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Juvenile incidence in ring seines operated in central Kerala, south-west coast of India

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ABSTRACT

Juvenile incidence is one of the major concerns reported in the ring seines fishery of Kerala targeting major pelagic fishes such as sardines, mackerel, and anchovies. The incidence of juveniles in the catch has increased considerably recently due to the use of nets with smaller mesh sizes and fishing in nearshore waters, which pose a threat to the sustainable use of fishery resources. The present study attempted to understand the incidental catches of juveniles in ring seines operated in Kerala. We have classified the ring seines into three types, viz., large meshed ring seines (LMRS), small meshed ring seine type I (SMRS-I), and small meshed ring seine type II (SMRS-II) based on their length and mesh size. We observed that juvenile incidence occurred in all categories of ring seines, and the highest was observed in SMRS-II (37.22 %), followed by SMRS-I (29.35%) and LMRS (13.60%). Our study indicated that an increase in mesh sizes can significantly reduce juvenile bycatch in ring seines. The total annual economic loss due to juvenile fishing in three categories of ring seines was estimated as Rs.55,632,956 in which SMRS-I recorded the highest economic loss of Rs.36528833 followed by SMRS-II (Rs.10057235) and LMRS (Rs.9046888). Hence, appropriate policy interventions on the mesh size are necessary for ring seines to ensure sustainability in the fishery.

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1. Introduction

Enormous changes in the species composition of the catch and the disappearance of formerly important species with an increase in small-sized species or fishes that are not marketed are signs of overfishing (Vijayan et al., 2000). In India, there are about 35 fish meal plants operating in the states of Karnataka, Kerala, Maharashtra, Gujarat and Tamil Nadu. Low-value fishes and trash fishes are mainly used in the production of fish feed. The fishes which are usually preferred for preparing fish meal are oil sardine, stomatopods, silverbellies and other trash fishes (Aswathy & Narayanakumar, 2013). To meet the demand for fish meal plants, a considerable amount of juveniles of small pelagic have been captured intentionally along the Kerala coast (Mohamed et al., 2014). Overfishing is a single process that contributes significantly to the problems of fisheries management because it results in damage to stocks, which may sometimes be irreparable (Pillai, 2011). Although there have been many changes in the techno-harvesting pattern of inshore fisheries in India, which has led to an increase in fish landings, the problem of bycatch and targeted juvenile fishing is ever-increasing (Najmudeen & Sathiadas, 2008). Juvenile fishing is the harvesting of young and newly hatched fish and sometimes accidental harvesting of eggs laid by fish (Sheriff et al., 2010). According to Hubbs (1943), juveniles are young fish mostly similar in the form of adults but not yet sexually mature. The juvenile stage lasts until the fish is fully grown, sexually mature and interacting with other adult fish. Juvenile incidence is a major problem and is reported in fishing gears such as trawls, gillnets, purse seines and ring seines. In countries where there is inadequate fishing regulation, the ratio of targeted and non-targeted juvenile fishes to the overall catch is very large (Hall & Mainprize, 2005). Growth overfishing happens when the fish are been harvested at a smaller size, but if they had an opportunity to grow to a larger size it would have produced maximum yield per recruit.

Ring seines are the important gears employed to catch pelagic fishes on the Kerala coast, but recently, the reduced mesh size and fishing near the shore have led to an increased quantity of juvenile landings in ring seines. Several authors have reported juvenile incidence in ring seines. The juveniles of fishes caught in ring seine comprised anchovies (40%), oil sardine (30%) and mackerel (15%) of the total catch along the Kerala coast (Najmudeen & Sathiadas, 2008). Juveniles are mainly caught in small meshed ring seines (*choodavala*) as the mesh size of the gear is small (8-10 mm) and Edwin et al. (2010) have reported the incidence of juveniles in small mesh ring seines in the range of 20-30% and the large meshed ring seine (*thanguvala*) in the range of 5-15%. Pramod (2010) reported the excess juvenile catch in ring seine fishery due to small mesh ring seine operation and ring seines of Kerala catch 0 and 1 year class of sardine and mackerel in high quantity every year.

Hence, the main aim of this study is to understand the juvenile incidence in the three categories of ring seines by comparing them with the MSM/MLS (Minimum size at maturity/Minimum legal size) recommended for each species. Fifteen frequently occurring species in the ring seines were selected for the study. The study also assesses economic loss due to juvenile incidence in different categories of ring seines.

2. Materials and Methods

The area selected for the study was Chellanam mini fishing harbour and Kalamukku fishing harbour, situated in the Ernakulam district of Kerala, South west coast of India. Chellanam is a fishing village in the southern part

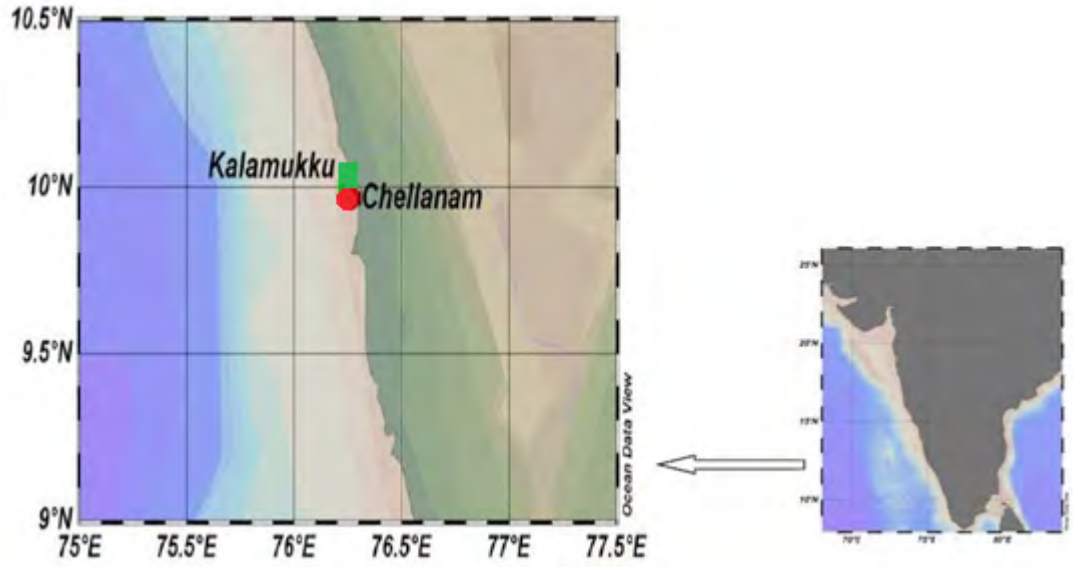

Fig. 1. Study area showing *Chellanam* and *Kalamukku* situated along the southwest coast of India

of Ernakulam district situated between 09 0 43'and 09 0 53' N latitude and is the centre of traditional ring seine activity. About 63% of the fishers in the fishing village are employed in the ring seine fishery sector. Single day fishery has been observed in the study area with only local fishers conducting fishing. The two types of fishing vessels, motorized and mechanized, are operated in the Chellanam area. The motorized fishing vessels start their operation from the Chellanam area and land in the same area. The mechanized craft starts their operation from the Cochin fisheries harbour and is landed at Kalammukku fishing harbour. Kalammukku is a major fish landing centre in the Southern part of Ernakulam district situated between 9°58'55.48"N 76°14'34.27"E and is also a major ring seine landing centre.

Ring seining is considered as one of the most efficient and effective fishing methods in the coast of Kerala. The study area, Chellanam fishing village, is known for its active ring seine fishery. At present, there are three types of fishing gear operated in the study area. They are classified on their length viz. large meshed ring seines (LMRS), small meshed ring seine type I (SMRS-I) and small meshed ring seine type II (SMRS-II). The LMRS is operated from the mechanized vessels of LOA 20-24m and SMRS-I and SMRS-II are operated from the motorized vessels of LOA 10-15m.

This study was conducted from January- December 2016. Samples were taken weekly from commercial ring seines catch of three categories of ring seine. Morphometric and meristic characteristics taken from the samples were Total length (cm), Fork length (cm), Weight, number, sex and maturity stages of commercially important species, Total weight of the catch (kg), Total weight of juveniles (kg). The minimum size at which an advanced matured ovary was found is considered as Minimum Size at first Maturity (MSM). Minimum size at maturity of individual species found from the individual species studies. The minimum legal size (MLS) recommended by CMFRI was used for the comparison (Mohamed et al., 2014).

2.1 Juvenile incidence analysis

To calculate the adult quantity that corresponds to 1 kg of juveniles were calculated using the formula of Najmudeen & Sathiadas (2008) as follows:

$$Q_A = \left(\frac{(1000/w)W}{1000}\right)(1-M)$$

Where,

QA = The quantity of adult fish corresponding to 1kg of juvenile fish after a period of 't' years

W = Individual adult fish weight after a period of 't' years

w = Individual weight of juvenile fish

M = Natural mortality

The length-weight relationship was used to calculate the weight of the fish with the corresponding length of each species using the formula as follows:

$$W = a\,L^b$$

Where,

W = Weight of the fish

L = length of the fish

a = constant

b = exponent

The economic loss due to juvenile incidence in ring seines was calculated as follows:

$$EL = \left(\frac{\sum_{i=1}^{n} C_i Q_i/(1+\delta)^t}{n}\right) - \left(\frac{\sum_{i=1}^{n} c_i q_i}{n}\right)$$

Where,

EL= the average economic loss for the quantity of juveniles landed per unit fishing trip

C_i = the annual average wholesale price of the adult fish of same species of juveniles

Q_i = the estimated quantity of adult fish corresponding to the quantity of juvenile fish

q_i = is an assumption that if juveniles were grown

n = total number of fishing tripper boat

δ = is the standard discount rate

3. Results and Discussion

The fifteen fishes that were selected for the analysis of economic loss due to juvenile incidence were oil sardine (*Sardinella longiceps*), rainbow sardine (*Dussumieria acuta*), Indian mackerel (*Rastrelliger kanagurta*), commerson's anchovy (*Stolephorus commersonni*), insular anchovy (*Stolephorus insularis*), torpedo scad (*Megalaspsis cordyla*), oblique-jaw thryssa (*Thryssa purava*), white sardine (*Escualosa thoracata*), tiger tooth croaker (*Otolithes ruber*), belanger's croaker (*Johnius belangerii*), pale spotfin croaker (*Johnius glaucus*), kadal shrimp (*Metapenaeus dobsonii*), kiddi shrimp (*Parapenaeiopsis stylifera*), Indian white prawn (*Penaeus indicus*) and tiger prawn (*Penaeus monodon*). In the present study, the mean length was compared with the MLS for the criteria of determining the juveniles in the three categories of ring seines. For the species whose MLS is not available, the MSM was taken as the criteria for determining the juveniles.

3.1 Juvenile Incidence in LMRS

In the present study, the dominant species in LMRS with the highest quantity of juveniles was rainbow sardine (*Dussumieria acuta*) which constituted a total catch of 62000kg of fishes in which 14600kg (23.55%) were juveniles. From the observation, it was noted that the mean length and mean weight of the species was 14.91± 1.7cm and 30.02 ±9.3gm, respectively which was less than that of the MSM (16cm). Indian mackerel (*Rastrelliger kanagurta*) was the second dominant species in LMRS, in which the highest percentage of juveniles was found. The species constituted a total catch of 4500kg of fishes, in which 2500kg (55.56%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 13.27±3.56cm and 31.18±33.95gm respectively which was less than that of the minimum legal size (MLS) (14cm). Mackerel landings in Kerala were 47020 tonnes and it has contributed to 9% of the state's marine landings during the year 2016 (Anon, 2017a). Along the Kerala coast fishing season for mackerel is from August to December and juveniles of mackerel are mostly landed during the lean season.

The third dominant species, which constituted the highest percentage of juveniles was kadal shrimp (*Metapenaeus dobsonii*), with a total catch of 5600kg in which 1800kg (32.14%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 5.8±1.22cmand 2.5±1.52gmrespectively, which was less than that of the MSM (6cm). The fourth dominant species recorded was the torpedo scad (*Megalaspsis cordyla*). This species constituted a total catch of 800kg of fishes in which 100% were juveniles and the observation of the mean length and mean weight of the species were 11.05±0.95cm and 14.94±3.2gm respectively, which was less than that of the minimum legal size (19cm). Carangid landings in Kerala was 15% of the state marine landings during the year 2016 (Anon, 2017a).

The fifth dominant species with the highest quantity of juveniles was kiddi shrimp (*Parapenaeiopsis stylifera*) and the species constituted a total catch of 1700kg of fishes in which 640kg (37.65%) were juveniles. The mean length and weight of the species was 7.5±1.02 cm and 3.2±1.44 gm respectively, which was less than that of the MLS (7cm). The sixth dominant species which recorded highest quantity of juveniles was oblique-jaw thryssa (*Thryssa purava*). The species constituted a total catch of 630kg in which 250 (39.68%) were juveniles and the mean length and mean weight of the species was 10.15±1.67cm and 7.75±4.52gm, respectively. The MSM of the species was 14.5cm.

The seventh dominant species was the pale spotfin croaker (*Johnius glaucus*) and this species constituted a total catch of 120kg of fishes in which 45kg (37.5%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 14.5±1.69 and 30.4±4.1, respectively which was less than that of the MLS (15cm). The eighth dominant species that constituted highest quantity of juveniles was insular anchovy (*Stolephorus insularis*). Anchovies are important pelagic resources along the Kerala coast and the genus *Stolephorus* are dominant catches along the south west coast of India. The species constituted a total catch of 900kg of fishes, in which 40(4.44%) were juveniles. The MSM of this species is 6cm and the mean length of the species was 6.2±0.72and the mean weight was 1.8±0.23.

Table 1. Constituents of juveniles occurring in large meshed ring seine (LMRS)

Species	Minimum size at maturity (MSM) (cm)	Minimum legal size (MLS) (cm)	Mean length with SD (cm)	Mean weight with SD (gm)	Total catch (kg)	Total juvenile catch (kg)	% juvenile in catch
Sardinella longiceps	15	10	14.47± 1.70	26.86 ±9.83	74350	0	0
Dussumieria acuta	16	-	14.91± 1.7	30.02 ±9.3	62000	14600	23.55
Rastrelliger kanagurta	17	14	13.27± 3.56	31.18± 33.95	4500	2500	55.56
Stolephorus commersonni	11	-	9.4± 2.29	7.3± 4.08	595	14	2.35
Stolephorus insularis	6	-	6.2± 0.72	1.8± 0.23	900	40	4.44
Megalaspsis cordyla	19	19	11.05± 0.95	14.94± 3.2	800	800	100
Thryssa purava	14.5	-	10.15± 1.67	7.75± 4.52	630	250	39.68
Escualosa thoracata	8.2	-	10.5± 1.23	11.4± 2.2	170	0	0
Otolithes ruber	17	14	15± 1.6	32.5± 4.36	135	20	14.81
Johnius belangerii	17	14	17± 1.2	41± 4	80	0	0
Johnius glaucus	15	15	14.5± 1.69	30.4± 4.1	120	45	37.5
Metapenaeus dobsonii	6	6	5.8± 1.22	2.5± 1.52	5600	1800	32.14
Parapenaeiopsis stylifera	7	7	7.5± 1.02	3.2± 1.44	1700	640	37.65
Penaeus indicus	13	-	14.6± 0.23	18.9± 2.35	405	0	0
Penaeus monodon	16.3	-	16.8± 0.56	21.7± 2.55	300	0	0
Total					**152285**	**20709**	**13.6**

The ninth dominant species was *Otolithes ruber*. The species constituted a total catch of 135kg of fishes, in which 20(14.81%) were juveniles. The MLS recommended for the species is 14cm. The mean length of the species was 15± 1.6 and the mean weight was 32.5± 4.36. The tenth dominant species was the commerson's anchovy (*Stolephorus commersonni*). The species constituted a total catch of 595kg of fishes, in which 14(2.35%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 9.4±2.29 and 7.3±4.08, respectively which was less than that of the MSM (11cm). The other species selected, such as oil sardine (*Sardinella longiceps*), white sardine (*Escualosa thoracata*), belanger's croaker (*Johnius belangerii*), Indian white prawn (*Penaeus indicus*) and tiger prawn (*Penaeus monodon*) did not constitute any juveniles. Thus in LMRS there was a total catch of 152285kg of fishes in which 20709kg constituted juveniles (13.60%).

3.2 Juvenile Incidence in SMRS-I

In the present study the dominant species in SMRS-I was rainbow sardine (*Dussumieria acuta*) which constituted a total catch of 99400kg of fishes in which 29870kg (30%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 15.45±1.2 and 30.76±9.6, respectively which was less than that of the MSM (16cm). The second dominant species was torpedo scad (*Megalaspsis cordyla*) in which the highest quantity of juveniles was found. The species constituted a total catch of 50248kg of fishes in which 100% were juveniles. From the observation it was noted that the mean length and mean weight of the species were 10.05±0.76 and 13.54±3.3 respectively which was less than that of the minimum legal size (19cm). Commerson's anchovy (*Stolephorus commersonni*) was the third dominant species in SMRS-I in which the highest quantity of juveniles was found. The species constituted a total catch of 40305kg of fishes, in which 9068kg (22.5%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 9.7±2.46 and 7.9± 4.96, respectively which was less than that of the MSM (11cm).

The fourth dominant species which constituted the highest quantity of juveniles was insular anchovy (*Stolephorus insularis*). The species constituted a total catch of 40250kg of fishes in which 8070kg(20.05%) were juveniles. From the observation it was noted that the mean length and mean weight of the species were 5.86±0.60and 7.9±4.96 respectively which was less than that of the minimum size at maturity (MSM) (6cm). The fifth dominant species was kadal shrimp (*Metapenaeus dobsonii*). This species constituted a total catch of 18015kg in which juveniles constituted 4665kg (25.9%). The MLS recommended for this species is 6cm and the mean length of the species was 5.4± 0.74 and the mean weight was 2.39±0.79. The sixth dominant species was kiddi shrimp (*Parapenaeiopsis stylifera*) which constituted a total catch of 12000kg of fishes in which 2580kg (25.9%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 7.2±1.14 and 3.7±1.46 respectively which was less than that of the minimum legal size (7cm).

The seventh dominant species was the Indian mackerel (*Rastrelliger kanagurta*). The species constituted a total catch of 10236kg of fishes, in which 2867 (27.8%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 13.88±3.60 and 36.35±36.19 respectively which was less than that of the minimum legal size (14cm). The eighth dominant species constituted quantity of juveniles were tiger tooth croaker (*Otolithes ruber*) and this species constituted a total catch of 1280kg of fishes in which 110kg (8.6%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 15.9±1.6 and 34.8±6.2 respectively which was less than that of the minimum legal size (14cm).

The ninth dominant species was oblique-jaw thryssa (*Thryssa purava*), which constituted a total catch of 1020kg of fishes in which 320kg (31.37%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 10.12±1.75and 7.25±4.47 respectively which was less than that of the

Table 2. Constituents of juveniles occurring in large meshed ring seine (LMRS) Constituents of juveniles occurring in small meshed ring seine type I (SMRS-I)

Species	Minimum size at maturity (MSM) (cm)	Minimum legal size (MLS) (cm)	Mean length with SD (cm)	Mean weight with SD (gm)	Total catch (kg)	Total juvenile catch (kg)	% juvenile in catch
Sardinella longiceps	15	10	14.34± 1.75	27.32± 10.15	121914	0	0
Dussumieria acuta	16	-	15.45± 1.2	30.76± 9.6	99400	29870	30
Rastrelliger kanagurta	17	14	13.88± 3.6	36.35± 36.19	10236	2847	27.8
Stolephorus commersonni	11	-	9.7± 2.46	7.9± 4.96	40305	9068	22.5
Stolephorus insularis	6	-	5.86± 0.6	7.9± 4.96	40250	8070	20.05
Megalaspsis cordyla	19	19	10.05± 0.75	13.54± 3.3	50248	50248	100
Thryssa purava	14.5	-	10.12± 1.75	7.25± 4.47	1020	320	31.37
Escualosa thoracata	8.2	-	9.6± 1.23	10.6± 2.16	520	78	15
Otolithes ruber	17	14	15.9± 1.6	34.8± 6.2	1280	110	8.6
Johnius belangerii	17	14	17.5± 1.6	43.6± 5.36	540	0	0
Johnius glaucus	15	15	14± 1.5	28.6± 4.3	500	12	2.4
Metapenaeus dobsonii	6	6	5.4± 0.74	2.39± 0.79	18015	4665	25.9
Parapenaeiopsis stylifera	7	7	7.2± 1.14	3.7± 1.46	12000	2580	21.5
Penaeus indicus	13	-	14.6± 0.28	18.5± 2.34	800	0	0
Penaeus monodon	16.3	-	16.4± 0.5	21.9± 2.55	495	0	0
Total					**367473**	**107868**	**29.35**

MSM (14.5cm). The tenth dominant species was white sardine (*Escualosa thoracata*). The species constituted a total catch of 520kg of fishes in which 78kg (15%) was juveniles. From the observation it was noted that the mean length and mean weight of the species was 9.6±1.23 and 10.6±2.16 respectively, which was less than that of the MLS (8.2cm). The next dominant species was pale spotfin croaker (*Johnius glaucus*) which constituted a total catch of 500kg of fishes in which 12kg (2.4%) were juveniles. From the observation, it was noted that the mean length and mean weight of the species was 14±1.5 and 28.6±4.3, respectively which was less than that of the minimum legal size (15cm). The other species selected such as *Sardinella longiceps, Johnius belangerii*, *Penaeus indicus* and *Penaeus monodon* did not constitute any juveniles. Thus, in SMRS-I there was a total catch of 367473kg of fishes in which 107868kg constituted juveniles (29.35%).

3.3 Juvenile incidence in SMRS-II

In the present study the dominant species in SMRS-II was rainbow sardine (*Dussumieria acuta*), which constituted a total catch of 32476kg of fishes in which 10619kg (32.7%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 15.21±1.7and 31.02±9.8, respectively which was less than that of the MSM (16cm). The second dominant species was torpedo scad (*Megalaspsis cordyla*) in which the highest quantity of juveniles was found. The species constituted a total catch of 24648kg of fishes, in which 100% were juveniles. From the observation, it was noted that the mean length and mean weight of the species was 11.15±1.25 and 15.30±3.10 respectively which was less than that of the minimum legal size (19cm). Commerson's anchovy (*Stolephorus commersonni*) was the third dominant species in SMRS-I in which the highest quantity of juveniles was found. The species constituted a total catch of 10567kg of fishes, in which 1109kg (10.5%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 9.9±2.98 and 8.2±5.23 respectively which was less than that of the MSM (11cm).

The fourth dominant species was kadal shrimp (*Metapenaeus dobsonii*). This species constituted a total catch of 4355kg in which juveniles constituted 2504kg (57.5%). The MLS recommended for this species is 6cm and the mean length of the species was 5.6±1.20 and the mean weight was 2.4±1.42. The fifth dominant species was the Indian mackerel (*Rastrelliger kanagurta*). The species constituted a total catch of 4102kg of fishes in which 233kg (5.7%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 13.71±3.91 and43.9±39.14 respectively which was less than that of the minimum legal size (14cm). The sixth dominant species was kiddi shrimp (*Parapenaeiopsis stylifera*) which constituted a total catch of 1020kg of fishes in which 335kg (32.8%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 7.9±1.02cm and 3.9±1.44gm respectively which was less than that of the minimum legal size (7cm). The seventh dominant species which constituted highest quantity of juveniles was insular anchovy (*Stolephorus insularis*). The species constituted a total catch of 600kg of fishes in which 28kg (4.7%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 6.1±0.61 and 1.8±0.20 respectively which was less than that of the minimum size at maturity (MSM) (6cm).

The eighth dominant species that constituted quantity of juveniles was oblique-jaw thryssa (*Thryssa purava*), which constituted a total catch of 180kg of fishes in which 85kg (47.2%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 9.82±2.02 and 6.98±5.30 respectively which was less than that of the MSM (14.5cm). The ninth dominant species was the tiger tooth croaker (*Otoliths ruber*) and this species constituted a total catch of 80kg of fishes in which 10kg (12.5%) were juveniles. From the observation it was noted that the mean length and mean weight of the species was 15.6±1.2 and 31.5±5.75 respectively which was less than that of the minimum legal size (14cm). The other species selected, such as *Sardinella longiceps*, *Escualosa thoracata*, *Johnius belangerii*, *Penaeus indicus* and *Penaeus monodon* did not constitute any juveniles. Thus in SMRS-II there was a total catch of 106315kg of fishes in which 39571kg constituted juveniles (37.22%).

Table 3. Constituents of juveniles occurring in small meshed ring seine type II (SMRS-II)

Species	Minimum size at maturity (MSM) (cm)	Minimum legal size (MLS) (cm)	Mean length with SD (cm)	Mean weight with SD (gm)	Total catch (kg)	Total juvenile catch (kg)	% juvenile in catch
Sardinella longiceps	15	10	14.75± 1.87	28.98± 10.73	27000	0	0
Dussumieria acuta	16	-	15.21± 1.7	31.02± 9.8	32476	10619	32.7
Rastrelliger kanagurta	17	14	13.71± 3.91	43.9± 39.14	4102	233	5.7
Stolephorus commersonni	11	-	9.9± 2.98	8.2± 5.23	10567	1109	10.5
Stolephorus insularis	6	-	6.1± 0.61	1.8± 0.2	600	28	4.7
Megalaspsis cordyla	19	19	11.15±1.25	15.30± 3.1	24648	24648	100
Thryssa purava	14.5	-	9.82± 2.02	6.98± 5.3	180	85	47.2
Escualosa thoracata	8.2	-	9.6± 1.14	9.71± 1.34	120	0	0
Otolithes ruber	17	14	15.6± 1.2	31.5± 5.75	80	10	12.5
Johnius belangerii	17	14	17.2± 1.5	41.8± 6.48	120	0	0
Johnius glaucus	15	15	15± 1.7	32.5± 6.32	57	0	0
Metapenaeus dobsonii	6	6	5.6± 1.2	2.4± 1.42	4355	2504	57.5
Parapenaeiopsis stylifera	7	7	7.9± 1.02	3.9± 1.44	1020	335	32.8
Penaeus indicus	13	-	14.6± 0.23	18.9± 2.35	470	0	0
Penaeus monodon	16.3	-	16.8± 0.56	21.6± 2.5	520	0	0
Total					**106315**	**39571**	**37.22**

3.4 Economic loss due to juvenile incidence

The economic deficit occurred due to the capture of juvenile fishes in three categories viz; LMRS, SMRS-I and SMRS-II of ring seines were worked out. In the study area the wholesale rate and juvenile rate in terms of money varied annually.

3.5 Economic loss in LMRS

From the selected fifteen species, it was found that ten species constituted juveniles. The percentage of the economic deficit caused by the ten species in LMRS in shown in Table 4. Among the ten species *Dussumieria acuta* recorded the highest loss of Rs.5288226 (58.45%) and *Megalaspsis cordyla* the least of Rs.24000 (0.27%) annually.

3.6 Economic loss in SMRS-I

From the selected fifteen species, it was found that eleven species constituted juveniles in SMRS-I. The percentage of economic deficit caused by the eleven species in SMRS-I is shown in Table 5. Among the eleven species *Stolephorus commersonni*recorded the highest loss of Rs.9821464 (26.89%) and *Escualosa thoracata* the least of Rs.46071 (0.13%).

3.7 Economic loss in SMRS-II

From the selected fifteen species, it was found that nine species constituted juveniles in SMRS-II. The percentage of economic deficit caused by the nine species in SMRS-II is shown in Table 6. Among the nine species *Rastrelliger kanagurta* (35.21%) recorded the highest loss of Rs.3541292 (26.89%) and *Thryssa purava* the least of Rs.36527 (0.37%).

3.8 Total economic loss

The total annual economic loss due to juvenile fishing in three categories of ring seines was estimated to be Rs.55632956 in which SMRS-I recorded highest economic loss of Rs.36528833 followed by SMRS-II (Rs.10057235) and LMRS (Rs.9046888).

The uncontrolled increase in fishing effort in terms of number of fishing units, dimensions of the gear and size and horsepower of the craft, accompanying increasing investment requirements and increase in the proportion of juveniles and sub-adults in the commercial landings have been major concerns in the ring seine fishery (Singh et al., 2007; Kurup et al., 2009). Juveniles are mainly caught in small meshed ring seines (*choodavala*) as the mesh size of the gear is small (8-10mm) and Edwin et al. (2010) have reported the incidence of juveniles in small mesh ring seines in the range of 20-30% and the large meshed ring seine (*thanguvala*) in the range of 5-15%. Pramod (2010) reported the excess juvenile catch in ring seine fishery due to small mesh ring seine operation and ring seines of Kerala catch 0 and 1 year class of sardine and mackerel in high quantity every year. Oil sardines ranging from 1.8-3 tonnes are dumped into Cochin backwaters every year as excess production of ring seine. 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. In the present scenario it is highly important to quantify the economic loss that occurred due to juvenile fishing in order to find solutions to minimize this process.

Table 4. The economic deficit of juvenile species in large meshed ring seine (LMRS)

Species	Quantity (Rs.)	Economic deficit (%)
Dussumieria acuta	5288226	58.45
Rastrelliger kanagurta	2359419	26.08
Metapenaeus dobsonii	512537	5.67
Stolephorus commersonni	208880	2.31
Stolephorus insularis	147899	1.63
Thryssa purava	131836	1.46
Johnius glaucus	129290	1.43
Otolithes ruber	124413	1.38
Parapenaeiopsis stylifera	120388	1.32
Megalaspsis cordyla	24000	0.27

Table 5. The economic deficit of juvenile species in SMRS-I

Species	Quantity (Rs.)	Economic deficit (%)
Stolephorus commersonni	9821464	26.89
Rastrelliger kanagurta	7936909	21.72
Dussumieria acuta	7585654	20.76
Stolephorus insularis	5139791	14.07
Megalaspsis cordyla	1507440	4.13
Metapenaeus dobsonii	1351760	3.7
Otolithes ruber	1168555	3.2
Johnius glaucus	905807	2.48
Thryssa purava	266726	0.73
Parapenaeiopsis stylifera	798656	0.19
Escualosa thoracata	46071	0.13

Table 6. The economic deficit of juvenile species in SMRS-II

Species	Quantity (Rs.)	Economic deficit (%)
Rastrelliger kanagurta	3541292	35.21
Stolephorus commersonni	3124970	31.07
Dussumieria acuta	2320194	23.06
Megalaspsis cordyla	739440	7.35
Stolephorus insularis	98286	0.98
Otolithes ruber	75860	0.75
Metapenaeus dobsonii	75049	0.75
Thryssa purava	36527	0.37
Parapenaeiopsis stylifera	45677	0.46

Table 7. Total economic loss of ring seines

Types of ring seine	Economic loss (Rs.)
LMRS	9046888
SMRS-I	36528833
SMRS-II	10057235
Total	**55632956**

4. Conclusion

During the present study, only fifteen commonly occurring and which are commercially utilized were selected. The result showed that juvenile incidence occurred in all categories of ring seines and the highest was observed in SMRS-II (37.22 %) followed by SMRS-I (29.35%) and LMRS (13.60%). Economic loss ranged from Rs.9046888

to Rs.36528833 which was highest in SMRS-I followed by SMRS-II and LMRS. It is necessary that strict regulations should be adopted for the effective control of juvenile catching in ring seines. Identification of spawning and nursery grounds of fishes caught in ring seines and enforcing seasonal bans during the particular season can be done to control juvenile incidence. Fishers should get proper awareness regarding the consequences of catching juveniles in the future so that they themselves take the initiative in preventing the catch of juveniles.

5. References

Aswathy, N. and Narayanakumar, R. (2013) Economic analysis of fish meal plants in Uttara Kannada district, Karnataka. Marine Fisheries Information Service. Technical and Extension Series. 27:5-7

Edwin, L., Nasser, M., Hakkim, V.I., Jinoy, V.G., Dhiju D.P.H. and Boopendranath M.R., (2010). Ring seine for the small pelagic fishery In: Coastal Fisheries Resources of India Conservation and sustainable utilization (Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N and Ninan, G., Eds) Society of Fisheries Technologists (India), Cochin: p 305-313

Hall, S.J. and Mainprize, B.M. (2005) Managing by-catch and discards: How much progress are we making and how can we do better. Fish and Fisheries. 6 (2): 134-155

Hubbs, C.L. (1943) Technology of early stages of fishes. Copeia 4:26

Najmudeen, T.M. and Sathiadas, R. (2008) Economic impact of juvenile fishing in a tropical multi-gear multi-species fishery. Fish. Res. 92: 322-332

Pillai N.G.K. (2011), Marine Fisheries and Mariculture in India, Central Marine Fisheries Research Institute, Kochi-682018, pp 326.

Pramod, G. (2010) Illegal, Unreported and Unregulated Marine Fish Catches in the Indian Exclusive Economic Zone, Field Report, Policy and Ecosystem Restoration in Fisheries, Fisheries Centre, pp 30, University of British Columbia, BC, Vancouver, Canada.

Purcell, J.E. (2012) Jellyfish and Ctenophore blooms coincide with human proliferations and environmental perturbations. Annu Rev. Mar.Sci. 4: 209-235

Sheriff, M. Kevin, K. Ndomahine, T.N., Taylor, E., Badr, O.K.M., Boateng, K.J. and Sandi, R. (2010) Catch rate of juveniles Ethamatosa fimbriata, Sardinella maderensis, and Brachydeuterus auritus fishing in Freetown Peninsular. African Journal of Environmental Science and Technology. 4 (8): 517-525

Vijayan V, Edwin L, Ravidran, K (2000). Conservation and management of Marine Fishery Resources of Kerala state, India; Naga, The ICLARM Quarterly 23(3):6-9