has been standardised and summarised using the following methods:

(i) Where a trip extended into more than one month, the landed weights have been assigned to individual months using the ratio of days fished in each month.

(ii) All shrimp catches have been converted to head on (live) weights, using a standard recovery rate of 0.6 (i.e., total weight has been assumed to be 60% of whole or live weight).

(iii) The effort data (days at sea) for each vessel has been standardised on the basis of trawl headrope length, to be equivalent to that by a trawler using 2 x 25m headrope nets, i.e., the days at sea have been multiplied by the vessel's total trawl headrope length and divided by 50 (2 x 25).

Following this basic processing, the data for all vessels has been combined into monthly and then annual (July to June years) summaries. This summarised data is presented in the following figures:

Figure 2: Total catch of shrimp and landings of fish by month for Bangladesh shrimp trawlers in the years 1978/79, 1979/80 and 1980/81.

Figure 3: Monthly catches of tiger, white and brown shrimp by Bangladesh shrimp trawlers in 1979/80 and 1980/81.

Figure 4: Catch rates for shrimp, and fish landings per day by Bangladesh shrimp trawlers in the years 1978/79, 1979/80 and 1980/81.

Figure 5: Catch rates for tiger, white and brown shrimp by Bangladesh shrimp trawlers in 1979/80 and 1980/81.

c. Kuwait Joint Venture Shrimp Trawlers

Although no catch data was available for this group of five vessels, their similarity in size and mode of operation to the Bangladesh shrimp trawlers suggests that for the purposes of this report they may be included under that category. During the period that they were reputed to have operated, January to October 1980, the average strength of the Bangladesh fleet was only four vessels. If it is assumed that the two groups had similar fishing abilities, a very rough correction to the catch statistics can be made by adjusting upward the Bangladesh trawler total by 2.25 to cover the Kuwait vessels.

d. Thai joint venture trawlers

Under the terms of the Thai-Bangladesh joint venture fishing agreement, Thai trawlers were to submit detailed (trawl by trawl) research log book records to the Bangladesh Directorate of Fisheries. The data supplied has been obtained from the Directorate for use in this report. Although all vessels were required to submit log book records, the maximum number of vessels submitting records in any month was 21, out of about 113 vessels (Youssouf Ali and Mohsin Ali, 1980) that were registered to operate. However, a reasonable proportion of those vessels who submitted records, did in fact appear to provide reasonably accurate data.

To utilize this data, only those records which were competently filled out were used to make monthly summaries of catch per day and days fished. For simplicity, the data for each trip was assigned to the month in which most of the effort was applied. This summarised data has been presented graphically in figures 6 and 7.

Figure 6: Records of days fished in each of the four major sections of the trawl ground from selected Thai trawler logbooks.

Figure 7: Catch rates of shrimp and landings per day of small fish and large fish (assuming 1 piece = 1 kg) by Thai trawlers from January to October 1980, based on selected Thai trawler logbook records.

e. R.V. ANUSANDHANI

Data from a short trial cruise (13 - 18.10.81) by this research vessel with the author aboard is being prepared for publication by the Marine Fisheries Research Staff - Bangladesh Directorate of Fisheries. Some of the data collected and observations of shrimp catches during the cruise have been used in this report.

CURRENT ASSESSMENT OF MARINE STOCKS:

a. Offshore Marine Demersal Fish

The offshore demersal fish stocks have been exploited by BFDC trawlers since 1972, by Bangladesh shrimp trawlers since 1978 and during 1980 by the Kuwait and Thai joint venture fleet.

(i) BFDC Production: The annual catch by BFDC trawlers has ranged from 4,766 tonnes in 1972/73 to 1,100 tonnes in 1978/79, and is currently (1979/80) about 1,499 tonnes (Mohiuddin *et al*, 1980). Mohiuddin *et al* (1980) have

noted that the total catch has shown a decline since 1972/73 despite an increase in the number of trawlers in the BFDC fleet. They have also noted that the catch/hour for various size categories of trawlers has also shown a decline since 1972/73. However, examination of annual catch and fishing effort data for individual vessels suggests that those vessels which were fully operational in each year, i.e. fished for at least 100 day/year, did not show any decline in catch per day from one year to the next. This indication that the stock had not declined, is also supported by the relationship between annual catch and total days fished by the fleet (figure 8) for the five years for which detailed data was available. This graph suggests a near linear relationship between catch and effort, which indicates that the BFDC fleet up to 1979/80 had not a significant effect on the stocks.

(ii) Bangladesh shrimp trawlers production: The total fish landings by these vessels, shown by month in figure 2, have been 147, 61 and 258 tonnes for the years 1978/79, 1979/80 and 1980/81 respectively. However, these landings do not represent the entire catch by these trawlers, which only retain a small proportion of their fish catch, because of restricted storage space. This is also reflected in Figure 4, which shows that the weight of fish landed per day of fishing is generally inversely related to the catch of shrimp, which implies that the rate of discarding will vary throughout the year. As a consequence of this variability, the fish landings have little direct value for stock assessment purposes.

As an alternative method of estimating the fish catch, a rough index of the total fish caught can be made directly using the shrimp catch and an estimate of the ratio of shrimp to fish in catches on the shrimp grounds. Data

from shrimp trawl catches by the R.V. ANUSANDHANI on the commercial shrimp grounds (October 1981) indicated that at that time, a figure of 6 : 1 (fish : shrimp) would be reasonable. If such a ratio held over the entire year, the fish by-catch by Bangladesh shrimp trawlers would have been in the order of 1400, 1300 and 4000 tonnes for the 1978/79, 1979/80, 1980/81 years respectively. In addition to the 1979/80 figure, the fish catch by the similar style Kuwait shrimp trawlers (as discussed previously) could be added. This would suggest a total catch for the two fleets in the order of 3000 tonnes for the 1979/80 year and a slight increase on the approximately 4000 tonnes suggested for 1980/81.

(iii) Thai Joint Venture Trawlers Production: The data from this fleet of relatively small stern trawlers, although unreliable in terms of total catch, does provide (under the previously stated assumptions) some useful data on patterns of fishing (Figure 6) and catchrates over time (Figure 7). Figure 6 indicates firstly that effort peaked in February 1980, then declined with the onset of the monsoon. Secondly and more interestingly, Figure 6 shows the fleet began fishing in the areas III and IV (South Patches to St. Martins), then as the year progressed, moved to Area II (Middle ground) and finally spent the latter months in Area I (Swatch of No Ground). It would appear that the fleet was forced to move further west as the season progressed, probably to maintain their catches. Had reasonable catchrates still been available in Areas III and IV, which were closer to their home port and facilities, there would not have been any reason for the change of grounds. The logbook recorded catch rate data also tends to support this view. For example, the catch of large fish (packed individually - figure 7) showed a steady decline throughout the period of fishing. In contrast, the recorded catch of small fish showed a marked increase up to May, then another increase from July to October when the records cease. Interpretation of this

data on small fish landings is however complicated by the problem of variable discarding. Since the Thai fleet was reported at times to be discarding significant quantities of small fish which are of low value, the retention of increasing quantities suggests, in fact, that the catch or expectation of catching more valuable products, such as shrimp or large fish, was decreasing. Figure 7 shows the tendency for declining catchrates of shrimp except for the month of May, when the recorded catchrate showed a rapid increase, probably due to an influx of new recruits relating to the onset of the monsoon. However, the true magnitude of the decline in catchrates will have been largely masked by the movement of the fleet to new grounds, as shown in Figure 6.

Since the fishing activity of the Thai fleet appears to have been sufficient to cause a significant decline in the demersal stocks, a knowledge of the level of catch taken to cause this decline would provide a useful indication of potential yield. For this purpose the catch recorded on the log sheets of approximately 1000 tonnes of fish and 350 tonnes of shrimps has been weighted up to approximate the total catch by using a ratio 113 : 21, i.e. the ratio between the maximum number of vessels registered to fish and the maximum number of vessels filling in log records in any month. This assumes that the proportion of vessels completing log records was constant, and therefore a change in the number of these records reflected a change in the overall level of effort for that month. This procedure suggested that a very approximate total of 5,300 tonnes of fish and 1,900 tonnes of shrimp may have been landed, but not necessarily in Bangladesh. However, for a number of reasons, these estimates could be regarded as minimum values. To place an upper limit on the production by the Thai vessels, a theoretical maximum for their landings has been estimated from the reasonably reliable catch per day data shown in

Figure 7, i.e. an approximate average daily catch rate of 200 kg of shrimp and 500 kg of fish has been assumed and multiplied up to represent the catch by 100 trawlers operating for 25 days per month for an 8 month season. This theoretical estimate of approximately 10,000 tonnes of fish and 4,000 tonnes of shrimp can be regarded as an upper limit for Thai landings. However, the estimates of total fish landed do not allow for discarding, which could be expected to perhaps double the values suggested.

Finally, because the fishing period extended over two financial years, all of the catch needed to be apportioned between the 1979/80 and 1980/81 years. For this purpose, the ratio of the log book effort in days fished in each year of 1644 days (1979/80) and 404 days (1980/81) has been used as a rough approximation.

(iv) Discussion: Prior to 1978/79 the production from the offshore marine demersal fish stocks was by BFDC trawlers exclusively (Mohiuddin *et al*, 1980). In 1978/79 four private Bangladesh shrimp trawlers also began fishing these stocks, and in 1979/80 there was a major increase in exploitation with the arrival of the Thai and Kuwait joint venture trawlers. Approximate values for the landings and catch in these two years are presented in Table 1. Since the 1980/81 BFDC data was not available at time of writing, the total 1980/81 catch cannot be estimated, however, the total including some Thai prodution is expected to be less than 6,000 tonnes, of which perhaps half may have been landed.

Although the suggested total catch for 1979/80 was relatively low in comparison with previously suggested sustainable yields, anecdotal evidence from Bangladesh trawler operators, suggests that the large increase in catch during this period resulted in a significant decline in the standing stock of both fish and shrimp. This subjective judgement

has been supported indirectly for fish by the standing stock estimates of Saetre (1981) from the two surveys of the R.V. FRIDTJOF NANSEN. These surveys which were just prior to the arrival of the Thai fleet (Nov-Dec, 1979) and again after 4 months of Thai trawler operations (May 1980), suggested that the demersal standing stock has decreased from 160,000 tonnes to 92,000 tonnes. Although the relationship between these estimates and absolute abundance relies on a number of untested assumptions, their use as indices of relative abundance appears quite reasonable. On this basis it is suggested that the catch during 1979/80 may have resulted in a reduction of the standing stock by about 50% over the full period of the joint venture operations.

A second method of assessing the likelihood of this suggested reduction in standing stock, is to consider the area swept by the fleet in relation to the total ground occupied by the stock. For this purpose, the approximate boundaries for the marine trawl fishery grounds have been drawn, based on information from both interviews with trawler skippers experienced in fishing Bangladesh offshore waters and previous survey data (Anon., 1972b; Rashid, MS; Saetre, 1981). This information suggests that an approximate inshore border for the demersal marine stock is the interface between the highly turbid inshore water influenced by the river outflow and the offshore clear marine waters. This boundary apparently varies between about 15 and 25m depth depending on time of year and location along the coast. The outer limit to the demersal stock appears to be controlled largely by the variable presence of low oxygen cold water which moves up onto the shelf to depths between 80 and 100m depending on time of the year (Anon, 1972b; Saetre, 1981). To indicate the approximate borders of the offshore trawl grounds, the area contained between the 15 and 80m depth contours which can be trawled has been shown in Figure 9. This area has been estimated graphically to be about 4000 sq nautical miles, or 13,720 square km.

To relate this area of the trawl ground (4,000 square miles) to the area swept by the Thai joint venture fleet, an estimate of the

ground swept per boat per day in required. For this purpose, an average net size of 25m headrope length (sweeping 15.5m width) operating at 3 knots for 15 hours per day has been assumed for the Thai fleet, which suggests that each vessel would sweep 0.36 square nautical miles (1.25 square km) per day. The reported fleet of approximately 100 vessels could therefore have swept the entire area once every 114 days. However, because of the reported tendency of the stock to aggregate within narrower depth ranges, depending on time of year (Anon, 1972b), it appears likely that the fleet operating in 1979/80 would have covered the most productive grounds a number of times during that year. This information is taken as additional support for the suggestion that the fishing during 1979/80 caused a significant reduction in the demersal marine stocks.

To use any of these "guestimates" to suggest future sustainable yields would be clearly unrealistic, however, the data with its multitude of imperfections does indicate that the fin fish stocks in question are not as extensive as previously thought.

b. Offshore Marine Shrimp Stocks:

Prior to the discovery of offshore stocks of penaeid shrimps in 1976/77, the fresh/brackish carid shrimps, such as *Macrobrackium rosenbergi* were the major species exploited in Bangladesh waters. Exploitation of penaeid shrimps was limited to the capture of migrating juveniles by the inshore traditional stake net fishery. In the absence of any reliable data on the magnitude of the inshore penaeid catch, it has had to be assumed that it is insufficient to alter the level of recruitment to the offshore adult stocks under discussion.

The common species taken by the present offshore trawler fleet are:

Penaeus monodon (tiger shrimp)
Penaeus semisulcatus (tiger shrimp)
Penaeus indicus (white or pink shrimp)

Metapenaeus monoceros (brown shrimp)
Metapenaeus affinis (brown shrimp)
Parapenaeopsis sculptilis (brown shrimp)

In addition to these large species, there are a number of small penaeid and carid shrimps included in the catch of the offshore trawler fleet.

i. Biology of major penaeid shrimp species:

The life cycle of most Penaeid shrimp involves a period of growth in an estuarine environment (post larval to sub-adult stages) followed by an offshore migration to join the adult stock, at about the time of onset of sexual maturity. The adult spawning stocks are almost exclusively found in marine waters offshore. Apart from these general characteristics of the penaeid life cycle, there are some specific features of the ecology of the dominant Bangladesh species which need to be considered in assessing the stocks.

Firstly, all of the large species exploited in Bangladesh waters tend to utilise rivers rather than coastal areas for their nursery areas (Kibria,1980) and such species usually show a high degree of variability in annual recruitment. Secondly, the three large Penaeus species involved, typically inhabit highly turbid waters which appears to be related to their poor burrowing abilities. This is particularly true of *P. indicus*, which rarely burrows, is caught most frequently during daylight and sometimes exhibits schooling behaviour, thought to be related to level of turbidity. Thirdly, fisheries based on the *P. indicus* and *P. semisulcatus* have a variable record for survival at high levels of exploitation (Penn, 1981).

As a result of the need to remain on turbid areas to survive, but also to move into marine waters to spawn, the distribution of these species in Bangladesh tends to follow the interface zone where the turbid low salinity waters meet the fully marine waters of the Bay. Depending on the geography of the sea floor, this band can be narrow if the slope is relatively steep, e.g., Area I (Figure Ib) or wide where the slope is gradual, e.g., Area III (Figure Ib). The actual location of this zone where the shrimps tend to congregate, can also be expected to vary throughout the year, depending on freshwater discharge. These local movements of the shrimp stocks related to the hydrology are well known to experienced shrimp trawler skippers, who trawl in varying depth zones depending on time of year. In October 1981 (i.e. at the end of the monsoon and the time of maximum freshwater outflow) the fishermen's prediction that the major concentrations of shrimp would be towards the deep end of the annual depth range (15 - 80m) was confirmed by the results of brief trawl sampling programme with R.V. ANUSANDHANI (Figure 10). This figure also shows that *P. indicus*, which rarely if ever burrows, tended to be at the shallower (more turbid) edge of the depth range. However, *P. monodon* and *P. semisulcatus*, which have better burrowing abilities, tended to be deeper and further offshore. Although the behaviour and turbidity preferences of *M. monoceros* are not known from the literature, it would appear that they also may not be so dependant on turbidity, since they were usually found furthest offshore.

ii. Bangladesh Shrimp Trawler Production:

The data given in Figure 2 show that the catch by this group of vessels was similar for the first two years of the fishery 1978/79 and 1979/80 at 240 and 225 tonnes, but

has shown a marked increase in 1980/81 to 668 tonnes. This increased catch was related to an increase in effort from 451 and 436 standardised days in 1978/79, 1979/80 to 536 days in 1980/81. The bulk of the catch, particularly in 1980/81 was from the brown shrimp category (*Metapenaeus* species) Figure 3. However, the increased catch by this fleet in 1980/81 was taken at lower catchrates (Figure 4) than in the two previous years, suggesting a generally lower level of recruitment. The data presented in Figure 5 shows that the catchrates for all of the species categories were lower in 1980/81 than in 1979/80, however tiger and white categories were most affected. Such variations in catchrates indicating variable recruitment, although a normal feature of single year class penaeid fisheries, should be taken into account when considering the economic viability of the vessels exploiting these stocks.

iii. Kuwait Shrimp Trawler Production:

As noted previously, catch and effort data for these five vessels was not available, but for the purpose of estimating total catch, the catch by the four similar Bangladesh vessels could be multiplied by 1.25 for the period January to October 1980. This would suggest that the approximate catch for the Kuwait vessels would have been about 190 tonnes for 1979/80 (Jan - June, 1980) and 74 tonnes in 1980/81 (July - Oct, 1980).

iv. Thai Joint Venture Production:

With the already noted qualifications on the use of the Thai log book data, the total shrimp catch for the period January to October 1980 has been roughly estimated at 1900 tonnes, with a highly unlikely upper limit of 4000 tonnes (method of estimation and assumptions described previously).

If this is apportioned to individual years using the ratio of the recorded effort in the two years, then the 1979/80 catch would have been 1520 tonnes (upper limit 3200 tonnes) for January - June, 1980 and 380 tonnes (upper limit 800) in 1980/81 for July - October, 1980.

Estimates of offshore catches of shrimp from Bangladesh waters since 1978, when commercial fishing began, are presented in Table 4. These data are likely to be more reliable than those for demersal fish production, because all shrimps caught are retained. However, apart from the Bangladesh trawlers catch, all other figures should be regarded as "guestimates" and used as indications of the likely order of magnitude of production only. With this proviso, it is suggested that the production of shrimp would have been in the order of 2000 tonnes during 1978/79 when the large Thai fleet was operating. The production in 1980/81 is more reliably estimated to be about 1100 tonnes, mostly taken by the small fleet of Bangladesh based trawlers. The reason that this small fleet has achieved an obviously greater annual catch per boat than did the Thai vessels in the previous year, is that these vessels are generally larger, their effort is concentrated in areas of high shrimp abundance and they are more efficient due to their design. In contrast, the Thai vessels were much smaller, dual purpose fish/shrimp trawlers, designed primarily to catch fish, and as a consequence, were less efficient at catching shrimp. The second reason for their overall lower shrimp catch, was that most of their effort was concentrated on the best fish grounds, rather than the shrimp grounds.

To produce a realistic estimate of potential yield from the Bangladesh shrimp stocks based on the existing data is clearly impossible, however, the 1979/80 catch of about 2000 tonnes indicates that future catches in that order are certainly possible. In addition, the data from the 1980/81 year is of interest, as it shows that the 668 tonnes of shrimp caught by Bangladesh vessels was taken using 1538 days of standard effort, which is the equivalent of sweeping approximately 1100 square nautical miles of seabed. If the shrimp stock is distributed over about half of the trawl ground (2000 square nautical miles) at

any one time, then the total trawling effort applied by all fleets would have only covered the ground, occupied by the stock, about once during the 1980/81 year. Had sufficient vessels been available to cover the ground 2 or 3 times within the year, as is the case in more heavily exploited penaeid fisheries, then a higher catch could have obviously been achieved, although the average catchrate should have been considerably lower. This necessity for sweeping the trawl grounds a number of times to obtain reasonable exploitation of the stocks is largely related to the efficiency of the trawl, and to the fact that recruitment occurs over a large part of the year, particularly in the multispecies situation occuring in Bangladesh waters.

An alternate method of assessing the shrimp stock, which can give a broad indication of potential yield, is to use the Bangladesh trawlers catchrate data for 1980/81 and the approximate area occupied by the stock in a swept area standing stock calculation. For example, if the shrimp stock is assumed to be distributed over 2000 square nautical miles, the peak catchrate of 550 kg/hour (Figure 4) for a standard trawler (using 2 x 25m headrope nets, opening width assumed at 0.6 x headrope length, being towed at 3 knots for 15 hours per day, net efficiency assumed to be 0.5) indicates a peak stock size of about 3000 tonnes. Since it has been suggested (Boerema, 1974) that the standing stock for penaeid shrimp should approximate the potential annual yield, this calculation indicates that 3000 tonnes may be available annually, but not necessarily at economic catchrates.

Although none of the methods used here to assess the stocks can produce close estimates of future yields, especially in view of the expected variability in annual recruitment, they do broadly indicate that the yield is more likely to be in the 2000-4000 tonnes range rather than 9000 tonnes previously suggested.

GENERAL DISCUSSION

A major cause of the previous difficulties in assessing marine fisheries in Bangladesh waters, has been due to the problem of defining the limits of distribution for the various stocks involved. This has resulted largely from the failure to recognise that most of the inshore waters of less than 10m are effectively an estuarine (brackish water) environment due to the river outflow. Although there are some species which overlap, the two water types appear to contain different groups of both demersal and pelagic species.

In this report only the stocks occuring in the marine offshore zone have been assessed. As a consequence, the potential yields suggested here can be regarded as separate from the existing so called "Marine" production from the inshore small scale fishery. The only area of overlap appears to be along the Cox's Bazar coast where marine waters approach the coast and small-scale fishing of truly marine stocks occurs. To this limited extent, there may be some overlap in the suggested yields, however, the catch data by species from Cox's Bazar 1971-72 (Mohiuddin *et al*, 1980) suggests the overlap will be mostly in terms of pelagic species.

In summary then, the potential production, in addition to the existing inshore catch, estimated at approximately 100,000 tonnes (Mohiuddin *et al*, 1980), may be in the order of 10,000 to 20,000 tonnes of demersal fish and 2000 to 4000 tonnes of marine shrimp. For the pelagic stock (excluding the inshore estuarine area) Saetre's (1981) data and methods indicate a figure of 30,000 to 60,000 tonnes as a "guesstimate" of potential yield. However, in view of the few supporting pelagic trawl catches, these potential yields should be treated with caution until some experimental work has been carried out to confirm that economically fishable stocks are available.

The existance of these marine stocks from which increased catches may be taken, does not, however, guarantee that additional fishing and production will occur. In the case of the shrimp stocks, the relat-

ively high value of the product, and hence profitably of fishing, will encourage further expansion of the fleet. However, it should be clearly recognised that, as the number of vessels increases, the average catch rates will decline, until ultimately the value of the catch by each vessel will virtually equal the cost of operating. At that time further vessels are unlikely to enter the fishery, but the fishery will be of little value to the owners of the vessels or secondly to the country, since most of the operating expenses are paid in hard currency. In such an uncontrolled fishery, or if too large an increase in the numbers of trawlers is permitted at any time, the probability of the fishery reaching this point is very high. Secondly, in this situation, recruitment overfishing of one or more of the species making up the stock, may occur as the vessel owners attempt to increase their catches to remain viable economically. For these reasons, it is suggested that a conservative approach to increasing the number of trawlers be adopted. An increase of perhaps five trawlers, in addition to the existing fleet of 18 for a set period of 3 or 4 seasons would be a workable approach. This should allow sufficient catch and effort data to be gathered by the marine fisheries research group to assess and predict the effect of further increase in fishing effort. By this method, the danger of permanently over capitalising the industry and possibly depleting the stocks can be minimised.

A second feature of shrimp trawling operations which is often discussed, is the apparent wastage of food through discarding of some of the fish bycatch. While the objective of making use of this wasted resource is reasonable, the practical difficulties in achieving such an objective are numerous. Firstly, the design of modern twin trawl nets which are towed from a bridle, virtually running in front of the net reduces the catching efficiency for large quality fish. As a result, the bulk of the by-catch is usually of small, low value species. Secondly, the shrimp trawlers do not generally have sufficient freezer capacity to allow the storage of large quantities of small fishes, in addition to the quantities of shrimp which are needed for them to be economically viable. Thirdly, the additional costs inherent in the

handling and frozen storage of small fish are likely to be in excess of the market value of the product. For these reasons, it is suggested that the trawlers can only be encouraged to use any excess capacity to bring in fish, and any form of compulsion is likely to be counter productive.

Unlike the shrimp fishery which is tending to expand, the production of fish from the offshore demersal fish stocks appears at present to be static and only carried out by BFDC. The fact that no private trawler operators are attempting to exploit this resource is a fair indication of the marginal economics of such a venture. Increased production from this resource can therefore best be achieved through increasing the catch of the BFDC vessels by utilising their excess catching capacity. For this purpose, a variety of methods, such as paying the crews entirely on a commission basis, or using two crews for each vessel, etc., might be considered. Since a major influx of vessels purely for fish trawling (excluding joint venture fleets) appears unlikely, there does not appear to be any need to restrict access to the stocks at present. However, any additional fishing should be closely monitored, both in terms of total catch and species composition, in view of the recent decline of similar stocks subject to heavy fishing in other nearby countries, Pauley (1979).

A similar situation to that of the demersal marine stocks exists with the pelagic marine stocks which are presently only fished by the inshore small scale vessels operating from the Cox's Bazar coast. In this case, development is only likely to occur if the presence of significant stocks can be shown by actual test fishing by a research vessel. Such a programme should be instigated at the earliest opportunity.

In conclusion, it should be noted that although these estimates of potential yields from the offshore waters are considerably lower than those previously reported, the suggested available yields (including the present "marine" catch) are relatively high by world standards, considering the short length of the coastline of Bangladesh.

RECOMMENDATIONS

1. All private trawlers should be registered with the Directorate of Fisheries and issued with licences specifically for shrimp trawling.

2. The present fleet of 18 private shrimp trawlers should be increased by not more than 5 additional trawlers, and that number (23) be maintained for at least 3 years. BFDC trawlers would be in addition to the twenty three shrimp trawlers.

3. During the next three years 1981/82, 1982/83, 1983/84, complete catch effort data should be obtained for both the shrimp and BFDC trawlers using the marine fisheries data collection system at present being operated. This data will be essential for the prediction of the effect of future changes in the level of effor

4. Increased catches from the demersal marine fish stocks should be encouraged, primarily by improving the performance of the under utilised BFDC fleet. Consideration might be given to using a system of salary payments based on production for the crews and shore staff at BFDC.

5. An investigation of offshore pelagic fish resources should be carried out in the form of test fishing by a research vessel, at the earliest opportunity.

6. The presently operating Marine Fisheries Data Collection System should be made permanent and its activities expanded to cover the inshore mechanised and traditional fisheries when additional staff are available. The census system being developed by FAO project BGD/79/015 may be used as the basis for designing such a system.

7. The research activities by the Marine Fisheries Project staff, should initially give priority to:

   a. surveying the offshore marine shrimp stock so that the commercial shrimp catch statistics can be properly interpreted and utilised for management purposes.

   b. surveying the offshore demersal fish stock to enable the commercial fish catch statistics to be interpreted, and to record any changes in species composition brought about by exploitation.

8. All present and future research carried out by and under the Marine Fisheries Project should be formally written up and published, preferably in the form of a series of Research Bulletins.

SUMMARY

1. The reappraisal of earlier estimates of standing stock and potential yields, particularly those of West (1973) suggests that they were over-estimates by a factor of at least 3. A breakdown of assumptions in relation to the abundance of demersal stock in unsurveyed areas has been shown to be the cause of over-estimation.

2. Using information from research vessel surveys and experienced trawler skippers, the approximate limits to grounds occupied by the main bulk of the marine demersal stocks have been described. This area has been estimated to be about 4,000 square nautical miles (13,750 square km) rather than the entire shelf (40,000 sq. km).

3. Production from the offshore marine stocks (as distinct from the inshore brackish water stocks exploited by the small-scale fishery) has been estimated for the years since 1978/79, when offshore shrimp trawling began.

4. The production data obtained suggests that the landings from the offshore trawl grounds reached a peak of approximately 8,000 tonnes of fish (total catch including discards approximately 16,000 tonnes) and 2,000 tonnes of shrimp in 1979/80. This catch, however appears to have caused a reduction in the level of standing stock, possibly by as much as 50%.

5. Insufficient data are available for accurate stock assessment and yield predictions, however, as a broad indication, it is suggested that annual catches in the order of 2,000 - 4,000 tonnes of shrimp and 10,000 to 20,000 tonnes of fish may be available, depending upon economic constraints. Such yields are in addition to the existing inshore small-scale fishery catch, currently estimated at 100,000 tonnes.

6. A conservative approach to increasing production from the marine demersal stocks, has been advocated in view of the recent declines suffered by fisheries operating on similar fish stocks in tropical waters, and the expected variability in recruitment of the shrimp species involved.

7. Future research and management of the offshore demersal stocks has been discussed and some broad recommendations made. These include:

   a. The registration of all trawlers and the issuing of specific authorisation for shrimp trawling.

   b. Additional trawlers be added, but in small groups, with the additional vessels operating for a period of 3 years before any further authorisations are issued.

   c. The recently set up marine fisheries data collection system for trawlers be made permanent and expanded to cover the important inshore small-scale fishery, as soon as practicable.

   d. Research vessel cruises should initially be used to provide supporting data for analysis of commercial catch statistics, in relation to management of the resources.

ACKNOWLEDGEMENTS

The author wishes to thank all the officers and staff he met and with whom he discussed the marine fishery programmes and problems, for the co-operation he received.

I wish to record my grateful thanks to Prof. P.C. George, FAO Fishery Adviser/Project Manager and his staff for benefit of discussion and the facilities extended to me for my work and stay in Bangladesh. I also wish to mention the excellent co-operation I received from the personnel of the Ministry of Fisheries and Livestock, the Directorate of Fisheries, and the Bangladesh Fisheries Development Corporation. Special thanks are due to my three counterpart officers, Mr. Harun-or-Rashid, Mr. Giasuddin Khan and Mr. Waḥidun Nabi Chowdhury, without whose assistance this work would have not been possible.

List of the persons met and with whom the project was discussed

A. FAO/UNDP

1. Mr. L.I.J. Silva, FAO Representative in Bangladesh
2. Prof. P.C. George, Fishery Adviser/Project Manager, BGD/72/016
3. Dr. H.C. Loesch, Fishery Resources Survey Specialist/Project Manager, BGD/79/015
4. Mr. D. Muthumala, Fishery Economist, BGD/72/016
5. Mr. Charles D. Grant, Fishery Statistician, BGD/79/015
6. Mr. G. Sneyers, Programme Officer, UNDP, Dacca.

B. Government of Bangladesh

1. Mr. M.K. Anwar, Secretary, Ministry of Fisheries and Livestock
2. Dr. M. Youssouf Ali, Additional Secretary, Ministry of Fisheries and Livestock
3. Mr. M.A. Huq, Director of Fisheries
4. Mr. A.H.A. Jalil, Assistant Director of Fisheries
5. Mr. Mohsin Ali, Deputy Director of Fisheries (Marine)
6. Mr. Md. Shahidullah, Deputy Director of Fisheries (Marine)
7. Mr. Safiqur Rahman, Project Director
8. Mr. Q. Mollah, Chairman, BFDC
9. Mr. Nurul Huda, Secretary, BFDC
10. Mr. N.M. Hussain, General Manager, BFDC, Chittagong
11. Mr. Shamsul Islam, Manager, Trawler Department BFDC

Assigned National counterparts

1. Mr. Harun-or-Rashid, Fisheries Production Officer
2. Mr. Wahidun Nabi Chowdhury, Scientific Officer
3. Mr. Giasuddin Khan, Scientific Officer

LITERATURE CITED

1. Anon (1969) Preinvestment survey for the development of Fisheries in East Pakistan. Interim Report FAO FI:SF/PAK 22. 34 p (Mimeo)

2. Anon (1972a) Report on the marine fishing village identification survey in Bangladesh, 1967-68 UNDP project publication No. 2.

3. Anon (1972b) Survey for the development of fisheries : Bangladesh. (Terminal Report) FAO FI:SF/PAK 22. 39 p (Mimeo)

4. Anon (1973) Report of the Agricultural Team for Bangladesh. FAO/DEN/TF 96. Vol II

5. Antony Raja, B.T. (1980) Current knowledge of fishery resources in the shelf area of the Bay of Bengal. FAO, BOBP/WP/8, 23 p.

6. Boerema, L.K. (1974). Provisional note on shrimp assessment and management. Paper presented at the 'Government consultation on shrimp resources in CIGAR area' Caracas, Venezuela, September 1974. FAO/FIR : SR/WP 12, 13 p.

7. Edeson, W.R. (1979) Legal and institutional aspects of the management of fisheries in the Bangladesh Exclusive Economic Zone. FAO/IOP/TECH/79/32, 54 p.

8. Gulland, J. (1971) The fish resources of the oceans. FAO/Fishing News (Books) Ltd., Survey. 255 p.

9. Karim, M.A. (1978) General description of marine small scale fisheries - Bangladesh. FAO/UNDP - RAS/73/031, WP No. 3, 50 p.

10. Kibria, G. (1980) Taxonomy, distribution, migration and spawning ground of Bangladesh prawns and shrimps. Special paper, Irrigation Fisheries Development Project, Directorate of Fisheries, Bangladesh and Snell Environmental Group Inc. USA. (Mimeo).

11. Mohiuddin, M.S., Kibria, G., Hossain, Md. M. and Liaquat Ali (Ed.) (1980) Bangladesh : Status paper on coastal fishery resources. SIDA/FAO, BOBP. REP 10.2. Stock Assessment Consultation Vol 2, 1 - 22.

12. Pauly, D., (1979) Biological overfishing of tropical stocks. ICLARM Newsletter Vol. 2 (3), 3 - 4.

13. Penn, J.W. (1981) The behavior and catchability of some commercially exploited penaeids and their relationship to stock and recruitment. Paper presented to 'NOAA/FAO Workshop on the scientific basis for the management of Penaeid shrimp.' (Florida, USA, November, 1981), 25 p.

14. Rashid, H. (M S). Mitsui - Taiyo shrimp survey 1976-77 by M.V. SANTAMONICA and M.V. ORION - 8 in the marine waters of Bangladesh. Submitted for publication to Ministry of Fisheries and Livestock, Government of Bangladesh, 29 p.

15. Saetre, R. (1981) Surveys on the marine fish resources of Bangladesh (Nov-Dec, 1979 and May, 1980). Reports on survey with the R.V. FRIDTJOF NANSEN, Institute of Marine Research, Bergen, Norway, 43 p.

16. Saville, A. (1977) Survey method of appraising Fishery resources FAO Fisheries Technical Paper No. 171, 76 p.

17. West, W.Q.B. (1973) Fishery resources of the upper Bay of Bengal. IOFC/DEV/73/28, FAO,Rome, 44 p.

18. Youssouf Ali, M. and Mohsin Ali, Md. (1980) Exploration and exploitation of marine fisheries resources of Bangladesh. Paper presented to National Seminar on 'Oceanography and Marine Resources', Dacca October, 1980. 10 p. (Mimeo)

Table 1

Approximate landings and catches of marine demersal fish in Bangladesh waters for 1978/79 and 1979/80.

1978/79

Fleet	Landing Est.		Catch Est.	
	Minimum	Maximum	Minimum	Maximum
BFDC	1,100	1,100	1,100	1,100
Private	147	147	1,400	1,400
Total:	1,247	1,247	2,500	2,500

1979/80

BFDC	1,400	1,400	1,400	1,400
Private	61	61	1,300*	1,300*
Kuwait	No data	No data	1,625+	1,625+
Thai	4,240	8,000	8,480x	16,000x
Total:	5,701	9,461	12,805	20,325

* Estimated from Bangladesh trawler shrimp catch assuming a 6:1, fish : shrimp ratio.

\+ Estimated from Bangladesh private trawlers catch data.

x Assuming a discard rate of 50%.

Table 2

Offshore trawl catches of marine shrimp by Bangladesh trawlers and "guesstimates" of the production by Kuwait and Thailand joint venture trawlers for 1978/79, 1979/80 and 1980/81.

Catch (Tonnes live weight)

Year	Bangladesh	Kuwait	Thai	Est. Total
1978/79	240	Nil	Nil	240
1979/80	225	150	1520 (3200)*	1895 (3615)*
1980/81	668	74	380 (800)*	1122 (1542)*

( )* - approximate upper limit for estimated catch.

Figure 1a

DIRECTORATE OF FISHERIES

MARINE FISHERIES PRODUCTION PROFORMA

DATE: RECORDERS:

VESSEL DATA	Fishing Company:		
Name of vessel:		Length (cm)	Tonnes:
GEAR: Trawl net / Gil net / Behundi	Bottom / Midwater / Pelagic	Length of head rope (m)	Mesh size of cod end (cm)
FISHING EFFORT DATA	Date started	Date finished	Fishing days
Duration of trip			
Average fishing hrs/day:		Fishing area: Chart on reverse	

CATCH DATA

Fish catch	Weight (Kgs)	Sl No.	Shrimp catch	Weight (Kgs)
GROUP—I			GROUP—VI	
Indian salmon		1.	Tiger shrimp	
Giant jew fish		2.	White shrimp	
Grunter		3.	Pink shrimp	
Eel		4	Brown shrimp	
Cock-up				
Red snapper			Sub-total :	
Sub-total :				
GROUP—II			GROUP—VII	
Cat fish		5.	Small shrimp	
Pomfret				
Tassel fish			Sub-total :	
Jew fish				
Bombay duck			Shrimp-total :	
Ribbon fish				
Others			GRAND TOTAL :	
Sub-total :				
GROUP—III				
Mixed small fish			REMARKS (if any)	
Sub-total :				
GROUP—IV				
Sharks, Rays etc.				
Sub total :				
GROUP—V				
Mackerel				
Hilsa				
Sub-total :				
FISH TOTAL :				

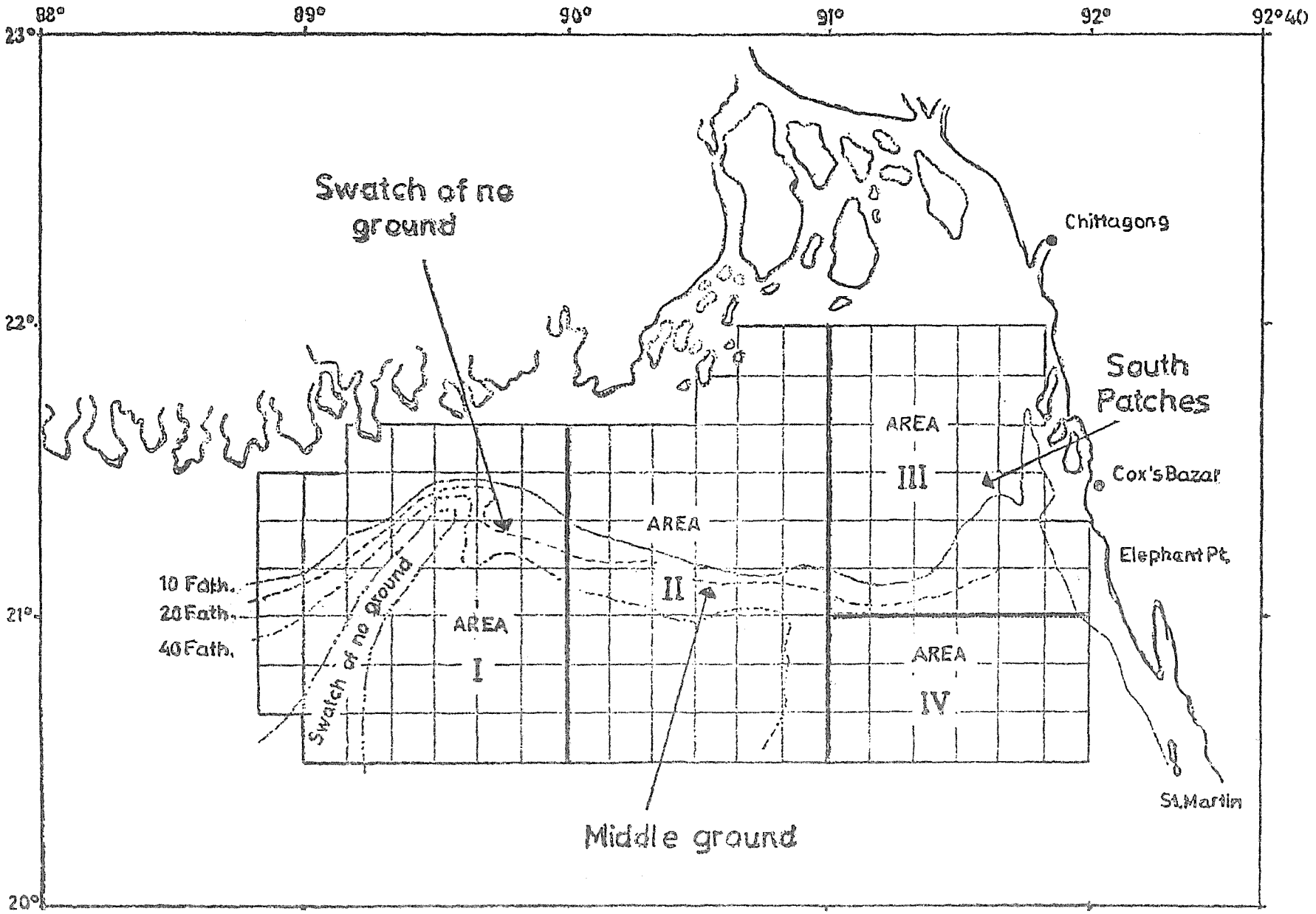

Fig. 1(b) - The reverse side of the Marine Fisheries Production Proforma showing the major subdivisions of the offshore trawl grounds used in the collection and analysis of the catch and effort data

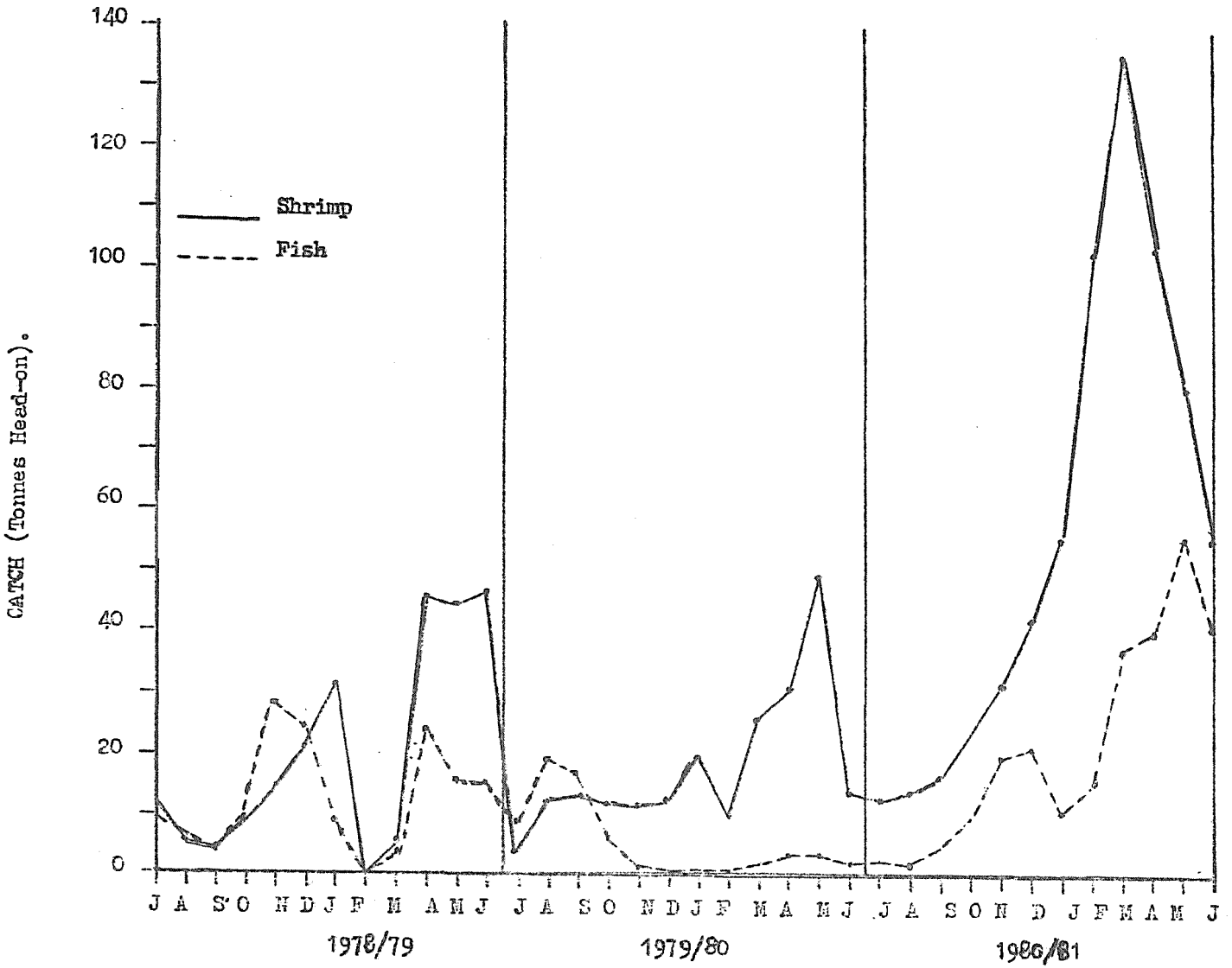

Fig. 2 - Total catches of shrimp and landings of fish by month for Bangladesh shrimp trawlers in the years 1978/79, 1979/80 and 1980/81

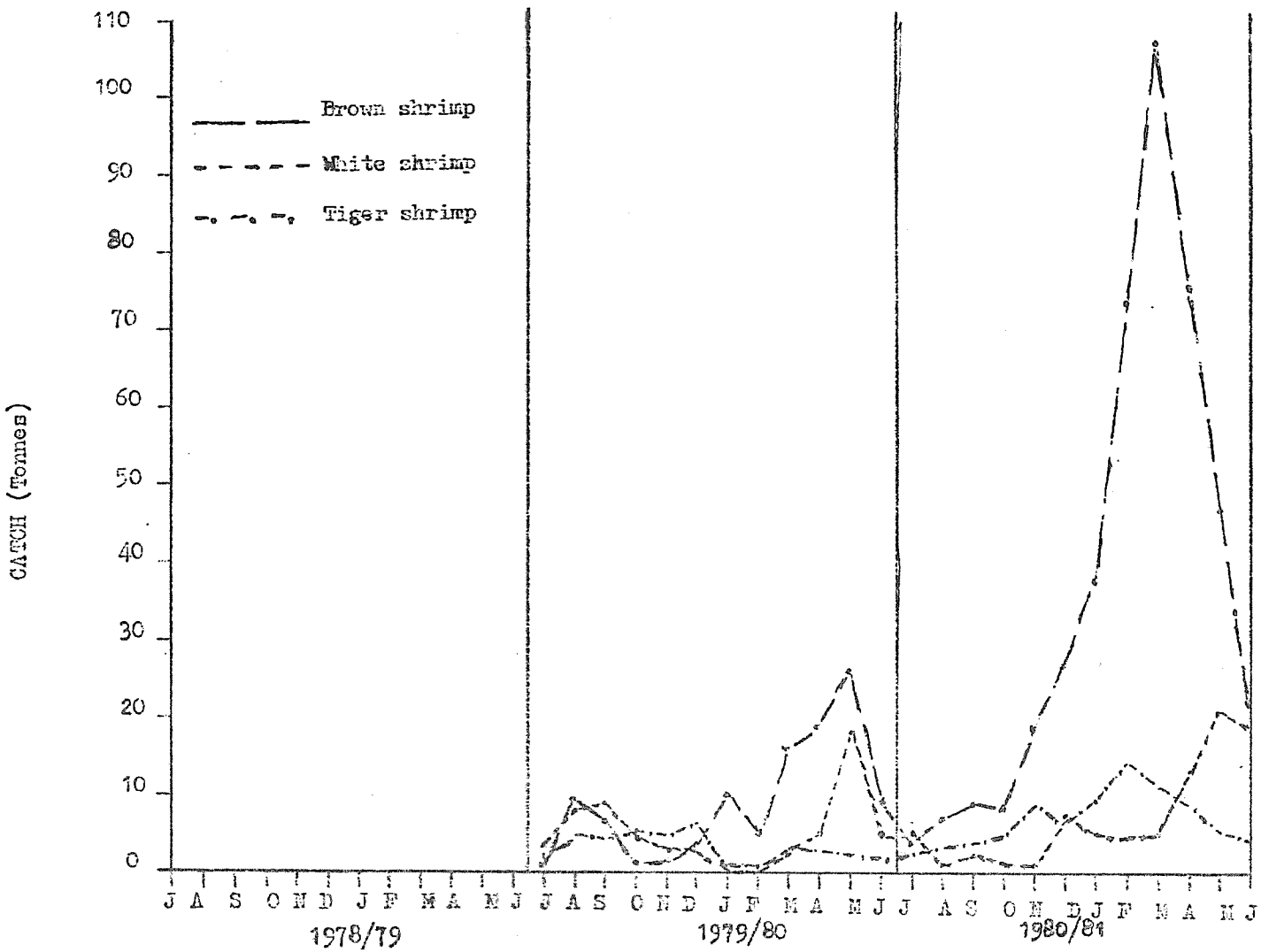

Fig. 3 - Monthly catches of tiger, white and brown shrimp by Bangladesh shrimp trawlers in 1979/80 and 1980/81 (Data for individual species was not available for 1978/79)

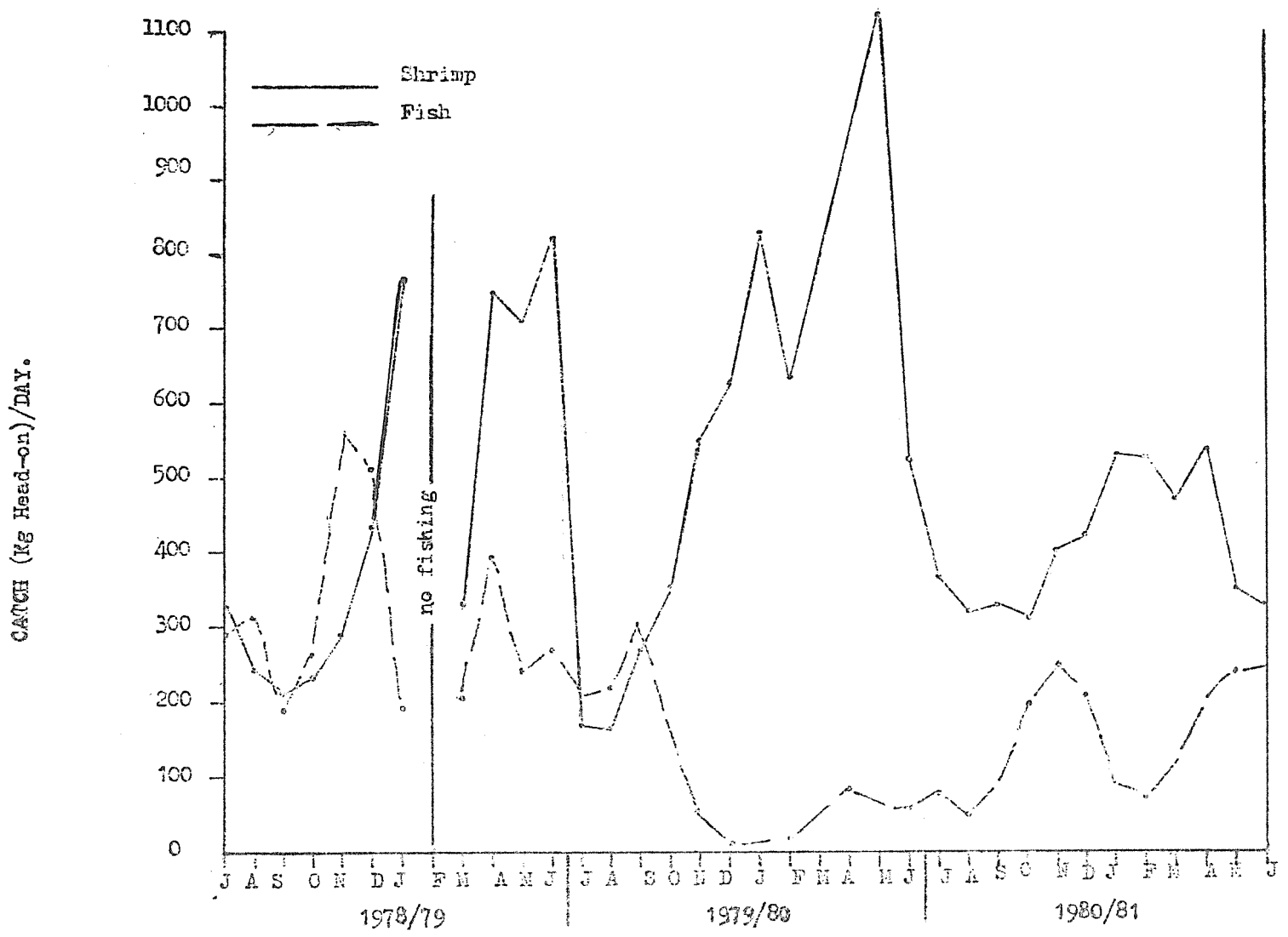

Fig. 4 - Catch rate for shrimp and fish landings per day by Bangladesh shrimp trawlers in the years 1978/79, 1979/80 and 1980/81

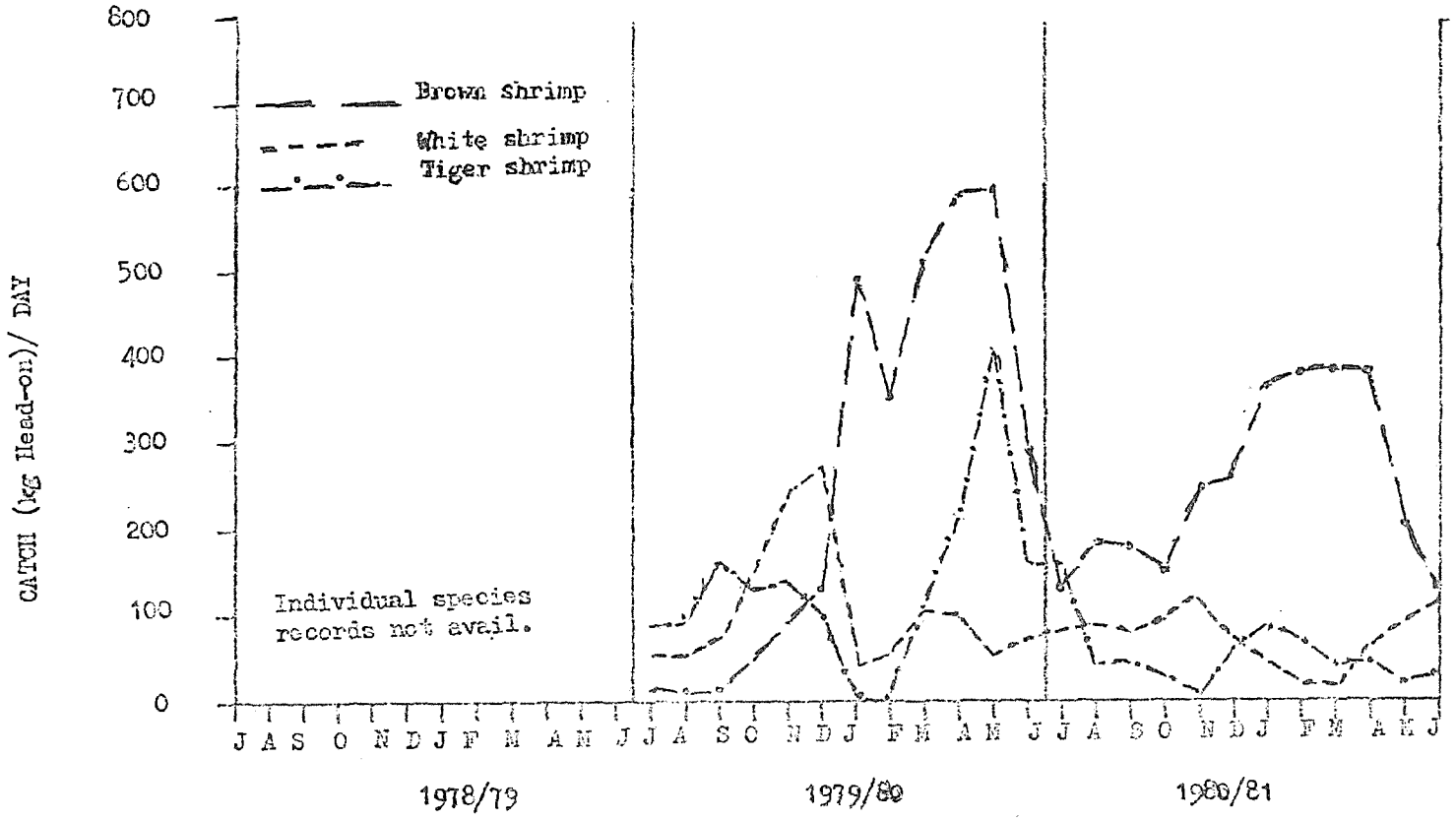

Fig. 5 - Catch rates (kg/day) of tiger, white and brown shrimp by Bangladesh shrimp trawlers in the years 1979/80 and 1980/81

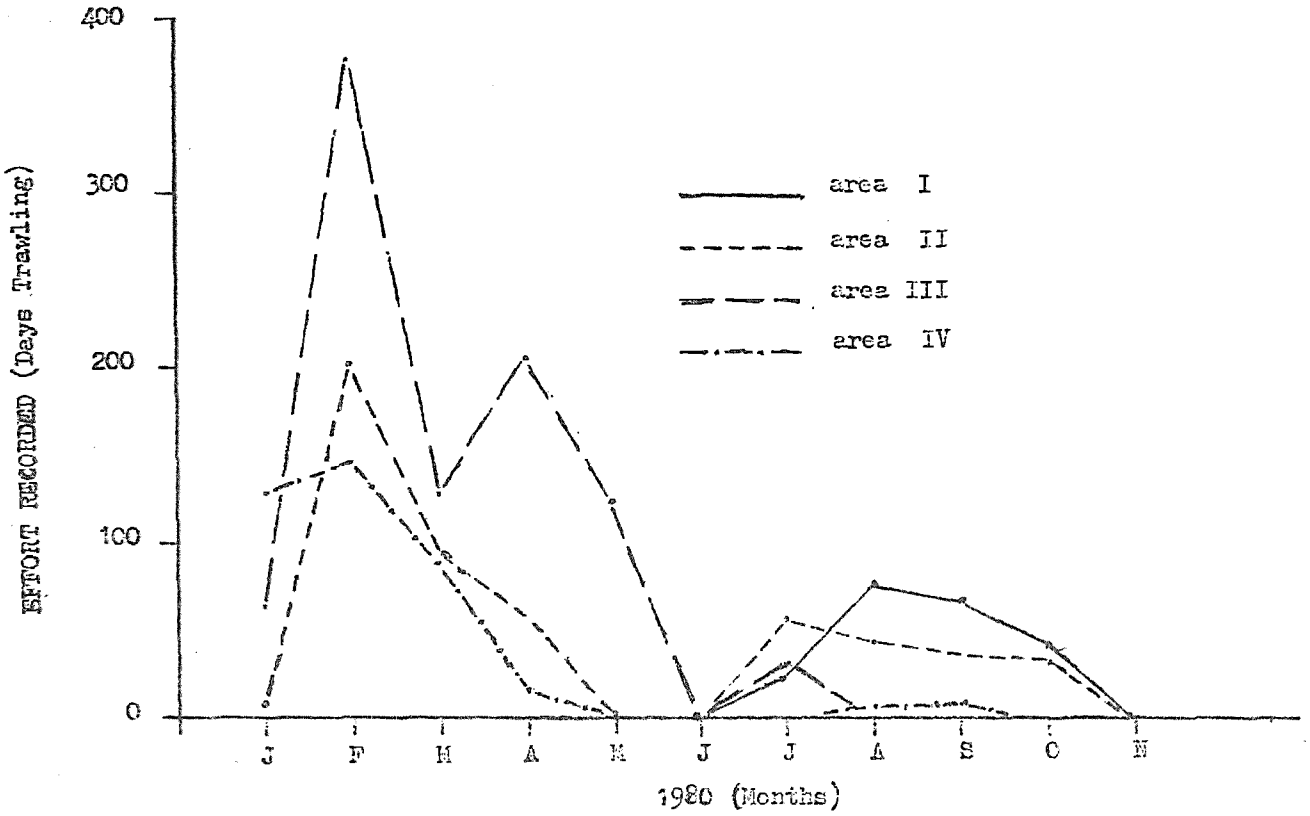

Fig. 6 - Records of days fished in each of the four major sections of the trawl ground from selected Thai trawler logbooks for the period January to October 1980

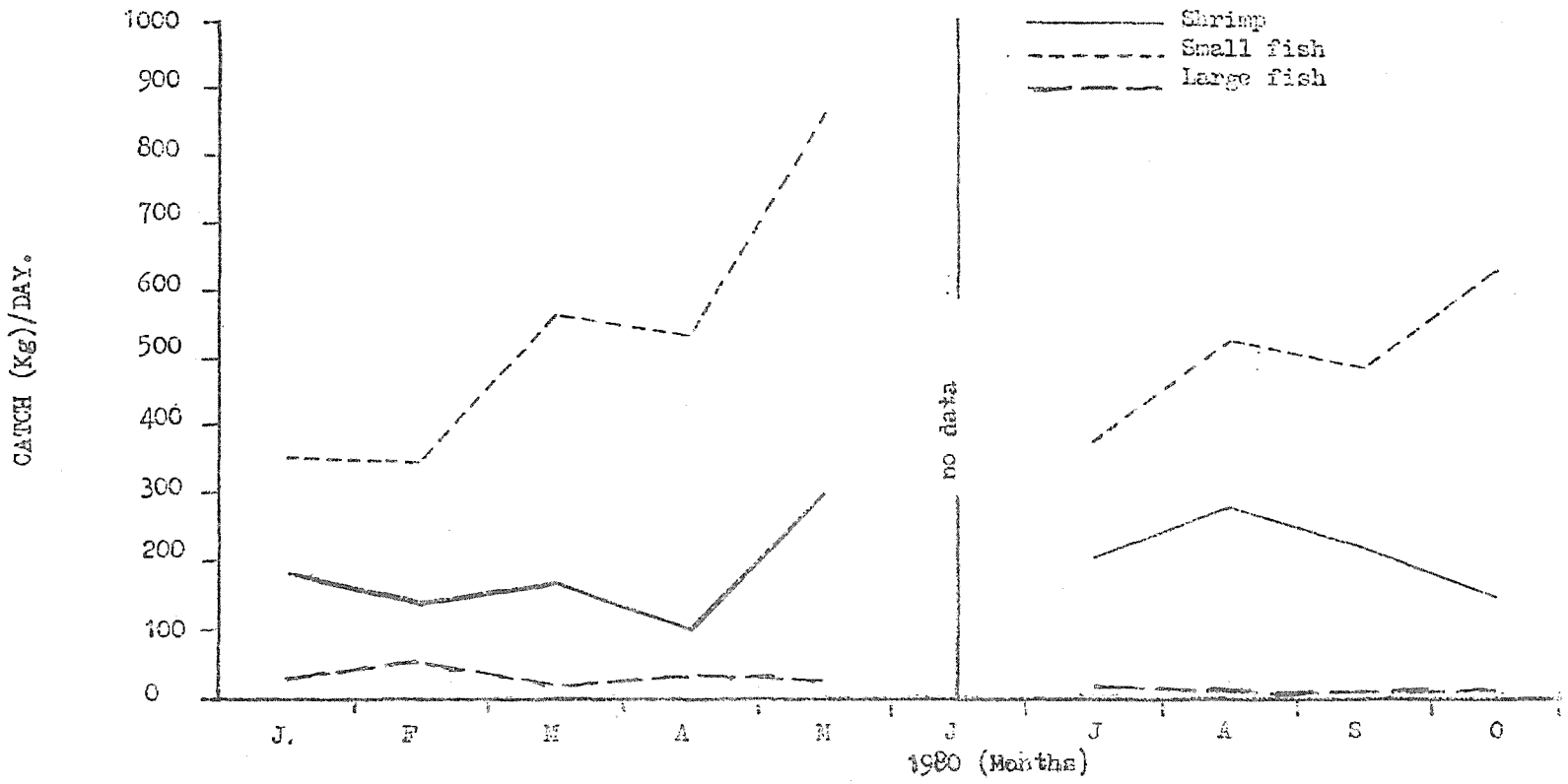

Fig. 7 - Catch rates of shrimp and landings per day of small fish and large fish (assuming 1 piece = 1 kg) by Thai trawlers from January to October 1980, based on selected Thai trawler logbook records

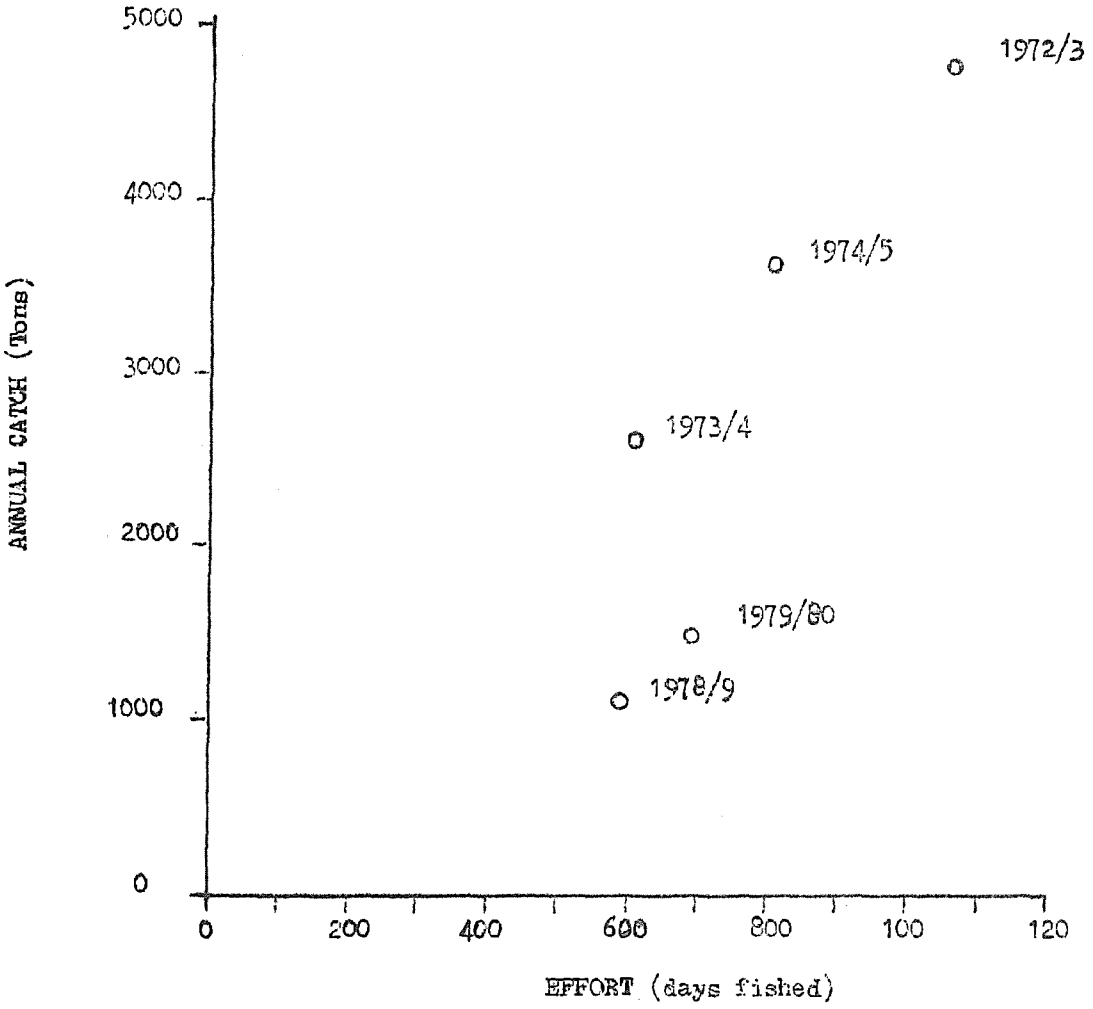

Fig. 8 - Catch (t) plotted against days of fishing by BFDC trawlers in the years 1972/3, 1973/4, 1974/5, 1978/9 and 1979/80. (Note: the fleet operating in 1978/9 and 1979/80 was of different vessels to the earlier years.) Source: BFDC Management records

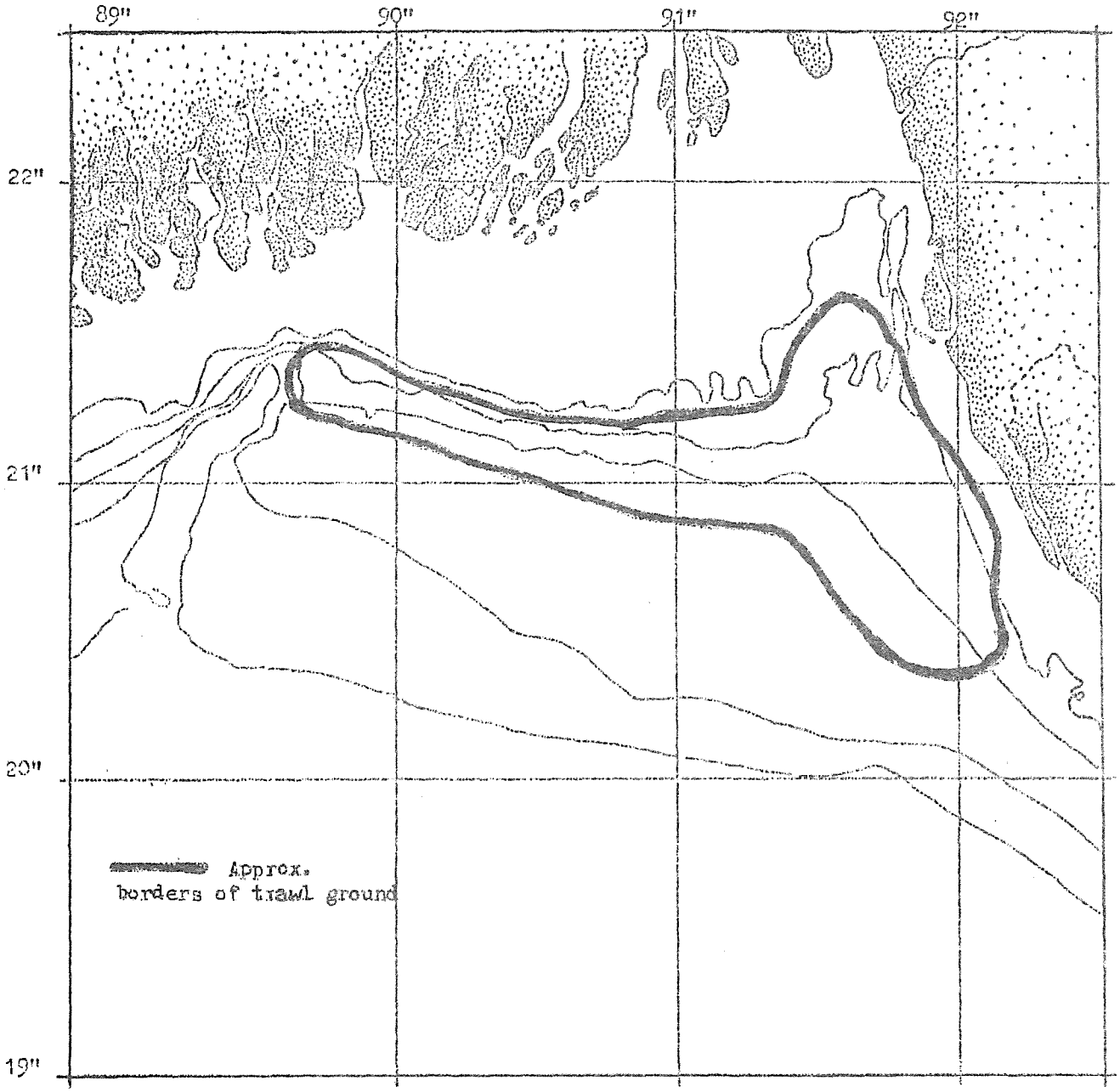

Fig. 9 - Approximate boundaries for the productive marine demersal fish and shrimp trawl grounds in Bangladesh waters

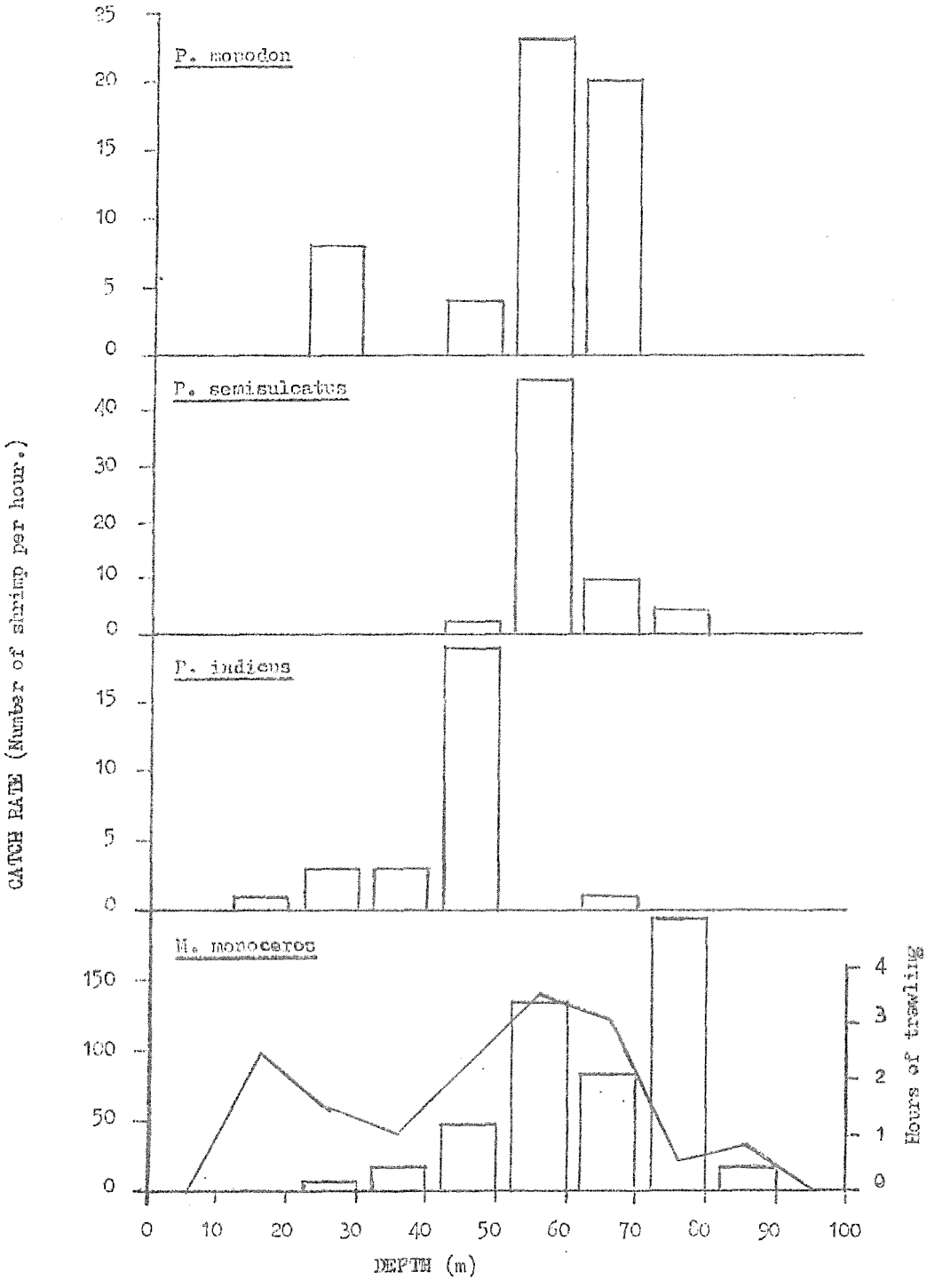

Fig. 10 - Catch in number per hour (histogram) of the four major marine shrimp species and hours of trawling (_____) by 10 m depth intervals during October 1981 (data from cruise of RV ANUSANDHANI)