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Occurrence of Low Value Bycatch in Trawl Fisheries off Karnataka, India

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Abstract

Bottom trawling in the most effective method of shrimp capture but highly intensive trawling adversely affects benthic ecology and biodiversity. The present study is aimed to throw light on low value bycatch (LVB) landings and catch composition of trawl boats, at Mangaluru fisheries harbour. The quantity of fish landings by single day trawlers (SDT) during 2012-14 was 2 151.3 t y^{-1}, of which 61.8% was considered as edible grade and 38.2% was LVB. Multiday trawlers (MDT) landed an estimated 165917.2 t of fishes/yr, out of which 79.6% were marked for edible use and remaining 20.4% was landed as LVB. LVB to target group ratio for SDT and MDT landings was 1:1.66 and 1:3.93, respectively. The LVB of MDT consisted of 121 finfishes belonging to 82 genera, 55 families and 13 orders. An estimated 47.53% of the finfish LVB landing by weight (56.1% by number) was contributed by juveniles of commercially important species and the estimated resource loss was 14044 t by weight and 11000 million in number. From the fishery resource conservation and sustainability point of view, the magnitude of resource damage due to trawl bycatch is alarmingly increasing. The study recommends using trawl nets with 35 mm square mesh codend, effort reduction in critical fishing grounds and adoption of Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) which minimizes juvenile fish catch.

Keywords: Trawl landings, bycatch, resource loss, codend mesh, Mangaluru

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Introduction

India is endowed with a long coastline of 8129 km with an exclusive economic zone of 2.02 million km^2 and a continental shelf area of 0.5 million km^2 (Ayyappan et al., 2011). Marine fish production of India was only 0.5 million t in 1950s and increased to 3.78 million t in 2013 (CMFRI, 2014). Bottom trawling is known to be the most effective method for shrimp capture and is widely accepted in the world. Intensity of trawling has a vicious impact on benthic ecology and biodiversity (Dayton et al., 1995). In fact, 30% of worlds marine fishery resources is over exploited, 60% fully exploited and only 10% moderately exploited (FAO, 2014). Incidental catching of non-target resources has become a serious problem faced by trawl fisheries in the world. Some part of the non-target catch may be retained for sale or use, while others are discarded back into the sea due to number of reasons and the biological and economic loss due to discarding is one of the important issue that has to be tackled by the fishery managers (Clucas, 1997; Kelleher, 2005).

The bottom trawling was first introduced by the Japanese trawler M.S. Kaiko Maru in Karnataka state during 1961. During 1963-67, vessels of the Indo-Norwegian Project conducted systematic exploitation of fishing grounds. Initially trawlers operated 10-15 km offshore, but later shifted to shallow waters which promised good catch (Kurup et al., 1987). The target species of trawlers in Karnataka were high valued prawns, squids, cuttlefish, threadfin breams and ribbonfish (Dineshbabu et al., 2012a). Single day trawlers (SDT) fish near to coast and most of the bycatch is brought to the landing centre. Onboard discarding is done by multi-day trawlers (MDT) where the bycatch obtained in the first few days is thrown back into the sea and the portion retained called trash fish

(Zacharia et al., 2006). Since fish protein landed in any form is having very high demand in fish meal plants, low value bycatch is being landed by the trawlers. Low value bycatch (LVB) consists not only of non-edible fish but also juveniles of commercially important species with the dominance of threadfin breams, flat heads and lizard fishes in Mangaluru (Dineshbabu, 2011; Dineshbabu et al., 2015). Several workers have reported the reasons for discarding of fishes (Saila, 1983; Northridge, 1991; Murawski, 1993; Jennings & Kaiser, 1998; Pillai, 1998; Kumar & Deepthi, 2006; Zacharia et al., 2006). However, the indiscriminate trawling in the last one decade has affected the bottom habitat and the demersal resources as well. There are evidences of a decline in the stocks of few demersal groups and shift in the composition of the landings. The negative impact of bycatch on ecosystems is reported (Hall et al., 2000; Lewison et al., 2004). Bycatch mitigation is also needed in the context of trawling induced mortality of huge quantities of juveniles and sub-adults (Alverson et al., 1994; Pillai, 1998). In order to ensure long-term sustainability of fishery resources, indiscriminate destruction of juveniles and sub-adults must be avoided by allowing them to escape from the fishing gear. This can be achieved through selective fishing practices by deployment of appropriate bycatch reduction devices (BRDs) (Bjordal, 1999).

Boopendranath (2007) had discussed the terminologies used such as gross catch, bycatch, discarded bycatch and retained bycatch. Costa et al. (2008) illustratively classified terminologies to avoid confusion of given terms and definitions: total catch is the quantity of all species brought onboard; target catch is the fraction of the total catch which includes the species towards which the fishing effort is directed (target species); retained (or landed) catch is the part of the total catch that has economic value (i.e. the quantity of target and bycatch species that can be marketed); and total bycatch is the portion of the total catch which includes all the species caught accidentally (non target species). Total bycatch may be retained if it has commercial value (LVB) and/or discarded at sea if it is not used for any purpose (discarded bycatch). A perusal of literature revealed that there is need for regular assessment of bycatch and discards associated with bottom trawling. Hence, the present study is taken up along Mangaluru coast of Karnataka state to understand the present trend of LVB landings and to the extent of resource damage due to indiscriminate fishing and loss of commercially important juveniles.

Materials and Methods

Mangaluru fishing harbour is one of the major landing centres of coastal Karnataka. The sampling station was selected keeping in view variability in fishing grounds, species diversity, fishing methods and landings of huge quantity of LVB from trawlers. Fish landing data were collected from Mangalore fishing harbour from both single day and multiday trawlers separately for 16 days in a month by employing the stratified random sampling design developed by CMFRI during the fishing seasons of 2012-13 and 2013-14. Multiday trawlers engage in fishing for 8 to 10 days in a trip with a break for a day for unloading and trading of ice between the cruises which results in about three trips per month. Hence an unsorted portion of LVB samples preserved in ice were collected thrice a month and brought to the laboratory to identify the fishes up to species level. The fish catch was recorded as those landed for edible purpose and the rest landed as low value bycatch (LVB) for non-edible purpose. Monthly estimates of catch and species composition of low value bycatch were prepared based on data collected (Srinath et al., 2005).

Along with fishing information an unsorted portion of LVB samples were preserved in ice and brought to the laboratory to identify the fishes up to species level (Appeltans et al., 2011; Fischer & Bianchi, 1984; Froese & Pauly, 2011). Qualitative and quantitative analysis of the samples were carried out in the laboratory. Weight of the sample was recorded and the species present in the sample were sorted out. The number, length and weight of individual fin fishes in each group were recorded and raised to the month's finfish LVB catch. Minimum Size at Maturity (MSM) was considered for segregation of juveniles from the adults (Hubbs, 1943). The terms and definitions illustrated by Costa et al. (2008) are used in this paper.

Results and Discussion

Single day trawl (SDT) fishing started in the month of October during 2012-13 and in November for 2013-14. The landings of SDT at Mangaluru during the fishing season of 2012-13 was 2238.8 t, of which 67% was of edible grade and 33% was LVB. It was estimated that during fishing season of 2013-14, out of 2,063.46 t landed, the composition was 56% and

44% respectively (Fig. 1). Seasonal trends in fish landings by single day operating trawlers revealed that the commercial landings showed increasing trend during post monsoon months and the highest landings were recorded in the month of March (338.12 t in 2012-13 and 268.45 t in 2013-14), there after fish landings decreased and lowest landings recorded in the month of May (21.82 t and 36.49 t) for both the fishing seasons. From the results it was depicted that the highest LVB landings was observed in March 2014 (165.20 t) followed by January 2014 (157.27 t). Meanwhile the lowest landings of LVB recorded in October 2012 (4.03 t), followed by May 2013 (75.49 t) (Fig. 2).

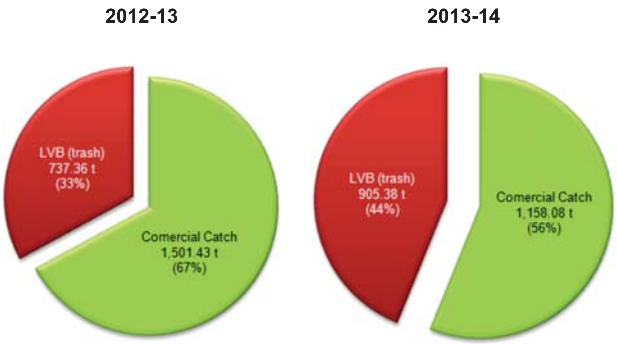

Fig. 1. Landings of commercial fishes and low value bycatch (trash) by SDT

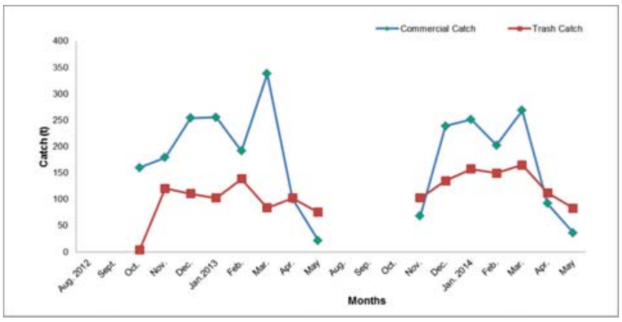

Fig. 2. Monthly variation in the contribution of commercial catch and low value bycatch landings from SDT at Mangalore during 2012-14

LVB to target group ratio for SDT landings was 1: 1.66 for the study period. The catch per unit effort (CPUE) for single day trawler commercial catch landings varied from 0.989 t in February 2014 to 0.306 t in November 2013. On the other side CPUE for LVB landings ranged between 0.573 t in Mar. 2014 to 0.063 t in October 2012 (Table 1). Stomatopods were the major components of LVB by SDT forming 58.5% during 2012-13 and 62.8% during 2013-14 (Table 2). Other than stomatopods, gastropods and crabs contributed substantially to the LVB. Finfishes and cephalopods contributed the least to the LVB.

Multiday trawl (MDT) fishing started immediately after the monsoon fishing ban (10th August) for both fishing seasons. Multiday trawlers engaged in fishing for 8 to 10 days in a trip and reach the waters beyond 120 meter depth. The total quantity landed by MDT was estimated as 17151.02 t in 2012-13, out of which 81% was landed for edible purpose and 19% was landed as LVB. In 2013-14, landing reduced to 160683.38 t out of which only 78% were landed for edible purpose and 22% were landed as LVB (Fig. 3). The seasonal trends in landings by multiday trawlers indicated that, highest quantity of commercial catches were recorded in the beginning months of fishing season for both years *viz.,* October 2013 (22048.44 t) and Sept. 2012 (21802.13 t) thereafter the catches declined throughout the fishing seasons. The maximum LVB landing was recorded in May 2013 (5270.27 t) followed by April 2014 (5184.72 t). The lowest landing of LVB was recorded in August (169.38 t and 218.32 t) for both the fishing seasons (Fig. 4).

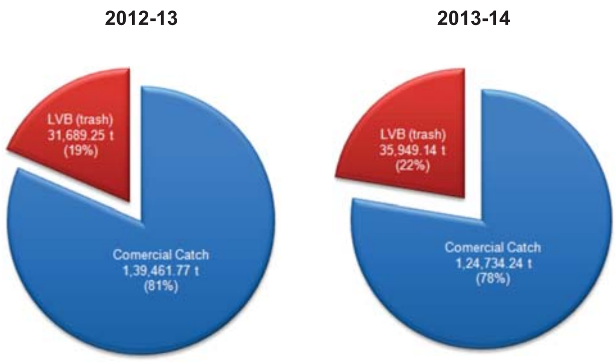

Fig. 3. Landings of commercial fishes and low value bycatch (trash) by MDT

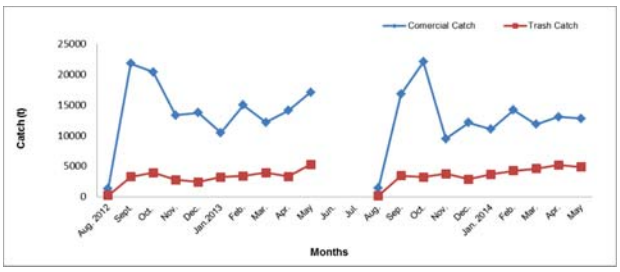

Fig. 4. Monthly variation in the contribution of commercial catch and low value bycatch landings from MDT at Mangalore during 2012-14

Table 1. Monthly variation in CPUE of Trawl landings (SDT & MDT) at Mangalore during 2012-14

Fish catch	Commercial catch		LVB or Trash	
Month	SDT (t)	MDT (t)	SDT (t)	MDT (t)
August 2012	--	7.35	--	0.62
Sept.	--	9.04	--	1.73
October	0.362	8.85	0.063	3.23
November	0.835	7.63	0.445	1.27
December	0.758	7.81	0.386	1.05
January2013	0.945	5.08	0.315	1.62
February	0.821	8.36	0.437	2.23
Mar.	0.759	6.15	0.283	3.12
April	0.672	8.18	0.354	2.18
May	0.510	7.67	0.270	4.85
June	--	--	--	--
July	--	--	--	--
August 2013	--	8.07	--	0.57
September	--	8.52	--	2.41
October	--	9.38	--	1.69
November	0.306	4.85	0.335	3.03
December	0.547	5.72	0.523	1.34
January 2014	0.698	5.13	0.564	2.93
February	0.989	8.21	0.556	3.75
March	0.610	5.38	0.573	4.12
April	0.515	7.17	0.418	4.51
May	0.346	6.35	0.308	4.27
Average	0.638 t	7.29 t	0.389 t	2.52 t

The ratio of LVB to target group in MDT landings was 1:3.93 for the study period. CPUE for MDT commercial catch recorded as high as 9.38 t $trip^{-1}$ in October 2013 to the lowest 4.85 t in November 2013. CPUE for LVB landings varied between 4.85 t $trip^{-1}$ in the month of May 2013 to only 0.57 t in August 2013 (Table 1). Finfish were the dominant group landed as LVB with contribution of 86.25% during 2012-13 and 88.34% in 2013-14 followed by cephalopods, crustaceans, bivalves and gastropods (Table 3).

Table 2. List of major groups and their percentage composition of LVB (trash) landed by SDT during 2012-14

Group	Percentage composition	
	2012-13	2013-14
Stomatopods	58.5	62.8
Gastropods	17.2	12.4
Crabs	14.5	16.7
Finfish	8.6	7.2
Cephalopods	1.2	0.9

Table 3. List of major groups and their percentage composition of LVB (trash) landed by MDT during 2012-14

Group	Percentage composition	
	2012-13	2013-14
Finfish	86.25	88.34
Cephalopods	8.26	7.47
Crustaceans	2.84	2.14
Bivalves	1.62	1.25
Gastropods	1.03	0.80

Extensive samples of LVB of multiday trawlers were analysed and 121 finfish species belonging to 82 genera, 55 families and 13 orders were identified. Order Perciformes was the most diversified group having 74 fish species followed by Clupeiformes with 13 species, Aulopiformes and Scorpaeniformes with six species each, Pleuronectiformes, Siluriformes and Tetraodontiformes with four species each, Anguilliformes and Lophiiformes with three species each to the total fish species, whereas other orders represented by single species each (Fig. 5). Among the families, family Carangidae represented by 14 species to the total number of species, followed by Engraulidae and Leiognathidae with eightspecies each, Synodontidae with six species, Sciaenidae with five species, Nemipteridae and Scombridae with four species each, Clupeidae, Mullidae, Lutjanidae, Serranidae, Sphyraenidae, Teraponidae, Scorpaenidae and Ariidae with two species each to the total fish species and the remaining families were contributed single species each (Fig. 6).

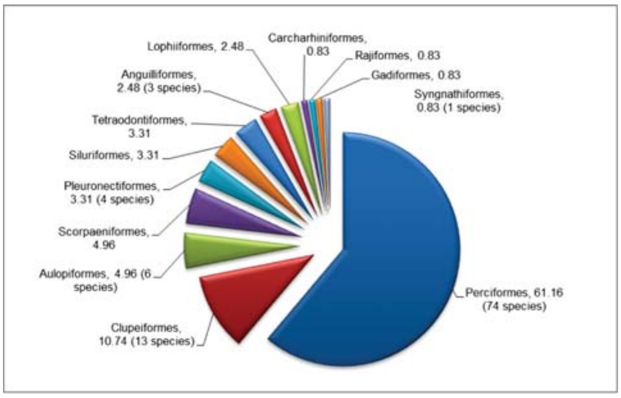

Fig. 5. Diagrammatic representation of the % number contribution of each order during 2012-14

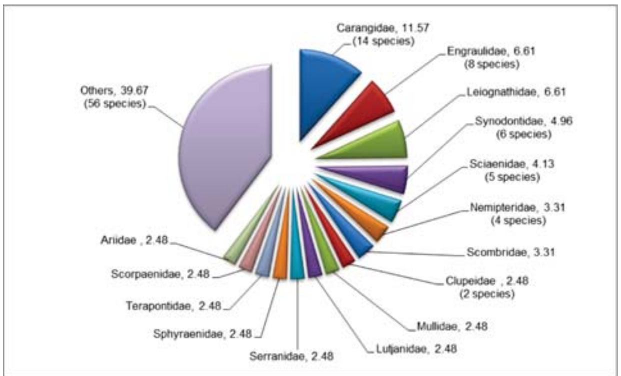

Fig. 6. Diagrammatic representation of the % number contribution of each family during 2012-14

Major portion of the LVB by weight was *Lagocephalus inermis* contributing 6788.40 t to the total finfish LVB landings with 23% of weight followed by *Decapterus russelli* with 5347.22 t (18%) and *Trichiurus lepturus* with 1978.70 t (7%). By numbers, *Decapterus russelli* was the most dominant species which contributed 16.16% to the total number of fish landed followed by *Lagocephalus inermis* (14.32%) and *Saurida tumbil* (7.57%). An estimated 46.56% (12725 t) of bycatch landings were constituted by juveniles of commercially important finfishes in 2012-13, in terms of number the estimated loss was 56.51% (1056 million). In 2013-14 the juvenile contribution was 46.92% by weight (14900 t) and 56.51% by number (1145 million). The first global estimate of bycatch was approximately 12 million t (Slavin, 1981). A detailed examination of bycatch in world fisheries was made by Saila (1983) who revealed that the minimum world discards of fish and shellfish were 6.72 million t in shrimp fisheries. It was observed by Rao (1988) that the quantity of bycatch discarded in Visakhapatnam (India) depends on the demand for finfishes in the external and domestic market. Single day trawlers generally starts their voyage in the month of October or November in Karnataka state and operate in waters up to 30 meter depth and entire catch is brought to shore, which is separated as commercial catch and the rest as low value bycatch. The landing of LVB from SDT at Mangaluru during the fishing season of 2012-13 was 33% (737.36 t) and during 2013-14 fishing season it was 44% (905.38 t). Multiday trawlers generally operate up to 180 m depth and in earlier years they use to bring LVB of last two to three days, but currently the trend has changed due to high demand for LVB from fish meal and poultry feed industries. The total quantity of LVB landed by MDT was estimated as 19% (31,689.25 t) for the fishing season of 2012-13 and 22% (35949.14 t) for 2013-14. Zacharia et al. (2006) assessed the bycatch and discards associated with bottom trawling along Karnataka coast. The bycatch landed from SDT was 52.3% in 2001 and 60.2% in 2002. Muliday trawlers contributed 52.3% as LVB in 2001 and 51.75% during 2002. About 30% of total catch from MDT was discarded whereas it was about 44% from SDT. Dineshbabu et al. (2012a) reported that, the LVB landing of SDT at Mangaluru in 2008 was 26% of the total landings, whereas in 2009 the LVB composition was 47%. In 2008, a total of 1 00 002 t of fishes were landed by MDT out of which 98% were considered as edible and rest was LVB.

Andrew & Pepperell, 1992 have reported than in tropical shrimp fishing the weight of bycatch can be 5-10 times greater than target catch. LVB to target group ratio for SDT and MDT landings during 2012-14 was 1: 1.66 and 1 : 3.93. The LVB landings for single day trawler varied from 0.573 t in March 2014 to 0.063 t in October 2012 with an average landing of 0.389 t. However the LVB landings by MDT recorded from as high as 4.85 t in May 2013 to 0.57 t in August 2013 with an average landing of 2.52 t trip^{-1} for the study period. Menon et al. (2000) revealed that the ratio of target: bycatch along the southwest and southeast regions of India were 1 : 4.6 and 1 : 1.26 respectively. According to Zacharia et al. (2006) the discard rate ranged from 7.5 kg h^{-1} to 27.0 kg h^{-1} in SDT and from 2.0 kg h^{-1} to 16.7 kg h^{-1} in MDT operated along the Karnataka coast. The studies conducted on the year wise bycatch landings at Calicut showed that the bycatch rate ranged between 23.18 kg h^{-1} in January and 74.87 in August.

Seasonal trends in landing of LVB by single day operating trawlers showed that highest LVB landings was observed in March 2014 (165.20 t) followed by January 2014 (157.27 t), February 2014 (149.41 t). In case of multiday trawlers, maximum LVB landing was recorded in May 2013 (5270.27 t) followed by April 2014 (5184.72 t). Hence the results of present study revealed that highest landings of LVB during pre-monsoon months when the conditions were favourable for fish drying and the demand for LVB was maximum, followed by post monsoon months than monsoon months. Zacharia et al. (2006) have recorded highest bycatch in March followed by May in multiday trawlers in 2002 and the discards were more in post-monsoon months than other months. In Mangaluru it was observed that highest landing of LVB was observed during pre-monsoon months of 2008-2009, when conditions were favourable for fish drying and the demand for LVB was maximum (Dineshbabu et al. 2012a). Monthly contribution of low value bycatch in Calicut ranged between 730 t in August and 1716 t in the month of May (Manojkumar & Pavithran, 2012).

In SDT, stomatopods were the major components of LVB, contributing on an average 61% during 2012-14, whereas major groups landed by MDT were finfishes (avg. 87%). Menon (1996) studied impact of bottom trawling on exploited resources along the southern region of Karnataka, Kerala and Tamil Nadu and found that the quantity of bycatch landed by trawlers in the above states was dominated by stomatopods in SDT and finfishes in MDT. Zacharia et al. (2006) reported that the bycatch of trawl boats in Mangaluru was predominated by stomatopods (39%) in SDT while finfishes (69%) were the dominant group in MDT. Dineshbabu et al. (2014) reported that finfish was the major component of LVB landed by multiday trawlers in Mangaluru and Calicut, and varied between 85 to 90%.

Considerable quantity of landings of LVB during the months of Sept. (Avg. 3,327.69 t), October (Avg. 3583.9 t) and November (Avg. 3372.23 t) during the study period shows the changed trends in LVB utilization in Mangaluru fishery harbour. However, with the dwindling returns from the fishing these trawlers have no options other than increase the utilization of LVB. Landing of LVB also helps to manage financial crisis during lesser catch of commercial fishes to partly meet the expenditure of fuel by fetching Rs. 8 kg^{-1} during post monsoon months to Rs. 16 kg^{-1} during pre-monsoon months. Dineshbabu et al. (2014) studied the changing trends in trawl bycatch utilization along the coast of India. They observed that though the highest annual LVB landing was recorded in Veraval (50000 t) the value realisation was highest in Mangaluru (Rs. 280 million) due to high demand for finfish (85 to 90%) dominated LVB landed by multiday trawlers. In Mangaluru the LVB was landed in semi preserved form by multiday trawlers fetched as high as Rs. 12 kg^{-1} in 2011, which was mainly used for fish meal preparation. SDT landed trash dominated by molluscs and crustaceans fetched only Rs. 4 kg^{-1}, which was mainly used for drying for low cost fishmeal. It was also observed that during summer period the value realized for the landed LVB gone up to Rs. 16 kg^{-1} in Mangaluru.

Analysis of LVB samples from multiday trawlers of Mangaluru in 2012-14 showed 121 species of finfishes, among them 74 fish species belonged to the order Perciformes followed by followed by Clupeiformes (8 species). While 14 species represented from the family Carangidae followed by Engraulidae and Leiognathidae (8 species each). Sujatha (1995) studied finfish constituents of trawl bycatch off Vishakapatanam and found that he discards included 228 species belonging to 68 families as a constituent of finfish bycatch. According to the observations of Pravin & Manohardoss (1996) 87 species belonging to 42 families constituted 82.7% of the low value bycatch landed by mechanised trawlers operating off Veraval. Sciaenids were the major group contributed 15.6%, followed by engraulids (12.84%), ribbon fishes (8.9%) and other fishes. Kurup et al. (2003) reported that the discards from bottom trawlers of Kerala coast were represented mainly by epifaunal species and juveniles of commercially valuable species and the discards were represented by 103 species of finfishes. Bycatch composition of trawl fishery of Malpe and Mangaluru was examined by Zacharia et al. (2006). The discarded catch in MDT 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). Bijukumar & Deepthi (2009) assessed bycatch composition of trawl landings of Kerala coast and recorded 217 species of fishes in the trawl bycatch, classified under 21 orders, 88 families and 155 genera, were represented predominantly by demersal (79 species) and reef-associated forms (78 species).

Lagocephalus inermis contributed 6788.40 t (23%) to the total finfish LVB landings during the present study period, followed by *Decapterus russelli* (18%) and by numbers, *Decapterus russelli* contributed 16.16% to the total number of fish landed followed by *Lagocephalus inermis* (14.32%). Dineshbabu et al. (2012a) reported a total of 123 species from LVB landing of SDT at Mangaluru. Stomatopods were the major components of the LVB. During 2008-2009 a total 198 species were identified from discard samples of MDT. Among them, 116 species of finfishes, 31 species of gastropods, 4 species of bivalves, 7 species of cephalopods, 13 species of shrimps, 3 species of stomatopods, 21 species of crabs, 3 species of lobsters and juveniles of unidentified sharks and rays were recorded. *Saurida* spp. contributed maximum portion to the low value bycatch by weight (12.65%) in 2008 followed by *Lagocephalus inermis* (11.2%) and during 2009 the species *Lagocephalus inermis* formed highest constituent (13.6%) followed by *Nemipterus* spp (11.4%). Dineshbabu et al. (2014) observed that the demand and price of LVB is determined by the species composition of LVB and finfish dominated LVB had better demand from fish meal plants. A total 95 species of finfishes, 27 species of crustaceans and 20 species of molluscs were identified from LVB landings at Mangaluru during 2007-2011. *Lagocephalus inermis* (12.80%) contributed a major portion to the bycatch by weight, followed by *Saurida* spp (11.705), *Decapterus* sp. (10.63%) *Sardinella longiceps* (8.59%) *Nemipterus* spp (8.56%), lesser sardines (5.93%), *Platycephalus* spp (4.06%) and other species. Further, it was also noticed that the species composition of LVB in the south west coast of India showed higher percentage of finfishes than those in east coast and that of northwest coast of India.

It is significant to note that the LVB contained juveniles of all commercial species and those in the early stages of development, which were invariably discarded leading to the depletion of the resources (Pillai, 1998; Pillai et al., 2004; Dineshbabu, 2011). To know the impact of trawl fishing with small codend meshes, the resource loss was estimated by assessing the juveniles in LVB landings. The juveniles of commercially important finfishes landed in LVB formed 14044 t during 2012-14, while the estimated loss in number was 1100 million. Juveniles of commercially important fishes constituted 46.56% of bycatch landings (55.64% by number) in 2012-13. The juvenile contribution in 2013-14 was 46.92% (56.51% by number). Sivasubramanyam (1990) reported that 50% of the bycatch sample studied was immature fish in trawlers from Bay of Bengal. Luther & Sastry (1993) studied the occurrence of spawners, juveniles, and young fish in relation to fishery seasons of some major fishery resources of India. They observed a bulk of the landings in different maritime states in different fishery comprised of juveniles. Menon (1996) estimated that 6,200 t of juvenile fish and prawns were discarded back into the sea during 1980-84 along the southwest coast of India. Pillai (1998) also observed that 40% of the catch from Indian seas was constituted by juveniles. Zacharia et al. (2006) observed that in Karnataka, juveniles contributed 36% of discards (15.9% of total catch) in single day fishing and 78% (23.5% of total catch) in multi-day fishing. Annually 14400 t of juveniles of finfishes, 2448 t of shrimps, 1673 t of cephalopods and 1702 t of crabs besides 4059 t of juveniles of other groups were removed by bottom trawling. Dineshbabu & Radhakrishnan (2009) projected that the threadfin breams exploited by trawlers of Mangaluru showed that the fishery loss due to juvenile catch of the species in Mangaluru was 7% by weight and 22% by value, and the economic loss was estimated at Rs. 286 lakhs annually.

From the fisheries sustainability point of view, resource loss in terms of number is more important than the weight, since maximum portion of the LVB were juveniles which form the backbone of the fishery for future. Dineshbabu et al. (2012a) observed that juveniles of commercial species formed 34% of the discards and in terms of number they formed 44% during 2008-2009. The discards constituted almost all commercial species and juveniles of pelagic fishes. In 2008-2009 total 37533 t of discards were estimated for Mangaluru Fisheries. Juveniles of *Platycephalus* sp. comprised about 2733 t in discards during this period and the discarded number estimated was 464 million. *Nemipterus randalli,* one of the highest contributor to trawl landings at Mangaluru, also contributed considerably to the discards and the quantity discarded in weight and numbers were 1341 t and 333 million respectively. The implications of Trawl bycatch on marine ecosystem along the south west coast of India have been highlighted by Zacharia et al. (2006) and Kumar & Deepthi (2006). Preliminary experiments of GIS based studies on spatio-temporal resource mapping for identification of critical fishing grounds and to employ spatial restriction and effort restriction have shown the positive prospects to conserve marine fisheries resources (Dineshbabu et al. 2012b). Stock assessments play major role in fisheries management policies, are generally on landing data of commercial fishery by ignoring the volume of juveniles landed in LVB, resulting in underestimation of year class strength (Casey, 1993; Dingsor 2001). The detailed study carried out by Kurup et al. (2003) on the trawl bycatch of Kerala, suggested that the discarded quantity also need to be added to arrive at reasonable estimates of the total removal of fishes from the sea.

Bycatch associated with bottom trawling has become major component of impact of fisheries on marine ecosystem in almost all tropical countries. The increased demand and high economic value for shrimps and bottom dwelling fishes are considered to be the principal reason for the expansion of trawl fishing throughout Indian coast. The high investment and fluctuating returns from commercial fisheries and demand for LVB from array of fish meal plants and feed industries encourage the trawl operators to land LVB in higher quantities. Utilisation of LVB also compensates the operational cost of trawl fishery to some extent. Even though it is often argued that better utilisation of the bycatch is a solution for problem, its impact on the fish stock and traditional fisheries remains to be investigated. There is a need for regular assessment of bycatch and discards associated with bottom trawling to understand the extent of resource damage due to indiscriminate fishing. Since trawl fishery is the backbone of Indian marine fisheries, bycatch is unavoidable in multi-species scenario. Declaration of certain coastal areas as closed for trawling, usage of bigger codend meshes, and adoption of Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) in trawls and restrictions on maximum engine power would help in reducing the amount of juveniles of commercially important fishes in LVB landings as well as conservation of marine organisms along the coastal areas of India.

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