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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the Fishery Data Centre and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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Cover Photo: Shrimp trawlers at Mangalore

BY-CATCH OF THE SHRIMP FISHERY IN INDIA*

Introduction

With the increasing demand for shrimps and consequent large scale shrimp trawling operations, considerable quantities of other fishes which are collectively termed as "trash fish" are landed everywhere. A survey of these catches would show that while in some countries these fishes are utilised in one way or other, in other countries they are wasted. A recent study undertaken by the International Development Research Centre (IDRC) Canada in collaboration with Food and Agriculture Organisation of the United Nations shows that every year as much as 21 million tonnes of edible marine fish are thrown away at sea by shrimp trawlers, which amounts to roughly the same quantity of fish eaten annually by the people of the developing countries. Surpisingly enough most of the waste occurs off the coasts of those countries where food is in short supply. Needless to say that in a world of increasing hunger we cannot afford to indulge in the luxury of this practice of dumping the trash fish over-board the fishing vessel. However, in India except for a very negligible quantity of catches contributed by some crustaceans and other miscellaneous varieties very little is wasted. In this connection a study was made to understand the shrimping by-catch and its utilisation in this country and the results are reported here.

Crafts and gear employed in shrimp fishing

Fishing crafts

A variety of indigenous crafts is used in shrimp fishery, from the simple catamarans of the east coast to the well-built canoes of Maharashtra on the west coast. Motorised pablo boats and small and large sized trawlers are engaged in shrimp trawling. Although the process of mechanisation of crafts has been in progress for the past several years, indigenous crafts like catamaran, canoes and plank-built boats are still operating in the small scale sector. According to 1973–77 census there were 1,06,480 non-mechanised crafts.

Catamarans: The catamarans are primitive types of crafts used on the surf beaten coast, consisting of 3 to 5 logs tied together in a raft fashion. In different areas the size and number of the logs used vary slightly. Usually 2 to 4 men operate the craft.

Canoes: The dug-out canoes are most common along the west coast, made by hollowing out a single log of wood and of varying sizes from 6.10 to 12.5 m length. Boat seines, shore seines, gill nets and cast nets are operated from these canoes often with a crew of 4 to 8 men. Plank-built canoes, out-rigger canoes and flat-bottom canoes are also in use in different areas.

Plank-built boats: These are sturdy boats used in the northern part of both east and west coasts, used for bag net fishing. Manned by 7 to 12 men, these are considered most suited for mechanisation and quite a number of them have been mechanised. The length of the boat ranges from 6.5 to 13.0 m. The various types of plank-built boats have been indigenously evolved on the basis of their suitability for operation in the respective local condition.

Mechanised crafts: Motorisation of the indigenous crafts was the first step in the mechanisation of shrimp fishing. In due course many designs of small and medium sized mechanised boats to be operated from harbours and sheltered bays were introduced. The number of mechanised crafts currently in operation is 12,000. Shrimp trawling is mostly carried out by the Dan boats (6.6 x 2.2 x 1.0 m), Pablo boats (7.4x 2.1 x 1.05 m) and the shrimp trawlers (9.6 x 3.1 x 1.2m and above). The horse power of the smaller boats ranged from 10 to 60. The larger of these boats are partly or fully decked and with trawling winches. Larger steel trawlers fitted with 90–300 HP engines and refrigerated fish holds are operated by some of the big firms as well as the Exploratory Fisheries Projects of the Government. The number of larger trawlers amounts to 75–100.

Fishing gear

As in the case of fishing crafts, a variety of indigenous gears are operated for capturing shrimps in addition

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to the trawl nets. Nearly 0.7 million gears of assorted types are operated in the country. According to the mode of operation the gears can be grouped under the following categories.

Fixed or stationary nets: These include the various types and sizes of bag nets and stake nets operated against the flow of the tide in both inshore waters and brackish water areas The bag nets constitute the most. important gears for shrimp fishing in Maharashtra and Gujarat coasts, where they are locally known as 'Dol nets'. Depending on the manner in which these nets are operated there are two types, namely *Khunt fishing* and *Sus fishing*. The nets are conical in shape, with a wide rectangular mouth. The size varies considerably, from 12 to 200 m in length with cod end mesh size of 10 mm. 'There are different types of bag nets operated in West Bengal and Andhra Pradesh also, locally known as *'Behundi Jal'* and *'Thoka vala'* respectively in these two areas. The fixed nets known as stake nets are in operation in the backwaters of west coast as well as east coast.

Seine nets: The seine nets include the seines with or without bags (and wings). They are known as boat-seines or shore seines depending upon whether they are hauled from a boat or from the beach. One of the important gears operated by the indigenous craft along Kerala coast is the boat seine known as *Thangu vala* of various dimensions, usually operated by two dug-out canoes with 6–10 men. Boat seines of different types and dimensions are in operation for catching shrimps in other areas also.

Although the shore seines are mostly used for catching inshore pelagic fishes, prawns are also caught in these nets. Shore seines of varying sizes are in use in all the areas of the coast-line.

Cast nets or falling nets: These are very common and primitive gears used all along the coast and limited in their efficiency. They are operated by a single person very near the shore in the open sea as well as in the creeks and estuaries. The size of the net varies from 2.5 to 6.0 m in radius with webbing of mesh size 10 to 20 mm. The net is cast, fully spread and as it closes traps the fishes and prawns in the water column below the net.

Scoop nets or skimming nets: These are employed exclusively in the creeks and backwaters and comprise of the hand net, push net and lift net. The Chinese dip nets of Kerala backwaters is a type of lift net.

Drift nets: The drift nets are passive wall nets of selective nature, also called gill nets made of cotton, hemp or synthetic fibre. The gill nets are at present increasingly used in fishing larger sized shrimps from the sea in certain regions.

Trawl nets: With the increase in demand for shrimps for processing and export, along with the mechanisation of the fishery stern trawling, particularly for shrimps, was attempted even with small mechanised boats and met with unprecedented success. Consequent to the expansion of the shrimp industry in a big way this new fishing method has come to stay, although indigenous crafts and gears are also being operated catching shrimps to a certain extent.

Otter trawls are the most effective gears operated for shrimp fishing, the sizes of the trawl nets varying with the sizes of the crafts from which they are operated. Generally two or four seam trawl nets, overhang or non-overhang type with headline length of 7–27 m between the upper wing ends are used. Depending on the dimensions of the net and the towing power required the size and weight of the otter boards vary. The Indian Standards Institution has also brought out requisite standards for the stern trawling gears for the different class of vessels.

Several new designs of trawling gear were introduced during the last few years. Design of a 15.25 m four-seam trawl for operation from a 9.45 m trawler is very popular. In addition to these trawls, bulged belly trawls are also in use. A 15 m bulged belly trawl suitable for 10.97 m trawler is being increasingly used. Some of the larger trawlers are resorting to out-rigger trawling.

Estimation of quantity of by-catch

A considerable quantity of fishes by way of by-catch from shrimp trawling as well as indigenous shrimp fishery, consisting of both trash fishes of cheaper varieties and quality table fishes is landed in India. Thus a bottom fishery or demersal fishery of very high magnitude exists in the country. In a total marine catch of 13,88,380 tonnes in 1979, 6,40,027 tonnes were contributed by demersal catches including those of indigenous fishery, the details of which are given in Table 1. In a total landings of 3,98,945 tonnes by smaller trawlers the fish and other miscellaneous by-catches apart from shrimp amounted to 3,15,902 tonnes, forming 79.18% in 1979 (Table 2). Maximum by-catch is seen in Tamil Nadu followed by Gujarat, Kerala and Maha-

Table 1. *Statewise distribution of bottom fishery during* 1979 *(in tonnes)*

State	Trawler catch		Total demersal catch including indigenous	Total marine catch
	Shrimp	Fish		
West Bengal	—	—	4,325	10,744
Orissa	2,160	7,275	28,675	51,808
Andhra Pradesh	5,373	23,312	49,377	91,426
Tamil Nadu	8,216	83,496	1,22,085	2,35,008
Pondicherry	492	3,158	4,273	10,068
Kerala	24,512	54,952	1,02,237	3,30,509
Karnataka	3,857	18,157	28,495	1,26,384
Goa	1,559	6,493	9,558	25,388
Maharashtra	31,242	48,788	1,86,102	2,93,326
Gujarat	5,632	70,271	86,836	1,91,312
Andamans	—	—	576	1,721
Lakshadwip	—	—	648	3,846
Private trawlers (large)	743	16,097	16,840	16,840
TOTAL	83,786	3,31,999	6,40,027	13,88,380

rashtra. The percentage of by-catch is maximum in Gujarat followed by Tamil Nadu and Pondicherry. It is at the minimum in Maharashtra and Kerala.

The details of landings (provisional) of commercial shrimp trawlers at some selected centres in the different maritime states during 1980 is given in Table 3. It is seen that among all the centres Sakthikulangara (Neendakara) in Kerala State shows the maximum units operated as well as landings of both fish by-catches and shrimps. It is interesting to note that the percentage of by-catch during the year is also at the minimum of 54.98 in this centre. At Cochin, the other centre of observation in Kerala also the percentage of by-catch is comparatively low. Sassoon Dock in Bombay comes next in the quantity of by-catch and shrimps landed by the trawlers, as can be seen in the table.

Table 2. *Landings of prawns and by-catches of commercial shrimp trawlers in different maritime states during* 1979

Maritime States	Total landings (tonnes)	Prawn catch (tonnes)	By-catch in tonnes				Percentage of by-catch in total landings
			Other Crustaceans	Cephalopods	Fish	Total	
Gujarat	75,903	5,632	939	4,824	64,508	70,271	92.58
Maharashtra	80,030	31,242	880	3,104	44,804	48,788	60.96
Goa	8,052	1,559	1,315	73	5,105	6,493	80.63
Karnataka	22,014	3,857	2,459	41	15,657	18,157	82.47
Kerala	79,464	24,512	7,384	1,536	46,032	54,952	69.15
Tamil Nadu	91,712	8,216	2,290	837	80,369	83,496	91.04
Pondicherry	3,650	492	98	39	3,021	3,158	86.52
Andhra Pradesh	28,685	5,373	352	474	22,486	23,312	81.26
Orissa	9,435	2,160	—	—	7,275	7,275	77.10
ALL INDIA	3,98,945	83,043	15,717	10,928	2,89,257	3,15,902	79.18

Table 3. *Landings of prawns and by-catches (in tonnes) of commercial shrimp trawlers at selected centres during* 1980 *(Provisional)*

Centres	Number of units operated	Total landings	Prawn catch	By-catch				Percentage of by-catch in total landings
				Other Crustaceans	Fish	Miscellaneous items	Total	
Bombay (Sassoon Dock)	21,469	18,144	5,138	4	12,924	78	13,006	71.68
Mangalore (Tadri)	7,922	2,417	353	1	1,779	284	2,064	85.39
Cochin	46,096	7,912	3,514	704	3,416	278	4,398	55.58
Sakthikulangara (Neendakara)	1,72,732	81,213	36,559	4,167	36,607	3,880	44,654	54.98
Tuticorin	31,517	6,417	534	12	5,871	—	5,883	91.67
Mandapam	25,143	2,533	217	151	2,047	118	2,316	91.43
Rameswaram	78,758	14,378	1,367	602	11,692	717	13,011	90.49
Nagapatnam	9,307	2,007	125	26	1,729	127	1,882	93.77
Cuddalore	16,012	1,969	121	31	1,642	175	1,848	93.85
Pudumanikuppam	13,154	1,416	165	62	919	270	1,251	88.34
Kakinada	41,174	9,025	2,698	352	5,557	418	6,327	70.10
Visakhapatnam	35,406	8,051	784	400	6,325	542	7,267	90.26

From the total by-catch including various groups of fishes and miscellaneous items consisting of crustaceans other than shrimps, cephalopods etc. only negligible quantity is being discarded. From a total by-catch of 3,15,902 tonnes in 1979, only an insignificant quantity of 5,000 tonnes (1.5%) consisting of *Squilla* and miscellaneous items such as young ones of fishes and shrimps and crabs were discarded. In the case of the smaller trawlers when the shrimp catches are unusually heavy the fish by-catches are discarded over-board due to lack of space for storage and transport to the shore base. From the larger trawlers operated, most of the smaller fish by-catch is discarded at sea, about which data is not available.

Statewise details of seasonal landings of by-catches during 1979 is given in Table 4. In all the states along the west coast of India except Kerala the by-catches are at the maximum during the south west monsoon months of June to August, there being not much of fishing operations by the small trawlers in the monsoon months. However, Kerala State shows the maximum in these months, mostly brought about by the peak activity of the shrimp fishing boats at Neendakara area. In Tamil Nadu along the east coast the by-catches are more or less evenly landed in almost all the year round, the maximum being in February, March and June and the minimum in September. Andhra Pradesh landed maximum in September, October and minimum in May and June. In Pondicherry the maximum by-catch landings were in June to September period, minimum being in November to January season.

Species and size composition in by-catches

The by-catches landed by shrimp trawlers include a wide variety of demersal fishes and a few species of cephalopods and crustaceans other than prawns. Among fishes, the most common items represented in the landings of the different maritime states are: Elasmobranchs, eels, catfishes, dorabs, lizard fish, perches, polynemids, sciaenids, ribbon-fishes, carangids, silver bellies, white fish, barracudas and soles (Fig. 1&2). The statewise abundance and seasonal distribution of major categories of by-catches for the year 1979 are shown in Table 5 and Fig. 3 respectively. Table 6 indicates the common size range of individual categories.

Elasmobranchs: This group, represented by sharks, skates and rays, is one of the common items of fish caught in shrimp trawls all along the west and east coasts and constitute nearly 5% of the annual landings of by-catches in the country. Out of 15,336 tonnes of elasmobranchs landed during 1979 more than 68% was recorded from Maharashtra and Tamil Nadu alone, forming 10.3% and 6.6% of the by-catches of the respective states. They occur in the trawl nets almost throughout the year, with peak landings during November–March along the coasts of Gujarat, Maharashtra and Kerala and during August–November in Tamil Nadu and Andhra Pradesh. The sharks caught are generally smaller in size as against the huge sizes captured very often in hooks and lines and other indigenous gears. Rays of all sizes upto about 2 m across the disc are encountered and they form the major component of the elasmobranch catch.

Eels: Although not very abundant as other groups, two species of eels namely *Muraenesox talabonoides* and *M. cinereus* are met with very often in the trawl catches of northwest coast and to a limited extent in the east coast. The highest catches are recorded in Maharashtra where they accounted for 5.4% of the

Table 4. *Monthwise landings of shrimp by-catches in different maritime states during* 1979

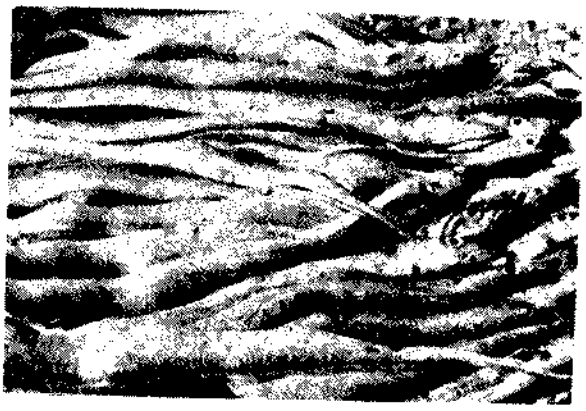
	Catch in tonnes												
Maritime States	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Gujarat	11,729	6,445	12,431	8,391	515	57	21	11	16,938	2,615	4,284	6,834	70,271
Maharashtra	8,132	6,590	5,254	5,397	4,764	1,245	623	770	2,764	5,106	3,880	4,263	48,788
Goa	527	432	1,602	814	398	15	18	11	72	233	890	1,481	6,493
Karnataka	3,557	1,604	5,403	2,895	2,259	135	—	—	437	697	59	1,111	18,157
Kerala	3,119	2,393	3,742	3,791	4,793	1,574	6,275	13,503	7,227	2,954	2,554	3,027	54,952
Tamil Nadu	5,464	8,971	9,152	7,086	4,799	9,662	5,516	6,498	4,671	8,117	7,468	6,092	83,496
Pondicherry	33	192	173	278	123	397	405	542	445	307	95	168	3,158
Andhra Pradesh	1,419	1,159	1,624	1,051	959	742	1,864	1,835	6,421	3,757	1,401	1,080	23,312
Orissa (Monthly figures not available)	—	—	—	—	—	—	—	—	—	—	—	—	7,275
ALL INDIA	33,980	27,786	39,381	29,703	18,610	13,827	14,722	23,170	38,975	23,786	20,631	24,056	3,15,902

a

b

c

c



f

Fig. 1. Dominant fishes in by-catches
a – Elasmobranchs, b – Catfish,
c – Lizard fish, d – *Nemipterus japonicus*,
e – Sciaenids, f – Ribbon fish

a

d

b

e

c

f

Fig. 2. Dominant fishes and other groups in by-catches
a – *Lactarius* sp. and *Leiognathus* sp.,
b – Soles, c – Crabs, d – Stomatopods,
e – Squids and cuttle fish,
f – Assorted collection of fishes.

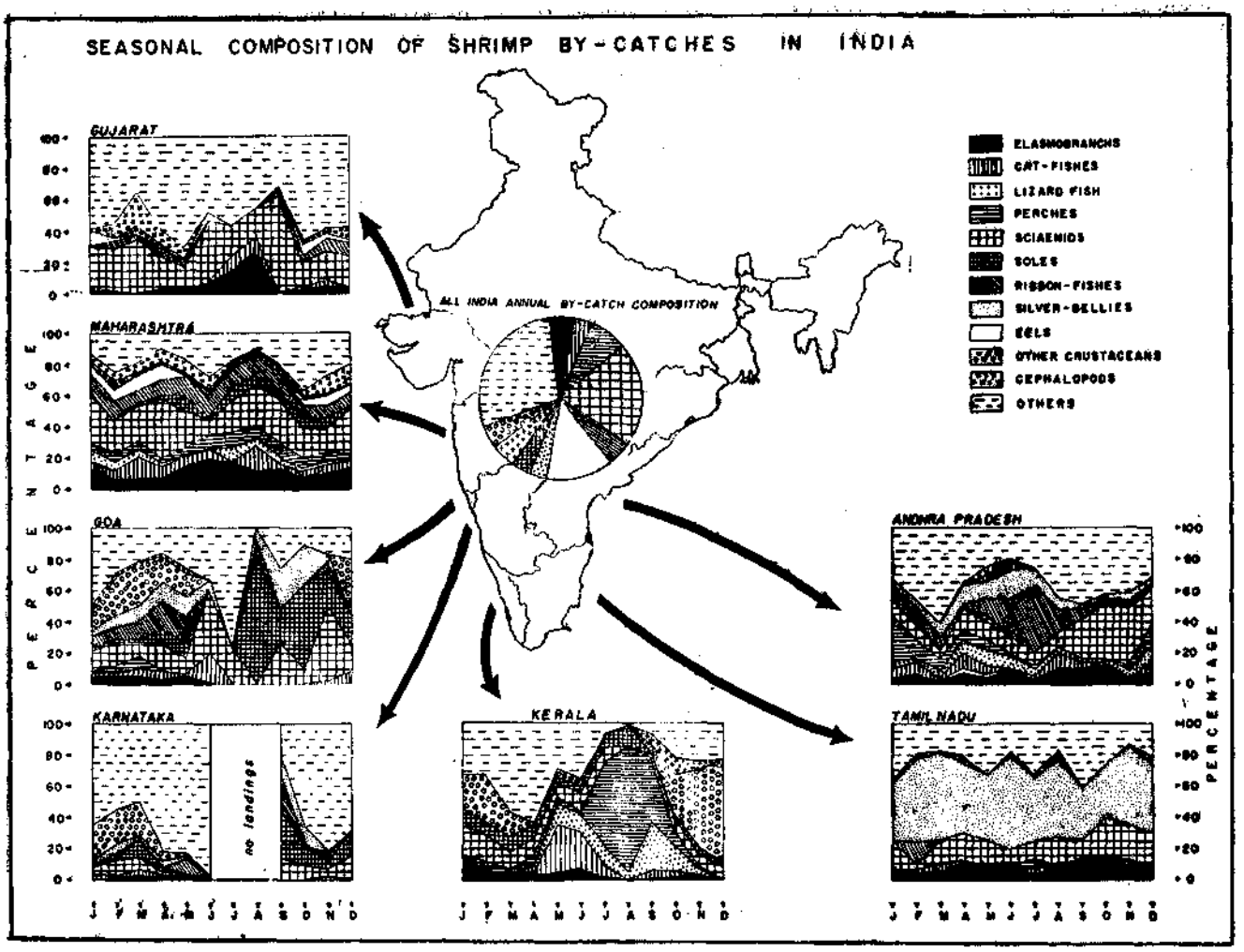


Fig. 3. Distribution pattern of major categories in the shrimp trawler landings of maritime states during 1979.

Table 5. *Landings (in tonnes) of important categories of by-catches by commercial shrimp trawlers in different maritime states during* 1979 *(Figures in parenthesis are individual percentages in the total by-catch)*

Categories	Maritime States									All India total
	Gujarat	Maha-rashtra	Goa	Karna-taka	Kerala	Tamil Nadu	Pondi-cherry	Andhra Pradesh	Orissa	
Elasmobranchs	1,095 (1.6)	5,054 (10.3)	170 (2.7)	153 (0.9)	1,202 (2.2)	5,470 (6.6)	87 (2.8)	1,694 (7.3)	411 (5.6)	15,336 (4.85)
Eels	1,973 (2.8)	2,613 (5.4)	—	—	1	35	8 (0.3)	187 (0.8)	—	4,817 (1.52)
Catfishes	538 (0.8)	3,059 (6.3)	276 (4.3)	506 (2.8)	2,778 (5.1)	1,215 (1.5)	27 (0.9)	734 (3.1)	597 (8.2)	9,730 (3.08)
Dorab	335 (0.5)	84 (0.2)	7 (0.1)	—	10	86 (0.1)	4 (0.1)	19 (0.1)	—	545 (0.17)
Lizard fish	100 (0.1)	1,973 (4.0)	102 (1.6)	57 (0.3)	5,238 (9.5)	1,130 (1.4)	247 (7.8)	887 (3.8)	—	9,734 (3.08)
Perches	497 (0.7)	2,598 (5.3)	169 (2.6)	34 (0.2)	18,195 (31.1)	2,016 (2.4)	895 (28.3)	1,151 (4.9)	82 (1.2)	25,637 (8.12)
Polynemids	9	1,240 (2.5)	—	—	25	358 (0.4)	—	191 (0.8)	658 (9.0)	2,481 (0.78)
Sciaenids	24,310 (34.3)	12,738 (26.1)	1,208 (18.9)	1,074 (5.9)	3,875 (7.1)	13,031 (15.6)	198 (6.3)	4,729 (20.3)	4,853 (66.7)	66,016 (20.90)
Ribbon fishes	2,968 (4.2)	5,210 (10.7)	487 (7.6)	507 (2.8)	813 (1.5)	1,491 (1.8)	64 (2.0)	2,268 (9.7)	248 (3.4)	14,056 (4.45)
Carangids	89 (0.1)	721 (1.5)	151 (2.4)	44 (0.2)	247 (0.4)	421 (0.5)	33 (1.1)	1,023 (4.4)	—	2,729 (0.86)
Silver bellies	—	96 (0.2)	484 (7.6)	609 (3.4)	1,003 (1.8)	39,517 (47.3)	579 (18.3)	1,440 (6.2)	—	43,728 (13.84)
White fish	751 (1.1)	369 (0.8)	247 (3.9)	78 (0.4)	26	631 (0.8)	10 (0.3)	116 (0.5)	—	2,228 (0.71)
Pomfrets	362 (0.5)	317 (0.7)	33 (0.5)	18 (0.1)	92 (0.2)	128 (0.2)	6 (0.2)	122 (0.5)	57 (0.8)	1,135 (0.36)
Barracudas	—	39 (0.1)	—	18 (0.1)	22	69 (0.1)	14 (0.5)	15 (0.1)	—	177 (0.06)
Soles	332 (0.5)	1,455 (3.0)	797 (12.5)	1,157 (6.4)	3,855 (7.0)	1,892 (2.3)	131 (4.1)	577 (2.5)	99 (1.4)	10,295 (3.26)
Other crustaceans	939 (1.3)	880 (1.8)	1,315 (20.6)	2,459 (13.5)	7,384 (13.4)	2,290 (2.7)	98 (3.1)	352 (1.5)	—	15,717 (4.98)
Cephalopods	4,824 (6.9)	3,104 (6.4)	73 (1.1)	41 (0.2)	1,536 (2.8)	837 (1.0)	39 (1.2)	474 (2.0)	—	10,928 (3.46)
Miscellaneous	31,149 (44.2)	7,238 (14.7)	974 (15.2)	11,402 (62.8)	8,650 (15.7)	12,879 (15.4)	718 (22.7)	7,333 (31.5)	270 (3.7)	80,613 (25.52)
TOTAL	70,271	48,788	6,493	18,157	54,952	83,496	3,158	23,312	7,275	3,15,902

total by-catches during 1979. Among the two species mentioned above *M. talabonoides* (Wam) is the most common and measures a maximum of about 2 m in total length.

Cat fishes: The catfishes form one of the common elements of the by-catches all along the Indian coasts and contribute to about 3% of the total landings. Maximum catches are recorded from Maharashtra and Kerala where they are caught throughout the year with peak abundance during the summer period (March–May). The cat fishes obtained in shrimp trawls

include a large number of species mostly of the genus *Tachysurus* and are generally represented in the size range 15–75 cm.

Dorabs: The dorabs or wolf herrings *(Chirocentrus dorab* and *C. nudus)* occur rarely in the trawl catches. In Gujarat they are encountered almost regularly from November onwards till the onset of monsoon.

Lizard fish: Contributing to about 3% of the total by-catches the lizard fish *Saurida tumbil* and allied forms constitute an important item of the catch landed in Kerala with peak abundance during the monsoon period. In other states like Maharashtra, Tamil Nadu and Andhra Pradesh also fair quantities are recorded occasionally during the non-monsoon periods. The common size range is about 15–40 cm.

Perches: The occurrence of several varieties of small and medium sized perches in shrimp trawls is a regular feature throughout the west and east coasts. *Nemipterus japonicus* (Kilimeen in Malayalam) is the most common species caught in Kerala where this group forms the largest component of the by-catches (31.1%) landed. Its peak abundance is observed during the southwest monsoon period. Other common perches are species of *Pomadasys, Lutjanus, Gerres, Kurtus, Sillago, Drepane* and *Therapon. P. hasta* locally known as "Karkara" is a highly sought-after species occurring more frequently in Bombay-Saurashtra waters.

Polynemids: The thread fins contribute to the by-catches in minor quantities in Maharashtra, Tamil Nadu, Andhra Pradesh and Orissa. In Bombay waters they form a sizable portion of the catch and are chiefly represented by two species namely *Polynemus heptadactylus* (Shende) and *P. indicus* (Dara), the former growing upto about 30 cm and the latter 140 cm in total length.

Sciaenids: Of all the by-catch categories, sciaenids, popularly known as 'Jewfishes', are the most common and are represented by various sizes upto about 120 cm. In 1979 they accounted for nearly 21% of the total by-catches of the country ranking first among the categories. The bulk of the landings was contributed by Gujarat and Maharashtra where the catch consists of two large growing species namely *Pseudosciaena diacanthus* (Ghol) and *Otolithoides brunneus* (Koth) and a number of smaller species collectively known as 'Dhoma' belonging to the genera *Johnius, Otolithus* and *Sciaena.* Substantial quantities of sciaenids are also landed in Tamil Nadu and other neighbouring areas of the east coast.

Ribbon fishes: They occur in moderate quantities all along the Indian coast contributing to nearly 5% of the total by-catches. Maximum landings are recorded in Gujarat and Maharashtra.

Carangids: Several species of *Caranx* and allied forms are often encountered in shrimp trawls as minor catches all along the west and east coasts. The carangids thus caught are generally smaller in size rarely exceeding 30 cm. They are relatively more common on the east coast where peak landings are recorded during the first quarter of the year.

Silver bellies: This is the second dominant item of the by-catches and contributes to about 14% of the annual landings. Out of 43,728 tonnes landed during 1979 nearly 90% was caught from Tamil Nadu coast alone. A number of species of the genus *Leiognathus* and a single species of *Gazza (G. minuta)* comprise the silver bellies catch, the former group being the most dominant. In Tamil Nadu the silver bellies are caught in trawl nets throught the year, the maximum catches being recorded from February to May.

White fish: The white fish *Lactarius lactarius* is one of the quality fishes caught in trawls occasionally. It is more common in the northwest coast and Tamil Nadu where the catch is generally represented by small and medium sized fish measuring 5–15 cm length.

Pomfrets: Like the white fish, pomfrets are also quality fishes occurring all along the Indian coasts but generally as stray numbers in the by-catches. In Bombay-Saurashtra coast, however, they are caught quite often in fair quantities and are represented by three types, of which the brown-pomfret *(Parastromateus niger)* and silver pomfret *(Pampus argenteus)* are dominant. The former species grows to fairly large size, with the sizes ranging from 10 to 30 cm.

Barracudas: One of the less common groups of by-catches, the barracudas are represented by a few species of *Sphyraena.*

Soles: The soles and other flat fishes form a regular component of the trawler landings throughout the Indian coasts and contribute to about 3% of the annual by-catch production. Maximum quantity is landed in Kerala. Except for a few large growing species

like the Indian halibut *Psettodes erumei* (Aayirampalli in Malayalam) and the large "tongue soles" *Cynoglossus dubius* and others caught occasionally, the bulk of the catch is constituted by the smaller species *C. semifaciatus* popularly known as Malabar sole. The usual size range is about 8–15 cm. At Neendakara in Kerala they are caught almost throughout the year with peak landings during the monsoon period.

Other crustaceans: Besides shrimps, the trawlers land considerable quantities of other crustaceans also as by-catches amounting to about 5%. Crabs and stomatopods are the most common and they occur in more or less equal proportions in the total catch. In 1979 nearly 50% of these items were landed in Kerala, followed by substantial quantities in Karnataka and Tamil Nadu. The crabs are predominantly represented by *Portunus pelagicus* and *P. sanguinolentus* and the stomatopods by a single species namely *Oratosquilla nepa*. Peak landings are observed during November–February along the west coast and May–October on the east coast. The spiny lobster *Panulirus polyphagus* is another important crustacean by-catch landed on Maharashtra and Gujarat coasts. Similarly, the deep-sea spiny lobster *Puerulus sewelli* has been trawled in considerable quantities along with shrimps from 250–400 m depth off Kerala coast.

Cephalopods: The cephalopods represented by squids and cuttle fishes contribute nearly 4% of the total by-catches of the country. Out of 10,928 tonnes landed in 1979 over 73% was obtained in Maharashtra and Gujarat. November–May is the period when maximum catch is landed. In Kerala also substantial quantities are landed particularly during August to November. *Loligo duvaucelli, Sepia pharaonis, S. aculeata* and *Sepiella inermis* are the common species, the former three being mostly represented by the size group 10–25 cm and the other by 5–10 cm in mantle length.

Miscellaneous: In addition, several species of trash fishes, both demersal as well as mesopelagic forms, are landed regularly at all centres of the coast. In the overall by-catch landings they collectively account for about 25%.

Utilisation of by-catch

Handling, collection and preservation (Figs. 14-19).

Most of the smaller type of mechanised fishing vessels while going for fishing take ice on board and the larger types of vessels have refrigerated fish holds in them. The catches on the decks of the trawlers are sorted into shrimps and fish by-catch. They are then handled separately and brought to shore, iced in the smaller vessels and frozen in the larger type of vessels. In some of the very small sized vessels fish by-catch is brought to the landing centres in un-iced condition. After landing, the fish is usually packed in bamboo baskets or plywood boxes with sufficient quantity of ice and taken in either lorries, carrier launches, refrigerated or insulated trucks, head loads or cycles to processing plants and to nearby or interior markets.

Table 6. *Common size range of important categories of by-catch*

Categories	Size range (cm)
Elasmobranchs	30–100
Eels	75–150
Dorabs	20–100
Cat fishes	15– 75
Lizard fish	15– 40
Perches	10–150
Polynemids	8–100
Sciaenids	10–120
Ribbon fishes	20– 80
Carangids	5– 30
Silver bellies	5– 15
White fish	5– 15
Barracudas	15– 80
Pomfrets	10– 30
Soles	8– 35
Crabs & Stomatopods	5– 13
Lobsters	10– 30
Squids & Cuttle fish	5– 25

Experiments conducted at Central Institute of Fisheries Technology has shown that the shelf-life of small fishes is considerably enhanced when packed in ice in 1:1 fish to ice ratio. The efficiency of bamboo baskets can be greatly improved by giving them an additional insulated lining with bitumen coated kraft paper. Plywood boxes lined with 25 mm thermocole is found to be very efficient, enabling fish to be stored without spoilage upto nearly 50 hours.

Processing of by-catch

While part of the fish by-catch is disposed in fresh condition in local markets, some of the larger varieties of fish are processed by freezing and filleting. Freez-

a

d

b

e

c

f

Fig. 4. Utilisation of by-catches

a – Baskets of fishes ready for marketing
b – Iced fish, c – Iced fish being packed
d – Sundrying of soles
e – Preparation for curing
f – Salted fish

ing is now the most important processing method in the country. In 1979, 24,126 tonnes of fresh frozen fish valued at Rs. 1,15,581 was exported in addition to the frozen shrimp products. Of course this would include the products contributed by the pelagic fishes also. Besides, frozen cuttle fish and fillets to the tune of 1,339 tonnes (value Rs. 35,310) from the by-catch was exported.

On account of the improved methods of transportation and marketing introduced in the country frozen fish and fish fillets have picked up considerable sales in many urban areas.

Fish curing methods

The cured and dehydrated products are widely produced because the technology involved is cheap. At present nearly 20% of the fish by-catch is processed in these methods.

Sun drying: Some of the smaller varieties landed are sundried for internal consumption as well as export, mostly prevalent in Kerala, Maharashtra and other maritime states. This is by far the cheapest method of curing fish. Mostly *Lactarius* sp., Bombay duck, eels, soles etc. are dried in this way.

Dry salted fish: This also is a very common method used for curing fish in the country. A wide range of fish to salt ratio is used depending on the size of the fish. 1:1 to 1:6 ratio of fish to salt is used for larger fishes and 1:8 to 1:10 ratio for smaller fishes.

Wet curing: In this method salt is applied in three instalments. Fish is dressed and eviscerated. Fifty per cent of the total salt is applied on all cut surface and the fish is stacked on the vessels. The other 50 per cent salt is added in two instalments in subsequent two days and the self-brine is allowed to drain. The fish is sold without further drying. The yield is 70.4% and has a shelf-life upto three weeks.

Pit curing: The fish is treated with the requisite quantity of salt and buried in pits lined with certain types of mattings over the sides, top and bottom. It is then covered with sand and trampled down to exert pressure. After two days the fish is taken out and marketed without further processing. The yield is 69.4% and has a shelf-life of approximately three weeks.

Colombo curing: This method has been in vogue in South Kanara region and Malabar coast of Kerala. The dressed fish is salted in the ratio 1:3 or 1:4 and a small quantity of Malabar tamarind is placed in the belly cavity of the fish. The fish is then arranged in barrels with intermittent layers of salt and Malabar tamarind (50 gm/Kg of fish). The yield is about 75.0% and has a shelf-life upto 6 months.

Products of by-catch

Under an all India Co-ordinated Research Project on transportation of fresh fish and utilization of trash fish carried out in the Central Institute of Fisheries Technology during 1971 through 1979 several products were prepared and developed, some of which have been recommended for pilot scale and large scale production.

Fish Protein Concentrate (FPC) was prepared from different species of trash fishes obtained in the by-catch and its storage life and analytical characteristics were determined. A pilot plant for production of FPC has been installed. Bacteriological peptone from threadfin bream, found to be of high quality, was put to commercial production for use as a growth supporting compound in microbiological media formulations.

Fish hydrolysates, fish soup powder, fish flakes, edible fish powder, fish fingers and canned pet food from cheap miscellaneous trash fish were some of the products for which methods of preparations were standardised. A large number of speciality products like fish paste, fish sausages, fish pappads, fish wafers, fish spirals, fish seva, fish diamond cuts, fish jam, fish noodles and canned fish paste products also have been developed and their consumer acceptability determined. A method for the preparation of fish silage (poultry and animal feed) from cheaper varieties of fish was standardised. Improved methods of sun drying, wet and dry curing and smoking were also developed.

Conclusion

The present study makes it clear that nothing much from the shrimp trawler catches is wasted in India and almost all the fishes, which are termed trash fish and discarded over board the vessel in some of the developed countries, are utilised either for human consumption

or as fish meal and fish manure. However it is to be pointed out that the handling, processing and utilisation of the fish catches, which form more than three fourths of the total landings, need further improvement. Streamlining of the handling, preservation, transport and marketing systems with the aim of proper and maximum utilisation of the valuable protein resources is essential.

NEWS—INDIA AND OVERSEAS

Lloyd's approval for Indian engine

The Kirloskar Cummins Ltd., at Kothrud, Poona, India is the first in Asia - excluding Japan - to be approved for the production of marine oil engines under the Lloyd's Register Batch and Line Production Scheme. Certificate has been issued to the firm and applies to the production of oil engines of approved types. Application of the scheme means that instead of each engine having to be inspected individually when a Lloyd's Register Certificate is required, all engines produced (together with their spare parts) will be eligible for a Lloyd's Register Batch and Line Certificate.

The Lloyd's Register Batch and Line Production Scheme, which has been operating successfully for 10 years, requires a Company's works and quality control procedures to be examined by LR's surveyors in order to verify full compliance with the requirements of the scheme. After approval, the procedures are kept under continuing surveillance by regular visits from LR surveyors to ensure that the approved standards are maintained.

Type specimens in Central Marine Fisheries Research Institute deposited in Zoological Survey of India

Since the inception of the Central Marine Fisheries Research Institute at Mandapam Camp the holotype and paratype specimens of zoological taxa newly described by scientists have been deposited in the research collections of the Institute over the years. As the Zoological Survey of India is the National Repository for type specimens it was decided to transfer all holotypes of Vertebrates and Invertebrates in the CMFRI collections to the National Zoological collections at the Zoological Survey of India, Calcutta. Accordingly these type specimens were recently transferred to the Zoological Survey of India from Mandapam Camp. On 19th December 1980 the specimens were handed over at Mandapam to Dr. K. C. Jayaram, Deputy Director of Zoological Survey of India (photographs) to be transported to Calcutta. The holotype thus re-

registered with the Zoological Survey of India and incorporated into the National Zoological Collections include species belonging to Pisces–12, Crustacea-50,

Mollusca-4, Annelida-3, Echinodermata–1, Chaetognatha-2, Coelenterata-7, Porifera-19, and Protozoa-1, making a total of 99 species.

Titanium for fish processing machinery

Soviet engineers have been testing titanium as a possible substitute for stainless steel in fish processing machinery, where corrosion by seawater and food additives can reduce the working life of machinery and cause loss of working time through breakdowns. Sometimes the product itself gets adversely affected by the corrosion. Results of these tests with titanium have been reported recently.

It seems that there is a startling difference between the corrosion resistance of the two metals. Taking depth of pitting as a measure of susceptibility to corrosion, one year in moving seawater produced a pitting depth of 0.061 mm in stainless steel and a negligible 0.00003 mm in titanium. In still water, over 480 days, stainless steel was pitted to a depth of 0.24 mm while titanium was unaffected. These results were borne out over even longer test periods.

The report states that special training is necessary for welders and others working in this material. No figures are given in terms of comparing high initial cost to low repair/maintenance cost.

World Fishing 29 (2): February 1980

Clams cultured in plastic island

Clams are being grown on lines hanging from an artificial island of floating plastic canisters near Cape Kaliakra, Bulgaria. The canisters are arranged radially from the centre, each radial arm being about 80 m long.

This is Bulgaria's first successful clam farm. Previous attempts failed because the sea was too rough. The island on canisters has survived all storms for more than two years.

Four tonnes of clam meat have been produced in a single crop from the artificial island. Bulgarian fishery officials hope to establish more than 100 similar islands in the sea around Cape Kaliakra.

World Fishing 29 (6): June 1980

Success in breeding tuna in captivity

Japanese researchers have reported that they succeeded in breeding bluefin tuna in captivity for the first time. Bluefin tuna *Thunnus thynnus*, growing to over 500 kg, was reared in pens and eggs laid by them were successfully hatched in rearing tanks.

The breakthrough of hatching bluefin has brought much closer the Japanese dream of culturing highly priced tuna species. Among several institutions currently involved in co-operative tuna culturing programmes, the present experiment had been conducted at Kinki University Fishery Experimental Laboratory at Shirahama. Here the work began in 1970 with the rearing of younger stages of tuna caught in fish traps in holding pens, 30 m in diameter and 7 m deep set in waters off Kushimoto. They hold some 4500 tuna of various sizes including 60 fish which have lived for a record five years in captivity and weigh about 100 kg. The males among these five year old fish were observed to pursue the females in early June last year. After a few days about 2,10,000 eggs were collected. These eggs were transferred to hatching tanks with water temperature maintained at between 22 and 24°C and they began hatching within a day. Algae *Clorella* extracts and oxygen were fed into the tanks. The larvae grew 4 mm in the first four days. The researchers are planning to rear the larvae through to maturity.

World Fishing 29 (6): June 1980

Skipjack tuna also have been spawned in captivity for the first time at the National Marine Fisheries Service's Honolulu Laboratory. Here more than 1,00,000 eggs were stripped from the ovaries of two females and fertilized with milt from two males. Many of the larvae produced from this spawning were alive and feeding actively ten days later. The rearing of the larvae is in progress under the leadership of Dr. Thomas Kazama. Planktonic food cultured in the laboratory is being used in the rearing experiments.

FNI 19 (10): October 1980

Heavy mortality of crabs in Taiwan

The worst drought in more than 50 years has hit crab farmers in Taiwan. The weather has been disastrous, causing serious losses to the farmers. Fishery experts are still investigating the causes for the large scale mortality of the crabs.

Among other problems brought out by the unusually hot dry weather has been a drastic increase in water salinity. Apparently the crabs cannot adjust to the increased salinity of the water, especially during their moulting stages, and have been dying in large numbers. Some areas have reported more than 80 per cent mortality.

FNI 19 (10): October 1980

Shrimp culture catching up in Latin America

FAO Market Information Service for Fish Products reports about the rapid development of shrimp farming in Latin American countries. Ecuador is leading in this development with more than 40,000 acres of ponds. Panama has about 1,600 acres and shrimp culture ponds are being constructed in Columbia, Costa Rica, Honduras, Peru and Nicaragua.

Feasibility studies for shrimp culture are underway in Brazil, Martinique, French Guiana, Mexico and Venezuela. According to the FAO Service Ecuador has the world's largest shrimp culture industry.

FNI 19 (10): October 1980

BOOKS

Fjord Oceanography: Edited by Howard J. Freeland, David M Farmer and Colin D. Legings, Plenum Press, New York, pp 715, 1980.

The papers contained in this volume were presented at a workshop funded by the NATO Advanced Studies Institute in Victoria, British Columbia.

This book presents an unusually broad summary of the present state of knowledge of this class of inlets. The volume considers physical problems ranging from the mathematical theory of circulation to engineering aspects of intentional and unintentional changes in oceanography. The ecology of Fjords is examined in detail, with emphasis on the effects of changes in the physical and chemical environment. Responses to natural and man-made changes particularly pollution, are considered at length. Reviews are presented that define the problems and give an overview of the present state of knowledge, and individual case studies of Fjords are presented that describe in detail the physical and chemical changes and the resulting ecological responses.

Ocean Dumping and Marine Pollution: Edited by Harold D. Palmer and M. Grant Gross, Dowden, Hutchinson & Ross, Inc. Pennsylvania, pp 268, 1979.

Majority of the papers from this volume were presented in a Symposium during the 51st Annual Meeting of the Society of Economic Paleontologists and Mineralogists in Washington, D.C., in June 1977. The contributors for this volume represent a variety of institutions, agencies, and private firms involved in the study of the fate of wastes dumped at sea. By way of an introduction, the editors have attempted to set the theme in a brief review of the source of materials dumped at sea, their fates and some statistics on volumes and the nature of wastes, direct observations . of materials other than dredged spoils are also included in this volume.

Ecological Processes in coastal and Marine Systems: Edited by Robert J. Livingston, Plenum Press, New York, pp. 560, 1979.

This volume comprehensively examines interactions between estuaries – coastal ecosystems and contiguous continental shelf areas. Offering new approaches to marine ecological research, the volume reviews and synthesizes current knowledge. The contributors focus on the coupling of physicochemical and biological phenomena, energy transfer mechanisms, and the community structure of diverse marine assemblages. The movement and distribution of populations, including life history progressions, are covered as well. Special attention is given to spatial and temporal variability and the source and nature of energy flow in these highly productive systems. Controlling and interacting functions and the effects of pollutions are also emphasized.

Compiled and prepared by Dr. M. J. George and G. Subbaraju. Published by Dr. M. J. George, Senior Scientist on behalf of the Director, Central Marine Fisheries Research Institute, Cochin-682 018 and printed at PAICO, Cochin-31.