Bycatch issues in Ring seine sector

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Introduction

Bycatch and discards are one of the major problems faced in the fishing industry globally. Bycatch is defined as that portion of catch other than targeted species caught while fishing which are either retained or discarded. Discarding is the practice of returning an unwanted portion of the catch back to the sea during fishing operations (Alverson et al., 1994). Fish are discarded for various reasons at sea, representing a waste of fishery resources and potential food (Clucas, 1997). Bycatch is recognized as unavoidable in fisheries but the quantity varies according to the gear operated (Riedel and DeAlteris, 1995; Clucas, 1998; Pillai, 1998; Ortiz et al., 2000; Hall et al., 2000; Gibin, 2008). Bycatch and discards pose a threat to biodiversity and long term sustainability of fishery resources. About 30% of the world's marine fishery resources is over exploited, 60% fully exploited and only 10% moderately exploited (DAHDF, 2014). Overexploitation of bycatch and target species in marine capture fisheries is the most widespread and driver of change and loss of global marine biodiversity (Gilman, 2011).

In Indian scenario, it is estimated that about 56.3% of the total catch of shrimp trawlers is bycatch (Pramod, 2010). In India bycatch is considered as a major threat and has been reported by several authors (Boopendranath, 2003; Sivasubramanyam, 1990; Gorden, 1990; Menon, 1996; Rao, 1998; Madhu et al., 2017).

Surrounding nets

Surrounding nets are roughly rectangular walls of netting rigged with floats and sinkers which after detection of the presence of fish are cast to encircle the fish school. Surrounding nets are generally operated in the surface area. Purse seines are the predominant type of surrounding nets (Meenakumari et. al., 2009). Purse seine fishing is one of the most aggressive, efficient and advanced fishing methods. It is aimed mainly at catching dense, mobile schools of pelagic fish and includes all the elements of searching, hunting and capture. The schools of fishes are surrounded and impounded by means of large surrounding net.

Beach seines have been used through the ages almost all over the world. According to Brandt (2005), seine nets (sagene) were used early Greeks in third millennium BC. Later Romans employed a large gear which they called 'sagena', and as they occupied very large areas of Europe this net was introduced by them to many countries. In France, the gear is known as 'seine' or 'senne' and, in the British Isles, as 'seine net' the gear is now known all over the world. They are usually deeper than the depth of the water. The top edge is framed with a float line and lower edge with a lead line. It is set in semi-circle at some distance from the shore and then hauled ashore onto the beach using long ropes. During hauling, the beach seine filters the enclosed waters from the surface to the bottom. As soon as the wing tips come within the reach of the fishermen they bring the lead line of both wings together in order to gather the fish towards the center. The bunt part with the catch inside is the last part to be brought ashore. In

purse seines, a pursing arrangement is incorporated in order to close the net at the bottom after surrounding a shoal of fish. This facilitated the operation of net in deeper waters.

A purse seine is made of long wall netting framed with float line and lead line and having purse rings hanging from the lower edge of the gear, through which a purse line made from steel wire or rope which allow the pursing of the net (Nedlec, 1982; Brandt, 1984). Thus, a bowl like space is created in which the fishes are enclosed and prevented from escaping. Modern purse seines were introduced in commercial fisheries more than a hundred years ago (Skogsberg, 1923). Description of the purse seines and their operation have been given by Ben-Yami (1994), Masthawee (1986), Sainsbury (1996), Hameed and Boopendranath (2000) and others. Advances in purse seining were supported by the introduction of high tenacity synthetic twines of high specific gravity, improvements in vessel technology and gear handling equipment's such as puretic power block, fish aggregation techniques, acoustic fish detection and remote sensing techniques (Ben-Yami, 1994 and Hameed and Boopendranath, 2000).

In some parts of the world, purse seining produces the largest single catches of pelagic fishes. Purse seine fishery for tuna is carried out over a far greater geographical area. Purse seines are also used to catch the demersal fish such as cod by modifying its design to operate close to the bottom. However, the major contributor to the purse seine fisheries of the world is the vast number of smaller vessels landing small pelagic species. A conservative estimate of percentage of the world catch caught by surrounding nets fisheries would be 25 to 30 % of the world catch. (Ben Yami, 1994).

Boat seines and shore seines are the age-old fishing methods of Kerala marine fisheries. The different regional names of boat seines, are arakollivala, ayilakouivala, choodavala, discovala, deppavala, ringvala, kudukkuvala, thanguvala, kollivala, koruvala, mathkollivala, paithuvala (Pillai et. al., 2000). According to FAO (1984) thanguvala is a lampara-type net with 150 m in length and operated from beach landing canoes (thanguvallams) of length 15 m, beam 1.4 m, and depth 0.85 m. The earlier versions of thanguvallams were made as dugout canoes. The first trials with motorization of the thanguvallam were made by the Indo-Norwegian Project in Neendakara around 1955. In September 1980, new motorization trials were started by the Kerala Fishermen's Welfare Corporation in Purakkad near Alleppey with inboard diesel engine of 9 hp, outboard diesel engine of 5 hp, and outboard kerosene engine of 7 hp. With a continuous improvement, the motorization program was a grand success and it spread throughout the entire coast of Kerala. Commercial purse-seine fishing started during the late seventies in Cochin, Kerala (Jacob et al., 1987) and the process of large-scale motorisation of country craft began in the early eighties. The eighties were an important period in the development of marine fisheries in Kerala. In the first half of the period the motorized sector grew rapidly and the adoption and popularization of ring seines in the mid-eighties was the single most significant development in the post motorisation of Kerala fisheries.

Evolution of Ring Seine Fishery

The ring seine or mini purse seine gear was first introduced by the Central Institute of Fisheries Technology as new gear for the traditional craft (Panicker et al., 1985). After the popularisation

of ring seine, the koruvala and kollivala become obsolete. Nair and Chidambaram (1951) reported during the period 1895, oil sardines were caught in boat seines (paithuvala, odamvala, etc.) for day fishing. Nair and Chidambaram (1951) have conducted a detailed study about the craft and gear employed for exploiting small pelagic fishery, fishing method and fishing seasons during which they observed the seine nets (mathikollivala and ailakollivala) made of hemp with 50-60 ft in length.

Pramod (2010) states that ban on purse seining initiated in the eighties to prevent loss of livelihood for traditional fishers, and an improvised gear called “ring seine” was developed from a traditional seine gear. Ring seine operation started in Kerala with plank built canoes. The large and medium sized plank built canoes locally called as thanguvallam and dugout canoes are used for the operation of the gear. There is no difference in the pattern of operation by these two categories of canoes except in the size of the net. The plank canoes use bigger size (length and breadth) of nets depending up on its accommodation capacity. There is also considerable variation between regions in the number of craft used for a ring seine unit. The ring seiners with 30 to 32 ft LOA having 8 to 15hp or 9.9 hp Suzuki engines used for propulsion of the craft was reported by D’Cruz (1998). However, in certain cases, two engines are also used in a single unit. These are necessitated by the total load of the large gear, 20-30 crew members and bulky catch.

Presently in Kerala the ring seine belt extends from Muthalampozhi in Thiruvananthapuram district to Talapady in Kasaragod (Edwin and Das, 2015). Each region has its own peculiarities in construction and operation of the gear. After the success of the ring seine fishery it spread to the other parts of the country including Andaman and Nicobar Islands and contribute 8.8 to 18.3 % of the total marine production of the country with 2.01 to 6.63 lakhs tonnes (Sivadas et al., 2015). In the state of Kerala ring seine contributed major share to capture fisheries (50.11%). Out of this, it contributes 92 % of sardine, 41.8% of mackerel, 82.8% of white baits, 13.3 % of carangids (CMFRI, 2013).

Structure of Ring Seine Net

Although there is great variation in the details of ring seines, not only in different fisheries but in each individual fishery, nevertheless there has evolved a certain basic design. The structure of the ring seine has many features of the purse seine and of the lampara. All three are kept on the surface of the water by a similar float line strung with floats, and are hung vertically in the water by a heavily weighted lead line. The ring seine, like the purse seine, has purse rings along its lower edge. Some of the chief structural differences between the ring seine and the purse seine are that the purse seine is made of comparatively heavy tarred webbing, is practically uniform throughout its entire length, and is practically square on the ends; while the ring seine, like the lampara, is made of light webbing, is gathered on the ends, and is made in three parts: a central bunt of thick webbing and two end portions or wings. The relative lengths of bunt and wings vary greatly.

The introduction of ring seine, offered an efficient alternative gear for operation from the boat seine craft thanguvallam in the artisanal sector. Along with CIFT's introduction and

popularisation of ring seines in Cochin and Kasaragod areas, other developments were initiated by fishermen (Rajan, 1993) contributing to easy acceptance of ring seines. According to Shyam et al. (2012), modification of the traditional boat seine vessels to make it more efficient resulted a most popular seining method for the pelagics along Kerala coast.

Typical cotton thanguvala of the early sixties described by Kuriyan et al. (1962) had a length of 42m and a depth of 5.2m. The mini- purse seine introduced by CIFT with an overall length of 250m and a depth of 15m at the wing end and 33m at the bunt. It is seen that the number of ring seine units as per estimates of 1992 was 2229 and the number further rose to 2875 by 2005 (GoK, 2005) as against the 300 recommended by the Central Institute of Fisheries Technology (Panicker et al., 1985). A number of variations have occurred in the design of the gear due to innovations by the traditional fishermen (Edwin and Hridayanathan, 1996; Vijayan et al., 2000). The impact of transition from the traditional boat seine, thanguvala or koruvala operated from thanguvallam (traditional boat seine craft) to the present-day ring seine has been studied by Achari (1993).

Many authors have studied the structural variations of ring seines of Kerala. According to the census conducted by SIFFS the ring seines are classified according to the type of craft, mesh size and size of gear (SIFFS, 1992). Rajan, (1993) classifies ring seines based on the number of crafts used for operation. The design and operational aspects of the ring seines prevalent in the Alleppey- Cochin coast was described by Edwin and Hridayanathan (1996). Rajan (1993) describes the salient features of the ring seine unit along Kerala coast. The size of gear as reported by Edwin and Hridayanathan (1996) showed that average length of a thanguvala of Alleppey region was 630m and depth 100m with a mesh 18-20mm. The thanguvala reported by D'Cruz (1998) showed that the thanguvala had further grown in dimensions and due to the large size of the nets, trolleys are used for transportation of the gear. The studies by Kurup and Radhika (2003) showed that the ring seines of Kerala had a length of 800-1700m with bunt mesh size of 16mm. Large ring seines up to 900m length and 90m depths were reported by Krishna et al. (2004) from Thrissur District and such gear could not be lifted manually. Edwin et al. (2010) reported ring seines with a mesh size of 20 mm with a length and depth of 600-1000 m and 83-100 m respectively and having a weight of 1500 to 2500 kg is targeted to catch the pelagic shoaling fishes like the sardines and mackerel in Ernakulam district. Edwin and Das (2015) describe the regional and structural variation of ring seine fishing systems of Kerala in detail.

Ring Seine Fishing Vessels

The introduction of ring seine offered an efficient alternative gear for operation from the boat seine craft thanguvallam in the artisanal sector. With CIFT's introduction and popularisation of ring seines in Cochin, other improvisation were initiated by fishermen in Kasaragod areas (Rajan, 1993) contributing to easy acceptance of ring seines. The ring seiners of Kerala are classified mainly in to two classes; outboard engine propelled motorized and the inboard engine driven mechanized ring seiners. The motorized ring seine fishery depict regional, operational

and structural differences. Among mechanized ring seine units, regional differences are limited and are similar in all districts.

Motorized Ring Seiners: Three types of motorized ring seine are commonly operated in Kerala. Large motorized ring seine vessels made of wood or FRP with an assisting skiff vessel are commonly observed in Thiruvananthapuram to Kozhikode districts. The fishing vessels used for operation are of 7.6-14.6 m and propelled with 25 and/or 40 hp outboard engine. Two types of fishing gear are used in such units i) 200- 500 m in length and 40-60 m in depth with mesh size of 10-14mm and ii) 350-650 m in length and 50-70 m in depth with mesh size of 16-22mm. Large motorized units have one additional carrier vessel for transporting the catch to the landing center.

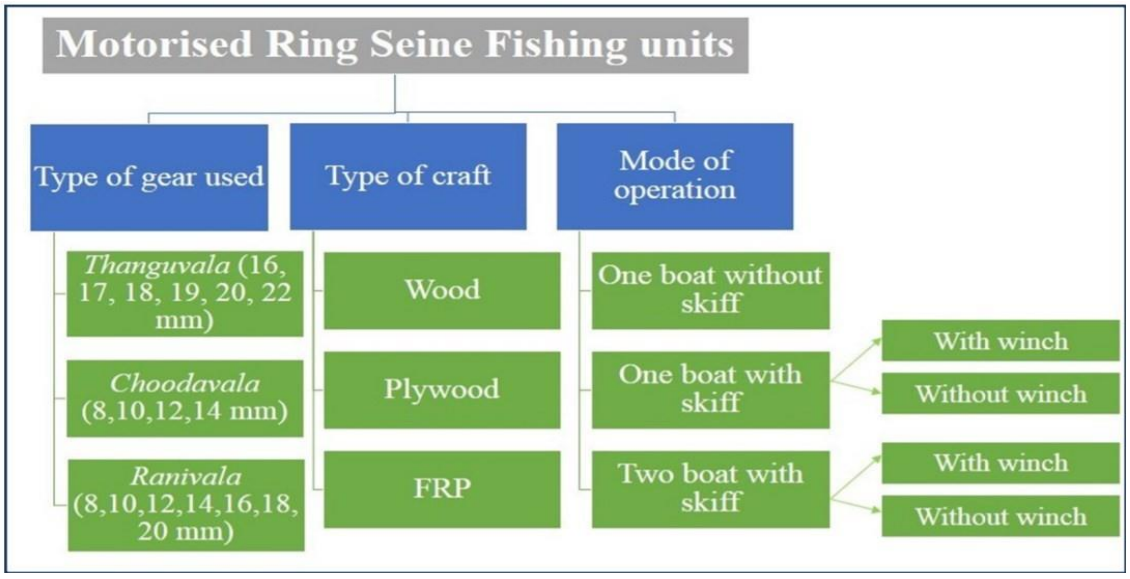

Fig.1. Classification of Motorised ring seiners of Kerala

One boat operation with a small FRP boat in near shore waters is widely prevalent in the districts of Alappuzha, Ernakulam and Kozhikode. In Alappuzha this type of fishing is locally known as sundarivala and in Kozhikode as ossamvala. The ring seine unit comprises of a 6.1-7.6 m wood /FRP fishing vessel propelled by one or two 9.9 hp outboard engines using a fishing gear of 130 -210 m in length and 35-45 m in depth with a mesh size of 8-10 mm.

The third type of motorized ring seine fishing unit is the ranivala, which is a common practice in the northern part of Kozhikode district, Kannur and Kasargod. Ranivala unit consists of three to six numbers of motorized craft, one large craft with fishing gear (ring seine) and known as valavallam of 9.8 – 11.6 m LOA fitted with 25 hp or two 9.9 hp or a combination of 25 hp and 9.9 hp OBM engines for propulsion.

Mechanised Ring Seiners: The number of mechanised ring seiners are less, compared to the motorised units. The common construction materials for mechanised ring seiners are steel, wood and FRP. The wooden ring seiner are restricted to an LOA of 70 m and the newly constructed inboard ring seiner are either steel or FRP construction. In northern districts like Kasaragod, Kannur and northern side of Calicut region mechanised ring seiners are of FRP construction. In southern region of Kerala coast steel and FRP ring seiners are in operation. In

central Kerala steel ring seine units dominated and the number of skiff (carrier) vessels associated with a mechanised ring seine fishing unit also varied with region. In Kozhikode and Malappuram districts ring seiners with three to four carrier vessels are a common sight.

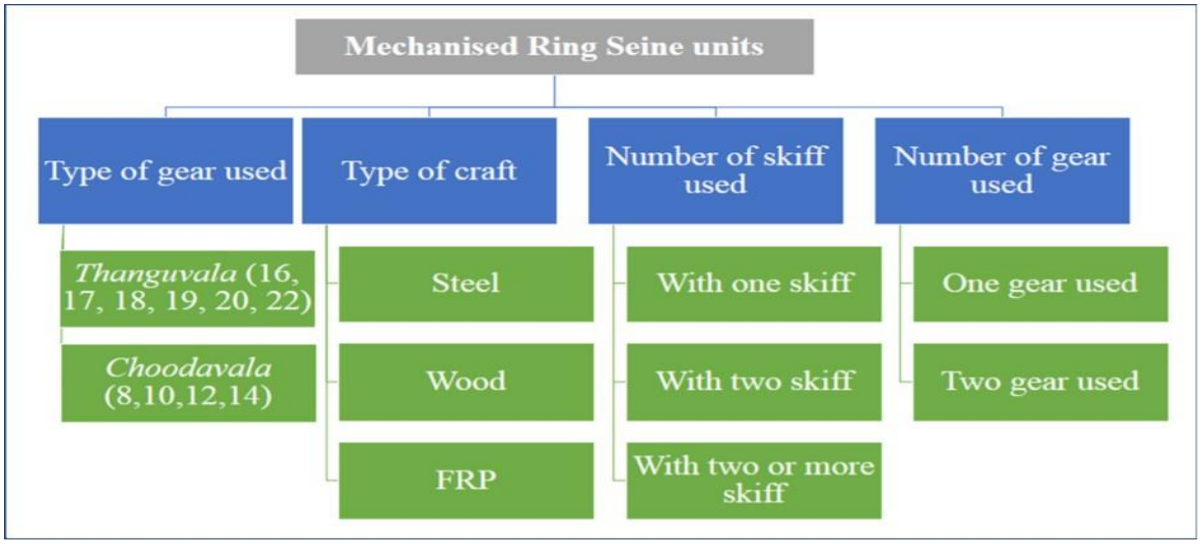

Fig. 2. Classification of the Mechanised Ring seine units

Bycatch occurrence in ring seines

Ring seines are usually defined as mobile gears intended to catch pelagic fishes are showing a changing pattern in its species diversity. Ninety percent of the ring seine catch comprises of targeted species like sardine, mackerel, anchovies and tunas along with 10% of non-targeted species like Thryssa spp, lesser sardine, carangids and seer fish in Andhra Pradesh region (Rajeswari et al., 2013). Bycatch studies in ring seines are scarce.

According to the study conducted by ICAR-CIFT it is shown that Large meshed ring seine (LMRS) targeted catch was 112379kg and bycatch constituted 8677kg. Small meshed ring seine (SMRS) the targeted catch was146520kg and bycatch accounted 50222kg. A total of 56 bycatch species were identified from ring seines. The targeted groups were sardine, mackerel, anchovies and prawns and the non-targeted groups were mullets, ambassids, half beaks, pomfrets, sciaenids, carangids, catfishes, silver bellies and miscellaneous (mixed group) of fishes.

The major pelagic resources constituted in bycatch were *Escualosa thoracata, Nematalosa nasus, Opisthopterus tardoore, Anadontostoma chacunda, Thryssa dussumieri, Thryssa hamiltonii, Thryssa mystax, Thryssa vitrirostris, Thryssa purava, Megalaspis cordyla, Caranx hippos, Caranx ignobilis, Alepes djedaba, Alepes klenii, Parastromateus niger, Scomberoides commersonianus, Sphyraena obstusata, Polynemus plebeius, Lepturacanthus savala, Scomberomorus guttatus, Valamugil cunnesius, Valamugil seheli, Mugil cephalus, Exocoetus volitans, Hyporhamphus limbatus*.

The major demersal resources constituted in bycatch were *Gerres poieti, Gerres filamentosus, Pampus argenteus, Pampus chinensis, Lactarius lactarius, Scatophagus argus, Secutor*

ruconius, Secutor insidiator, Leiognathus splendens, Leiognathus brevirostris, Siganus canaliculatus, Trypouchen vagina, Acanthurus pyroferus, Sillago sihama, Epinephelus ongus, Epinephelus diacanthus, Johnius belangerii, Johnius glaucus, Kathala axillaris, Ambassis gymnocephalus, Cynoglossus macrostomus, Cynoglossus bilineatus, Cynoglossus arel, Arius caelatus, Arius arius, Arius dussumsieri, Arius maculates, Lagocephalus inermis, Ostracion cubicus, Pisodonophis cancrivorus.

In LMRS, bycatch constituted 7.7% of the total catch. There were 29 species belonging to 22 genera, 16 families and 5 orders. The major families constituting the bycatch in LMRS were Clupeidae, Engraulidae, Carangidae, Stromateidae, Sphyraenidae, Leiognathidae, Trichiuridae, Gobiidae, Acanthuridae, Sillaginidae, Serranidae, Sciaenidae, Scombridae, Exocoetidae, Hemiramphidae and Tetraodontidae. In SMRS, bycatch constituted 34.2 % of the total catch. There were 45species belonging to 26 genera, 19 families and 6 orders. The major families constituting the bycatch were Clupeidae, Engraulidae, Carangidae, Gerreidae, Stromateidae, Lactariidae, Sphyraenidae, Leiognathidae, Trichiuridae, Gobiidae, Sillaginidae, Sciaenidae, Ambassidae, Cynoglossidae, Ariidae, Mugilidae, Hemiramphidae , Tetraodontidae and Ostraciidae.

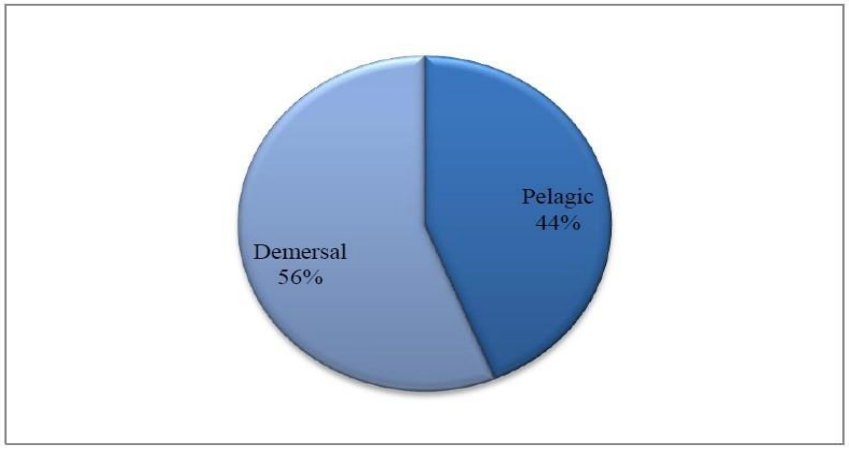

Fig.3. Percentage of demersal and pelagic groups in bycatches of ring seines

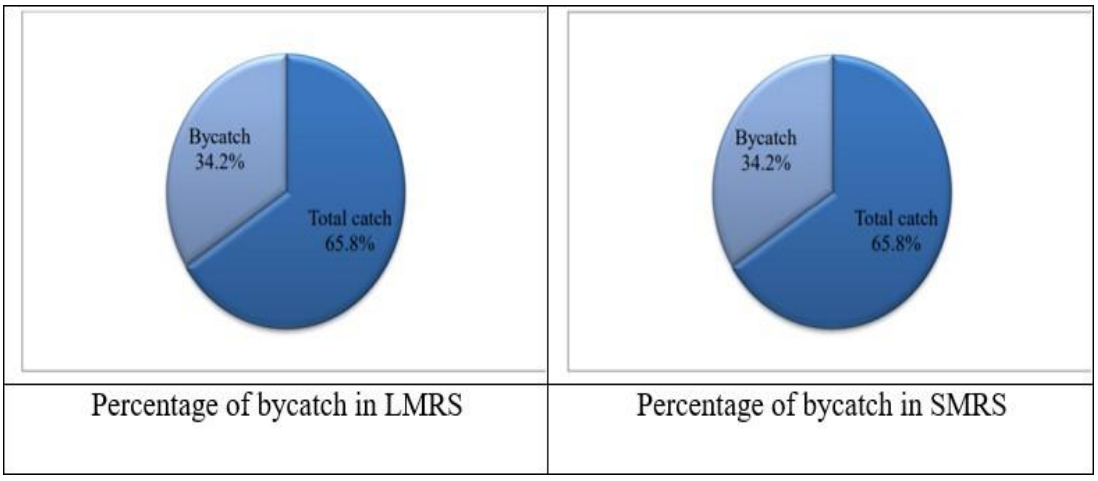

Fig.4. comparison of percentage catch between LMRS and SMRS

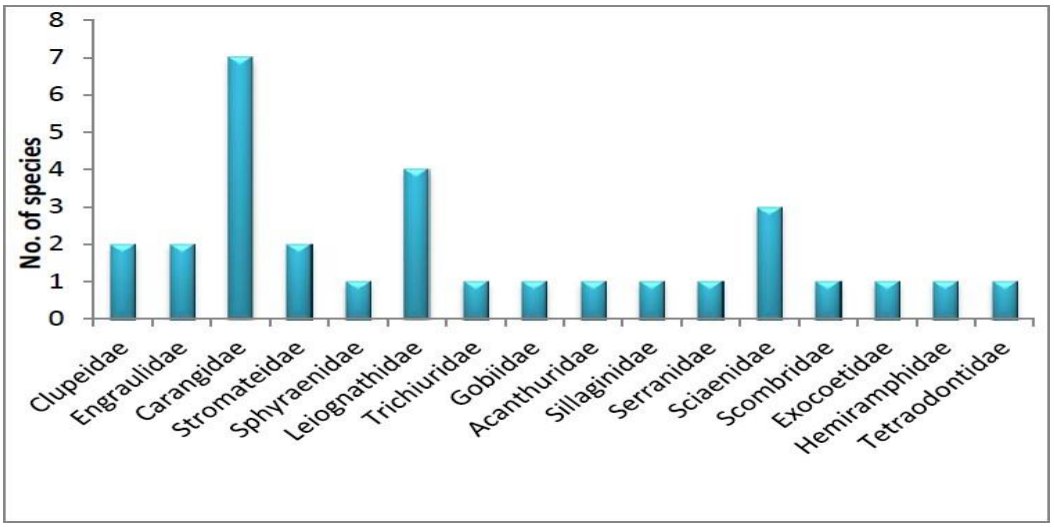

Fig. 5. Number of species in each family in LMRS

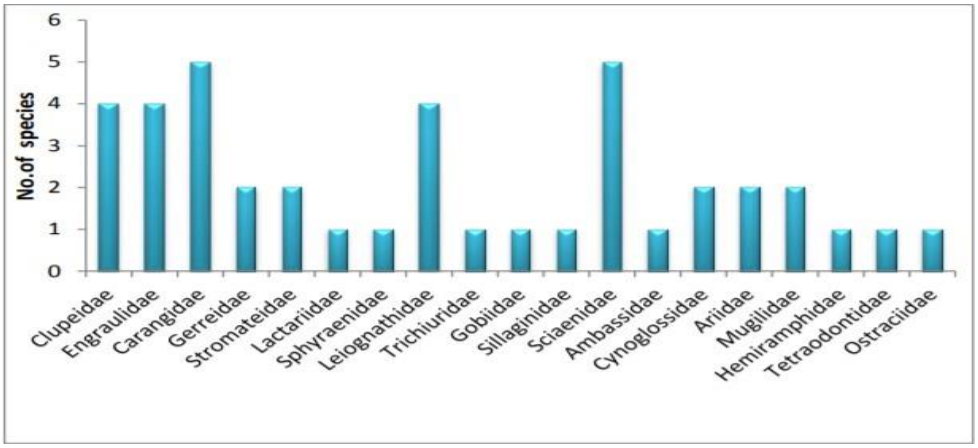

Fig. 6. Number of species in each family in SMRS

Name of Gear	vernacular name	Minimum mesh size (mm)	Type of mesh	Maximum Dimension (hung length and hung depth)
Seine net*				
Sardine/Mackerel seine nets	Chalavala	22	Diamond	600 m X 60 m
Anchovy seine nets	Netholivala	10	Diamond	250 m X 50 m

Table 1. Regulation of size and mesh size of Ring seines

Juveniles fish in ringseine comprises of oil sardine (30%) and mackerel (15%) of the total catch along the Kerala coast. (Najmudeen and Sathiadhas, 2008) Juveniles in choodavala was in the range of 20-33% (Edwin et al., 2010). Large scale occurrence of Juveniles (less than 140 mm) (in numbers landed) in ring seine landings was as high as 90%. (CMFRI, 2013) of Cochin.

A short-term study in 2016 was conducted by ICAR-CIFT on the juvenile incidence in the small mesh ring seine fishery of Chellanam which showed that Sardinella longiceps (oil sardine) was the most dominant species landed. Total juvenile landings from the study were 6.70 t of which oil sardine juveniles formed 76.11% (Gomathi, 2016). According to CMFRI (2017), during the period 2013-2015, the juvenile fish catches of oil sardines in Kerala had an estimated loss of 48 crores.

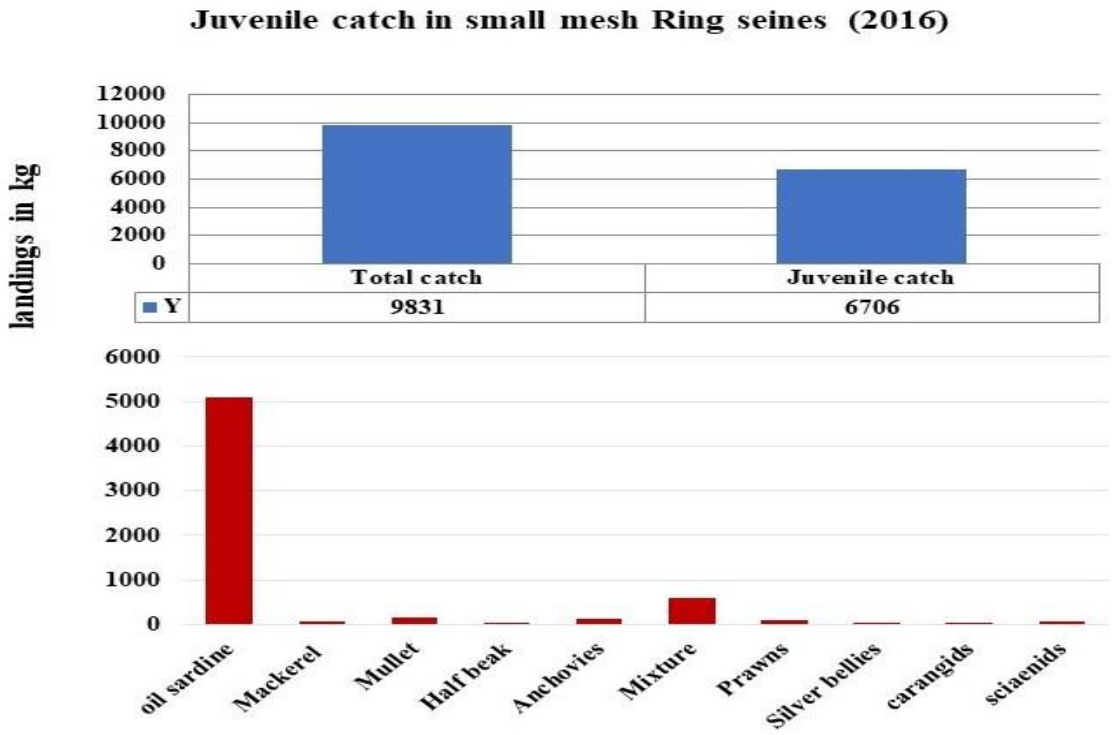

Fig.7. Juvenile landings by individual species: a case study by ICAR-CIFT

Suggested Management measures:

- Mesh size regultion-22mm oil sardine and mackerel (Kurup et al., 2009)
- Anchovy ring seines-12mm (Kurup et al., 2009)
- Identification spawning and nursery ground and imposing seasonal ban on the ring seine units in the identified areas.
- Regulation of size and mesh size of Ring seines

Marine mammal bycatch

Dolphins interaction with fishing gears have been recorded for centuries, however their reported frequency has increased in the recent years. The exact reasons are still unclear (Bearzi, 2002), nevertheless, this might come as a consequence of human population growth and the increasing demand of fish protein for human consumption, which naturally lead to increased fishing and to the gradual depletion of fish stocks across the world's oceans (Pauly et al., 2002). Dolphin interactions can be useful for in seining where the presence of dolphins is used as an indication to detect fish shoal. Most of the reports describe unfavourable effects, i.e. gear damage and catch loss due to cetacean depredation and scattering of fish shoal (Wise et al., 2001).

Incidental catch of finless porpoise, *Neophocaena phocaenoides* are reported from Off Mangalore and Gulf of Mannar regions (Jayaprakash et al., 1995). Dolphins 'caught' in large numbers by a ring seine operating at Cochin Fisheries Harbour, is also reported (Prajith et al., 2014). Silas et al. (1984) reported that 1% of the total landings by fishing gear at Cochin were dolphins. Joseph et al. (2021) reported 15% fishers reported incidental bycatch of cetaceans in seines and gillnets. Cetacean bycatch reported by seines mainly occurred in shallower waters (Joseph et al., 2021).

Compared to the high sea purse seiner, ring seines are lightly constructed purse seines with polyamide multifilament twines. Cetaceans can easily tear the webbing and escape from the gear, even it is accidently entered in the gear. It leads to the partial or total loss of catch and huge economic loss to fishers. Incidentally captured cetaceans in the bunt portion were release alive to avoid further damage to gear and catch. Due to the above mentioned reason, fishers avoid fishing particularly in the areas with severe encounter of cetaceans and rarely fishers harm the animals with spear, stones, crackers etc. to move away from the fishing ground.

Measures:

- Bycatch can be minimised by improvement in the net design appropriate for schools of target fishes, mesh size optimisation, use of aprons and operational procedures.
- Use of dolphin wall net (DWN) on the outer side of the purse seine to reduce the bite of the net by marine mammals has been reported by Prajith et al. (2014).
- Use of acoustic pingers and alarms have also been observed to reduce marine mammal interaction in gears.

Conclusion

There are not many reports of incidental bycatch landings like dolphins and turtles in purse seines operating in Indian waters. Bycatch reduction is not only a technical issue of harvesting technology and biology, but also a human issue involving behavior and decision-making by producers and consumers. Bycatch reduction also occurs within the context of different industrial and regulatory structures of fisheries, which in turn can impact the choice of basic regulatory approach – private solutions, direct regulation, incentive- (market-) based, and hybrid – and then choice of policy instruments. Initial trials of acoustic pingers have been carried out along Kerala coast by ICAR-CIFT and the results are encouraging.

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