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Designs of Typical Small-Scale Fishing Vessels and Gears in Nagapattinam-Kanyakumari Coast of Tamil Nadu, India

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Abstract

The current study was carried out to document different designs of small-scale fishing vessels and gears from selected centers of Nagapattinam to Kanyakumari districts, along the coast of Tamil Nadu. Personal interviews and direct observation were used to gather primary data. The two major groups, wooden and FRP fishing vessels were segregated, out of which 12 types were sub-grouped for design documentation. Based on the type, area and method of operation, small-scale fishing gears were grouped as gillnets, hook and lines, and trawl nets. In total, 12 types of fishing vessels and 9 different types of fishing gears were recorded. Design parameter of each fishing vessel and gear was recorded and technological development in small-scale fisheries was observed. The outcome of the study is a comprehensive database of selected small-scale fishing systems, which can be the source of primary input for researchers, government agencies, and other stakeholders to formulate guidelines and policies.

Keywords: Small-scale fisheries, fishing vessel, gillnet, long line, shrimp trawl

Introduction

Small-scale fisheries is of subsistence, artisanal and traditional in nature, with relatively simple fishing vessels and gears (Jadhav, 2018). The term "small-scale fisheries" is interpreted variously by researchers or scholars (Soltanpour et al., 2017). Small-scale fishing varies across the globe. Compared to the modern and industrial fisheries of the Global North, the Global South including India is dominated by small-scale fisheries. This is characterised by fishing vessels with low-capital investment, nearshore fishing, community-based economic output which helps in enhancing output for local markets, comparatively simple and traditional fishing practices (FAO, 2014). As per FAO (2018), small-scale fisheries in developing countries account for half of the worldwide fish catches, and 90% of fishers rely on small-scale capture fisheries. Although small-scale fisheries have a significant contribution to the local and national economy, this sector is poorly planned & regulated, inadequately funded, and lack efficient management. If managed more effectively, the small-scale fisheries can play important role in poverty alleviation, provide food security in the long-term especially in developing countries, avoid the collapse of marine ecosystems and avoid the loss of biodiversity associated with the global aquatic environment (Smith, 1979; Berkes, 2001; Purcell & Pomeroy, 2015).

Post the mechanisation of Indian fishing fleet, the up-gradation of fishing vessels & gears, fishing patterns, the expansion of fishing areas and market demand have played an important role in terms of fish landings (Sivadas et al., 2020). Tamil Nadu state ranked first in overall marine landings in India during 2019, contributing 7.75 lakh tonnes (21.8%) of total marine landings (3.56 million tonnes) of the country. The contributions of mechanised, motorised and non-motorised sectors to the total landings in Tamil Nadu were 83.3, 16.3 and 0.4% respectively (CMFRI, 2020). As per CMFRI (2012), out of the 46,070 fishing vessels in Tamil Nadu, 10,692 are mechanised, 24,942 are motorised and 10,436 are

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non-motorised. According to FAO (1985), the term "fishing vessel" is used for any fishery vessel engaged in catching operation (e.g., gillnetter, long liner etc.), and the vessel types can be subdivided into classes based on the size of vessel i.e., gross tonnage or length. In Tamil Nadu, catamarans, plank-built boats and canoes are the three types of traditional vessels reported by Edwin (2009). Similarly, Chrispina et al. (2012) has observed various types of fishing vessels such as mechanised boats (<15 m L_{OA}), motorised FRP (Fiberglass Reinforced Plastics) catamaran and motorised FRP vallam.

Tamil Nadu, being one of the leading coastal states in terms of marine landings, lacks design details of small-scale fishing vessels & gears. Therefore, this study has been taken up for proper documentation of design details of small-scale fishing systems at selected centers of the coast of Tamil Nadu.

Materials and Methods

Primary data on design and technical details of various types of fishing vessels & gears were gathered using personal interview method with the help of pretested questionnaire, as well as personal observations during the survey conducted during August 2020 to April 2021. Selection was based on the preference of most widely distributed fishing vessels & gears from Nagapattinam to Kanyakumari districts of Tamil Nadu for design documentation. During the survey, the length overall (L_{OA}), breadth, depth, draught, free board, deck arrangements, crew, type & capacity of engine, and other design and technical data of the selected fishing vessels were physically examined and documented. Design and technical specification of fishing vessels and gears were documented according to Hameed & Boopendranath (2000) and Boopendranath (2000). The design drawings of fishing vessels and gears were made by using the Inkscape open-source software programme (v.1.1) and units were indicated in metric equivalents such as metres (m), centimetres (cm), millimetres (mm), kilograms (kg) etc., upto two decimals. The hanging coefficient with which the fishing gear was rigged was calculated by dividing the length of the frame line 'L' (head rope) by the stretched length of the netting section (Thomas, 2012; Parsa et al., 2014).

Results and Discussion

Along the coast, various types of small-scale fishing vessels have been observed. The selected fishing vessels were mainly grouped as wooden and FRP fishing vessels. Furthermore, fishing vessels were grouped into four sub-classes based on engine type, fishing gears and methods. The four groups were subdivided into twelve types based on their length class (Table 1). Design and technical details of selected fishing vessels were shown in Table 2.

Except large wooden vallam (100 to 300 hp) and large FRP vallam (150 to 300 hp), engine capacities ranged from 2.5 to 48 hp depending on fishing methods (Table 2). The wooden vessels were mostly found in the fishing villages of Ramanathapuram, Thoothukudi, and Kanyakumari districts. For the construction of wooden fishing vessels, fishermen have generally used locally available woods (Table 3). Apart from the wooden vessels, FRP vessels were also found across the study area.

Table 1. Types of selected small-scale fishing vessels

	Types of small-scale fishing vessels			
Class	Wooden fishing vessels		FRP fishing vessels	
Sub-class	Group A	Group B	Group C	Group D
Feature	Traditional fishing vessel made of wood; fixed with inboard engine for propulsion; targeting fish and shell fishes by gillnets or long lines.	Traditional fishing vessel made of wood; having oars or sail for propulsion; targeting near shore fish and shell fishes by gillnets.	Fishing vessel made of FRP; fixed with inboard engine for propulsion; targeting fish by gillnets, long lines or drift gillnets.	Fishing vessel made of FRP; fixed with long tail engine or outboard engine for propulsion; targeting fish and shell fishes by gillnets, long lines, handline, or trawl nets.
Type	Type-A1, A2 & A3	Type-B1, B2 & B3	Type-C1, C2	Type-D1, D2, D4 & D4

Table 2. Design and technical details of the selected small-scale fishing vessels

Sl. No.	Type of fishing vessel	Local names	L_{OA} (m)	Breadth (m)	Depth (m)	Free board (m)	Engine capacity (hp)	Crew size (nos.)	Trip duration
				Group A					
1.	Type-A1	*Nattupadagu*	6-7	1.2-1.37	1.4-1.52	0.9-1	10-12	1-3	5-6 h
2.	Type-A2	*Vallam*	8-9.8	3-3.5	2.4-3	1.5-1.8	20-48	4-6	7-9 h
3.	Type-A3	*Periya vallam*	9.8-11	3.5-4.1	3-4.5	2.4-2.74	100-300	8-10	4-5 days
				Group B					
4.	Type-B1	*Vattai*	3.7-4.6	0.9-1	0.76-1	0.6-0.7	-	1	5 h
5.	Type-B2	*Vattai*	6-6.5	1-1.2	0.9-1	0.6-0.7	-	1-2	5 h
6.	Type-B3	*Thoni*	8.2-8.5	2.4-2.5	1-1.37	0.6-0.9	-	6-8	1-2 h
				Group C					
7.	Type-C1	*FRP vallam*	9.1-11	2.1-2.74	1.2-1.5	0.9-1.1	14-20	4-5	9-11 h
8.	Type-C2	*Periya FRP vallam*	12-13	3.3-3.65	3-3.65	2.1-2.74	150-300	8-12	4-5 days
				Group D					
9.	Type-D1	*FRP katamaram*	6.7-7.3	0.9-1	0.6-0.76	0.36-0.45	2.5, 5, 9.9	1-2	7-10 h
10.	Type-D2	*FRP katamaram*	7.3-8.5	1.5-2.2	0.76-0.9	0.6-0.7	9.9, 10	2-4	8-10 h
11.	Type-D3	*FRP vattai*	7.3-9.1	1.2-2.4	0.76-1	0.45-0.76	7, 9, 9.9, 10	2, 3, 4, 5	5-11 h
12.	Type-D4	*FRP vattai*	9.1-11.5	1.37-2.9	0.9-1.2	0.5-1	9.9, 10, 12, 15	3, 4, 5, 6	7-11 h & 1-3 days

Table 3. List of the locally available wooden materials used for construction of different parts of vessel

Sl. No.	Parts of the vessel	Types of wood
1.	Hull	*Tectona grandis* (teak wood or *thekku maram*), *Vachellia nidotica, Albizia lebbeck* (*Vaagai* or *vaakai maram*)
2.	Keel	*Terminalia elliptica* (*karumaruthu*), *Hopea parviflora* (*kongu maram*)
3.	Joints	*Artocarpus hisutus (ayini maram)*

The Group A were subdivided as Type-A1 wooden vessel with IBM (In-Board Motor), Type-A2 wooden vessel with IBM (Fig. 1) and Type-A3 wooden vessel with IBM. The capacities of engines were in the range of 10 to 48 hp for Type-A1 & A2 wooden fishing vessels and 100 to 300 hp diesel engines for Type-A3 wooden fishing vessels. Type-A3 wooden fishing vessels had higher engine capacity, greater trip duration, largest crew from 8 to 10 nos., insulated fish hold, life-saving appliances like life jackets and navigational equipment such as GPS, VHF, echo sounder etc. Type-A2 & A3 vessels use mechanical power by means of hydraulic net hauler for hauling nets.

During the study, it was observed that only a few fishing communities, mostly in the Ramanathapuram district, had non-motorized wooden fishing vessels. Often, these kind of small fishing vessels are operated close to the seashore e.g., set gillnet

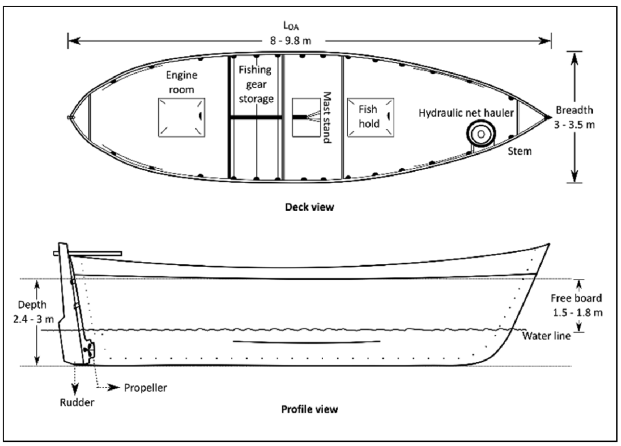

Fig. 1. Typical design of group A fishing vessel: Type A2

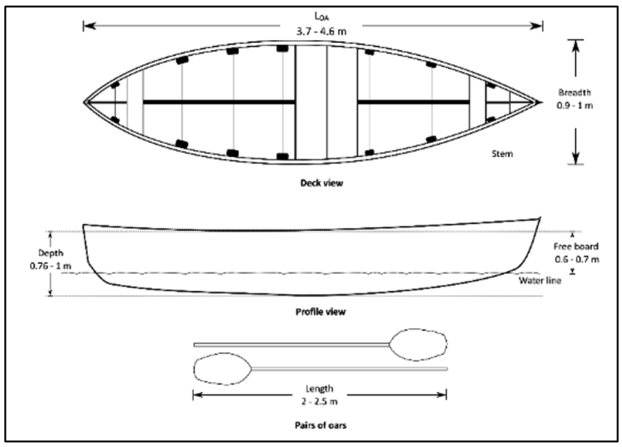

Fig. 2. Typical design of group B fishing vessel: Type B1

fishing. The selected non-motorised wooden fishing vessels with their fishing methods are as follows: i) Type-B1 wooden fishing vessel with oars: At villoonditheertham, Rameshwaram island, these wooden fishing vessels are handled by a single fisherman. The fishing vessel was propelled by a movable pair of oars that could be installed in the centre of the vessel during crushing (Fig. 2). Set gillnets were the primary gear used by fishermen in this sort of fishing vessels. ii) Type-B2 wooden vessel with sail & oar: Fishermen were using the ancient mode of propulsion in chinnapalam, Rameshwaram island, where the fishing vessels were powered by sail and oar. The most often used fishing methods for this fishing vessels are gillnets. iii) Type-B3 wooden vessel with 3-4 pairs of oars: These sorts of fishing vessels were mostly employed for beach seine. The fishing vessel was propelled by three to four pairs of oars, which was used to encircle the fish near the beach. The dimensions of oars are shown in the Fig. 3.

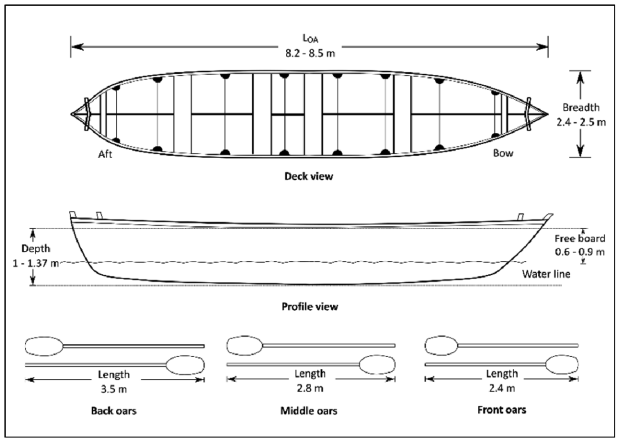

Fig. 3. Typical design of group B fishing vessel: Type B3

After massive destruction of fishing vessels by Tsunami in 2004, many FRP vessels have been manufactured in the coastal districts. Majority of the vessels along Tamil Nadu coast were made up of FRP which were considerably efficient for small-scale fisheries and comparably affordable by fishermen. As per the collected data, three major types of FRP vessels were operated along the coast, which were subdivided as Type-C1 (Fig. 4) & C2 FRP vallam with IBM, Type-D1 & D2 (Fig. 5) FRP catamaran with OBM (Out-Board Motor) and Type-D3 & D4 (Fig. 6) FRP vessel with OBM/long tail propulsion. It was observed that FRP vallam with IBM were mostly of higher engine capacity and FRP catamarans with OBM were of lower engine capacity. Other FRP fishing vessels with OBM were having lower to medium engine capacity. Fishing vessel designs varied across region, with different designs for the seer, stem, stern, length, breadth, and freeboard depending on the geographical conditions of their coastal fishing zone/area. The largest Type-C2 vessel had a higher engine capacity, longer trip duration, larger crew of 8 to 12 nos., wheel house, insulated fish hold, life-saving appliances and navigational equipment.

FRP shrimp trawlers were operated with the aid of three masts: foremast, main mast and mizzen mast. The main mast was supported by a boom-like structure constructed of a sturdy hardwood plank, which also helped in towing the shrimp/bottom trawl. While sailing, a sand-filled gunny bag weighing 12-20 kg was kept onboard to maintain the

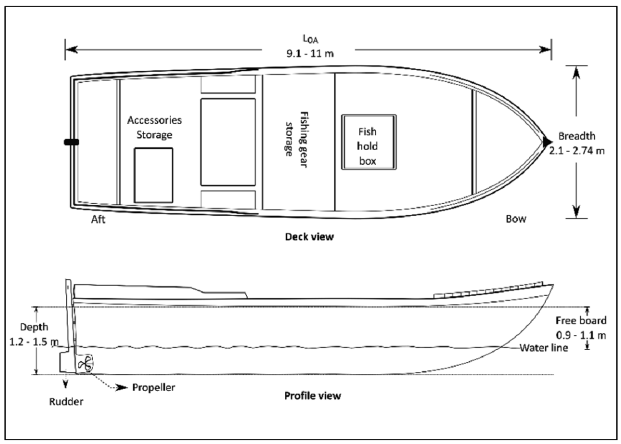

Fig. 4. Typical design of group C fishing vessel: Type C1

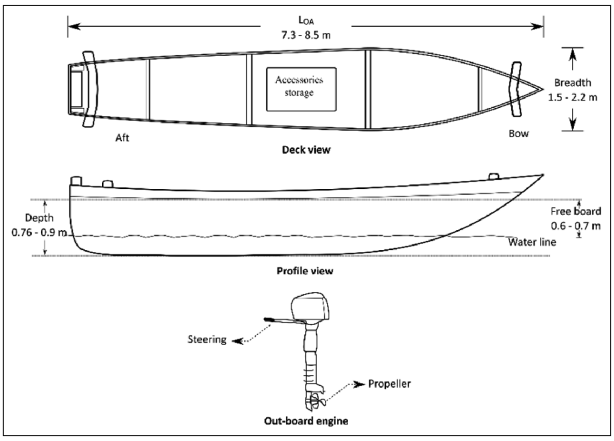

Fig. 5. Typical design of group D fishing vessel: Type D2

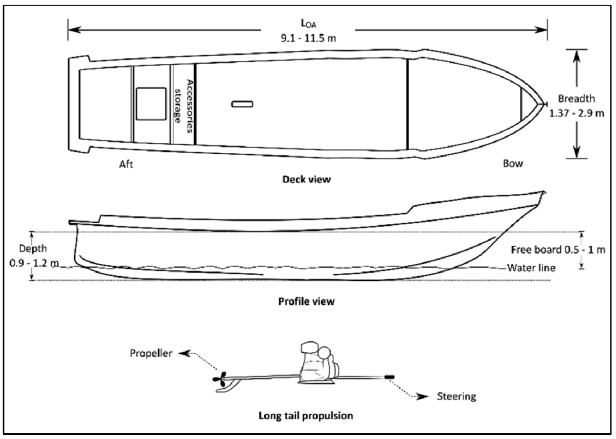

Fig. 6. Typical design of group D fishing vessel: Type D4

vessel's stability (Fig. 7). The outboard motor was attached to the stern of the vessel, was solely used for cruising and not for towing. A sail using wind energy was used to tow the trawl net.

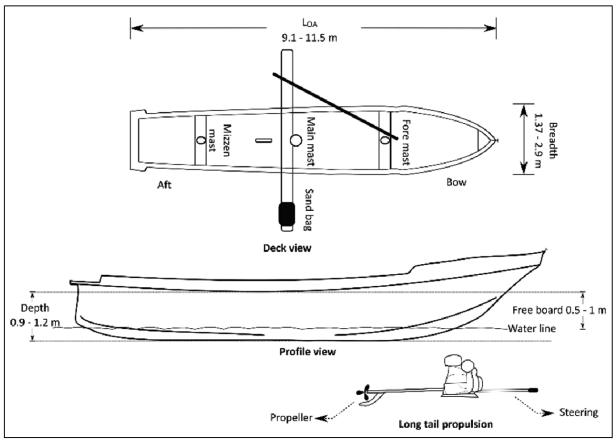

Fig. 7. Typical design of FRP vessel with traditional sail and long tail propulsion

Different types of fishing gears were used by fishermen along the coast. Different types of small-scale fishing gears selected for the study are listed in Fig. 8. Design of the fishing gears and fleet size were found varying from place to place based on the availability of fish resources in the region. The fishing gears are grouped as gillnets, hook and lines, and trawl nets based on the data obtained. Among them different fishing gears were subdivided based on the type and depth of operation (Fig. 9). Each coastal district dominantly operates particular type of fishing gear e.g., drift gillnets in Thoothukudi. Mostly PA (polyamide/nylon) and PE (polyethylene) netting; PP (polypropylene) ropes; floats made of cork, PUF (polyurethane foam), PS (polystyrene), PVC (Poly vinyl chloride) plastic etc.; sinkers made up of lead (Pb), concrete, stone or cotton etc. are in common use for fishing gear fabrication. Fishermen procure gear accessories locally, and prefer to make their fishing gear by themselves.

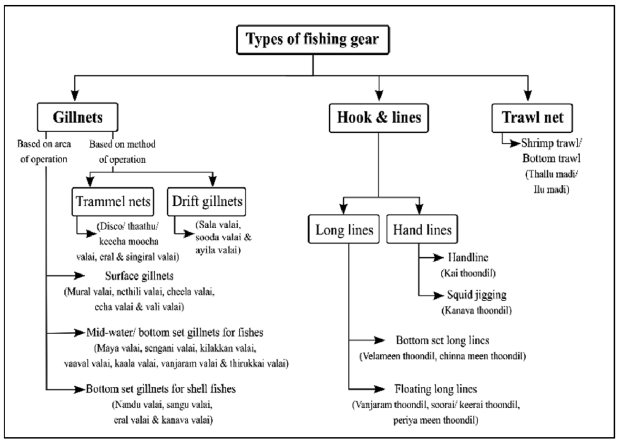

Fig. 8. Types of selected small-scale fishing gears

Gillnets were segregated as surface gillnets, mid-water/bottom set gillnets for fish, set gillnets for shellfish, trammel nets and drift gillnets for sardine & mackerel based on the types of fishing, target species, distance of fishing ground and fishing depth. Typical designs of gillnets and trammel nets are depicted in Fig. 9 and Fig. 10 respectively.

Surface gillnets targeting belonid and anchovy (i.e., *mural valai, periya mural valai, nethili valai* and *echa valai*) were having mesh sizes ranging from 23 to 36 mm, and surface gillnets targeting barracuda and mackerel (i.e., *cheela valai* and *vali valai*) were having mesh sizes ranging from 55 to 70 mm. Cork floats are mostly used for surface gillnets. Most of the surface gillnets were not having sinkers, were drift nets. The surface gillnets may be fixed with flagpoles to mark the place and prevent losing. Hanging coefficient varied between 0.5-0.7 and the nets are placed less than 1 m from the surface when targeting belonid (needle fish / mural) and 7 to 18 m for anchovy. The main webbing was of PA monofilament (0.16-0.28 mm) or PA multifilament (210×1×2) e.g., anchovy net (*nethili valai*). Selvedge was made of PA multifilament (210×1×3 to 210×3×3) which were 0.2-0.9 mm thicker than the main webbing to prevent the wear and tear of the gear during hauling. The fishing distance ranged from 4 to 12 nm from shore, and the majority of the surface gillnets were appropriated for single day trip. The number of hauls per day varied from 1 to 3 with soaking time of 1-2 h, except *vali valai* and *echa valai* having soaking time of 2-4 h.

Mid-water (*maya valai*, *kaala valai*, *vaaval valai* and *vanjaram valai*) / bottom set gillnets (*senganni valai, kilakkan valai* and *thirukka valai*) were most suitable for seasonal fishing. Mesh sizes of the mid-water/ bottom set gillnet varied from 25 to 430 mm, of which 25-80 mm were used for gillnets targeting mackerel, whiting and cod fish, and 100-430 mm for gillnets targeting pomfret, seer fish and ray. The hanging coefficient of gillnet stargeting snapper, whiting, and seer fish ranged from 0.46 to 0.7 and of gillnets targeting mackerel, pomfret, cod fish, and ray ranged from 0.7 to 0.8. PA monofilament with a diameter of 0.28-0.3 mm were used in main

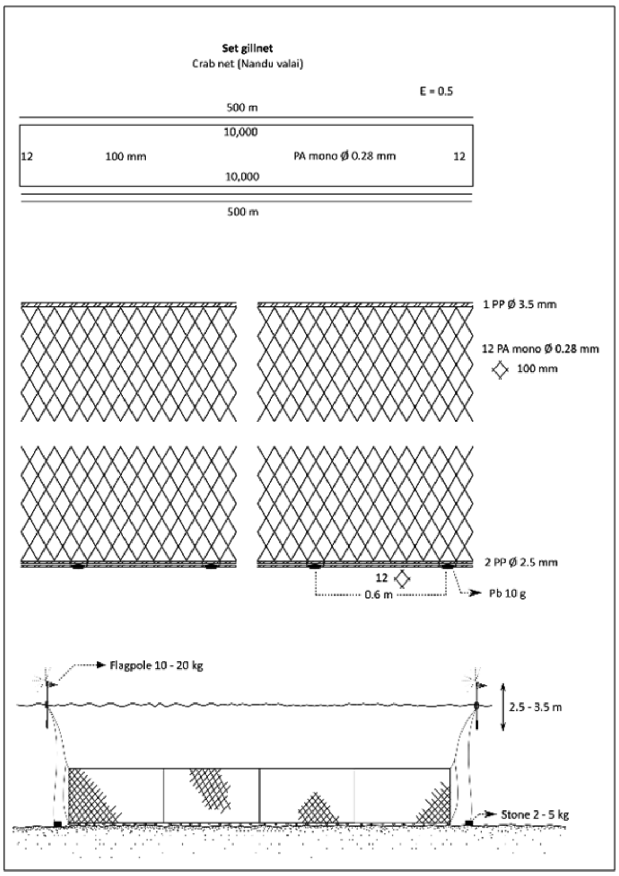

Fig. 9. Typical design of set gillnet

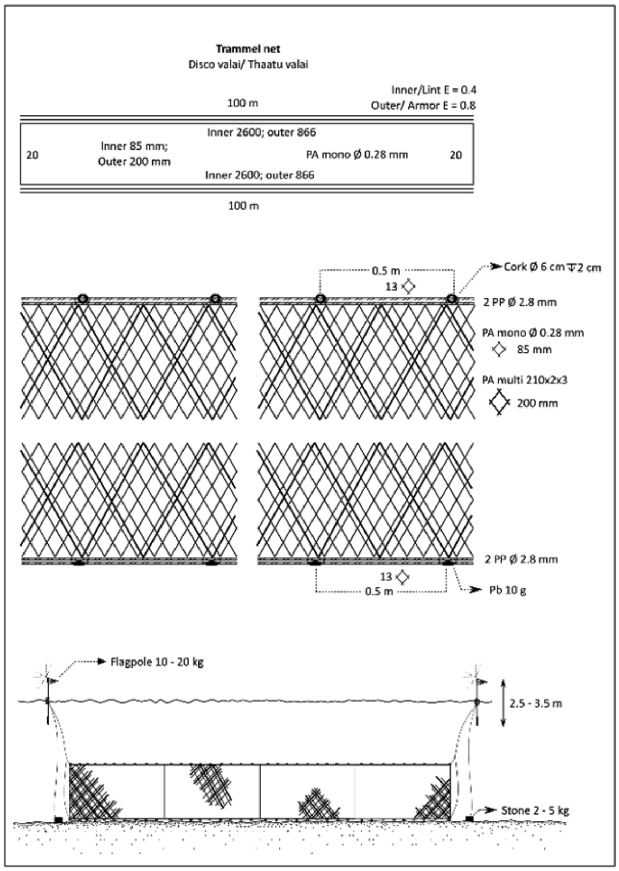

Fig. 10. Typical design of trammel net

webbing for the gillnets targeting snapper, mackerels, whiting and cod fish. Main webbing made of PA monofilament with diameter of 1.6-2.8 mm and selvedge made of PA multifilament (210×3×3 to 210×9×3) used for pomfret and seer fish, except ray net which had main webbing made of PA multifilament (210×6×3 to 210×9×3). Plastic buoys were used for rigging with main webbing to fix the gillnets in the desired depth. Lead is being used as sinkers in bottom set gillnets, which were rigged without floats. Although ray net (*thirukka valai)* is categorised as a bottom set gillnet, the gear was having minimum number of floats for proper vertical shape. Stone or concrete (cement) has been used as sinkers in mid-water/bottom set gillnets targeting pomfret, cod, seer and ray. The fishing distance ranged from 5 to 20 nm from the shore and depth of fishing ground ranged from 10 to 55 m. The number of hauls per day varied from 1 to 3 with soaking time of 2-6 h.

Crab net, chank net, shrimp net, and lobster net were grouped under the category of set gillnets which had higher soaking time from 4 to 12 h. The whole operation of crab net is completed by two trips; one for setting of the net and another for hauling the net, after a long soaking time (4-12 h). The optimum mesh size ranged from 75 to 100 mm, with a hanging coefficient of 0.5 to 0.7. Though lead (wt. about 10 g) has been used as sinker, cotton rope has also been used at some places (i.e., Thondi, Ramanathapuram). For set gillnets, there were no floats, buoys or selvedges (Fig. 9). The foot ropes were 15-35 cm shorter than the head rope length, making the net loose for entangling crabs, lobsters etc. Gill nets of this type were made of PA monofilament (diameter of 0.28 to 0.6 mm) webbing. The fishing distance was found less than 6 nm from shore, and depth of operation ranged from 5.5 to 11 m.

Trammel nets were used to catch crabs, shrimp, lobsters, squids, and a variety of fishes. The mesh sizes for the lint/inner mesh and the armors/outer mesh were 35-85 mm and 130-200 mm respectively. Lint and armors had hanging coefficients of 0.4-0.5 and 0.8-0.9 respectively. PA monofilament was preferred for trammel nets with various yarn thicknesses for inner and outer webbing. Depending on the target fish, the yarn diameter of inner mesh varied from 0.23 to 0.28 mm, whereas that of outer mesh made of PA multifilament (210×2×3 to 210×3×3). Cork or PVC floats, and lead (wt. around 10 g) sinkers were used for trammel nets, but without selvedge and buoys (Fig. 11). The fishing distance ranged from 2 to 10 nm and fishing depth ranged from 2.4 to 7.3 m. The number of hauls per day varied from 1 to 2 with soaking time of 1-5 h.

In Thoothukudi, drift gillnets (Fig. 11) were the most popular fishing nets for sardine and mackerel. Mesh size varied based on the fish species i.e., 26-30 mm for sardine and 50-54 mm for mackerel. Sardine drift nets were made up of PA multifilament of 210×1×2 webbing with diameter of 0.22 mm. Cork floats, round concrete sinkers (wt. about 150 g), top & bottom selvedge made of PA multifilament of 210×2×3 were used in sardine drift gillnets. In case of mackerel drift gillnets, made of PA monofilament with diameter of 0.6 mm; cork floats, lead (wt. about 20 g), top & bottom selvedgemade up of PA multifilament (210×2×3 to 210×3×3) were used. The selvedge mesh size ranged from 60 to 80 mm. The drift nets generally had 2-4 rows of top selvedges and 1-3 rows of bottom selvedges. A unit of drift net usually has two buoys which are tied with 1.8-3.6 m rope at either ends of the net. Material of

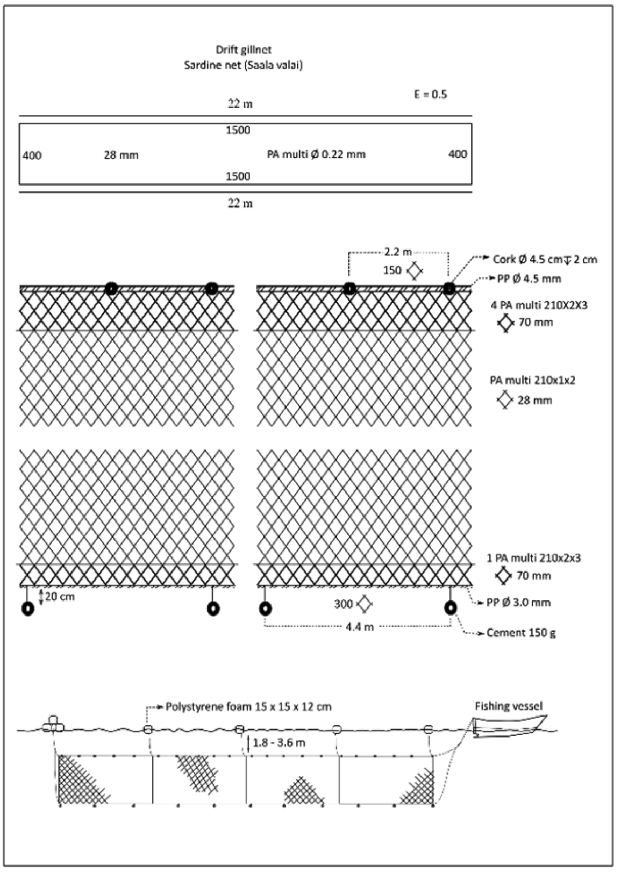

Fig. 11. Typical design of drift gillnet

buoys may change as PS / thermocol, PUF, PVC or locally available plastic can (e.g., oil can) based on the fishermen's preference. The fishing distance ranged from 10-20 nm from shore and depth of operation ranged from 3.6 to 46 m. The number of hauls per day varied from 1 to 2 with soaking time of 2-4 h.

Long lines (Fig. 12) and hand lines (Fig. 13) were two types of hook & lines used by fishermen along the coast while handlines were most popular in Kanyakumari district. Bottom set long line and floating long line, the two types of long lines, where the hook size varied from no.12 to 14 for sardine, needle fish, snapper, and bream, and no.4 to 9 for mackerel, grouper, tuna and seer fish. The number of branch lines per basket on floating long lines ranged from 150 to 300. Whereas bottom set long lines were having 750-2000 branch lines per basket. Generally, the diameter of the main line (1.0-1.58 mm) was greater than branch lines (0.55-1.2 mm). Swivel was used for the long lines targeting large sized fishes. Floating long lines were having snood wire to avoid fishes biting off the line as the fishing

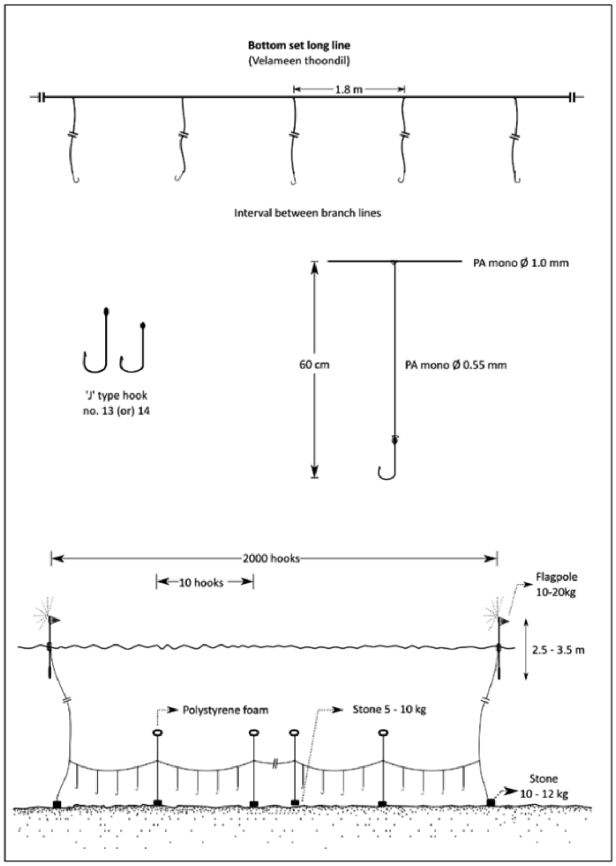

Fig. 12. Typical design of longline

gears target large sized fishes like tune, seer fish etc. Based on different fishing conditions, buoys of the long lines varied *viz.*, PS/ PUF/ plastic cans etc. Stone or sand filled plastic water bottles were used as sinkers in the bottom set long lines and hand lines. A hand line was having 20 to 30 branches with hook size ranging from 12 to 16. Hand line for squids was having 2-4 branches of squid jig. The fishing distance ranged from 10 to 30 nm from shore and depth of operation varied from 3.7 to 73 m. The number of hauls per day varied from 1 to 6 with soaking time of 1-6 h based on the type of operation (i.e., bottom set or floating long line).

The selected trawl net was bottom trawl or shrimp trawl, locally called as "*Thallumadi / Thallu valai*" or "*Ilu madi / Ilu valai*", found mainly at districts of Ramanathapuram, Pudukkottai and Thanjavur. The trawl was towed assisted by sail while OBM was used for reaching the fishing ground and back to shore and for searching the ground (Fig. 14). Though the entire net was made up of PE, diameter and mesh sizes varied at different parts. At the codend, diameter of the twine and mesh size were 0.35 mm and 20-23 mm respectively. Mesh size of the codend was the smallest among different parts of the trawl. In the case of belly/ body of the trawl, twine diameter and mesh were about 0.28 mm and 25 mm respectively. Wings had the twine diameter same as that of belly/ body of the trawl. There were differences in mesh size between lower and upper wings. The mesh size of upper and lower wings were 35 mm and 25 mm respectively. About 6-8 PVC floats at the head rope and 25 kg of iron chain at foot ropewere used for better vertical opening of trawl. Bamboo pole (height about 0.9 m) with three round shaped ironring (weight about 3 kg) were used for joining the wing to towing warp.

Somvanshi (2001) categorised the Indian fishing fleet as: i) Traditional fishing vessels with or without outboard engines (L_{OA} of less than 12 m), mostly engaged in passive fishing; ii) Mechanised fishing vessels (L_{OA} of 12-28 m), mostly engaged in active fishing, e.g., trawler. In the present study, 12 types of small-scale fishing vessels were categorised i.e., Type-A1 to A3 of wooden vallam with IBM, Type-B1 to B3 of non-motorised fishing vessels, Type-C1 & C2 of FRP vallam with IBM, Type-D1 & D2 of FRP catamaran with OBM, and Type-D3 & D4 of FRP vessel with OBM/long tail propulsion.

Thomas and Hridayanathan (2006) classified gillnets based on construction (i.e., single and multi-walled),

mesh size (i.e., small and large mesh), mode of operation (i.e., drift and set net). Thomas (2019) stated that "the general classification of gillnets was based on type of capture, construction, area of operation, method of operation and targeted species". In the present study, surface gillnets, mid-water/ bottom set gillnets for fish, set gillnets for shellfishes, trammel gillnets and drift gillnet for sardine & mackerel were the common. Of which, first three types of gillnets were mainly grouped based on the area of operation (surface, mid-water, and bottom of the sea around fishing grounds). Whereas, the drift gillnets were grouped based on the method of operation (drift gillnet tied with the vessel is being drifted for catching target fish) while trammel nets were grouped based on the construction (trammel net is a set gillnet trapping/ pursing fish with the help of multi-walled webbing). The surface gillnets were passive fishing gear while drift gillnets for sardine & mackerel are active fishing gear. The Indian gillnets are classified into small mesh nets with 14-45 mm mesh size range and large mesh size range is from 45 to 500 mm (Thomas, 2019). For the present study, the mesh sizes of gill nets varied based on the target catch. Surface gillnets were having mesh size of 23-36 mm for sardine and anchovy, and 55-70 mm for barracuda and mackerel. Mid-water/ bottom set gillnets for fishes were having mesh size of 25-80 mm for snapper, mackerel, whiting and cod fish, and 100-430 for pomfret, seer fish, and ray. Set gillnets for shell fishes were having mesh size of 75-100 mm for crab, chank, shrimp, and lobster. Inner and outer mesh of trammel nets were having mesh size of 35-85 mm and 130-200 mm respectively. Drift gillnet for sardine and mackerel was having mesh size of 26-30 mm for sardine and 50-54 mm for mackerel.

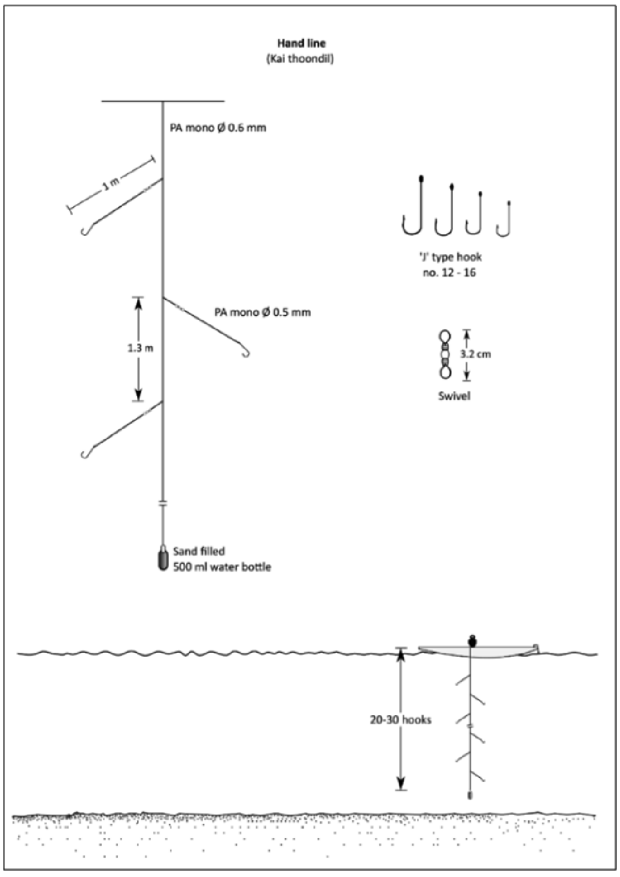

Fig. 13. Typical design of hand line

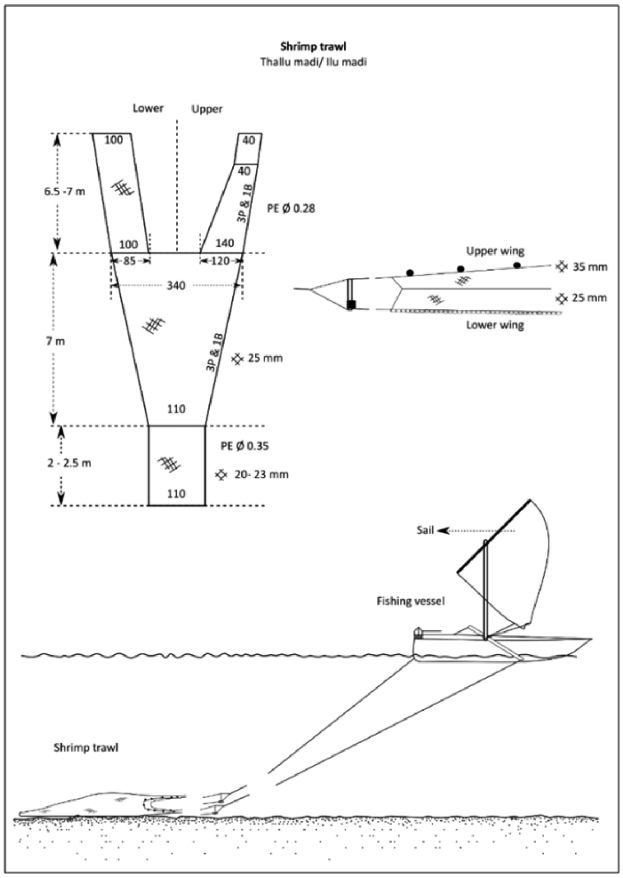

Fig. 14. Typical design of trawl net (shrimp trawl)

According to Sainsbury (1996), the hanging coefficient of gillnets for fishes is typically between 0.5 and 0.66 with 0.6 being common. Similarly, Thomas (2019) stated that the hanging coefficient of large mesh gillnets targeting mackerel and pomfrets is about 0.5 whereas the hanging coefficient for seer fishes, tunas and sharks is around 0.45, with a range of 0.41-0.65. There are chances of entangling when

the hanging coefficient is less than 0.5. The hanging coefficient of 0.7-0.78 for bottom set gillnets were recorded by Kumar et al. (2014). In the present study, the hanging coefficient of surface gillnets ranged between 0.5-0.7, and the mid-water/ bottom set gillnets ranged between 0.46-0.8, whereas 0.8 was observed for the mid-water/ bottom set gillnets. Set gillnets for shellfishes were having hanging coefficient of 0.5-0.7. Hanging coefficient of trammel net was about 0.4-0.5 for inner mesh and 0.8-0.9 for outer mesh. Trammel nets having hanging coefficient of 0.52-0.68 for inner and 0.65-0.79 for outer meshes were reported by Harsha (2016) in Thoothukudi.

According to Parsa et al. (2014), drift gillnets with a hanging coefficient of 0.5-0.6 had a good fish capture efficiency. Harsha (2016) reported a hanging coefficient of 0.6 for drift gillnets for sardine & mackerel at tharuvaikulam, Thoothukudi. In the present study, the hanging coefficient of drift gillnet for sardine and mackerels in Thoothukudi district were found as 0.5.

In Tamil Nadu, hook sizes of no.7 & 8 were used for long line fishing at Gulf of Mannar (Menon et al., 1993; Kumaran et al., 2015); and for large pelagic hook & line fishery for seer fishes, tunas (Sivadas et al., 2020); while no. 8 to 11 was recorded in longline targeted for *Lethrinus elongatus* in Thoothukudi coast (Durai et al., 2011); and no.6 & 7 for carangids, seer fishes also in Kombuthurai village of Thoothukudi district (Anuja & Yadav, 2018). In Kerela, 5 to 15 hooks were used for hand line fishing (Menon et al., 1993; Surya et al., 2019). In Visakhapatnam, 6-10 hooks were used for hand lines (Immanuel & Rao, 2012). Hand line with hook size of no. 5 to 7 was recorded in Thoothukudi district (Kumaran et al., 2015; Radhakrishnan et al., 2016). In the present study, hook & line fishing was sub divided into bottom set longline, floating longline, and hand line. Two to four squid jigs (*kanavathooondil*) were also used in hand lines at Kanyakumari district. Long line fishing methods were having different hook sizes i.e., no.12 to 14 for small sized fishes and no.9 to 4 for medium to large sized fishes.

As a result, the design of small-scale fishing vessels and gears varied across the study region, including parameters like size of fishing vessel, engine capacity, crew size and type of fishing. These parameters changed in response to fishing distance, fishing method or traditional practice, and target species. The technological adaptions (e.g., outboard motors, GPS) has substantially increased in small-scale fisheries because of the rising competition between small-scale fishing sectors and large / industrial fishing sectors across the study area.

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