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## Design characteristics, catch composition and selectivity of drift gill net in Chettuva backwaters, Thrissur

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### Abstract

Estuary is one of the most important ecosystems on which many fishermen are dependent for their livelihood. Estuaries harbour many diversified species being the main breeding and feeding grounds for many aquatic species. This paper deals with the design, catch composition, selectivity and by catch characterisation of drift gill nets in the Chettuva estuary. Polyamide (PA) monofilament twine was used for construction of net. Meshsizes of main webbing of drift gill nets was 30, 35 and 45 mm. The total fleet length varied from 63 to 91 m. A total of 9 species of fish, jelly fishes and crustaceans were recorded in the gill net. Major catch composition of drift gill nets consisted of small pony fish (*Leiognathus equulus*), Malabar blood snapper (*Lutjanus malabaricus*), mullet (*Mugil cephalus*), Spotted butter fish (*Scatophagus argus*), Pearl spot (*Etroplus suratensis*), Tilapia (*Oreochromis niloticus*), croaker fish (*Johnius carutta*), climbing perch (*Anabas testudineus*) and shrimps (*Penaeus indicus*).

**Keywords:** Drift gill net, Chettuva, design, catch composition, selectivity

### Introduction

Gill nets are mostly used to capture of fishery resources like *Mugil cephalus*, *Scatophagus argus*, *Ambassis gymnocephalus*, *Engraulis hamiltonii*, *Epinephelus malabaricus*, *Etroplus suratensis*, *Gerres filamentosus*, *Gerres setifer*, *Liza parsia* and *Sillago sihama*. As passive gear, their catching ability relies on the movement or migration of fish through the area where the nets are set and operculum of fishes get entangled in the meshes of nets when the fishes try to pass through it (Laxmappa *et al.*, 2014) <sup>[11]</sup>. Gill net is both species and size specific gear. Gill netting is a more eco-friendly method compared to some of the active fishing operations. With appropriate selection of mesh size, overexploitation and capture of juveniles can be avoided and by catch can be minimized, as not many species other than the targeted fishes will be caught (Thomas, 2010) <sup>[16]</sup>. It is a passive gear set gill net is apparently the only type of fishing gear suitable for reservoir gill net fishing. Gill net is the only gear in which the mesh size of the gear itself serves the dual function of catching fish and selecting the fish to be caught (Anon, 1994) <sup>[1]</sup>. The design aspect of gill net is important for the selection of type and size of the species. Though the principle of gill netting has not changed over the years, the equipment and materials have undergone change and are widely recognized as an efficient and selective type of gear (Bjoringsoy, 1996) <sup>[3]</sup>. Low-powered vessels used are fuel efficient and hence relatively cheap, cost effective, and also easy to operation. operation. The minimum investment on nets and a smaller number of crew are some of the characteristics of gill net fishing worldwide. An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with freshwater derived from land drainage (Cameron and Pritchard, 1963) <sup>[5]</sup>.

The need of the hour is to utilize the fishery resources judiciously. By catch is an inevitable outcome of gillnetting and it should be properly managed for better returns from the fishery. Globally, there is now an emphasis on reducing the by catch. This will help in conserving the fishery resources constituting the commercially important species and non -targeted species. Overfishing and irresponsible fishing practices have long been recognized as leading causes that have reduced aquatic biodiversity.

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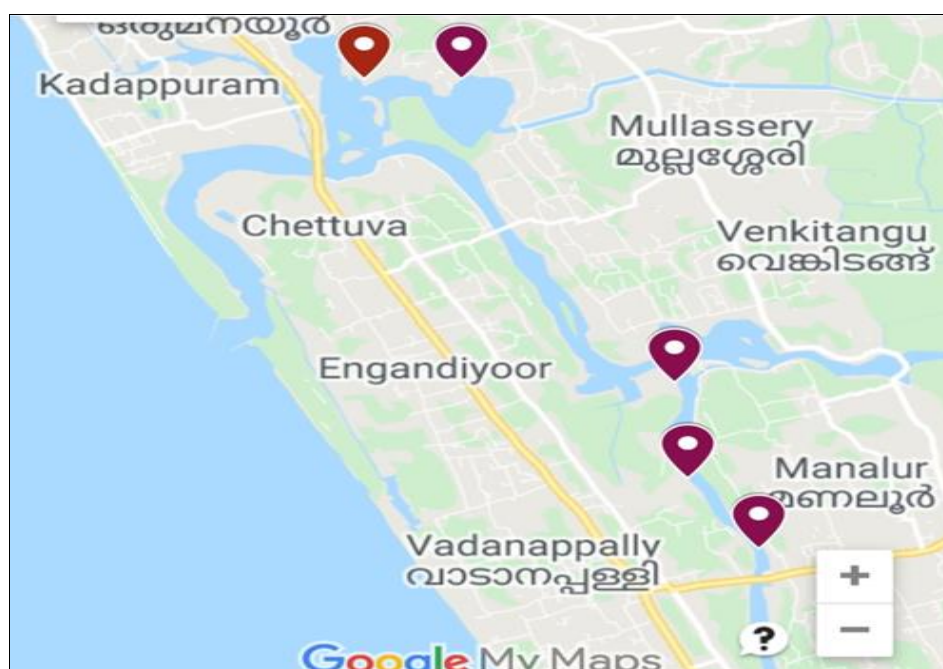
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The present study was undertaken with the objective of investigating the design details of drift gill net in Chettuva backwaters, to analyse the catch composition in drift gill net, to assess the selectivity of fishing gear and by catch characterization and quantification.

### Materials and Methods

The Chettuva backwaters (10.54 N, 76.06 E) located in Thrissur district is a part of Vembanad - Kol wetlands cited under Ramsar sites of Kerala. Data for the drift gill net fishery was collected during the gill net fishing season from December 2020 to February 2019. Based on the prevalence of

fishing operations and accessibility to data collection from local fishermen, five sites of fishing grounds of Koorikkadu and Kanathara of Chettuva backwaters were studied. A monthly drift gill net operational details and catch composition were examined for three months (December 2019- February 2020 i.e., post monsoon). Information on gill net was collected through intensive field survey and interaction with the local fishermen of the Chettuva backwaters during the study period. The gear operations at five study sites of Koorikkadu (two sites) and Kanathara (three sites) fishing grounds were observed. The gill nets were set at midnight and catch was harnessed at early morning.



**Fig 1:** Study sites of experimental gillnetting

### Fishing gear design characteristics

The design details of fishing gears (mesh size, length, width and materials) were collected from fishermen at the fishing spot through interview and direct observation. The different mesh sizes of gill net were measured. The design details of fishing gears were prepared and presented as per FAO catalogue of Fishing Gear Designs (Nedelec, 1975) [12].

### Catch composition

The total catch composition of experimental drift gill net were recorded. The catch composition was identified (Day, 1889) [6] and then sorted species wise. The measurements on total length and weight of individual fish species were recorded. The catch per unit effort (CPUE) of fishing gear was determined.

### Gear selectivity

The mesh size variations in drift gill net were recorded. The different species caught in each mesh size was noted. The maximum length and minimum length of each species caught in each haul will enable to study selectivity of gill nets operated in the study area.

### By catch characterization and quantification

The species composition of by catch constituting juveniles of commercially important species and non-target species in each mesh size of drift gill net was recorded. The amount of

by catch generated in each haul was quantified.

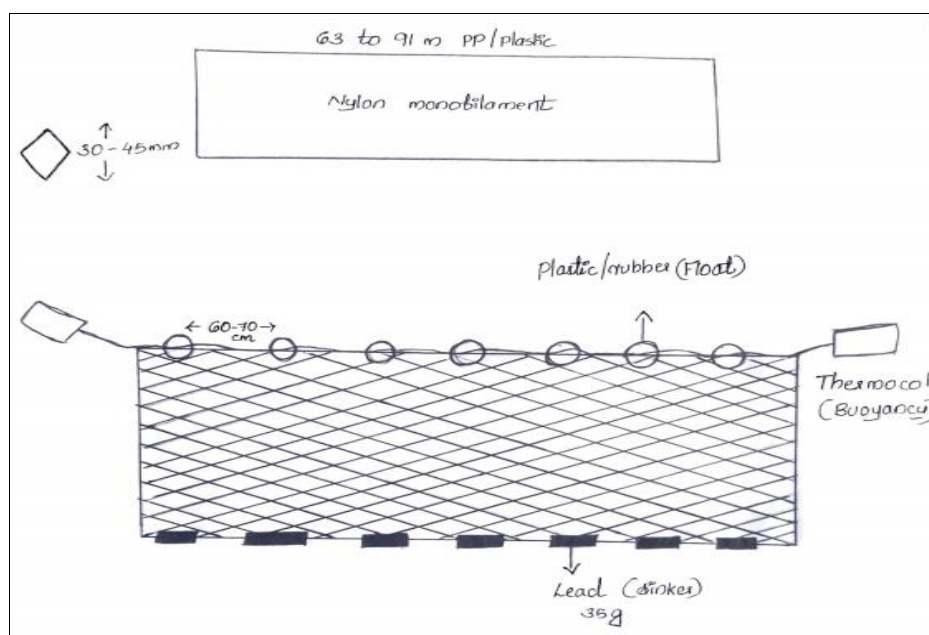
## Results and Discussion

### Design of the net

Drift gill net is locally known as *Khaandadi vala*. Main webbing of net was made of white monofilament nylon polyamide (PA). The mesh sizes are 30, 35 and 45 mm; mesh opening ranged from 29 to 44 mm and mesh circumferences ranged from 74 to 137 mm. The headline material was polypropylene and with diameter ranging from 3 to 4.5 mm and R-Tex values ranged from R2939Tex-R4048Tex. The footrope material was nylon with diameters ranged from 4.5 to 5 mm and R-Tex values ranged from R4351Tex-R5926Tex. The float numbers on the headlines varied from 105 to 130 and the headline lengths varied from 63 to 91 m. The lead sinker weighed 35g and the numbers of sinker per footrope ranged from 100 to 135, the footrope lengths varied from 63 to 91 m. The number of meshes per stapling distance was 3 and the stapling distances/mounted lengths varied from (60-96) mm. The numbers of meshes in headline ranged from (38436-140000). The numbers of meshes in depths varied between (50-90). The vertical and horizontal hanging coefficient varied between 0.87 to 0.5. The technical specifications and the design of the net for the surface drift gill net are shown in Table 1 and Figure 2, respectively. Pradhan *et al.* (2017) [13] studied the gill nets in Bhayander estuary. White coloured nets were mainly used. Nets of light

green, blue, yellow and grey colour were also preferred by pomfrets. Gill net without footrope are reported in Central Kerala by Baiju (2005) [2]. The studies in gangetic plain of West Bengal by Sandhya *et al.* (2019) [15] reveals that gill nets having mesh size of about 50- 100mm are commonly used there. The mesh sizes ranged between 39-160 mm are used in Lekki Lagoon, reported by Emmanuel *et al.* (2010) [7]. The wide use of gill net in Bhayander estuary having a mesh size ranged between 80 to 100 mm. It was studied by Pradhan *et al.* (2017) [1]. Pomfret gill nets operated in other areas of Maharashtra such as Ratnagiri were studied by Kazi *et al.* (2010) [10]. The nets were made up of polyamide multifilament with mesh size ranging from 70 to 150 mm.

Gladston *et al.* (2017) [8] documented the design of Pomfret gill net in Satpati, Maharashtra. For catching pomfrets, gill nets of mesh size 110 mm to 130 mm were commonly used. Ramesan *et al.* (2009) reported that gill net having a mesh size ranges about 50 to 200 mm are commonly used in Hooghly-Matlah Estuary in West Bengal. The widest range of mesh sizes starting from 20 mm to 140 mm in multifilament gill net and 0.20 mm PA monofilament gill net, mesh sizes range between 25 mm, 120 mm were reported in Central Kerala by Baiju M (2005) [2]. Gill nets were rigged with hanging coefficient 0.42 to 0.51 were used in Satpati, Maharashtra documented by Gladston *et al.*, (2017) [8].



**Fig 2:** Design of drift gillnet operated in Chettuva backwaters

**Table 1:** Technical specification of drift gillnet operated in Chettuva backwaters

Design characteristics	Measurements and Description
Gear color	White
Type of set	surface
Type of mesh net	knotted
Headline length(m)	63-91
Headline material	Plastic, polypropylene
Headline diameter(cm)	3-4.5
Headline R-TeX value	R2939Tex-R4048Tex
Footrope length (m)	63-91
Footrope material	Nylon Polyamide (PA)
Footrope diameter (cm)	4.5-5
Footrope R-TeX value	R4351Tex-R5926Tex
Stapling distance (mm)	60-96
Number of meshes per stapling distance	3
Mesh size(mm)	30-45
Mesh opening (mm)	29-44
Mesh circumference(mm)	74-137
Horizontal hanging coefficient	0.5
Float material	Plastic (FRP), polypropylene
Number of floats	105-130
Distance between floats (cm)	60-70
Number of meshes in headline	38436-140000
Number of meshes in depth	50-90
Number of sinkers	100-135
Weight of sinkers (g)	35
Distance between sinkers (cm)	63-70
Material of sinkers	lead
Vertical hanging coefficient	0.87

**Catch composition**

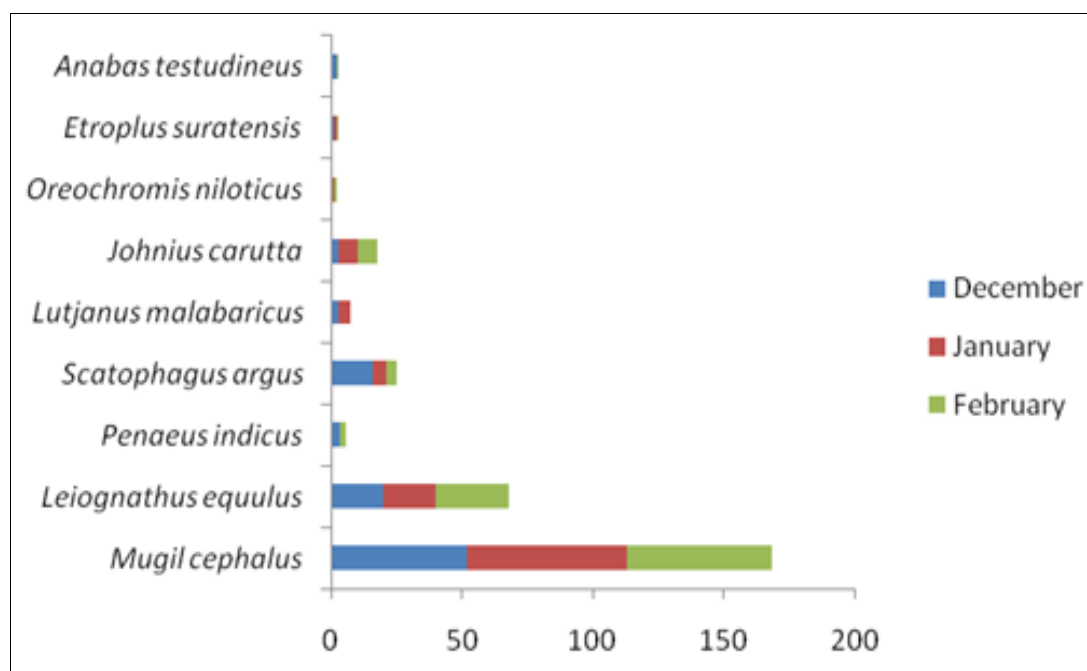
The abundance (no.) and biomass (g) of different species caught in gill net was recorded (Table 2, Figure 3). The total catch of experimental gill netting composed of five thousand one hundred and sixty eight (5168 no.) specimens for the three months. It comprised 130.26 kg total weight. The total catch comprised nine fish species (figure 4). The fish species harvested by the gill net were small pony fish (*Leiognathus equulus*), Malabar blood snapper (*Lutjanus malabaricus*), mullet (*Mugil cephalus*), Spotted butter fish (*Scatophagus argus*), Pearl spot (*Etroplus suratensis*), Tilapia (*Oreochromis niloticus*), croaker fish (*Johnius carutta*), climbing perch (*Anabas testudineus*) and shrimps (*Penaeus indicus*). The catch composed of fishes of marketable size and juvenile fishes were discarded as by catch. *M.cephalus* had the highest percentage composition by number 2906 (56.23%) and *O.niloticus* had the least percentage of 0.69% (36 no.) (Table 2). The Catch Per Unit Effort (CPUE) (number of catch per trip) was 800; the average number of fish caught per hour was 99.

Catch composition of drift gill net in Bhayander estuary were studied by Suraj Kumar Pradhan *et al.* (2017) [1]. Their major catch composition was *Otolithoides biauritus*, *Johnius amblycephalus*, *Johnius macrorhynchus*, *Protonibea diacanthus*, *Mugil cephalus*, *Plicofollis dussumieri* and *Leptomelanosoma indicum*. Sandhya *et al.* (2019) [15] studied the catch composition in Gangetic plain in West Bengal. The net is operated throughout the year mainly for catching the

stocked fishes like Indian major carps, Exotic carps, and indigenous fishes like *Mystus sp*, *Glossogobius giurus*, *Anabas testudineus* etc and the average catch per day is about 3-10 kg. Small sized gill net with smaller mesh sizes locally called as Puntijal are also used for catching small indigenous fishes like *Puntius sp*, *Trichogaster sp*, *Chanda nama* etc. According to the study of Remesan *et al.* (2009) [14] the catch composition in the gillnets in Hoogly-Matlah Estuary in West Bengal are *Tenualosa ilisha*, *Pangasius pangasius*, *Mystus sp*, *Rita rita*, Clupeids, *Setipinna sp*, Gobids, *Catla catla* and *Labeo rohita*.

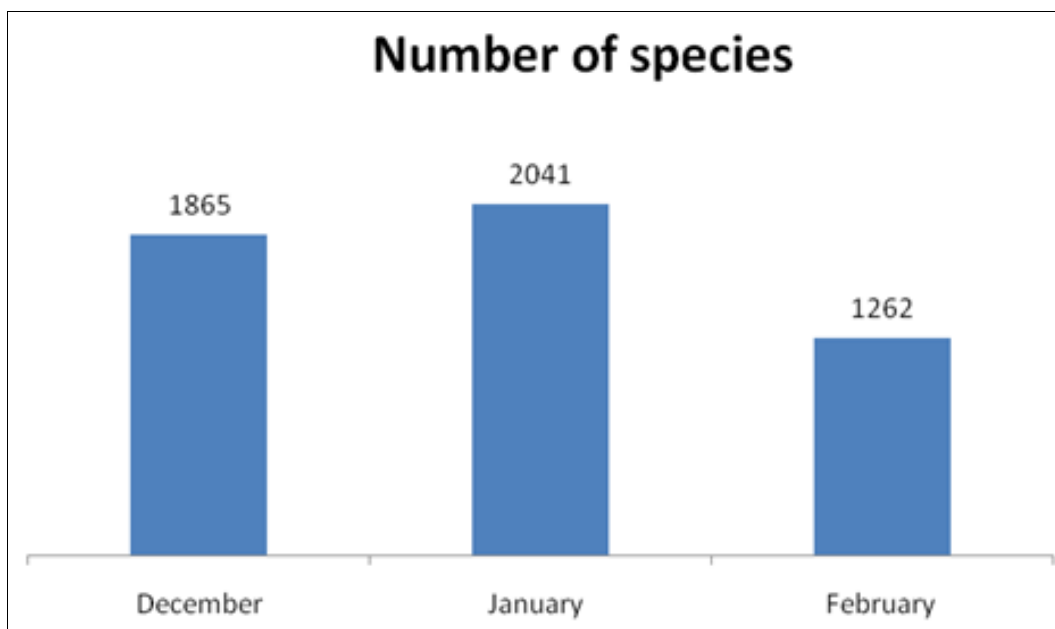
**Table 2:** Abundance (number) and Biomass (g) of targeted catch composition

Species	Number	Percentage	Weight	Percentage
<i>Mugil cephalus</i>	2906	56.23	80.05	61.45
<i>Leiognathus equulus</i>	1133	21.92	10.19	7.82
<i>Penaeus indicus</i>	90	1.74	0.26	0.19
<i>Scatophagus argus</i>	452	8.74	12.04	9.24
<i>Lutjanus malabaricus</i>	150	2.90	6.9	5.29
<i>Johnius carutta</i>	300	5.80	7.41	5.68
<i>Oreochromis niloticus</i>	36	0.69	7.42	5.7
<i>Etroplus suratensis</i>	56	1.08	5.75	4.41
<i>Anabas testudineus</i>	45	0.87	0.24	0.18
Total	5168	100	130.26	100



**Fig 3:** Catch composition of different species





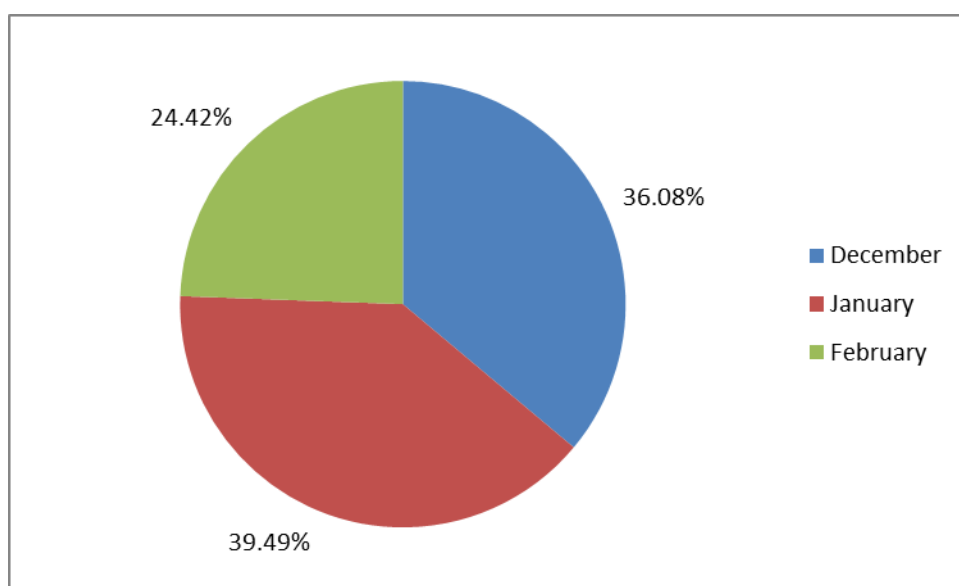
**Fig 4:** Total number of species caught in experimental gillnetting

The monthly variations in fish species caught with gill net are shown in Table 3 & figure 5. The number of *Mugil cephalus* caught was 968, 1238 and 700 in December, January and February respectively. The least caught species by gillnet was

*Oreochromis niloticus*. The total number of fish caught were 1865, 2041 and 1262 respectively, for three consecutive months. The highest catch was in the month of January (39.49%) Figure 5

**Table 3:** Monthly variation in species composition of experimental gillnetting

Species	December		January		February	
	No	%	No	%	No	%
<i>Mugil cephalus</i>	968	51.90	1238	60.65	700	55.46
<i>Leiognathus equulus</i>	377	20.21	400	19.59	356	28.20
<i>Penaeus indicus</i>	60	3.21	0	0	30	2.37
<i>Scatophagus argus</i>	300	16.08	100	4.9	52	4.12
<i>Lutjanus malabaricus</i>	50	2.68	100	4.9	0	0
<i>Johnius carutta</i>	50	2.68	150	7.34	100	7.92
<i>Oreochromis niloticus</i>	0	0	23	1.12	13	1.03
<i>Etroplus suratensis</i>	20	1.07	30	1.46	6	0.47
<i>Anabas testudineus</i>	40	2.14	0	0	5	0.39
Total	1865	100	2041	100	1262	100



**Fig 5:** Monthly variation in total catch (%) of experimental gillnet

The length weight distribution of fish catch in experimental gill netting is given in Table 4. The smallest size range recorded was *P.indicus* (3-6 cm) while the highest size range was recorded in *M.cephalus* (10-25 cm). The smallest weight was recorded in *P.indicus* (2-6 g) and the highest weight recorded in *O.niloticus* (100-350 g).

**Table 4:** The length-weight distribution of catch in experimental gillnetting

Species	Total length range (cm)	Total weight range (g)
<i>Mugil cephalus</i>	10-25	12-57
<i>Leiognathus equulus</i>	7-10	3-17
<i>Penaeus indicus</i>	3-6	2-6
<i>Scatophagus argus</i>	8.5-11.5	18-49
<i>Lutjanus malabaricus</i>	10-15	34-59
<i>Johnius carutta</i>	14-25	20-30
<i>Oreochromis niloticus</i>	20-26	100-350
<i>Etroplus suratensis</i>	10-19	10-200
<i>Anabas testudineus</i>	5-9	4-7

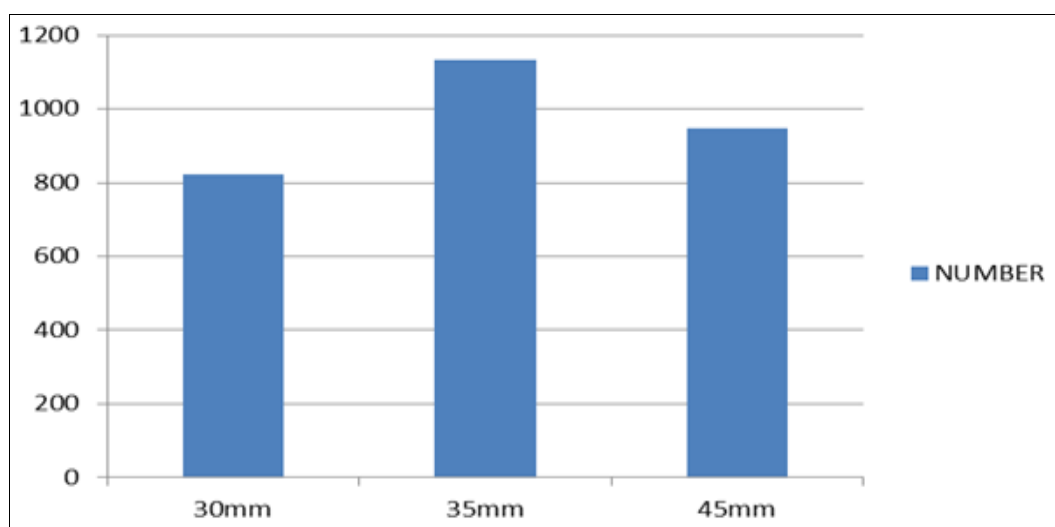
**Selectivity**

The gillnet was species specific and size specific. The gill netting in Chettuva backwaters is targeted for *Mugil cephalus*. The selectivity for 30-45 mm mesh size of gillnet was indicated by length and girth of fishes caught. The gill net was size specific for 10-25 cm of mullet (Table 5). The gill girths

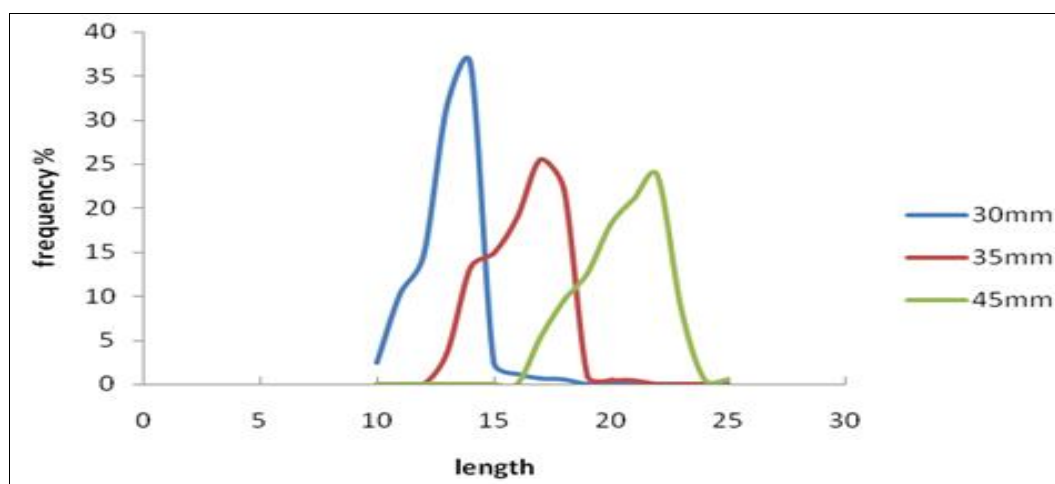
of all the specimens ranged between 2-10 cm. *Mugil cephalus* was caught more in the mesh size 35mm (1133 no) and caught least in the mesh size 30mm (Figure 6). So it shows that the target species is caught more in the mesh size 35 mm of length range 13 to 21 cm. The species which caught in the 30 mm are small size. The species caught in the 45 mm have large size (17-25 cm).

**Table 5:** Length frequency distribution of *Mugil cephalus* caught by gillnets 30mm, 35mm and 45mm stretched mesh sizes

Length	30mm	35mm	45mm
10	20(2.42)	0	0
11	85(10.31)	0	0
12	120(14.6)	0	0
13	260(31.6)	40(3.53)	0
14	300(36.40)	150(13.23)	0
15	20(2.42)	169(14.91)	0
16	10(1.21)	215(19)	0
17	5(0.6)	290(25.6)	50(5.3)
18	4(0.5)	10(0.9)	90(9.48)
19	0	5(0.44)	120(12.64)
20	0	4(0.4)	172(18.12)
21	0	0	200(21.07)
22	0	0	225(23.70)
23	0	0	82(8.64)
24	0	0	5(0.52)
25	0	0	5(0.52)
Total	824	1133	949



**Fig 6:** Catch of *Mugil cephalus* in different mesh sizes



**Fig 7:** Selectivity curve for *Mugil cephalus* caught by experimental gill netting

Based on the selectivity curve (Figure 7), the juveniles of 10-15 cm are mainly caught in 30 mm mesh size. 13 to 20 cm length sized *Mugil cephalus* is caught more in 35 mm mesh size. 17 to 25 cm sized mullets are caught in 45 mm mesh size. As gill nets operated in Chettuva backwaters are *Mugil cephalus* targeted, there is overfishing of juveniles in 30 mm mesh size. This is one of the reasons for the decline of mullet catch in Chettuva backwaters. According to fishermen, mullet catch has declined over the years in Chettuva backwaters. Optimisation of gill net mesh size according to the target species and size group and judicious deployment of gillnet in fishing depth and season in order to minimise the gear interaction with the juveniles of the targeted and non-targeted species are important for gill net fisheries (Boopendranath, 2013) [4]. The present study recommends to minimize the use of gillnets with meshsize of 30mm as juveniles are overfished. *T.guineensis*, one of the most abundant fish species that command high economic value in the lagoon reported by the studies of Emmanuel *et al.* (2010) [7]. The most caught fish length for 40 mm mesh size was fish of total length 14 cm while fish of total length 16 cm was mostly caught by 50 mm gillnet and 75 mm gill net mesh size caught mostly fish of 22 cm total length.

Baiju M (2005) [2] theoretically estimated mesh size required to harvest the most desirable size group (210 mm in length) of *Hypsleobarbus curmuca* worked out to 24 mm mesh size (stretched mesh size: 48 mm). All gill nets operated in Chettuva backwaters are of 30 mm to 45 mm and are targeting *Mugil cephalus*. Diversified gill netting with larger mesh size should be promoted to harness other species of commercial importance like *Etroplus suratensis* and *Oreochromis niloticus*.

### By catch composition

The non-targeted catch constitute of jelly fishes (*Cyanea annaskala*) and mud crab (*Scylla serrata*). The juveniles of targeted species were *Leiognathus equulus*, *Mugil cephalus* and *Scatophagus argus*. The most dominant species contributing to bycatch was *Mugil cephalus* (50 no) of 5-8 cm length. This can lead to decline the population of *Mugil sp.* due to overfishing of juveniles. The non-targeted species and juveniles of the targeted species and jellyfishes constituted by catch of gill net. As these by catches have no commercial value, the fisherman discards them without marketing. Sometimes by catches are thrown back to water; but they are injured or may die during clearing of the net. This may lead to the biodiversity loss of non-targeted species. It seriously affects the biodiversity. The by catches caught in the experimental gill netting is given in table 6.

**Table 6:** Bycatch composition generated in experimental gillnetting

Species	Number	Length range (cm)	Weight range (g)
<i>Leiognathus equulus</i>	45	3-4	2-7
<i>Cyanea annaskala</i>	35	7-12	7-12
<i>Scylla serrata</i>	28	4-8	6-15
<i>Mugil cephalus</i>	50	5-8	5-15
<i>Scatophagus argus</i>	40	4-9	10-16
Total	198		

The quantity of crabs in the catch was low, in the Bhayander estuary as reported by Pradhan *et al.* (2017) [13]. By catch in the gill net of South Africa were studied by Hutchings and Lamberth (2002) [9]. *Pomatomus saltatrix*, *Trachurus trachurus capensis*, *Chelidonichthys capensis* and

*Galeichthys feliceps* were the most common by catch species, and contributed 4.2% to the total catch numerically and occurred in 12-47% of the marine 44-64 mm gillnet catches that were monitored. The proper utilization of by catch is important. The by catch can be used for making dried fish and fish meal for economic management.

### Ghost fishing

In the present study, at two instances the gill net set at midnight was lost in turbulent water currents. Gill nets which allowed to drift with winds and currents gill, entangle and enmesh a wide range of organisms such as jelly fishes, shrimps and juveniles of the target species. Lost gill nets continue to gill and entangle fish and another aquatic organism which is generally termed ghost fishing. Approaches to minimize ghost fishing include (1) use biodegradable natural fiber twines to connect the netting to floats in gill nets, so that when floats are separated due to disintegration of the link, the gill nets loose the fishing attitude and hence the ability to fish and (2) locate and retrieve lost fishing gear.

### Conclusion

Harvesting of fishery resources by artisanal or traditional fishermen for their livelihood without destroying the estuarine ecosystem is a challenge and also major concern. The study highlighted gill netting as the main harvesting method in the Chettuva backwaters. A total of 37 species was reported from the gill net catch during the study period including the by catch species. The maximum catch was reported in the month of January. *M.cephalus* has the highest percentage composition by number 2906 (56.23%). Main webbing of gill net was made of white monofilament nylon polyamide. Mesh sizes of gill nets are 30 mm, 35 mm and 45 mm. Total catch of experimental gill netting composed of five thousand one hundred and sixty-eight (5168 no) specimens for the three months. It comprised 130.26 kg total weight. Gill net is species specific and size specific. The gill netting in Chettuva backwaters is targeted for *M.cephalus*. Gill net was size specific for 10-25 cm of mullet. *M.cephalus* was caught more in the mesh size 35 mm and caught was least in the mesh size 30 mm. Selectivity curve reveals that the juveniles of *Mugil cephalus* is mainly caught in 30 mm mesh size. There is overfishing of juveniles in 30 mm mesh size. This can be one of the reasons for the decline of mullet catch in Chettuva backwaters. By catch is composed of juveniles of targeted species of *Leiognathus equulus*, *Mugil cephalus* and *Scatophagus argus*. The non-targeted catch constituted of jelly fishes (*Cyanea annaskala*) and mud crab (*Scylla serrata*). This may lead to the biodiversity loss of non-targeted species. Dominant species contributing to by catch was *Mugil cephalus* of 5-8 cm length. This can also lead to decline of population of *Mugil sp.* Due to overfishing of juveniles. There is a prevalence of ghost fishing in the study area.

### Acknowledgement

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