Comparative Catching Efficiency of Traditional Prawn Fishing Gears in Pulicat Lake of Tamil Nadu, India

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Prawn fishery in Pulicat Lake has a significant role in livelihood of the fishers, which is being harvested through different fishing gears. Here, we investigated the prawn-fishing gear and their catch composition. The information on various aspect about the gears was collected from the 48 respondents each month through pre-designed interview schedule by adopting random sampling. Results revealed that the quantity of prawn were higher in stake net (209.83 kg), followed by barriers (118.58 kg), drive-in-net (55.58 kg) tangle net (18.25 kg) and was statically significant at 5 %. It was estimated that more than half (52.16 %) of the total prawn catch in Pulicat Lake was obtained through stake net than the barriers (29.48 %), drive-in-net (13.82 %) and tangle net (4.54 %). The maximum quantity of prawn was obtained during the November and December in all the prawn-fishing gear (p < 0.05). This study concludes that non-selective fishing gears resulted in the abundant catch of juvenile fishes and crabs, need to be regulated mesh size, to support the conservation and sustainable harvest of the fishery resources in Pulicat Lake.

[**Keywords:** Brackish water fisheries; Lagoon; Stake net; Sustainable gear]

Introduction

Pulicat Lake in Northeast of Tamil Nadu is the second largest brackish water ecosystem, which has greater biodiversity and aesthetic value. This lake provides nursery and breeding ground for many marine water species (prawn, crab, pony fish, and catfish), and supports for commercial fishing. The fauna and flora of this lake are very often changing both qualitative and quantitative due to natural process and anthropogenic activities. Fishing is the primary occupation for 55 fishing villages for those who are living around the Pulicat Lake[1]. The catamaran and motorized fishing vessels are typically used for fishing. A total of 39 fish species was reported in Pulicat Lake, among them 30 species were common. Of this, prawn has acted as an economically important commodity for the community living in Pulicat Lake whereas landing was dominated by *Penaeus indicus*, *P. monodon*, and *P. semisulcatus* due to an ideal nursery for these species[2].

The prawn fishery of Chilka Lake was exploited using traps (*daudi* and *boza*), fishing net and large impoundments constructed with split bamboo in shallow regions[3,4]. The stake nets, drag nets and cast nets were operated to catch prawns in Krishna estuary by Dug-out canoes and plank-built[5] and similarly, stake net was the main gear to catch prawns in Killai backwaters[6]. The capture fishery is practiced in the open backwaters of Kerala by operating indigenous gears such as stake nets, Chinese dip nets, cast nets and drag nets[7]. However, studies were conducted in Pulicat Lake about hydrobiology, and fisheries[7,8], but detailed information regarding fishing gears employed to catch the prawn is still scanty though diversified gears practiced in Pulicat Lake. Therefore, this present investigation is aimed to document the eight fishing gears and one fishing method employed to capture the prawn and of which, the catch composition for four important fishing gears. Hence, the stake net (*Adappu valai*), barriers (*Suthu valai*), drive-in-net (*Kal valai*) and tangle net (*Kotra valai*) was important prawn fishing gear in Pulicat Lake and the gears classified according to the International Standard Statistical Classification of Fishing Gear (ISSCFG) and Fisheries Department, Food and Agricultural Organization, Rome[9].

Materials and Methods

The present study was conducted to examine the fishing gears which are being used in Pazhaverkadu

(Lat. 9^0 14' N; Long. 78^0 47' E) for the period March 2017 to February 2018. The Pulicat Lake is located in the southeast coastline of Tamil Nadu (Fig. 1), dry part of the lagoon extending up to 14.0° N. This is well known for prawn (*Panaeus indicus* and *P. monodon*) and mud crab fisheries (*Scylla serrata* and *S. tranquebarica*)[1]. Three different methods are being practiced for prawn fishing in Pulicat Lake, namely stake net fishing, prawn picking and barriers[10]. However, the present study focused on the different types of prawn fishing gears and methods practiced by prawn fishers in Pulicat Lake through field visits and by the interactions with the fisherfolk. Specifications of the individual fishing gear were recorded through pre-tested interview schedule including the length of the mesh, dimensions, depth of operation, catch, the season of operation and their mode of operation.

Table 1 describes the design details of eight prawn fishing gears and one fishing method. Of which, seven were non-selective and two were the selective fishing gear (lantern net (*Chikkan*) and prawn picking) (Fig. 2 F and I). The non-selective fishing gears namely stake net (*Adappu valai* and *Kattu valai*), barriers/Fences (*Suthu valai)*, multi stick dragnet (*Konda valai*), drive-in-net (*Kal valai*), cast net (*Veechu valai*), tangle net (*Kotra valai*) (Fig. 2 A-H).

Non-selective fishing gears

Stake net (Adappu valai)

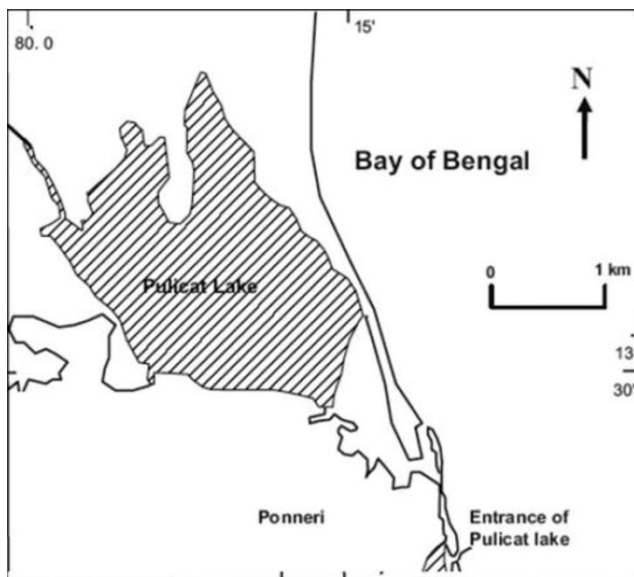It is made of nylon multifilament webbing materials. It is a conically shaped bag net used to catch all size of prawns from the lake. It consists of four panels with four different mesh size of 40 mm, 20 mm, 16 mm and 14 mm, respectively. It is 2000 meshes in length and depth of 1st panel has 100 meshes followed by a 2nd panel with 150 meshes, 3rd panel with 50 meshes and cod end with 200 meshes. It is fixed in across bar mouth region in 'conical' shape. While hauling the gear after 2 to 3 hours, the prawns were collected using scoop nets. The gear is operated by four people, in that three persons were engaged in setting and hauling; and the other one person involved in the collection of prawns.

Stake net (Kattu valai)

This gear is operated whenever the water depth becomes low; a similar observation was reported in the backwaters of Travancore[7]. It is having one panel with a different mesh of 16 mm, 18 mm, and 20 mm in the middle portion and 32 mm, 36 mm and 40 mm in upper and lower portion respectively. It has 1500 meshes in length and 50 meshes in depth. It is fixed inshore region of the lake towards the water current in 'U' shape. Hauling was done after 2 to 3 hours soaking, and prawns were collected from end bottom opening of the webbing panel.

#### Barriers/Fences (Suthu valai)

It is locally also known as '*Thadukku*', and installed across bar mouth of lake connecting to sea in the configuration of the circle in shape and wooden poles fasten both ends are together with coir or plastic ropes. It consists of three panels with different size of meshes *viz.* 13 mm, 14 mm and 24 mm; It has 3400 meshes in length and 60 meshes in the 1st panel and 100 meshes in the 2nd and 3rd panel in depth. Four people operate this gear, and generally, five operations are carried out per day. It is fixed in water at circle shape and nets are fastened with wooden poles. This is the most efficient prawn fishing gear operated to catch all size of prawns from the lake. It is operated in and around the Pulicat lake during the North-east monsoon, similar observations were reported in Pulicat Lake[3], backwater of Kerala (October to January)[11].

Multi stick dragnet (Konda valai)

The gear is operated mainly in shallow water when the water depth is below 2 m. This is made up of nylon multifilament webbing of 0.6 mm dia. twine and is rigged with both head rope and foot rope. The mesh size varies from 20-30 mm (stretched). It is about 25-50 m long and about 1.5 m in depth. Three

Fig. 1 — Description of the study area

Table 1 — Design description of the prawn fishing gears operated in Pulicat Lake

S. No.	Particulars	Stake net		Barriers/fences	Multi stick drag net	Drive-in-net	Lantern net	Cast net	Tangle net
		Adappu valai	*Kattu valai*	*Suthu valai*	*Kanda valai*	*Kal valai*	*Chikkan*	*Veechu valai*	*Kotra valai*
1	Webbing material	Nylon multifilament	Nylon multifilament	Nylon multifilament	Nylon multifilament	Nylon multifilament	Nylon multifilament	Nylon multifilament	Nylon monofilament
2	Mesh size (mm)	1st panel – 14 2nd panel – 16 3rd panel – 20 4th panel – 40	Middle portion – 16, 18 & 20 Lower and upper portion – 32, 34 & 40	1st panel – 13 2nd panel – 14 3rd panel – 24	20 – 30	14 & 16	16	16	24
3	Twine size (mm in diameter)	0.7	0.6	0.6-0.7	0.6	0.5	0.5	1.0	0.5
4	No. of meshes in length	2000	1500	3400	850	1500		Depends on the panel	10000
5	No. of meshes in depth	1st panel – 100 2nd panel –150 3rd panel – 50 4th panel – 200	50	1st panel – 60 2nd panel –100 3rd panel – 100	60	130		185	100
6	Horizontal hanging co-efficient	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.68
7	Vertical hanging co-efficient	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.72
8	Floats	Wooden poles	Wooden poles	Wooden poles	Wooden stick	Styrofoam	Nil	Nil	Plastic
9	Sinkers (gm)	Steel anchor				Stone – 2000	Nil	Lead – 10	Lead – 20
10	Hauling rope (mm in diameter)	Polypropylene – 10	Polypropylene – 6	Polypropylene – 8	Polyamide – 10	Cotton – 14	Nil	Polyethylene –6	Polypropylene – 8
11	Cost (₹)	8500	4500	5000	4500	6000	700	4500	15000
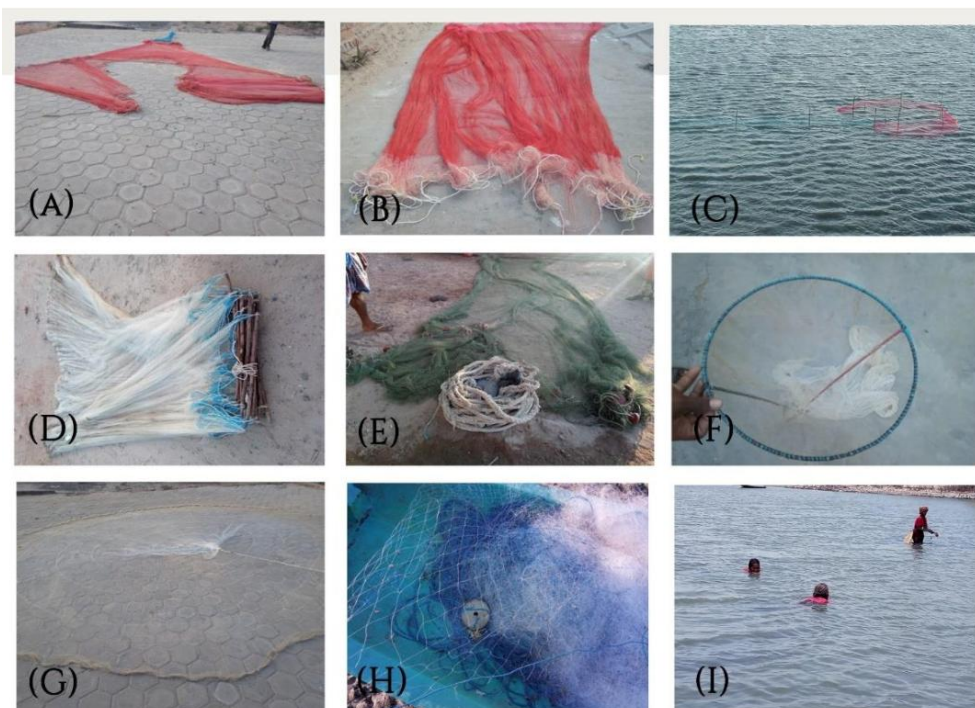
Fig. 2 — (A) *Adappu valai*; (B) *Suthu valai*; (C) *Kattu valai*; (D) *Konda valai*; (E) *Kal valai*; (F) *Chikkan*; (G) *Veechu valai*; (H) *Kotra valai*; (I) Prawn picking

wooden sticks are fastened in the middle, lower and upper end of the net. Two people drag this gear by holding the head rope with hand and foot rope is attached to foot at the time operation.

Drive-in-net (Kal valai)

This gear is made up of nylon multifilament webbing diameter of 0.5 mm and rigged with both head rope and foot rope. It is consists of two panels with a different mesh size of 14 mm and 16 mm (stretched). It is about 15-20 m long and about 1.5-2 m in depth. A float made up of Styrofoam is attached to the head rope. Separate coir or plastic rope (10 mm dia) attached with stone (*kal*) are used to disturb the bottom areas. *Kal valai* is usually operated by four fishers. While three fishers were engaged in installation of the net; other one fisherman was engaged in dragging of rope with stone towards the net, and they come closer, the right end of fishers drag the gear in a circle form to reach the opposite end of the net. After hauling, fishers scoop out the prawns.

Cast net (Veechu valai)

It is also locally known as '*Mani valai*'. The gear is operated mainly in a shallow region when the water depth is below 3 m. This gear also operated around the year in Pulicat Lake, but the peak operational period was observed in North-East monsoon season. Pulicat fisher were using two types of *veechi valai* for catching fish (Monofilament cast net) and prawns (Multifilament cast net). The multifilament cast net is the most efficient gear used to catch prawns and monofilament cast net targets the catch of milkfish, mullet, Pearl spot, etc. This gear consisted of 7 pairs of panels made up of nylon multifilament webbing with 16 mm mesh size and 1 mm twine thickness. But monofilament cast net consisted of 9 pairs of panels and webbing of 25 mm mesh and 0.7 mm dia. thickness. The top pair of the multifilament cast net panels comprised of 60 meshes in length and 15 meshes in depth. The second pair consist 120 meshes in length and 20 meshes in depth. The third panel includes 180 meshes in length and 30 meshes in depth. The fourth panel consist 240 meshes in length and 30 meshes in depth. The fifth panel consist 300 meshes in length and 30 meshes in depth. The sixth panel includes 360 meshes in length and 30 meshes in depth. The end panel consist of 420 meshes in length and 30 meshes in depth. The upper panels were joined vertically together to form an upper panel of the webbing and the lower panels were joined vertically

to form bottom panel of the webbing with a take-up ratio of 2/3. The upper and bottom panels were laced with nylon twine of 1 mm diam. The rearmost part of the panel is rigged with foot rope with a lead sinker to prevent the escapement of trapped shrimps or fishes.

Tangle net (Kotra valai)

Cotton was previously used to fabricate the tangle net. At present, it is made of monofilament nylon webbing (0.5 mm dia.) consists of one panel of webbing (15 mm). The *kotra valai* can be used up to 0.5 km in the lake, and it can be kept for 2 hours. This net is mostly operated during the night.

Selective fishing method
Lantern net/Light Trap (Chikkan)

This gear is used in Pulicat Lake throughout the year and when water flows towards the sea. This cone-shaped net was observed in Thonirevu and Senjimanager fishing village of Pulicat Panchayat, and it is made up nylon multifilament webbing (16 mm stretched mesh) which is attached to the circular iron frame (6 mm dia.) with a long handle. Previously kerosene lamp was used for attracting the targeted prawns. Now a days, LED torch light is used for attraction. As soon as prawns approach near the base of the light, it is caught by casting the trap. Suddenly prawns were pulled with leg towards the conical net. Prawns trapped inside the conical net tied with the hoop (0.45 m dia.).

Prawn picking

Tribal women living in seven hamlets at the southern end of the Pulicat Lake have been traditionally picking prawns with their hands, while they tread on the lakebed, in shallow waters. This method of picking is being practiced by both men and women in daytime. This is the most efficient selective fishing methods compared to other fishing gears. Similar observations were reported in Pulicat Lake during 1971-72[12].

Four numbers of each gear were operated for 2 to 3 hours in every month at each fishing ground. All gears were operated during low tide except the *suthu valai* and *kotra valai*. Among the eight prawn fishing gears, *kal valai* and *veechu valai* were operated during day hours. Usually, fishers monitor all these gears by taking out for observation of any possible catch in it after a soaking period of 2-3 hours except the *veechu valai*.

Data analysis

All the data were tested for normality using the Kolmogorov-Smirnov, and the homogeneity of

variance tested using the Levene's test. The data were presented as the mean and standard error. The difference of month wise catch among the fishing gears were analysed by one-way analysis of variance. The significance level was set at P < 0.05. The entire statistical analysis was performed using Statistical Package for Social Science (SPSS, 20).

Results

The month wise prawns catch details in traditional fishing gears are presented in Table 2. It was estimated that more than half (52.16 %) of the total prawn catch in Pulicat Lake was obtained through stake net than the barriers (29.48 %), drive-in-net (13.82 %) and tangle net (4.54 %) (Fig. 3). Significantly, an increasing trend of prawn catch was noticed in stake net from March to November. A similar trend was noticed for other three prawn-fishing gears from March to December then it was declined during January and February and had a statistical significance (5 % level). Further, highest catch was obtained during northeast monsoon in all the fishing gears. The same trend of catch noticed in bycatch also (Table 3) and species composition of bycatch is depicted in Figure 4. A maximum catch of 130 kg was noticed in stake net (December) and 47 kg in barriers, 35 kg in drive-in-net and 15 kg in tangle net (November). There was a statistically significant difference in bycatch was accounted between the prawn-fishing gears and whereas stake accounted for 60 % of the total fish catch and followed by the barriers (19 %), drive-in-net (15 %) and tangle net (6%) (Fig. 3). Further, an average prawn and bycatch

in Pulicat Lake were caught at stake net (209.83 and 101.25 kg), followed by barriers (118.58 and 32.25 kg), drive-in-net (55.58 and 25.67 kg) tangle net (18.25 and 10.42 kg, respectively) (Fig. 5).

Discussion

In the current context of global change and ecological crisis, there is an increasing demand for harvesting the fishery resources with suitable fishing practices, in addition to the environmental pressure[13]. In this study, we documented the gears, which are used to catch the prawns and their catch details of the target and non-target species for management measures in Pulicat Lake. Despite several limitations, this study presents to our knowledge the attempt to assess the potential impact of the prawn gear used in Pulicat Lake, India. Prawn fishery is remarkably practiced using the stake net, shore seine, hand picking in Pulicat village complex, Sunnambukulam and Arambakkam, whereas fishing was performed
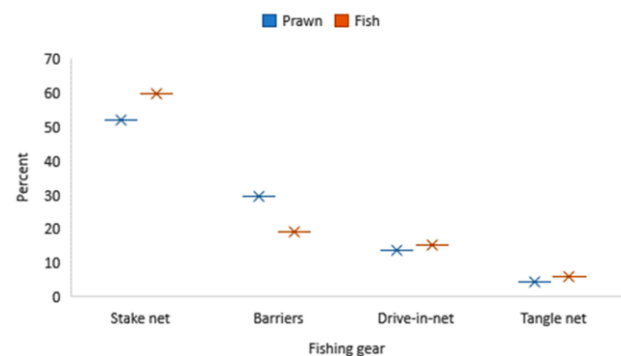

Fig. 3 — Percent share of the major prawn fishing gear

Table 2 — Summary statistics of the month wise prawn landing in different traditional prawn fishing gears

Months	Stake net	Barriers	Drive-in-net	Tangle net
March-2017	110 ± 0.05 [d]	90 ± 0.06 [c]	25 ± 0.13 [b]	12 ± 0.25 [a]
April	115 ± 0.07 [d]	85 ± 0.05 [c]	28 ± 0.08 [b]	12 ± 0.25 [a]
May	110 ± 0.07 [d]	80 ± 0.05 [c]	27 ± 0.08 [b]	13 ± 0.28 [a]
June	118 ± 0.05 [d]	78 ± 0.03 [c]	32 ± 0.08 [b]	15 ± 0.24 [a]
July	150 ± 0.06 [d]	80 ± 0.05 [c]	30 ± 0.13 [b]	16 ± 0.2 [a]
August	200 ± 0.04 [d]	90 ± 0.06 [c]	40 ± 0.09 [b]	18 ± 0.14 [a]
September	250 ± 0.05 [d]	100 ± 0.04 [c]	70 ± 0.05 [b]	20 ± 0.15 [a]
October	350 ± 0.04 [d]	150 ± 0.03 [c]	80 ± 0.04 [b]	22 ± 0.10 [a]
November	325 ± 0.01 [d]	170 ± 0.03 [c]	85 ± 0.03 [b]	25 ± 0.09 [a]
December	320 ± 0.01 [d]	200 ± 0.03 [c]	110 ± 0.04 [b]	25 ± 0.14 [a]
January-2018	300 ± 0.02 [d]	190 ± 0.02 [c]	90 ± 0.06 [b]	24 ± 0.11 [a]
February	170 ± 0.02 [d]	110 ± 0.05 [c]	50 ± 0.06 [b]	17 ± 0.17 [a]

Mean values and standard error (mean ± SEM) are presented for month wise prawn landing in different fishing gears. Different superscripts in a same row indicate significant differences among different traditional prawn fishing gears for a given month (P<0.05, One-way ANOVA, Duncan Post-Hoc).

Table 3 — Summary statistics of the month wise fish landing in different traditional prawn fishing gears

	Stake net	Barriers	Drive-in-net	Tangle net
March - 2017	95 ± 0.04 [c]	25 ± 0.09 [b]	20 ± 0.23 [b]	7 ± 0.31 [a]
April	93 ± 0.05 [c]	28 ± 0.18 [b]	23 ± 0.13 [b]	9 ± 0.47 [a]
May	102 ± 0.05 [c]	25 ± 0.17 [b]	23 ± 0.18 [b]	8 ± 0.37 [a]
June	90 ± 0.05 [c]	23 ± 0.13 [b]	21 ± 0.13 [b]	9 ± 0.41 [a]
July	85 ± 0.05 [d]	30 ± 0.18 [c]	22 ± 0.18 [b]	9 ± 0.35 [a]
August	89 ± 0.04 [c]	29 ± 0.14 [b]	23 ± 0.23 [b]	10 ± 0.39 [a]
September	94 ± 0.05 [c]	30 ± 0.15 [b]	24 ± 0.22 [b]	11 ± 0.36 [a]
October	105 ± 0.05 [d]	42 ± 0.1 [c]	32 ± 0.13 [b]	13 ± 0.29 [a]
November	120 ± 0.04 [d]	47 ± 0.08 [c]	35 ± 0.1 [b]	15 ± 0.28 [a]
December	130 ± 0.06 [d]	46 ± 0.06 [c]	34 ± 0.12 [b]	14 ± 0.21 [a]
January -2018	110 ± 0.06 [c]	33 ± 0.13 [b]	29 ± 0.17 [b]	11 ± 0.34 [a]
February	102 ± 0.03 [d]	29 ± 0.15 [c]	22 ± 0.18 [b]	9 ± 0.49 [a]

Mean values and standard error (mean ± SEM) are presented for month wise fish landing in different fishing gears. Different superscripts in a same row indicate significant differences among different traditional prawn fishing gears for a given month (P<0.05, One-way ANOVA, Duncan Post-Hoc).
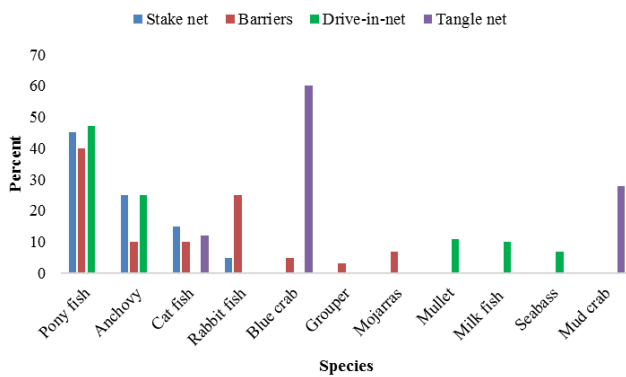

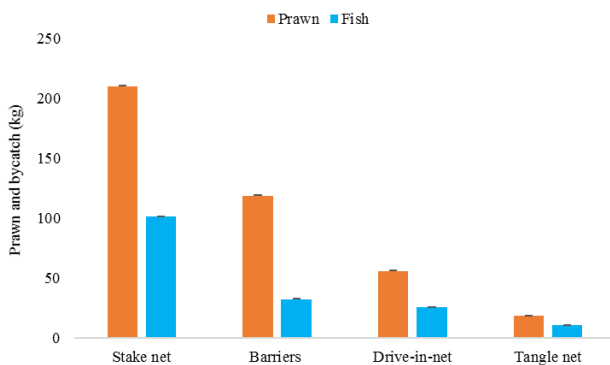Fig. 4 — Percent of bycatch in prawn-fishing gear

Fig. 5 — Prawn and fish (bycatch) catch in prawn-fishing gear

using the stake net fishing, hand picking, shore seine and other gears[10].

Prawn-fishing gear and operation

Stake net (*adappu valai*) is the most efficient fishing gear used, which operated (night hours) in bar mouth of the lake to capture all size prawn. The catch rate depends on the seasons (migration of the population), the recorded an average catch was 209.83 kg/trip. Similar finding was reported in backwater of Kerala[7], Krishna[10], Goutami Godavari[11], Pulicat lake[12], and Killai backwaters[6,14]. The catch of prawns using stake net at Pulicat Lake more or less gradually increases from November to December[15]. Another stake net (*kattu valai*), the operation also alike to stake net (*adappu valai*), however, the catch rate was meager of 5 kg/operation. A barrier (*suthu valai*) is operated round year but predominantly during Northeast monsoon (October to December), the more great catch was obtained when water depth becomes high. A parallel report was documented in Pulicat Lake[3] and backwater of Kerala[11]. The recorded total catch of 55.55 kg/trip was in Drive-in-net (*kal valai*). Tangle net (*kotra valai*) was primarily meant for higher sized prawns, and the tiger prawns were observed to be frequently caught an average catch rate of 18.25 kg/trip. A coherent picture was reported in river Krishna[7].

Multi stick dragnet (*konda valai*) and lantern net (*chikkan*) and cast net (*veechu valai*) was operated to catch the prawn in Pulicat lake and estimated catch was 5, 4 and 3 kg/operation respectively. Generally, these gears employed during the Northeast monsoon. Similar type gear was used to capture the prawn and fishes in Chilka lake[3], Kerala backwaters[7], Godavari[16], Pulicat lake[12], and Killai backwaters[14] and the cast net was commonly employed to catch prawns in Manakkudy estuary by using small *Catamaran* manned which is usually operated by two persons[17]. However, opposite to the present study, the shore

seine was significantly contributed to prawn landing and the cast net also contributed meagre amounts[18].

Catch composition of the fishing gears

The study's results highlight that under current conditions the stake net is contributing more than those that of barriers, drive-in-net, and tangle net to catch the prawn. Studies were conducted in lake, backwaters, and estuaries about gears used to capture the prawn. In estuaries (Kozhikode), the percent share of prawn caught was higher in stake net, followed by the cast net, and gillnet[17]. Stake net accounted for around half of the total prawn landing of the Killai backwaters than cast net and dragnet[14]. Drag nets and stake nets operated from plank built *navas* and *shoe donis* together accounted for over 90 % of the prawn landings in Godavari estuarine system[16]. However, all these reports were parallel to the present findings but controversial to this study, the prawns in Pulicat lake accounted for 35.8 and 17.3 % of the catches in dragnet (*konda valai*) and shore seine (*badi valai*), respectively[13].

The catch composition of the prawn was almost similar for the drive-in-net, and tangle net. The gill nets were used mainly to catch large-sized prawns during April and September-November in Manakkudy estuary[16]. A similar observation could be seen in the present study, and large size prawn was caught in tangle net, followed by stake net, drive-in-net, and barrier. In the present study, rest of the selective and non-selective fishing gears contributing only meagre amounts (< 3 %). Another study found that the shore seines were significantly contributed to the prawn landings but the cast nets contributing meagre amounts[18].

Estimation of the prawn

Studies were conducted to estimate the prawn production in different water bodies[6,18]. An average annual prawn production for India was 57 tons[18] which is majorly caught by stake net. The estimated prawn landing by stake net at Thonithoral was 41.8 t in 1973[6]. The estimated catch in the present study was 4.827 tons in Pulicat Lake, whereas, the stake net was accounted for 2.518 tons, and followed by barriers, drive-in-net, and tangle net was recorded for 1.423, 0.667 and 0.219 tons, respectively.

Bycatch

The pony fishes accounted for more than 40 % of the total bycatch in all the prawn fishing gear except tangle net. However, the pony fish, anchovies, catfish and rabbit fish were major share (more than 85 %) of the total bycatch in stake net and barriers. The highest share of pony fish was due to the nature of the species. They normally found in the river mouth and muddy shore areas. Juveniles were commonly found in the mangrove, estuaries, and entering lower reaches of freshwater streams[19]. The bycatch of crab was higher (88 %) in tangle net than those that of other fishing gear. The blue crab is active and abundant in shallow inhibit. Due to migration habits of megalopae and young crabs were caught in tangle net[20].

Conclusion

The present study concludes that the catch rate was found higher in stake net than barriers, drive-in-net and tangle net, whereas, based on the production performance the stake net has been considered as the best gear in prawn-fishing practice. The higher catch was obtained because this gear has been operated in the bar mouth of the lake and smaller mesh size as compared to other prawn-fishing gear. Lantern net was recognized as safest prawn fishing gear due to the selectivity of the gear, though its contribution was lesser. The operation of the multi-stick dragnet has damaged the fishing ground during net operation. This study also noticed that the use of non-selective fishing gears resulted in the abundant catch of juvenile fishes and crabs, need to be regulated mesh size, to support the conservation and sustainable harvest of the fishery resources in Pulicat Lake.

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