

Indigenous fishing gears of the Pulicat lagoon of Tamil Nadu

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A study was conducted on the design and the operational details of fishing gears and craft operated from 54 fishing villages bordering the Pulicat lagoon, one of the important lagoons of India (lat. 13.5593° N, long. 80.2098° E). Information was collected from 320 respondents covering a minimum of 5-7 fishermen from each fishing village. The investigation revealed the existence of 26 types of traditional fishing gear belonging to 15 categories. The pattern of operation of fishing gears used by fishermen was as follows: stake nets (33%), drift gillnets (24%), set gill nets (19%), drive-in nets (14%), and other gears (<10%). Among the 26 types of fishing gears analyzed, 7 gears, viz., hand-lift net, crab fishing gear, lighted crab scoop net, prawn fishing gear, wooden cover pot, cradle trap, and mono line with multiple hooks, were found to be eco-friendly. Further, the multi-stick drag net was found to be a detrimental fishing gear as its operation leads to indiscriminate fishing with a high contribution of juveniles fishes with higher growth potential. The study revealed that the fishing pattern with traditional gears being practiced in the Pulicat lagoon might be continued without further introducing detrimental fishing gear such as gill nets or mini trawl that are operated adjacent to this lagoon in the sea to sustain the fishery of this lagoon.

Keywords: Brackish water, Lagoon fisheries, Sustainable fishing gear, Traditional gears

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Though fishing has been practiced ever since the prehistoric period¹, our experience stresses the need for ensuring the usage of eco-friendliness of fishing gear at a mass scale. This fact is evident through the collapse of a few important fisheries owing to inadequate planning and implementation of fishery regulations². Technically advanced fishing gears also pose problems to the aquatic ecosystem due to their non-eco-friendliness³. Hence, both technically advanced and traditional fishing gears are to be analyzed for their eco-friendliness before mass-scale adoption to ensure sustained fishery. Further, the analysis of eco-friendliness plays a key role in the management of fishery resources in confined marine ecosystems such as lagoons. Further, among the traditional gears, drag nets and seine nets are also found non-eco-friendly as their operation affects the bottom of the coastal ecosystem that inhabits fish and other aquatic organisms⁴. Brackish water bodies are also not unaffected by the impact of the operation of non-eco-friendly fishing gear as they act as a cozy shelter for many brackish water animals, including

fish⁵. Hence, in general, detailed investigations on the type of fishing gear used in the aquatic ecosystem and their degree of eco-friendliness need to be analyzed irrespective of their type, that is, whether advanced or traditional⁶. As lagoons provide livelihood security to a large section of the rural fishers, a judicious way of exploitation of fishery resources in the lagoon is essential.

In recent days, there has been an interest in knowing and seeking support from the rural people who hold indigenous knowledge and practice it¹. Knowledge from the traditional fishers plays a key role in planning for sustained fishery from dynamic open-access ecosystems⁷. The design features of traditional fishing gears vary from region to region and are mainly based on the nature of the bottom of the aquatic ecosystem in which they are operated⁸. Among different aquatic ecosystems, the brackish water ecosystem is known for its species diversity and hence provides nutrition-rich food to people⁹. Hence, studies have been concentrated on brackish water bodies to understand their ecology besides fish production⁷. Studies related to fishing gear and craft of brackish water bodies and their impact on the

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brackish water ecosystem are scanty in India¹⁰⁻¹². Most of the studies have been restricted to traditional fishing gears and methods of lotic and lentic freshwater bodies of Northeast India,¹³ Chhattisgarh,¹⁴ Krishna River (Andhra Pradesh),¹⁵ Tripura,¹⁶ West Bengal^{17,18} and Assam^{1,19}.

The Pulicat lagoon is the second largest lagoon in India after the Chilika lagoons (lat. 19.8450° N, long. 85.4788° E). It lies between Andhra Pradesh and Tamil Nadu with a water spread area of 350 sq. km. It is a natural brackish water lagoon with diverse fauna and flora, housing several species of birds²⁰. Fishermen inhabiting 50 fishing villages that are located around the Pulicat lagoon and get food and livelihood security⁵. No documentation on fishing gears and craft being operated in this lagoon has been made so far though it plays a remarkable role in fishing. This study aimed at documenting fishing gears being used in the fishing villages bordering the Pulicat lagoon and analyzing their degree of eco-friendliness.

Methodology

Pulicat lagoon turns into a brackish water lagoon during the rainy season due to freshwater inflow. It offers employment to thousands of fisherfolk who are involved in capturing fish by hand picking and using fishing gear. This study included fishermen from 54 fishing villages belonging to five blocks of Tamil Nadu, viz., Pazhaverkadu, Annamalaicherry,

Mangodu, Sunnabukulam, and Arambakkam (Fig. 1). A total of 320 respondents were contacted covering a minimum of 5-7 fisher folk from each fishing village from May 2016 to April 2019. A questionnaire was prepared, pre-tested, and finalized before conducting the survey. The questionnaire contained questions related to the design details of fishing gears, fishing craft, and their methods of operation.

Results and Discussion

A total of 26 types of fishing gears were found operating by the fishermen (Fig. 2). A notable diversity could be observed among the types of fishing gears operated with rich representation by traditional types of gears. A total of 15 categories of fishing gear were observed among which 10 categories showed representation by a single type of fishing gear whereas the remaining 5 categories showed multiple representations by two or three types. It is worth mentioning that higher representations of traditional gears were still prevailing despite the technological advancement taking place in the fishing industry. Of 15 categories of fishing gear reported, except gill net, the remaining 14 categories belonged to the traditional fishing gear sector. The fishing patterns of fishermen with various types of fishing gears were as follows: stake nets (33%), drift gill nets (24%), set gill nets (19%), drive-in nets (14%), and other gears (<10%) (Fig. 3).

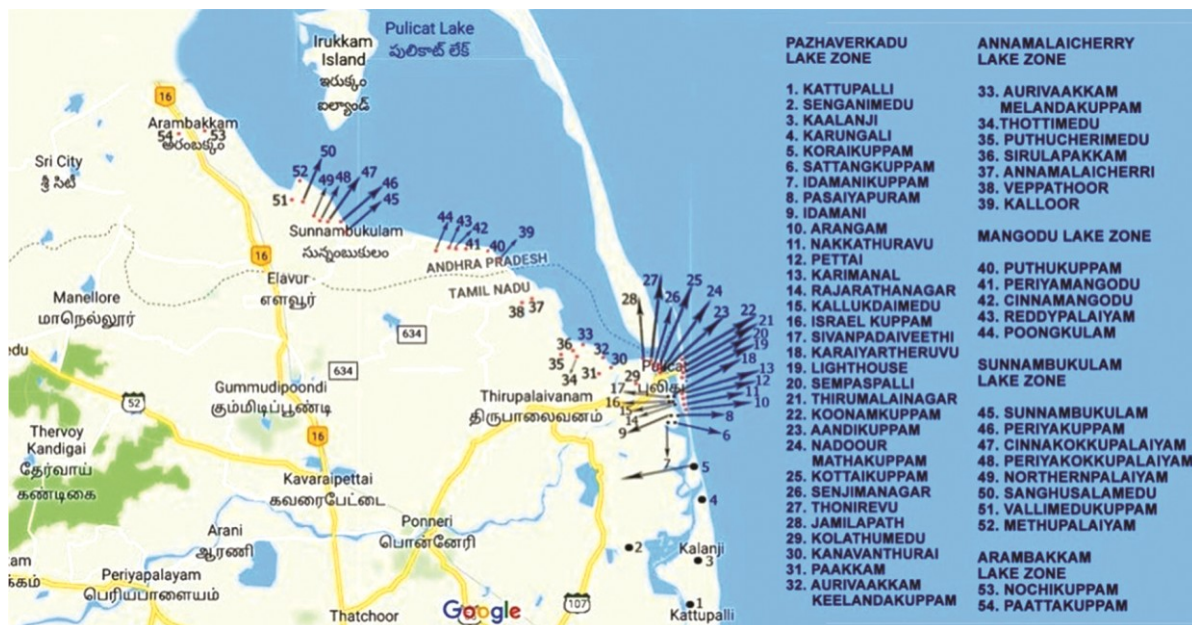


Fig. 1 — Study localities of the Pulicat lagoon, India

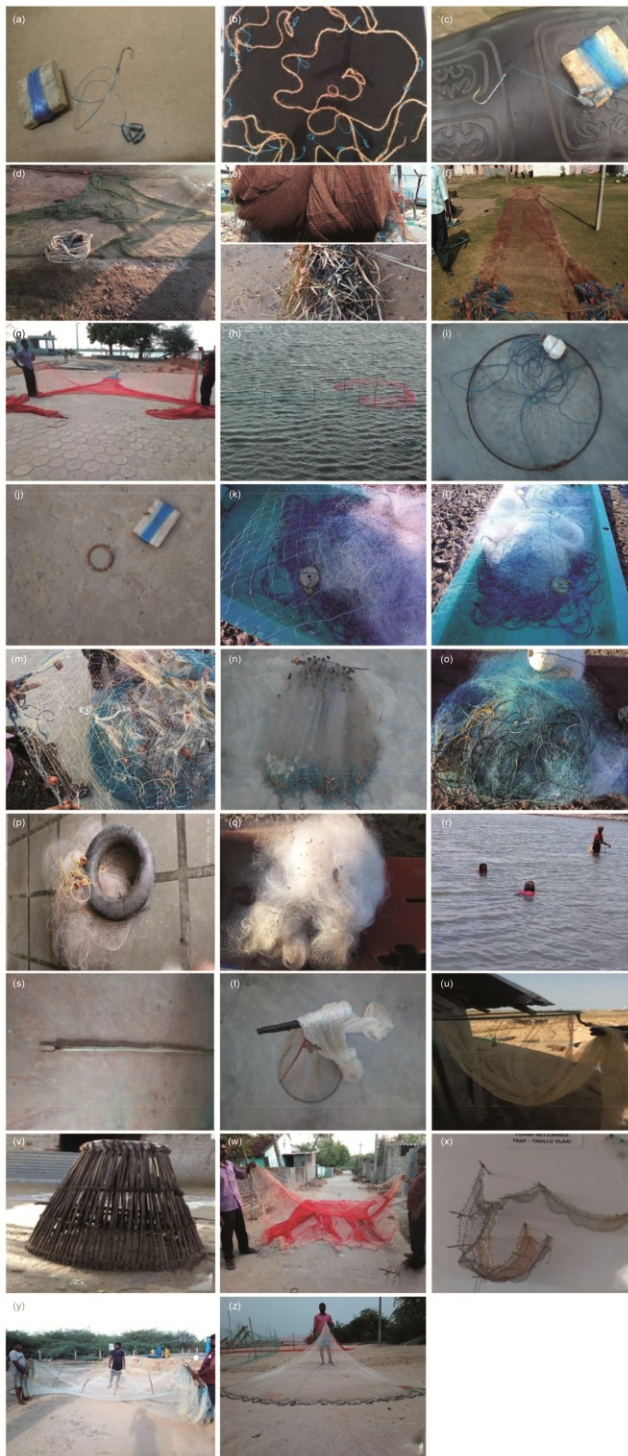


Fig. 2 — Traditional fishing gears of Pulicat lagoon, a-z: (a) *Kaithoondil*, (b) *Nandu salanga*, (c) *Nandu kavuru*, (d) *Kalvalai*, (e) *Siruvalai*, (f) *Oi valai*, (g) *Adappuvalai*, (h) *Kattuvalai*, (i) *Kaccha*, (j) *Surukku*, (k) *Kotralvalai*, (l) *Nanduvalai*, (m) *Eppovalai*, (n) *Poosanivalai*, (o) *Kilankanvalai*, (p) *Paththuvalai*, (q) *Aravalai*, (r) Hand-picking; (s) *Mandaal*, (t) *Chikkan*, (u) *scoop net*, (v) *Vutha*, (w) *Suthuvalai*, (x) *Thulluvalai*, (y) *Kondalvalai*, (z) *Veechuvalai*

Categories of fishing gear with multiple representations

Seven categories of fishing gears showed multiple representations, either two or three types of fishing gears. They were (i) hook and line, (ii) drive-in net, (iii) stake net, (iv) hand-lift net, (v) tangle nets, (vi) set gill net, and (vii) drift gill net. The design and operational methods of categories of fishing gears with multiple representations are described below:

(i) Hook and line

Under the hook-and-line fishing method, two types of fishing gears were observed. They were monoline with multiple hooks and crab long lines. The monoline with multiple hooks was of a single type called *Kaithoondil*, whereas the crab long line was further represented by two types of gears namely *Nandukavuru* and *Nandu salanga*.

Monoline fishing with multiple hooks (Kaithoondil)

The monoline used in the Pulicat lagoon is locally called *Kaithoondil* (Fig. 2a). It consists of a mainline of 25 m long and 0.6 mm diameter with two or three branch lines each with a length ranging from 0.3 to 0.45 m and the thickness of 0.4 mm diameter. The ‘J’-type hooks with hook No. 12 or 13 were found to be used. A lead sinker or a small stone weighing about 25 g was tied to the main line to take the main line down into the water. Further, a thermocol float with the dimension of 5 cm (*L*) × 3 cm (*B*) × 1 cm (*H*) was used as a float in the main line as the indicator float. The thermocol float and the lead sinker (25 g) were used for the proper setting of the main line during operation. This gear was found operated in most parts of the Pulicat lagoon throughout the year. However, it was found used only during high tide when water depth was raised to 2 m. This gear was used at the shore during day time with red worms as bait. The fishermen pulled the

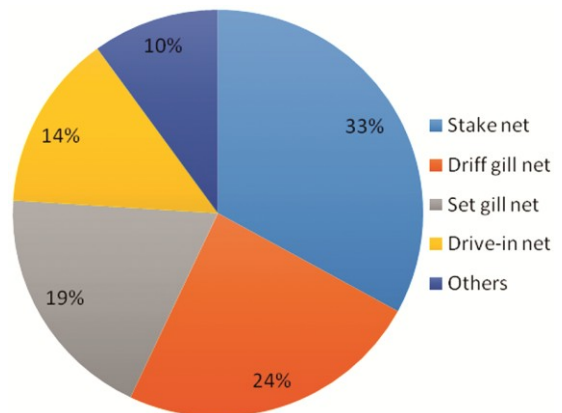


Fig. 3 — Fishing pattern of fishermen of the Pulicat lagoon

mainline when the fish started biting the bait. The fish caught in the hook was collected in the basket hanging on the back of the fisherfolk. Generally, small fish such as emperor fish and tiger perch are caught by this method. The practice of a similar kind of hand line fishing technique has been reported in the brackish water bodies of Northeastern parts of India^{16,21,22}.

Crab long lines

Two types of fishing lines are being used to capture mud crabs. The crab long line gear found to capture crabs without a hook is called *Nandu salanga* whereas with hooks is called *Nandu kuvuru*.

(a) *Nandu salanga*

It is a type of set crab long line without hooks and has indicator floats at each end (Fig. 2b). The length of the main line is about 100 m and is made up of coir rope of 8 mm diameter. A single unit of *Nandu salanga* is made up of an 80 cm coir rope with a diameter of 6 mm and consists of 50 branch lines. The inter-distance between two branch lines is about 2 m. The bait fish is tied at the rear end of the branch line. When fishermen feel that crabs have started biting the baits, they haul the gear slowly and scoop out the crabs holding the bait with the help of a scoop net. Usually, big mud crabs are caught by this gear.

(b) *Nandu kuvuru (setline with hooks)*

It is yet another fishing gear used to capture mud crabs in fishing grounds with muddy bottom (Fig. 2c). The two extreme ends of the gear have an indicator float on each side. The mainline is made up of monofilament with a length ranging from 100 to 130 m and a thickness is 1.5 mm. Branch lines ranging from 20 to 25 are found attached to the main line with an inter-distance of 5 m. Hook No.7 was used at the end of the branch lines. To position this gear in a place in the water column, the rear end of the main line was attached with three lead sinkers each weighing 50 g whereas the other end was with the boat. To attract the crabs, catfish, and flesh was used as the bait in the hooks. When a crab started grabbing the bait, the line was hauled slowly till the hooks along with the bait and crabs reached the shore. Later, a scoop net was used to scoop the crabs out of the water quickly. A similar kind of net has been reported in Nicobar Islands²³.

(ii) *Drive-in nets*

Drive-in fishing was found to be one of the common practices in the Pulicat lagoon. To perform

this fishing method, a stationary net barrier and freighting rope with hanging stone or Palmyra leaves were used. Apart from the scaring devices, the fishers used to make loud sounds and move toward the stationary net barrier. Further, to drive the fish into the net when sufficient shoaling of fish was found in the vicinity of the barrier net, the net was made to scoop the fish out of the water. Three types of drive-in fishing methods were observed, which are described below:

a. *Kalvalai (barrier net with stone)*

In this gear, the barrier component consisted of two types of nylon multifilament net panels; one with a mesh size of 14 and 6 mm (Fig. 2d). The panels were found rigged with headrope and footrope. The barrier net had a length ranging from 15 to 20 m and a depth ranging from 1.5 to 2.0 m. The net was attached with 20 floats made up of Styrofoam on the headrope with an interval of 1 m. A coir or plastic rope 50 m long and 10 mm diameter was used as the freighting rope to act as a barrier. The freighting rope was fabricated with 20 stones having a weight of 100 g each attached in a series of branch lines measuring 30 cm long with a space interval of 1 m. weight of 100 g each. Four fishermen were involved in operating this gear. Of them, two fishermen were engaged in upholding the net and hauling the fish by encircling while the remaining two fishermen operated the freighting rope. The catch mainly constituted in this gear was shrimps.

b. *Siruvalai (barrier net with Palmyra leaflets)*

This gear was found made up of two layers of nylon multifilament webbing with the mesh size of 15 and 20 mm and with a twine thickness of 1 mm (Fig. 2e). The webbings were rigged both with a headrope and footrope each measuring 30 m long. Both top and bottom selvages were found to be used. The top selvedge was found fabricated with 2 mm diameter polyethylene twine and had two rows of 40 mm meshes. The bottom selvedge was found fabricated with Nylon multifilament twine with the specification of 23Tex/2/3. A total of 60 sponges or PVC floats were attached to the headrope with an inter-distance of 50 cm. However, no sinkers were found attached to the footrope. The freighting rope was made up of coir or polypropylene of 4mm diameter and measured 50 m long. Palmyra leaflets were found hanging from the freighting rope so that on towing the Palmyra leaflets disturbed the water column from surface to bottom. Two fishermen are engaged in upholding the barrier

net and hauling the fish by encircling, the remaining two fishermen operate the freighting rope. Once sufficient shoal of fishes frightened by the freighting rope with Palmyra leaflets, the frightened fish accumulate near the vicinity of the barrier net, and then the barrier is scooped out of the water to collect the entrapped fish. This gear is considered more efficient than *Kalvalai* as bigger mullets and milkfish were found to be major constituents of the catch.

c. Oi valai

Unlike *Kalvalai* and *Sirivalai*, *Oi valai* has a single component of stationary net barrier and the frightening is done not by any implement; however, sounding is the means of driving the fish toward the barrier (Fig. 2f). As the sound includes the repetition of word “*Oi*”, this net is called *Oi valai* in Tamizh. The design of this barrier net resembles that of *Kalvalai* and *Sirivalai* and is made up of nylon webbing using multifilament nylon twine. However, the mesh of the double-layered barrier net has relatively bigger meshes. Although the mesh size of one barrier net webbing was 28 mm, another had a mesh size of 32mm. The webbings were rigged both with head rope and foot rope, each measuring 30 m through the top and bottom selvages, respectively. The top selvedge was fabricated with 2 mm diameter polyethylene twine and had two rows of 40 mm mesh. About 60 sponges or PVC floats were attached to the head rope with an inter-distance of 50 cm and the foot rope did not have any sinkers. The entire fishing operation was carried out by eight fishermen. To position the stationary net barrier, four fishers were found engaged and the rest of the fishers used to repeat the sound *Oi* and move toward the barrier net to drive the fish toward the net. Milkfish constituted the major portion of the catch in *Oivalai*.

(iii) Stake net

Stake nets work on the principle of sieving fish by installing barriers either against the tidal current or against the water current. Unlike drive-in nets, the operations of these nets did not involve any drive-in devices.

a. Adappuvalai (obstruction net)

It is a bag-shaped net installed against the current in the bar mouth of the lagoon during the low tide, mainly targeting the prawns that migrate from sea to lagoon during the high tide (Fig. 2g). It is like a mini-trawl having a wing, belly, and the cod end. The wings facilitate fixing this gear in a ‘V-shaped pattern. The

belly of the net was conical, which channelized the prawns entering the net to the cod end. Multifilament nylon webbings were found to be used for the construction of this gear, which was mounted with a headrope and foot rope. The belly had three sections with gradually decreasing mesh size toward the cod end. The panels of the first, second, and third sections had a depth of 100, 150, and 50 meshes, respectively. The respective mesh sizes of the panels were 40, 20, and 16 mm, and the cod end had 200 meshes in depth with a mesh size of 14 mm. Each wing consisted of 2,000 meshes of 40 mm mesh size along the length. The net was found hauled 2-3 h after the initiation of the high tide by four fishermen during night hours. Among the four, three fishermen got engaged in setting and hauling whereas the remaining one collected the prawns through the near end of the cod end. The migration rate mainly decided the catch rate of prawns in this gear. Maximum catch up to 200 kg/haul was witnessed. Among the different types of fishing gear, *Adappuvalai* was found to yield the highest catch (Fig. 3). Similar operation of the gear has been reported in the rivers of Goutami Godavari²⁴ and Krishna²⁵ and backwaters such as Killai backwater²⁶.

b. Kattuvalai (barrier trap)

Kattuvalai is a barrier trap usually installed with a small guiding device against the water current in the middle of the Pulicat lagoon in a semicircular pattern (Fig. 2h). Though *Kattuvalai* is not a bag-like gear as *Adappuvalai*, there are resemblances in the operation of both the gears and it is also hauled during the ebb end of the operation. To facilitate the easy flow of water current and filtration of shrimps, this gear consists of a wall of webbing with three mesh panels. The upper and lower panels were found to have bigger mesh sizes ranging from 32 to 40 mm whereas the middle panel had a mesh size varying from 16 to 20 mm. The wall of webbing altogether had about 1,500 meshes in length and 50 meshes in depth. This net was found installed during the evening at low tide and was hauled 2-3 h after the initiation of the high tide. This gear was found operated throughout the year, taking advantage of the low water depth at low tide and less visibility during the night hours. Similar observations of the operation of barrier traps have been reported in other rivers of India^{13,27,28}.

(iv) Hand-lift crab fishing gear

Hand-lift fishing is an ideal fishing method to capture sluggish marine animals such as octopus and

crabs. Although octopus pots are used in the sea, hand-lift crab fishing gears are used in lagoons. Hand-lift crab fishing gear being a passive gear was found positioned at selected places of the lagoon with the help of a ring with the bottom closed or opened. When crabs were attracted toward the baited ring, they were either made to entangle in loops tied around the ring or lifted slowly to the water's surface without entangling.

a. Kaccha (ring crab trap)

This was found to be a simple gear with a ring of 0.5 m diameter closed at the bottom (Fig. 2i). It is locally known as *Kaccha*, and is circular. An iron ring of 6 mm diameter was found closed with polyethylene (PE) netting at the bottom. A lift line of 6 mm diameter was found tied with the ring through three bridles of 4 mm diameter tied on the iron frame at equidistance of 0.5-0.75 m. A Thermocol float was found used in the lift line as the marker float for easy identification of the gear. This crab fishing gear was found normally operated during daytime and its operation was found throughout the year including the peak period of monsoon seasons. The mud crab was found to be the major catch and the catch rate varied from 2 to 3 crabs per haul and the total catch varied from 2.0 to 3.0 kg/day. It is reported that a gear resembling *Kaccha* has been in use in the Pulicat lagoon of India and Kokilai lagoons of Sri Lanka^{29,30}.

b. Surukku (ring with baited loop lines)

The gear is locally known as *Surukku*, made with a circular ring of 5-7 cm diameter with 3-4 monofilament lines having sliding loops at their end (Fig. 2j). The tightening of loops results in the capture of crabs on any parts of the body, most preferably on the claw of the legs. A polypropylene rope of 4 mm diameter served as a lift line, which was attached to the center of the ring through three connecting ropes. The length of the lift line varied from 1 to 3 m based on the operational depth. A Thermocol float was found attached to the lift line and was used as the marker float for easy identification of the gear. Two fishers operated this gear during day hours. Although one person maneuvered the boat, the other person looked after both the laying and hauling of the gears besides collecting the entangled crabs. Marine catfish were used as bait. Each ring was baited with a single fish in the middle of the ring. To cover a large area, about 20 *Surukku* were laid at a time, maintaining an inter-distance of 5-7 m between two gears. Normally,

a soaking duration of 30-45 min was given for the entrapping of the crabs. The crabs get entrapped in any one of the loops of the gear when they move toward the center ring to grab the bait. The movement of the indicator float indicated the entrapping of crabs in the gear. A scoop net was used for the collection of crabs. The catch rate varied with the locality, season, and population density of the crabs. The gear was selective to medium-sized crabs with a carapace width of less than 100 mm and large-sized crabs. It has been reported that *Surukku* is the most efficient gear to fish big mud crabs from lagoons²⁴. The study revealed that *Surukku* is not a location-specific gear for crab fishing as its operation has already been reported along the Kerala coast¹³ and northeast coast of India³¹.

(v) Tangle nets

Tangle nets with single walls or triple walls were found used for the capture of shrimps and crabs in the Pulicat lagoon. They are popularly called *Kotravalai*, *Nanduvalai*, and *Eppovalai*.

a. Kotravalai

This is a single-walled entangling gill net fabricated with a monofilament of 0.5 mm diameter (Fig. 2k). Earlier, this gear was fabricated with cotton twine and nowadays nylon monofilament twines are used for the fabrication of this gear. The mesh size of the webbing is 1 mm. The headrope ran to about 0.5 km whereas operation and the soaking duration was normally 2 h. This gear was normally operated in deep water regions of the lagoon, targeting bigger prawns during night hours. The operation of a similar gear has also been reported in River Krishna^{25,32}.

b. Nanduvalai

Nanduvalai is also a single-walled entangling gill net as *Kotravalai*. Whereas the former is used for capturing shrimps, the latter is used to capture crabs (Fig. 2l). It was found made up of nylon webbing of mesh size varying from 70 to 85 mm. The webbing was fabricated with monofilament twine of 0.4 mm diameter and was rigged with both head and footropes. The length of the foot rope ranged from 85 to 100 m whereas the hung depth varied from 1.5 to 2 m. About 20-30 cork floats were used in the head rope, depending on the length of the gear. To position the net during the operation, one end of the footrope was anchored whereas the other end was fastened to a bamboo or *Casuarina* pole. Baits were attached to the footrope at several points to lure the crabs. This gear was mostly operated during the night time with 8-10 h

of soaking. The use of monofilament entangling gill nets for crab fishing has been reported in Killai estuary²⁶ and Chilika lagoon³², Nagapattinam coastal region of India³³ and Kokkilai lagoon of Sri Lanka³⁰.

c. Eppovalai (trammel net)

Eppovalai is a traditional triple-walled entangling type of gill net made up of multifilament nylon webbing (Fig. 2m). It consisted of three layers of webbing; the outer layers have larger meshes (42 mm) fabricated with thicker twine. The middle layer was made of smaller meshes (13 mm) of thinner twine and was found comparatively loosely hung. This gear ran to about 0.5 km during operation and was operated for about 3 h. In *Eppovalai*, prawns that enter through the larger meshes of outer layers on either side get entangled while making pockets with the loosely hung middle layer. This gear was found mostly used during night hours, targeting Indian white prawns, and was hauled on the next day early morning hours. The use of the trammel net to capture fish of different size groups in inland water bodies of the northeastern part of India has been reported¹³.

(vi) Gill net

Gill net is one of the common gears used in the Pulicat lagoon for targeting finfish, although shrimps and crabs form fishery as by-catch. This net is either made to drift or set with the help of anchors during operation.

i. Set gill net

a. Poosanivalai

The traditionally used set gill net of the Pulicat lagoon is popularly called *Poosanivalai*, which is found to be used after substituting the cotton twine with nylon twine for fabricating the webbing (Fig. 2n). A nylon monofilament webbing of 54mm mesh size made up of 0.7 mm diameter twine was found to be used in this gear. The head rope length varied from 100 to 125 m whereas the hung depth varied from 1.5 to 2 m. As in the case of the operation of *Nanduvalai*, in the operation of *Poosanivalai* also, one end of the footrope was anchored whereas the other end was fastened to a bamboo or *Casuarina* pole. Though the use of cork floats was a common phenomenon observed in all types of gill nets of this lagoon, the use of clay sinkers is a specific phenomenon observed in this gear. The number of sinkers used depended on the water depth and length of the net. This gear was primarily operated during the night hours. It was circularly fixed in the water column and was fastened with two wooden poles

at each end, which were erected from the bottom, leaving a passage for the entry of the fish. On frightening the fish by causing turbulence, the fish entered the passage and got enmeshed in the gill net. A similar kind of net has been reported used in the lower Gangetic plains, West Bengal³⁴.

b. Kilankanvalai

This gear was fabricated with 0.5-diameter monofilament twine having a mesh size of 30 mm. The head rope and foot rope lengths were 150 and 175 m, respectively, whereas the hung depth varied from 2.0 to 2.5 m (Fig. 2o). The operation of *Kilankanvalai* was found similar to that of *Poosanivalai*. This gear was mostly operated in the bar mouth region targeting *Elops* spp. (ladyfish) during the flow of tidal water toward the sea during night hours. A similar kind of net was observed in Nicobar Island²³.

(vii) Drift gill net

Two types of drift gill nets were found operated in the Pulicat lagoon, of which *Tube valai* was operated throughout the lagoon both during the low and high tides whereas *Ara valai* was used mostly during the high tide, targeting ladyfish and mullets.

a. Tube valai

It is locally known as *Pathu valai* as it is operated from an air-filled rubber tube craft (Fig. 2p). The gear is a small gill net made up of nylon monofilament of 0.4 mm diameter with a mesh size of 30 mm and a hung depth of 1.5 m. Mulletts, milkfish, prawns, and crabs were caught by the entangling process in this fishing gear. A single person usually sat over the tubular craft and looked after both shooting and hauling of the gear.

b. Ara valai

Earlier, this gear was constructed with cotton but nowadays 0.3 mm diameter nylon monofilament twine has been used for fabricating (Fig. 2q). The mesh size varied from 35 to 40 mm whereas the head rope length was about 1 km long; the hung depth ranged from 1.5 to 2.0 m. It is a drift gill net and the operation is similar to *Tube valai*. However, this gear was mostly operated in relatively deeper waters³⁵.

(viii) Without gear

Prawn/crab picking

It is one of the traditional fishing methods still practiced by the tribal fisherfolk inhabiting the "seven hamlets" located at the southern end of the Pulicat

lagoon (Fig. 2r). Prawns and crabs were used to be handpicked in the shallow water regions of the lagoon in the day hours during the low tide, which has been also reported in the east and northeastern coasts of India¹³.

(ix) Grappling and wounding gear

Mandaal (spears)

Mandaal is also one of the Indigenous fishing practices that involves the use of a long wooden pole with steel and two-pronged barbed sharp projectiles to pierce the fish under the target (Fig. 2s). It is mainly used to catch bigger catfish, sea bass, groupers, etc. This fishing method is efficient only when the lagoon water is clear and transparent. Generally, this gear is operated during day hours from the shore, when fish wander in the shallow water. On spotting a fish, *Mandaal* is thrown to pierce it. A similar net was used in the river of North-east, India and the Batang Bungo River River, Indonesia^{13,36}.

(x) Lighted scoop net for crab and prawn fishing (Chikkan)

Conical bag-like scoop nets used to capture crabs and prawns are locally called *Chikkan* (Fig. 2t). In both types of gears, a battery-operated torchlight attached to the head of fishermen is used³⁷.

(a) Scoop net for crab

This gear was found to be made up of a conical bag of polyethylene webbing of 20 mm mesh size whose mouth was attached to a circular iron ring of 60 cm diameter and an iron rod of 6 mm thickness (Fig. 2u). The ring had a short handle to facilitate scooping of the net. Crabs were attracted toward the net with the help of the battery-operated torch light attached to the head of the fishermen. Adult and subadult crabs are mainly caught in this net. This gear was usually found operated mainly during summer in shallow water regions. The use of scoop nets for mud crab fishing has been reported in Southeast Asian countries such as Indonesia, Thailand, and Sri Lanka³⁸⁻⁴⁰.

(b) Scoop net for prawn

This was a funnel-shaped gear made up of multifilament nylon webbing with a mesh size of 16 mm and its mouth was fitted to a circular iron frame of 30 cm diameter made up of a 6 mm thick iron rod with a long handle. Though the operation of this gear was observed throughout the year, its operation was intense when the water flowed from the lagoon toward the sea. In earlier days, kerosene lamps were

used to attract prawns; however, at present torch lights with LED bulbs fitted on the head of the fishermen are used. Fishers were found to target bigger prawns. After locating a prawn, this gear was cast near the location of the prawn, and fishers used their legs to divert the prawn into the gear. The use of this cone-shaped net was found common in fishing villages located adjacent to Pulicat Lake such as Thonirevu and Senjimanager. The use of the scoop net to capture shrimps in the River Krishna and Narmada Estuary, Gujarat has been reported^{13,41}.

(xi) Wooden cover crab pot

Vutha

Vutha is a conical cover pot made of bamboo sticks woven together along with coir rope and has an opening at both ends (Fig. 2v). The circumference of the upper and bottom openings was about 15 and 60 cm, respectively. The height of the *Vutha* was about 60 cm, and the slit gap between each adjacent stick was about 0.5 cm. It was found operated by a single fisherman in the shallow water region mainly during the summer season. On spotting the crab, the fisherman covered the crab with a broad opening facing downward and removed the entrapped crab through the top opening by hand. This gear was found getting vanish in the Pulicat lagoon. Similar reports on the use of *Vutha* in the Brahmaputra valley of Assam^{19,42} and Gumti river of Muradnagar upazila, Bangladesh⁴³ have been published.

(xii) Barriers/fences

Suthuvalai

This gear resembled a trawl net without a cod end and wings (Fig. 2w). This trapezoidal gear consisted of both upper and lower panels shaped with a suitable cutting rate and seamed at the edge to form a bag. As in the trawl net, there was a gradual reduction in the mesh size from the fore to the rear end. Both the top and bottom panels had three mesh panels with mesh sizes of 24, 14, and 13 mm joined using horizontal joining. The gear's first, second and third top panels had 1,700, 1,660, and 1,560 meshes, respectively. The numbers of meshes in the respective panels along the depth were 60, 100, and 100 meshes. This gear was circularly installed across a bar mouth by fastening wooden poles with the help of coir or polypropylene ropes. A group of fishermen repeated the operation 4-5 times a day. An estimated mean catch of 90 kg per haul was obtained. The

operation of similar gears in the backwater of Kerala during the northeast monsoon (October-January) has been reported¹³ and also reported in the Northern Nigeria water bodies⁴⁴.

(xiii) Aerial trap

Thulluvalai (cradle trap)

As the name implies in Tamil, this net was meant for capturing those fish that jump on coming across a barrier (*thullu* in Tamil means 'jumping'). This net had two components *viz.*, a vertical barrier set circularly with one end facing inwardly and horizontal webbing with adequate looseness was set as a cradle at the curvature of the circle (Fig. 2x). The cradle was made of a horizontal layer of cotton webbing with 250 meshes in length and 150 meshes in breadth fitted with two bamboo poles of 25 m in length one at each edge the operation breadth of the cradle was about 3m and the cradle was just fixed above the water surface. The vertical wall had 3000 meshes in length and 100 meshes in depth whereas all the webbings had the same mesh size of 20 mm. During the operation of the gear, the mullets that entered the circular barrier got freighted and jumped. Such fish that had jumped fell on the horizontal cradle. This gear was found operated throughout the year in the regions of the lagoon with a relatively lower water depth. The operation of similar types of aerial traps for catching the prawns across the river flow in River Krishna^{13,25} and Birbhum district, West Bengal has been reported⁴⁵.

(xiv) Multi-stick dragnet

Konda valai

This gear was found fabricated with nylon multifilament webbing with a mesh size ranging from 20 to 30 mm using 0.6 mm diameter twine (Fig. 2y). The webbing was rigged both with head rope and foot rope, each ranging from 25 to 50 m long. The hung depth of the webbing was about 1.5 m. Nine wooden sticks of 50 mm diameter were used to connect the head rope and foot rope at an equal interval of 5 m. This gear was usually operated during the northeast monsoon season in the shallow regions of the lagoon, especially when the water depth is below 1.5 m. The gear was operated by dragging involving two persons. While the head rope was held in hand, the foot rope was held under the foot during the operation. The use of a similar type of gear for catching prawns and fish has been reported in, Godavari, Killai backwaters, and Chilika lagoon^{24,26,32}.

(xv) Hand-thrown cast net

Veechu valai/Mani valai

Two types of the cast net (*Veechu valai*), one made up of nylon multifilament twine for capturing prawns and another made up of nylon monofilament for capturing finfish such as milkfish, mullet, and tilapia, were observed (Fig. 2z). The nylon multifilament cast net consisted of seven pairs of panels of 8 mm mesh size and 1 mm twine thickness. The top upper panel of this net had 60 meshes in length and 15 meshes in depth. Thereafter, in each panel, the number of meshes in length increased by 60 meshes, however, with 30 meshes in depth in all the layers. The lower edge of each panel was attached to the upper edge of subsequent panels at a take-up ratio of 2/3. The junction of the upper and lower panels was laced with nylon twine of 1 mm diameter. The circular mouth of the net was rigged with a foot rope bearing lead sinkers to take the mouth of the net beneath the water column so that the prawns or fish available in the area of operation are covered and captured. The monofilament cast net also consisted of nine pairs of panels with 25 mm mesh size, fabricated with 0.7 mm diameter twine. These gears were found to operate throughout the year mainly in shallow water regions, particularly during the northeast monsoon, especially when the water depth was less than 2 m. Operation of a similar gear for the capture of prawns and fish has been reported in River Krishna²⁵ and Netravati-Gurupur estuary³⁶.

Conclusions

The study revealed traditional fishing gear and craft are still in use at Pulicat lagoon. The highest diversity of usage of over 26 types of traditional gears was observed in this region, though gill net was found predominantly used. Among the different types of gears found operated, stake net ranked first in terms of catch rate followed by gill nets and drive-in nets. In terms of eco-friendliness, almost all the gears used in public were eco-friendly except multi-stick dragnet. Thus, the traditional fishing operations in the Pulicat lagoon may be allowed to continue without any introduction of technically advanced fishing gears such as gill net and mini trawl, which are practiced in the coastal waters adjacent to the Pulicat lagoon.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

All authors declare that they have no conflict of interest.

Author Contributions

KM Conceptualized the theme, and the idea of the research and reviewed drafts of the manuscript and approved the final version. NN Reviewed drafts of the manuscript. LG: laboratory observation. SM Sample collection from fish landing centres & species identification, laboratory observation. RV: laboratory observation. RK: Technical contributions to data analysis were carried it in collaboration with the research team.

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