



Temporal changes in the ring seine fishery of Kerala, India

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ABSTRACT

The marine fisheries of India is unique in that it is a typical multi-species, multi-gear tropical fisheries with a heterogeneous management system. Mini purse-seine (ring seine) was first introduced in the early eighties to enable the non-motorised traditional fisherman to counter the strongly emergent mechanised fishing in the state of Kerala. Ever since its introduction, there has been a phenomenal increase in the size and numbers of the fishing units and this fishing method has spread to other maritime states of the country. The present study analysed the evolution and growth of the ring seine fishing systems of central Kerala from 1985 to 2014. The economic and social impacts of the ring seine fishery were also studied and the findings emphasised the need for implementation of management measures to downscale the excess capacity in the fishery.

Keywords: Excess capacity, Juvenile incidence, Pelagic fishery, Ring seines

Introduction

Indian marine fisheries is a typical multi-species, multi-gear fishery characterised by a heterogeneous management system, involving various governmental and community management organisations in the different maritime states of the country. The total active marine fishermen population of India is about 14 million (NFDB, 2018). The fisheries sector contributed 1.07% to the Gross Domestic Product (GDP) and 5.15% to the agricultural component during 2017-18 (NFDB, 2018). The marine fisheries sector in India has witnessed phenomenal growth during the last five decades both quantitatively and qualitatively. India has been one among the top ten fish producing countries of the world since 1960; with its position changing between the third and the seventh rank. Currently, India ranks seventh in marine landings, contributing about 4.19% to the world marine production of about 81 million t (FAO, 2016). The pelagic fin fishes contributes major share (52%) to the total marine landings of the country (CMFRI, 2017). Region-wise and resource-wise estimates of marine fish production shows that the west coast is the most productive region contributing 64% of the total landings. Kerala contributes a remarkable 14.4% of the total marine production (CMFRI, 2017).

Fisheries in Kerala is a very important economic activity and a flourishing sector with varied resources and potential. Pelagic resources contributed 61% of the total marine fish landings (CMFRI, 2017). Major resources contributing to the pelagic landings were oilsardine (57.4%), carangids (15%) and Indian mackerel (13.7%) (CMFRI, 2017). Ring seine sector contributed the major share to capture

fisheries (50.11%) and 71% of the pelagic resources. Over the years, the fishing practices along the Kerala coast had undergone tremendous changes and the region in the depth range of 0-50 m has been thoroughly exploited. Pelagic fish stocks such as the oilsardine and mackerel have been the main contributors to the landings in the state. The variations in abundance of any one of them would affect the total production. Fishery independent factors, such as the water chemistry, oceanographic parameters, meteorological variables and food availability in coastal waters play crucial roles in determining abundance of pelagic fishery.

Mini purse-seine (ring seine) was introduced in Kerala in the early eighties to enable the non-motorised traditional fisherman to counter the strongly emergent mechanised fishing. Ever since its introduction, there has been a phenomenal increase in the size and numbers of the fishing units. The technical and social aspects of ring seine fishing and the changes that have been brought about were studied by many authors (Anon., 1991; Rajan, 1993; Sathiadas *et al.*, 1993; Balan and Andrews, 1995; Edwin and Hridayanathan, 2006). The main objective of this study was to elucidate the nature of increase in fishing capacity of ring seine fishing sector of Kerala, to analyse the technological, economic and social implications of the same and to identify key management areas that need to be addressed for scaling down the fishing effort.

Materials and methods

Thirty major ring seine centres in Kerala between Talapady in Kasargod District to Poovar in Thiruvananthapuram District comprising fishing harbours

and fish landing centres, were surveyed during the study. Details on design and construction of ring seine fishing vessels, gear, operation, engine and other relevant information were collected from fishermen, net makers, boatyard operators and other stakeholders. Census data on fishing boats was sourced from Marine Fisheries Census-2010 (CMFRI, 2012a) for identification of important landing centres. The centres selected for study are given in Fig. 1.

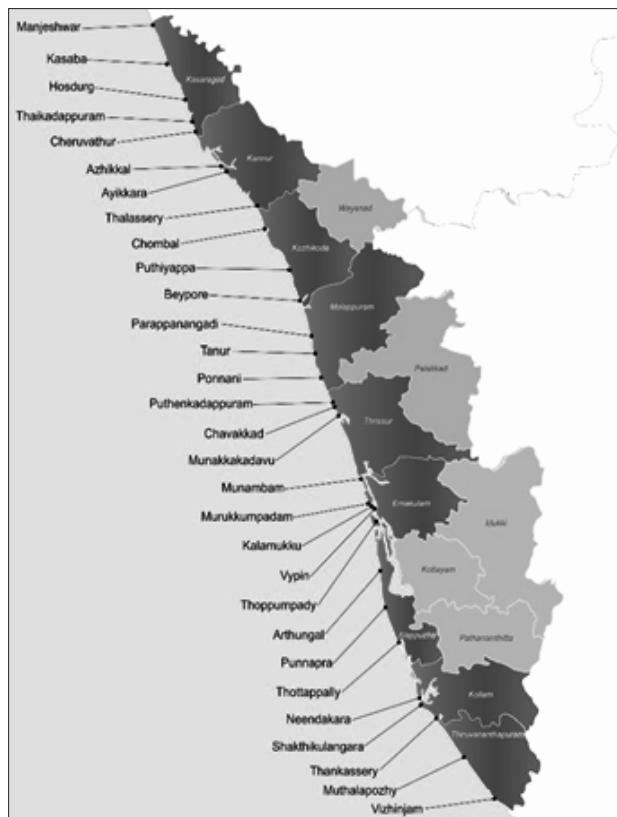


Fig. 1. Map of Kerala showing coastal districts and fish landing centres selected for the study

Technical survey of craft and gear

Field visits and interviews using structured questionnaires were the main tools to collect details of fishing vessel and fishing gear. Representative samples from each category of craft and gear from important landing centres in the coastal districts were examined to obtain design and operational details. The motorised and mechanised fishing vessels were surveyed as per FAO standards (Fyson, 1986). The gear designs were documented following FAO conventions (FAO, 1975; 1978; Nedlec, 1982). Engine horse power and other details of engine and onboard equipment were collected from crew members and verified at fishermen co-operative societies. Method of operation was studied by onboard participation

in data collection from the major centers. This data on craft and gear was then compared with the reports of earlier workers (Panicker *et al.*, 1985; D'Cruz, 1998; Krishna *et al.*, 2004; Edwin *et al.*, 2010; 2014). The Department of Fisheries, Kerala; Kerala State Co-operative Federation for Fisheries Development Ltd. (MATSYAFED), other fishermen societies and log books maintained by fishing vessel operators were used as secondary data source.

Socio-economic survey

Ring seine operating fishermen of different age groups from varying socio-cultural background were interviewed using an unstructured questionnaire with open-ended questions. People who seemed comparatively more knowledgeable among the group were contacted individually and interviews were held with them. The data was validated through focus group discussions and interactions with group leaders of the fishing craft and experienced fishermen.

Results and discussion

Trends in ring seine fisheries sector of Kerala

The ring seine fishing can be considered as a typical example of unbridled and thriving tropical fishery. Before the eighties, small pelagic fish stocks were exploited mainly by traditional fishermen employing traditional gears such as the boat seine, shore seine, small gillnets and other gears operated from traditional boats. The early eighties witnessed the introduction of mini purse seine (ring seine) in the artisanal fisheries sector to counter the sidelining of the traditional fisheries sector by the strongly emergent mechanised sector (Panicker *et al.*, 1985). Subsequently, it evolved and became the most popular gear among traditional fishermen. At present, ring seiners of Kerala can be classified into motorised ring seiners (using outboard motor, OBM) and mechanised ring seiners (using inboard motor, IBM) (Edwin and Das, 2015). The mechanised ring seiners are mainly targeting species like mackerel, sardine, shrimps and pomfrets while motorised ring seiners target sardine, anchovy and shrimps. About 71% of pelagic fish landings in Kerala are contributed by ring seine fishery with oilsardine (38.6%), Indian mackerel (24.2%) and anchovies (23.2%) being the most dominant resources contributing about 86% of the catch (CMFRI, 2016).

Ring seine fishery, since its introduction has registered a steady growth both in terms of fishing effort and yield till 2012. Thereafter, due to declining catches, mainly of oilsardine, there was a declining trend in ring seine landings which influenced the state production as well. In 2015, a total of 0.48 million t of marine fish were landed (CMFRI, 2016), registering a decline of 20%

and 16% over the previous years 2013 (0.67 million t) and 2014 (0.58 million t) respectively (CMFRI, 2015), whereas in 2012 it was 0.84 million t (CMFRI, 2013).

The ring seine was designed and introduced by the ICAR-Central Institute of Fisheries Technology (ICAR-CIFT) to be operated from the traditional plank built canoes which were being used by the artisanal fishermen for the operation of boat seine locally called the *thanguvala* (Panicker *et al.*, 1985). The craft was fitted with a 9.9 hp outboard motor for facilitating propulsion to reach the fishing ground and to reduce manual labour. Only 300 ring seines were recommended for use along Kerala coast by ICAR-CIFT in 1985. The ring seines dominated the fishery and caused major setback to the non-motorised traditional boat seine operations. According to GOK (2005), a total of 2800 units of ring seines are operating in Kerala and it represent 80% of the fishing units in motorised sector.

IBM ring seines first introduced in 1999 became more popular due to high catch rate as well as high returns and resulted in its wide adoption subsequently. This system of fishing was so successful that it is now the dominant technique in nearly the whole of the state of Kerala and spread to other parts of the country, but later there was a reversal in trend which started nearly 10 years back. Subsequently several workers reported on ring seine operations in different regions along the Indian coast *viz.*, about the ring seine introduced in Malpe Fisheries Harbour, Karnataka (Rohit and Naik, 1998); ring seine boats for commercial exploitation of pelagic fish resources of Puducherry Coast (Mohanraj *et al.*, 2011); 15-20 mm mesh sized ring seine in Odisha Coast (Vijaykumaran and Chittibabu, 2005); introduction of mini purse seine in the MH-1 zone of Maharashtra Coast (Shiledar, 2009) and on introduction of ringvala (ring seine) along Kakinada Coast made of silk yarn (Burayya, 2006). Ring seines contributed 5.2% of Karnataka and 8% of Goa total marine landings during 2010 (CMFRI, 2011). Rajeswari *et al.* (2013) elaborated the three types of ring seines operated in the Andhra Pradesh Coast. Ring seines with 10-25 mm mesh size were studied by Arur *et al.* (2014) in Andaman and Nicobar Islands. Presently the ring seine fishery is spread throughout the maritime states of the country except West Bengal and Lakshadweep Islands. The success of

this fishing method attracted more number of fishermen which resulted in the increased number of fishing units.

Increase in size of fishing unit

It is observed that there has been a significant increase in the size of the gear with a commensurate increase in size of the fishing craft and horsepower of the engine. The dimensions of the gear rose incrementally over the years and the size of the vessels and horsepower increased subsequently.

The gear is a wall of nylon knotless webbing and the similar cotton encircling gear (*thanguvala*) of the early sixties described by Kuriyan *et al.* (1962) had a length of 42 m and a depth of 5.2 m. The ring seine, which is a modified innovative version of the *thanguvala*, on the other hand had an overall length of 250 m and a depth of 15 m and 33 m at the wing end and the bunt respectively and pursing was done with the help of rings (Panicker *et al.*, 1985). The size of gear as reported by Edwin and Hridayanathan (1996) in south central Kerala region was 630 m and depth 100 m with a mesh size of 18-20 mm. Ring seine of smaller mesh size (8-10 mm) is used to target small fish like anchovy which operate in shallow waters. D'Cruz (1998) reported that the gear had grown in dimensions and due to the large size of the nets, trolleys are used for transportation of the gear. Large ring seines up to 900 m length and 90 m depth were reported to be operated in Thrissur District of Kerala which could not be lifted manually (Krishna *et al.*, 2004). Edwin *et al.* (2010) reported that a gear with mesh size of 20 mm, ranged from 600 to 1000 m in length, 83 to 100 m in depth and 1500 to 2500 kg in weight, which were operated from fishing vessel of L_{OA} 70-76 feet long, operated with inboard engine, having a crew size of 35-45. In the past 28 years, the size of the ring seines have grown at least 3 to 4 times, to the extent of about 1000 m in length and 100 m in depth in Kochi area (Table 1).

The craft from which the erstwhile boat seine was operated, which was later used for introduction of the ring seine (Kuriyan *et al.*, 1962) had an average length of 11.8-13.0 m and breadth of 0.9-3.3 m. These fishing crafts are basically plank built, deckless canoes. Studies conducted by the South Indian Federation of Fishermen

Table 1. Changes in dimensions of the purse seines

Length (m)	Depth (m)	Mesh size (mm)	Webbing material	Targeted species	Source
250	33	18	Nylon	Sardine, Mackerel	Panicker <i>et al.</i> (1985)
400-600	60-70	20	Nylon	Sardine, Mackerel	D'Cruz (1998)
900	90	20	Nylon	Sardine, Mackerel	Krishna <i>et al.</i> (2004)
250-500	45-75	8-10	Nylon	Anchovy, Sardine	Edwin <i>et al.</i> (2010)
600-1000	83-100	18-22	Nylon	Sardine, Mackerel	Edwin <i>et al.</i> (2010)
1000-1500	90-120	18-22	Nylon	Sardine, Mackerel	Edwin and Das (2015)

Societies (SIFFS) (Anon., 1991) indicated that between 1985 and 1988, the length of ring seine craft increased to 13.0-16.0 m in Alappuzha region with maximum breadth of 1.30 m and depth of 1.25-1.40 m.

The increase in size of the ring seiners during the last three decades is shown in Fig. 2. Since majority of the vessels are in the size range of 18.3-25.9 m, they cannot be beach landed after operation as in the case of smaller crafts. The vessels are left anchored at sea and the vulnerability to damage in rough weather is high. The craft is exclusively designed for ring seine operation and the fishing season of ring seine is restricted to six months in a year and large size of the canoes restricted its use for alternate types of fishing. Lifesaving and firefighting appliances, fish storage as well as crew accommodation facilities are lacking onboard these fishing vessels and they are engaged only for single day fishing operations.

Increase in size and capacity of the fishing units and the fleet size have led to increase in fishing effort in the ring seine fishery sector of Kerala. In order to accommodate the huge gears, the size of the crafts also increased two fold and number of craft forming a unit increased as many as four times.

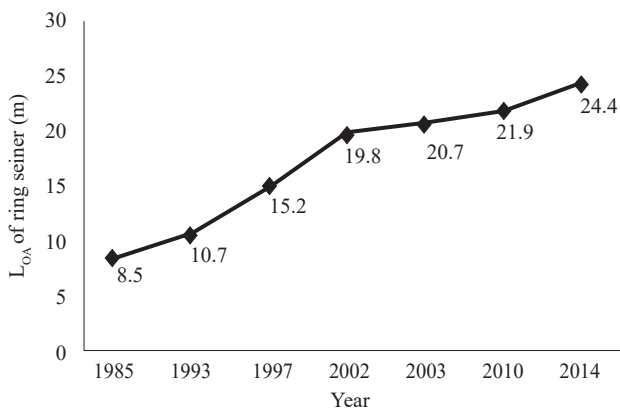


Fig. 2. Increase in size of ring seiners (1985-2014)

Over powering of the fishing units

The ring seiners used 8 to 15 hp engines for propulsion of the crafts (D'Cruz, 1998) in the early days of its introduction. However, in certain cases, two engines are also used in a single unit. to cope with large gear used, 50-60 crew members and bulky catch. In late 90's during intensification of mechanisation, refurbished truck and bus engines were introduced in ring seiners and the use of such engines resulted in high maintenance cost as well as fuel consumption. Currently such vessels use single inboard engines of 120-440 hp depending upon the size of the craft (Fig. 3). An all Kerala survey conducted by

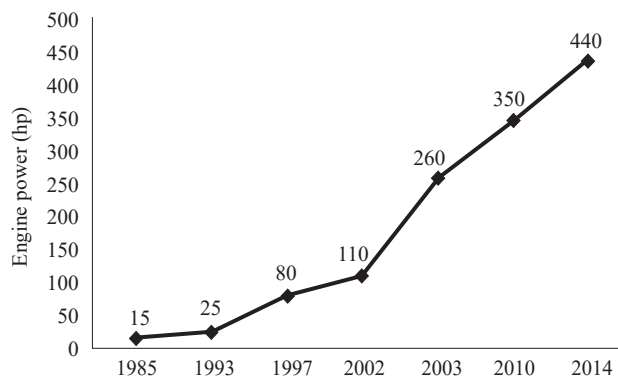


Fig. 3. Increase in engine power of ring seiners (1985-2012)

ICAR-CIFT in 2013 has shown that the fishermen are not satisfied with the power and performance of these engines and they are constantly on the lookout for more powerful marine engines (Edwin *et al.*, 2014). Large scale entry of imported engines into the marine fishing industry with promises of delivering more power at a lesser price compared to the available branded marine engines in the market attracts the fishermen. Shortage of experienced mechanics and scarcity of spare parts of imported engines are some of the problems faced by fishermen. The availability of powerful engines also fuelled the growth of the ring seine units.

High juvenile incidence

In central Kerala, anchovies and sardines account for nearly 70% of the total juvenile catch, the rest is contributed by mackerel and shrimps and the landings are mainly during the months from September to December (Edwin *et al.*, 2010). Juveniles are mainly caught in gears using 8-10 mm mesh size and such units are operated at shallow depths touching the bottom in inshore waters. Studies showed that the juvenile incidence in small meshed units is in the range of 32 - 48% and that of large meshed units is 5-12% (Edwin and Das, 2015). Small sardines are landed in huge quantity and only 25% goes to the fresh fish market for human consumption and rest goes for manure and fish meal plants where juveniles are in greater demand (Edwin and Das, 2015).

Najmudeen and Sathiadas (2008) reported that juveniles caught in ring seiners comprised of anchovies (40%), oilsardine (30%) and mackerel (15%) of the total catch along the Kerala coast. The estimate shows that the annual economic loss due to juvenile fishing made by trawlers, purse seiners, ring seiners and mini trawlers together along the Indian coast was around US\$ 19,445 million whereas the annual revenue generated by these fishing units was only US\$ 836 million, causing a net deficit of US\$ 18,609 million annum⁻¹ (Najmudeen and

Sathiadas, 2008). According to this study, ring seiners with a fleet size of 2351 caused economic loss to the tune of US\$ 2037 million annum⁻¹ and it ranked second in generating economic loss among the units operated in Kerala coast.

Pramod (2010) reported that juvenile catch in ring seine fishery due to small meshed ring seine operation in Kerala include 0 and 1 year class of sardine and mackerel in high quantity every year. During the peak season, excess landing of small pelagic fish like sardine result in decline of market prices and during such periods the excess fish is dumped in backwaters as discards (Van der Heijden, 2007). Every year 1.8 -3 t of oilsardine is discarded in Cochin backwaters as excess production of ring seines (Pramod, 2010).

In 2011, there has been a heavy exploitation of young ones and juveniles of sardine and 78.5% of the landings were contributed by seine net units (CMFRI, 2012b). Juvenile fish landing causes 65-75% income reduction and results in catch depletion. The juvenile landings of other fishes like seer fish, carangids and shrimps were also reported in ring seine fishery. Juveniles of mackerel are usually landed in monsoon season but the fishermen get moderate price as the quantity landed is less and it mainly goes for human consumption. It is understood that fishermen surround the shoal with a fairly good idea of the size of the fish and it is rare that they are totally unaware of the long term impact of juvenile capture. The fishermen catch juvenile shoals also as the returns from sale of juveniles would help to cover the operational costs.

Economic implications of excess capacity

Capital investment: The introduction of outboard motors to the traditional fishery in the early eighties had a significant role in the growth of marine fisheries of Kerala (Balan *et al.*, 1989). The advent of motorisation replaced the traditional boat seines with the more productive ring seines and the crew strength also increased (Balan and Sathianandan, 2007). The ring seine landings are much higher than the same species landed by other gears. Competition among the different fishing units to encircle and catch the shoals spotted by them has led to the increase in size of the gear as well as the fishing unit as a whole. Najmudeen and Sathiadhas (2008) reported that for ring seiners operated along the Kerala coast, annual fixed cost accounts for US\$ 4,321, total operational cost US\$ 28,982 annum⁻¹, gross revenue US\$ 41,540 annum⁻¹ and net profit from the sector is only US\$ 8236. For example, in Chellanam, a predominantly ring seine operating fishing village, in central Kerala where the fishing units are owned by fishermen groups, each time a group launches a new craft and gear they ensure that this fishing unit is larger than the

one launched previously from the same village. Due to this competitive attitude, the capital investment in the artisanal sector has increased five to ten fold between 1980-81 and 1988-89 (Achari, 1993). Rajan (1993) estimated that the total investment in the artisanal marine fisheries sector in Kerala in 1991 was ₹1597.4 million. Capital investment for the large meshed ring seine unit is ₹2.5-3.3 million and that of small meshed ring seine unit is ₹1.5-2.3 million. A sudden increase in the capital investment of ring seine units occurred after 2003. The uncontrolled growth in size of craft and gear are the main reasons for the huge investment (Edwin *et al.*, 2010). Introduction of new types of engines and change of wooden craft to steel craft have also contributed to increased capital investment.

Kurup and Radhika (2003) reported that the cost of production of IBM wooden ring seiner unit was about ₹1.14 million in 2003 and the cost increased many times thereafter. Currently the average investment on a steel IBM unit (craft and gear) is about ₹5 million to 8 million and for the gear it is ₹1.5-2.0 million (Das *et al.*, 2011). The huge capital investment leads to collective ownership patterns (Paul, 2002). In collective ownership system, each fishing unit is owned by 3-15 members and the wages are given as share of the total revenue obtained after deducting all the operational expenditure.

High operational cost: It is to be noted that OBM ring seiners which depend on petrol for starting the engine and kerosene for running, faced an increase of 800% cost in petrol and 2100% rise in cost of kerosene since 1986. Diesel prices increased by 1500% since 1986. The fishermen generally avoid small shoals and search only for big shoals and this increases the fuel consumption and sometimes cause non-fishing days of inboard ring seiners.

Earlier studies conducted by ICAR-CIFT (Edwin, 1997; Das, 2015) and data obtained through interaction with ring seine fishermen provided primary information on the durability, repair/replacement and other operational expenditure. The chance of damage of ring seine is comparatively very high compared to other gears owing to the webbing material *i.e.*, Nylon-PA 210d/2/2 and the operational procedure. The average durability of nylon webbing of this specification is only around two years. The low durability of the material leads to periodic replacement of webbing, increasing the cost of repair. An inboard ring seine unit replaces 500-1000 kg webbing every year as was observed during the study period. Polyamide multifilament 210d/2/2 webbing costs ₹48,000 per 100 kg and the mending is very labour intensive which can be carried out only by skilled workers. There is an acute shortage of skilled net makers and menders. Repairing of the huge net will take one to four weeks and the repairing charges may reach more than

₹0.2 to 0.3 million. Each ring seine unit usually has minimum two to four major repairs in a year. The loss of revenue during the days of repair and the repairing charges are additional burden to fishermen.

According to Chako (1991), the operational cost of ring seine unit would be about ₹1,500 per day. The operational expenses comprises of expenses for fuel, labour, daily operational allowance to the fishing crew, transportation, maintenance and repair. The high cost of fuel accounts for the high operational expenditure. It is estimated that 62-66% of the total operational cost in OBM operated vessels and 70-80% in IBM craft is spent on fuel. Cost of labour accounts for 10-15% for IBM craft and 12-21% in OBM craft. Travel expense accounts for 6-9% in IBM craft and 10-15% in OBM craft. Other expenses come to around 5-8% of the total expenditure for both the craft types.

Social implications

Since the fishing units are capital intensive, access to credit is a pre-requisite for the acquisition of assets and for operational expenditure. The auctioneer plays the dual role as money lender and merchant. Auctioneers provide their financial services as ready cash both for capital and operational expenses, without any formalities and security. They charge heavy rates of interest and even then the fishermen accept finance offered due to the easy and timely access to credit. The repayment is collected through the sales proceeds of the catch by established right in the first sale of catch. It is observed that the producers are getting only 30-40% value of their produce and the rest is taken by the merchants and the money lenders at the various links in the marketing chain. The primary producers are literally bonded to the merchant-cum-money lender, locally called *tharakan* in central Kerala and *kuttikaran* in north Kerala.

The average number of fishers attached to a *thanguvala* unit is 45 to 60 and in monsoon season the number will rise to 85. The surplus labour that cannot find a place in the craft that go fishing on a particular day are called the *karanila* fishermen (Kurien and Vijayan, 1995). *Karanila* literally means 'status on shore'. As all the fishermen going onboard or staying ashore, are physically capable of taking up the fishing activity, the work is rotated and fishermen going for one fishing trip may be replaced by others in the next trip. This way there is an almost equal sharing of work among the available labour in the community. The number of *karanila* fishermen is not uniform every day. During monsoon season, when trawl ban is imposed, labourers working onboard the trawlers become idle and join the ring seine units. As a social custom, their entry is never denied. The average crew size of smaller units is 25-30.

The huge size of these fishing vessels partially restricts its entry into harbours and it is difficult to beach land at the small fish landing centers. The fishermen have to leave their home early morning (at about 03 00 hrs) and travel to far away harbours for boarding the vessel for fishing. Special vehicles are hired by the crew for this purpose as public transport is not available at such early morning hours. Depending on the catch, the carrier vessels will return to the landing centre with the catch and the mother vessel will continue to search for more shoals and fishermen reach home very late in the night. This in the long run would be detrimental to the health of the ring seine fishermen.

Besides, earlier when the ring seine crafts used to beach land, fisherwomen took an active role in the unloading, transportation and sale of catch. But increase in the size of crafts forced the units to move away from their fishing villages and the role of women diminished and they no longer play a role in the ring seine fishery in Kerala.

Key management issues and recommendations

The optimum fleet capacity, though advocated at 3:00 numbers for the Kerala state, has not been validated in view of the increase in fleet size. Increase in the size of the craft and gear have necessitated huge capital investment in the sector. The high financial investment by fishermen have resulted only in increasing their indebtedness and dependence on middlemen who provide loans. The Marine Fishing Regulation Act implemented in the state of Kerala in 1980 has covered almost all aspects that lead to the sustainable development of the coastal fisheries. But, strict monitoring, control and surveillance does not take place. Lack of manpower and trained personnel in monitoring organisations also pose problems.

The use of optimum mesh size in ring seines can reduce juvenile incidence considerably. It is recommended that the mesh size of small meshed ring seines be regulated at 10 mm and the large meshed ring seines at 22 mm for reducing capture of juvenile fish. The reduction in size of the gear to around 600 m would help in reducing the excess effort in the fishery. The reduction in size of gear will in turn bring about a reduction in the size of the fishing vessel and horse power of engine. The fishermen if made aware of the negative impact of excess capacity will voluntarily abstain from overfishing. Strict regulations should be brought about in this regard. Restrictions on the landing and sale of juvenile fish in the domestic market would also help to prevent catching of juveniles. Major issues arising due to partial control can be circumvented through provision of alternative employment to fishermen during the ban period by providing training in fishery-related

enterprises like boat and engine repair, maintenance and net mending and other allied activities. Local councils can be set up at the landing centre in which fishermen leaders are members which can to a certain level, prevent landing and sale of juveniles. This ‘bottom up approach’ can be utilised for the deployment of vessels as well as in restricting size of craft and gear.

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