



Sustain Fish

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Cochin, India

Editors

B. Madhusoodana Kurup
K. Ravindran

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Editors

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Assessment of bycatch and discards associated with bottom trawling along Karnataka coast, India

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Abstract

The quantity of bycatch and discard was estimated from the landings of multi-day fishing trawlers (MDF) at fisheries harbours and using the data collected onboard single-day fishing trawlers (SDF) for the period 2001-02. The quantity of bycatch generated by trawling along Karnataka coast was estimated as 56,035 t in 2001 and 52,380 t in 2002 forming 54 % and 48 % of total trawl catch respectively. The quantity of discards was estimated as 34,958 t in 2001 (34 % of total trawl catch) and 38,318 t in 2002 (35 % of total the trawl catch). In MDF, 33,098 t of bycatch was landed annually and in SDF the quantity was 21,109 t. About 30 % of total catch from MDF was discarded (21,336 t) whereas it was about 44 % from SDF (15,301 t). The most dominant group among bycatch was stomatopods in SDF forming over 39 % followed by finfishes (36 %) while finfishes formed the dominant group in MDF (69 %). The data pooled for two years showed that, catch rate of discards ranged from 7.5 kg h⁻¹ to 27.0 kg h⁻¹ in SDF and from 2.0 kg h⁻¹ to 16.7 kg h⁻¹ in MDF. The discarded catch in MDF consisted of 53 species of fishes (23 always discarded), 12 crustaceans (6 always discarded), 27 molluscs (22 always discarded) and 7 other invertebrates (always discarded). In the SDF, 53 species was seen in the landings and 60 in discard. The catch rate of discards was high during monsoon in MDF and pre-monsoon in SDF. Juveniles of various groups constituted an important bycatch of trawl fishery of Karnataka forming about 15.9 % of the total catch in SDF and 23.5 % in MDF at catch rate of 7.8 kg h⁻¹ and 9.4 kg h⁻¹ respectively. Juveniles in general constituted 36 % of bycatch in SDF and 78 % in MDF. Bottom trawling annually removes 14,400 t of juveniles of finfishes, 2,448 t of shrimps, 1,673 t of cephalopods and 1,702 t of crabs besides 4,059 t of juveniles of other groups. The quantitative and qualitative aspects of bycatch and juvenile catch from the present study are compared with available studies from Indian waters.

Keywords: Bottom trawling, Karnataka, Bycatch, Discards

1. Introduction

According to the FAO's report (Alverson, *et al.*, 1994), it is estimated that 27 million t or approximately 27 % of the global catches are discarded annually. Few studies have been conducted on bycatch and discards from the Indian waters (Sivasubramanyam, 1990; Gordon, 1991; Rao, 1998; Kurup *et al.*, 2003). Though few studies are available

on the trawl fishery of Karnataka (Rao, 1993, Zacharia *et al.*, 1996, Mohamed and Zacharia, 1996) no concerted effort has been made to study the bycatch and discards of the trawl fishery. Hence an attempt has been made for the first time to assess the bycatch and discards associated with bottom trawling along Karnataka coast.

2. Material and methods

The catch composition of MDF trawlers was analysed in the laboratory using samples collected from the last days' haul of boats operating from Mangalore and Malpe fishing harbours. For SDF boats the data on bycatch and discards were collected by participating in daily fishing trips. Data were collected from 150 MDF trawlers and 150 SDF trawlers during 2001 and 2002.

The catch from individual hauls was examined separately and was processed as target (all the species a fishing vessel tries to collect in as high numbers as possible -commercial sized fishes and shrimps) and non-target or bycatch (all species not directly fished for-juveniles of target, non-edible fishes, crabs, *etc* of no/little commercial value and the catch that is not used for human consumption are considered as discards. Since the bycatch which otherwise form discard would fetch some price, SDF trawlers generally bring it to the landing centre and sold for making fish-meal or poultry-feed. However, the MDF trawlers generally bring back the last two days' hauls and the discards caught (both thrown back to sea as well as retained) was arrived by raising the last hauls discards to the total number of hauls obtained by enquiry. Separate information was collected regarding the percentage of juveniles of target and non-target fishes which form incidental catches and discards respectively. The data on target and bycatch groups was analysed season wise- Pre-monsoon (February-May), monsoon (June-August) and Post-monsoon (September-January) for SDF and MDF trawlers.

The discards were sorted and identified up to species level. The catch details from individual boats were collected along with other informations like overall length of boat, cod-end mesh size, depth of operation and nature of fishing grounds. The monthly discarded fraction was calculated by multiplying the average catch arrived at from individual units multiplied by total units operated from the harbour. The actual effort was calculated based on the actual time spent in sea for fishing and the catch rate was calculated as kg h^{-1} .

3. Results

Along Karnataka coast, two categories of bottom trawl units are in operation. The SDF boats generally operate in waters up to 30 m depth whereas the operation of MDF trawlers sometimes extend up to 150 m. Trawlers observe fishing-ban during monsoon months, June-August.

3.1 Total catch in SDF and MDF

3.1.1 Single day Fleet

Details of discards and bycatches from SDF and MDF are given in Table 1.

Table 1. Total catch, bycatch and discard in SDF and MDF along Karnataka coast

Year	Total catch (t)			Bycatch (t)			Discards (t)		
	SF	MF	Total	SF	MF	Total	SF	MF	Total
2001	31,729	71,207	102,936	18,814	37,221	56,035	13,371	21,587	34,958
2002	38,880	70,414	109,294	23,405	28,976	52,380	17,232	21,086	38,318
Average	35,304	70,810	106,115	21,109	33,098	54,207	15,301	21,336	36,638

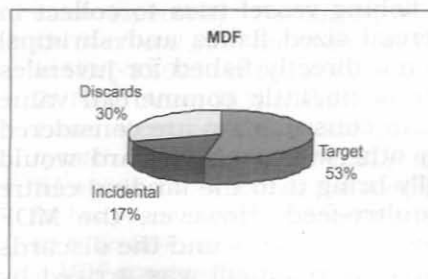


Fig.1 Percentage composition of target, incidental and discard categories of marine living organisms in MDF and SDF during 2001-2002

3.1.2 Multi day Fleet

Table 2. Details of bycatches from SDF and MDF

Group	2001				2002			
	SDF		MDF		SDF		MDF	
	Target	Bycatch	Target	Bycatch	Target	Bycatch	Target	Bycatch
Finishes	3,563	6,961	23,667	26,228	4,002	8,276	28,641	20,026
Molluscs	0	867	5,186	2,369	0	1,388	6,257	1,895
Crustaceans	9,351	10,772	5,235	8,495	11,473	11,133	6,540	6,925
Other								
invertebrates	0	214	0	128	0	1,608	0	130
Total	12,914	18,814	34,088	37,269	15,475	23,404	41,438	28,976
Fishing hr	706,521	1,641,485	859,899	1,880,512				
CPUE (kg h ⁻¹)	18.28	27.85	20.71	22.70	17.99	27.27	22.03	15.41

The total quantity landed by MDF trawlers was 71,207 t in 2001 and 70,414 t in 2002 (Table 2), out of which 34,038 t (47.7 %) were targets in 2001 and 41,483 t (48.3 %) in 2002. Among target the dominant groups were finfishes 23,616 t and 28,641 t), molluscs 5,186 t and 6,257 t) and crustaceans 5,235 t and 6,540 t in 2001 and 2002 respectively. Maximum catch of 14,602 t was seen in September while

maximum catch rate of 69.3 kg h^{-1} was recorded in November in 2001. In 2002 maximum catch ($13,630 \text{ t}$) and catch rate (71.7 kg h^{-1}) were observed in May.

3.2 Bycatch

3.2.1 Total bycatch in SDF

The bycatch landed was $18,814 \text{ t}$ (52.3%) in 2001 and $23,405 \text{ t}$ (60.2%) in 2002, out of which $13,371$ and $17,232 \text{ t}$ were discards respectively. On an average, bycatch ($21,109 \text{ t}$) formed 59.8% of the total quantity caught. The group-wise bycatch was finfishes ($3,563 \text{ t}$ in 2001 and $4,002 \text{ t}$ in 2002), molluscs (867 t and $1,388 \text{ t}$), crustaceans ($10,772$, $12,133$) (Table 3). The catch rate of bycatch was 26.6 kg h^{-1} in 2001 and 27.2 kg h^{-1} in 2002. In the pooled data maximum catch and catch rate was seen in September (Fig. 2).

Group-wise catch of bycatch in SDF pooled for 2001 and 2002 is shown in Fig 3. It is seen that stomatopods was the most dominant group among the bycatch followed by finfishes whereas, non-edible crabs, invertebrates, cephalopods and other molluscs were in lesser quantities. The bycatch consisted of 20 families of finfishes represented by 35 species, 3 families of crustaceans (6 species), 3 families of cephalopods (3 species), 1 family of stomatopods (1 species), 2 families of echinoderms (2 species), 5 families of bivalves (8 species), 5 families of gastropods (6 species), 1 family of sea snake (1 species) and 1 family of colenterates (1 species) (Table 3).

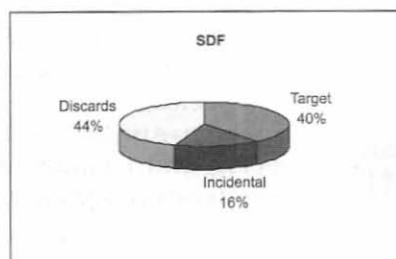


Fig. 2 Monthly catch rate of bycatch bycatch in SDF and MDF during 2001 and 2002

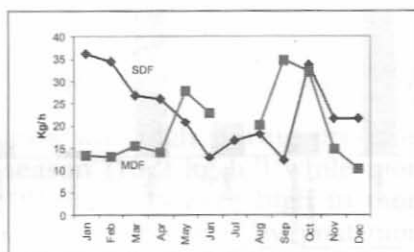


Fig.3 Group-wise catch in SDF of during 2001 and 2002 (pooled)

Table 3. Total as well as group-wise no. of species landed and discarded in SDF and MDF

Gear type	Species landed	Discard				
		Total species	Finfish	Crust	Molluscs	Other invertebrates
SDF	53	60	35 (10)	6 (3)	14 (14)	5 (2)
MDF	57	99	53 (23)	12 (6)	27 (22)	7 (7)

3.2.2 Total bycatch in MDF

MDF trawlers caught 37,221 t (52.3 %) as bycatch in 2001 and 28,976 t in 2002. In MDF the group-wise catch in bycatch was, finfishes 26,228 t in 2001 and 20,026 t in 2002, molluscs 2,369 t and 1,895 t, crustaceans 8,495 t and 6,925 t and other invertebrates 128 t and 130 t respectively for 2001 and 2002. In the pooled data bycatch formed 46.7 % of the total catch. Bycatch was caught at 22.7 kg h⁻¹ in 2001 and 15.4 kg h⁻¹ in 2002 (Table 2). In 2001 bycatch was landed more in September while maximum catch rate was seen in October. In 2002, maximum catch was recorded in March followed by May. Good landing of non-targets in MDF was noticed in June also. The catch rate was low during March-April in 2001 and November-December in 2002. In the pooled data (Fig. 2), catch rate of non-target group was more during September (34.74 kg h⁻¹) with finfishes dominating followed by crabs.

Group-wise catch of bycatch in MDF pooled for 2001 and 2002 is shown in Fig 4. Finfish was the most dominant group among bycatch accounting for 78.9 %. Crabs, cephalopods, shrimps and other crustaceans, molluscs other than cephalopods were found in lesser quantities. The bycatch consisted of 27 families of finfishes represented by 53 species, 4 families of crustaceans (12 species), 3 families of cephalopods (5 species), 1 family of stomatopods (1 species), 3 families of echinoderms (4 species), 7 families of bivalves (9 species), 8 families of gastropods (12 species), 1 family of sea-snake (1 species) and 1 family of coelenterate(1 species).

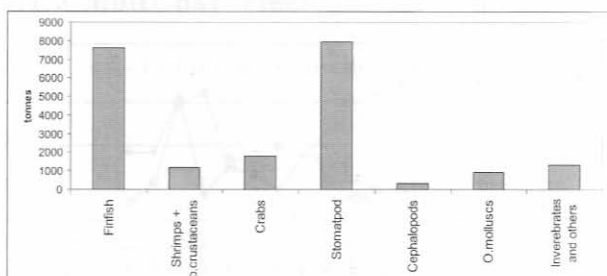


Fig.4 Group-wise catch of bycatch in MDF during 2001 and 2002 (pooled)

3.3 Discards

Out of 18,814 t of bycatch caught in 2001 by SDF, 5,043 t was constituted by incidentals and utilized whereas 13,371 t (71.1 %) was categorised as discards. In 2002, 17,232 t was discarded forming 73.6 % of the 23,405 t caught as bycatch. In the pooled data the average discarded quantity was 15,301 t at a catch rate of 19.7kg h⁻¹ forming 72.4 % of the total bycatch and 43.3 % of the total landing by SDF trawlers. The dominant group in discarded fraction was stomatopods followed by finfishes (Table 3).

The quantity of discard in MDF was 21,587 t in 2001 and 21,086 t in 2002 forming 30.3 % of the total catch in 2001 (Fig. 3) and 29.9 % in 2002. Discards formed 57.9 % of the bycatch in 2001 and 72.9 % of the bycatch in 2002. In the pooled data the quantity of discards was 21,336 t forming 30.3 % of the total MDF catch and 64.4 % of the bycatch.

CPUE of discards

The catch rate of discards in different months in 2001 and 2002 is shown in Fig. 5. In SDF, in 2001 the catch was high in January but highest catch rate was seen in October (27.0 kg h^{-1}) and January (23.9 kg h^{-1}) (fig 6). In 2002 highest catch (3,130 t) and catch rate (28.82 kg h^{-1}) was recorded in January whereas lowest catch and catch rates were in May and September respectively. In the pooled data maximum catch as well as catch rate were seen in January followed by February. Lowest catch and catch rate were seen in June and September respectively.

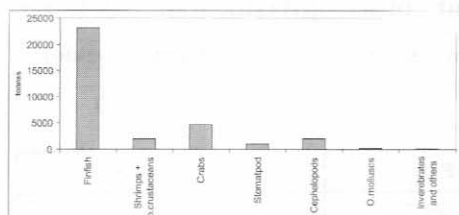


Fig.5 Monthly variation in CPUE (kg h^{-1}) of discards in MDF

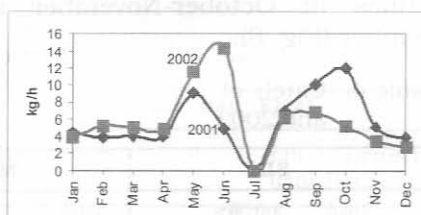


Fig.6 Monthly variation in CPUE (kg h^{-1}) of discards in SDF

In SDF, the catch rate of discards was high during pre-monsoon (20.8 kg h^{-1}) than post monsoon season (19.2 kg h^{-1}) while monsoon period recorded 13.2 kg h^{-1} . In MDF discards were high in monsoon season recording catch rate of 6.7 kg h^{-1} followed by post-monsoon season with 6.5 kg h^{-1} and pre-monsoon season (5.4 kg h^{-1}).

Species constituting bycatch

The number of species in bycatch in SDF is listed in Table 3. Fifty-three species are seen in the target. Among 60 species discarded in SDF 35 species belong to finfishes, 6 species crustaceans, 14 species molluscs and five species invertebrates.

Fifty seven species are recognised in the target category and 99 species in the discarded component. There were 53 species of finfishes (23 always discarded), 12 crustaceans (6 always discarded), 27 species of molluscs (22 always discarded) and 7 invertebrates which were always discarded.

3.4 Juvenile catch

3.4.1 Total juvenile catch in SDF

Juveniles of various groups were estimated as 5,205 t in 2001 and 5,969 t in 2002, forming 16.5 % and 17.2 % of the total catch respectively (Table 4). Maximum juvenile catch was recorded in January and the catch showed gradual fall with the minimum in September (Fig 7). Highest catch rate was seen in October. The group-wise quantity in the average data for 2 years was finfishes 2,577 t; shrimps 863 t; crabs 630 t; cephalopod 51.4 t and invertebrates and others 1,262 t. Among finfishes, sciaenid were represented by *Otolithes* spp, *Johnius* spp, flatfishes represented by *Cynoglossus* spp, crustaceans by *Parapenaeopsis stylifera*, *Metapenaeus dobsoni* and crabs by *Portunus* spp. In 2002, juveniles of finfishes were caught more in March and December. Juveniles of other crustaceans and molluscs were high in October, November and December. Cephalopod juvenile were caught only in negligible quantities. In the pooled data juveniles of finfishes were caught at high rates in April and December, shrimp juveniles in October-November and other juveniles in October-November (Fig. 8).

Table 4. Catch of juveniles (t) in SDF trawlers along Karnataka in 2001 and 2002

	SDF			MDF			Pooled		
	Total Catch	Juveniles Catch	%	Total Catch	Juveniles Catch	%	Total Catch	Juveniles Catch	%
2001	31729.0	5205.3	16.5	71207	15283.7	22.61	141621.0	36231.6	22.7
2002	35880.0	5969.6	17.2	70414	20947.9	25.16	70609.0	11174.9	16.7

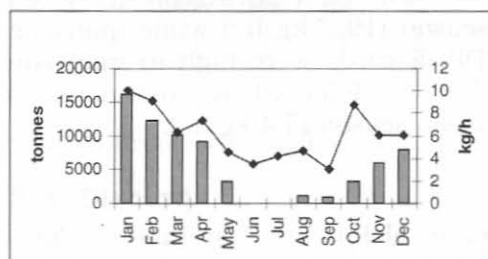


Fig.7 Month-wise catch (t) and catch rate (kg hr⁻¹) of juvenile fish in SDF during 2001 and 2002

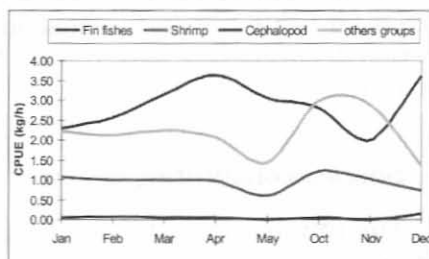


Fig.8 Monthly variation in the catch rate (kg/h) of juveniles in SDF

3.4.2 Total juvenile catch in MDF

Juveniles of various groups were estimated at 15,284 t in 2001 and 20,948 t in 2002 forming 22.6 and 25.1 % respectively of the total trawl catch of MDF trawlers. In MDF juveniles were landed in maximum

quantity and at high catch rate in (Fig 9). Catch was high in January but gradually showed a reduction whereas the catch rate shows a gradual increases from June reaching a peak in September (Fig. 9). The catch rate of finfish juveniles was maximum in April, followed by January and September. Juveniles of shrimps and cephalopods were high in April and January whereas that of other groups was maximum in June (Fig. 10).

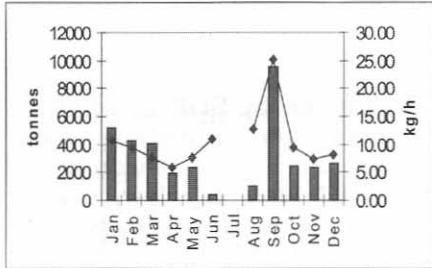


Fig.9 Month-wise catch(t) and catch rate(kg/hr) of juvenile fish in MDF during 2001 and 2002

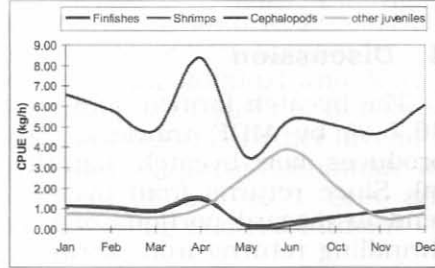


Fig.10 Monthly variation in the catch rate of juveniles in MDF

Table 5. Length range and size at maturity (Lm) of major juvenile species

Single Day Fleet			Multi Day Fleet		
Groups	Lm (cm)	Length range	Groups (cm)	Lm (cm)	Length Range (cm)
Crustaceans			Finfish		
Prawns			<i>Carcharhinus limbatus</i>	58.7	25-58.5
<i>Parapenaeopsis stylifera</i>	7	2-6.3	<i>Sardinella longiceps</i>	14.1	3.5-14
<i>Metapenaeus dobsoni</i>	7	2-6.2	<i>Epinephelus dicanthus</i>	31.6	12-31.5
<i>Penaeus indicus</i>	11.5	3-11	<i>Priacanthus hamrur</i>	18.8	5.5-18.5
<i>Metapenaeus monoceros</i>	12.0	3-11.2	<i>Nemipterus japonicus</i>	18.8	5.5-18
Crabs			<i>Nemipterus mesoprion</i>	17.2	6-17.0
<i>Portunus pelagicus</i>	12.7	4-12.5	<i>Trichiurus lepturus</i>	63.8	32-63.0
<i>Portunus sanguinolentus</i>	12.5	4-12.3	<i>Rastrelliger kanagurta</i>	17.8	5-17.5
Finfish			<i>Scomberomorus commerson</i>	71.5	18-70.5
<i>Otolithes cuvieri</i>	18.5	4-18	<i>Scomberomorus guttatus</i>	37.4	18-37
<i>Otolithes ruber</i>	19.7	4-19.5	<i>Pampus argenteus</i>	19.3	8-19.0
<i>Johnnieops sina</i>	12.2	3-12.0	Crustaceans		
<i>Pampus argenteus</i>	19.3	8-19.0	<i>Metapenaeus monoceros</i>	12.0	3-11.2
<i>Cynoglossus macrostomus</i>	10.9	3-10.5	<i>Penaeus indicus</i>	11.5	3-11
			<i>Solenocera</i> spp.	5.5	3-5.3
			Molluscs		
			<i>Loligo duvaucelii</i>	21.6	5-21.2
			<i>Sepia pharonis</i>	19.4	6-18.5

The total catch of juveniles occurring in SDF and MDF together was estimated at 20,489 t in 2001 and 26,917 t in 2002. Juvenile catch formed 19.9 % in 2001 and 24.6 % in 2002. In the pooled data, finfish accounted for 17,085 t, shrimps 2,259 t, cephalopods 2,330 t, crabs 1,072 t and other groups 2,797 t.

The length-range of the important juveniles occurring in SDF and MDF and size at first maturity of the species collected from literature is given in Table 5.

4. Discussion

The bycatch formed 59.8 % of the total catch by SDF trawlers and 46.7 % by MDF trawlers. The SDF operation in inshore waters produces more bycatch than the MDF operation in deeper waters (>30 m). Since returns from bycatch or trash fish are very low, trawlers tend to discard portions of bycatch into the sea. However, with the dwindling returns from shrimp trawlers these trawlers have no other options other than increase the utilization of bycatch. Therefore, most of the bycatch is brought to the landing centre for selling to partly meet the expenditure on fuel. Annual average quantity of discard in SDF was 15,301 t forming 43.3 % of the total trawl catch while the quantity was 21,153 t forming 30 % of the total trawl catch in MDF. Discards formed 72.4 % of the bycatch in SDF and 64.4 % in MDF.

Kurup *et al.*, (2003) has estimated the bottom trawl discards along Kerala coast. The quantity of discards thrown back into the sea during 2000-01 and 2001-02 has been estimated as 2.62 and 2.25 lakh t compared to the quantity of discards by both SDF and MDF along Karnataka coast is low and is estimated as 0.35 lakh t in 2001 and 0.38 lakh t in 2002. This is because, along Karnataka coast 80-90 % of the bycatch which amounts to 0.56 lakh t in 2001 and 0.52 lakh t in 2002 are brought to the landing centre whereas, the entire quantity is thrown back to sea in Kerala. Onboard discarding is very less in SDF trawlers whereas the estimates of discards in MDF trawlers take into account the onboard discarding made during the initial days of operation. Ye *et al.*, (2000) estimated bottom trawl discards from Kuwait waters as 7.5 fold higher than the annual fish landings. The quantity varied from 34,700 to 55,000 t and more than 98 % of bycatch is discarded back to sea. In the North-Mediterranean Sea, bottom trawl discards accounted for 39-40 % of the total catch and the quantity estimated was 13,500-22,000 t annually (Machias *et al.*, 2001).

Kurup *et al.*, (2003) has stated that the discarded quantity also need to be added to the landing data to arrive at reasonable estimates of the total removal of fishes from the sea by trawlers. The discarded quantity if added the total landings from Kerala works out to a high of 7.63 lakh t, thus reaching the potential stock level. However, in the present study from Karnataka coast onboard discarding is estimated to constitute only 4 % of the total trawl landings in 2001 and 2.7 % in 2002. Therefore an addition of only 4,177 t and 2,953 t has to be made

to the total trawl landings respectively for 2001 and 2002. Kurup *et al.*, (2003) has observed that the high rate of discards from the Kerala study is due to the use of small mesh size of 18 mm against the statutory mesh size of 35 mm. The percentage composition of discards from Kerala is constituted by finfish (37.13 %), crabs (28.64 %), stomatopods (8.13 %), gastropods (9.94 %), shrimps (1.96 %), jellyfish (0.85 %), cephalopods (1.5 %), and soles (1.17 %).

Menon, (1996) has estimated 6,200 t of juvenile fish and prawns discarded back into the sea during 1980-84 along southwest coast of India. The quantity of shrimp juveniles destroyed in the study by Kurup *et al.* (2003) was 5,110 t and 5,662 t during 2000-01 and 2001-02. In the present study also 2,448 t of shrimps, 14,400 t of finfishes and 1,673 t of cephalopods, 1,702 t of crab and 4,059 t of other juvenile groups were found to have been removed from sea along Karnataka. It is seen that most of the fishes are caught before it gets an opportunity to spawn, thus affecting the spawning and recruitment of the species.

In MDF bycatch was caught maximum in September with high catch rates whereas in SDF high catch and catch rate was observed in January and October. Discarding was high during January-February in SDF and during May-June and September-October in MDF. Catch of juveniles was high in January with high catch rates in October in SDF whereas, high catch and catch rates was recorded in September in MDF. In the study from Kerala discarding was maximum during August-September in 2000-01 and May and September in 2001-02.

The reasons why fish and other marine living organisms are captured and then discarded in the sea were studied by several workers (Saila, 1983; Northridge, 1991; Murray *et al.*, 1992; Pikitch 1992; Murawski, 1993 and Jennings and Kaiser, 1998). The identified reasons can be categorized as follows: (1) physico-biological interaction, (2) economic, and (3) legal. The physico-biological reasons for the capture of unwanted species are due to the facts: (1) target and non-target species co-inhabit the ocean space coming under the influence of the harvesting systems employed, (2) the species encountered may behave differently to the fishing gear and (3) the methods of gear deployment and the physical characteristics of the gear deployed are, for the most part, not species-or sex-specific and in varying degrees, not size-specific. Economic factors underlying discards can involve discards of (1) species for which no reasonable market exists, (2) sizes or sexes of species not acceptable to markets, (3) physically damaged fish, (4) fish generating problems for other species within the catch (slime, abrasiveness, etc.), (5) species which deteriorate rapidly, (6) availability of space and refrigeration on vessels and (7) high-grading.

In Karnataka waters, the maximum discards were stomatopods in SDF and finfishes in MDF. Karnataka lands maximum quantity of

squilla in the country. Squilla accounted for 81 % of the annual landings of trawlers in the southern coasts of India during 1985 - 90 (Menon, 1996). Squilla though not having any economical value have significant ecological importance as it forms one of the food item of a large number of demersal organisms (Mohamed, 2004). Gordon (1991) estimated that 25-30 % of discards were comprised of juvenile shrimps along the Visakhapatnam coast. In the present study juvenile shrimp forms 12.7 % of total discards. Shrimp bycatch in Visakhapatnam is constituted by 85 species (Sivasubramanyam, 1990)

Estimation of discards poses great problem as variations in discarding rates among hauls within trips and within vessels. In Karnataka waters most of the bycatch are brought to the landing centre by SDF trawlers only whereas onboard discarding is observed in MDF where the bycatch obtained in the first few days is thrown back into the sea. Whenever the catches are poor, the bycatch like juveniles of various fish groups will be kept in the freezer and as and when more valuable fish groups are caught and requirement of storage space increases these bycatches are taken to the deck and kept there with little ice ($1/8^{\text{th}}$ quantity of the ice kept for valuable items). The entire bycatch of the last days' haul are kept on the deck and brought to the landing centre in a highly spoiled state. Therefore the estimate of discard by MDF was made by back calculating from the last few hauls with the total number of hauls usually made during the entire voyage. In the case of SDF there is very little discarding to the sea. The present observation agrees with the observations made by (Gordon, 1991). In North Eastern Mediterranean Sea trawling is allowed to be practiced from 50 m depth. Discarding is much higher in areas with 28 mm stretched mesh size than 40 mm stretched mesh size. The present study also agrees that bycatch is more in the SDF trawlers operated in the shallow waters with small mesh size nets.

Conclusion

As in any tropical fishery, bycatch associated with bottom trawling along Karnataka coast is a major component accounting for 54,207 t annually. Bycatch was more in trawls operated in shallow waters while discarding was high in bottom trawls operated in deeper waters. The trawlers use nets with different mesh sizes depending upon the time of trawling and target species. The codend mesh size varies from 10 to 22 which is much lower than the recommended 35 mm. Bycatch problem in Karnataka waters to a greater extent can be reasonably addressed by allowing trawling with nets with bigger mesh sizes and banning of trawling in certain seasons.

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