

Bycatch issues in the inland capture fisheries of India

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Introduction

Total world inland capture fish production was 11.63mmt in 2016 and China was the leading nation followed by India with 1.46 mmt. Inland waters include freshwater and brackish water bodies in the form of rivers, reservoirs, lakes, backwaters, mangroves, estuaries, tanks, ponds, paddy fields, wetlands, etc. India has vast inland resources in the form of rivers and canals, 1,97,024 km; reservoirs, 3.15 million ha; ponds and tanks, 2.35 million ha; oxbow lakes and derelict waters, 1.3 million ha; brackish water, 1.24 million ha and estuaries, 0.29 million ha. Inland water bodies include fresh water and brackish water areas. The river systems of the country are classified into five groups namely Ganga, Brahmaputra, Indus, Peninsular east coast river systems and west coast river systems. It comprises of 14 major rivers, 44 medium rivers and several small rivers and streams.

Fishery resources include 2546 species so far listed 73 (3.32%) belong to the cold freshwater, 544 (24.73%) to the warm fresh waters, 143 (6.50%) to the brackish waters and 1440 (65.45%) to the marine ecosystem. Lakhs of people are engaged fishing and allied activities and earn their livelihood from the inland waters in our country. Currently, these water bodies are under stress due to dam construction, siltation, pollution, land reclamation, water abstraction, etc., which adversely affected fish production and fishery collapsed in several water bodies. Ganga action plan launched in 1986 with the main objective of pollution abatement, to improve the water quality by treatment of domestic sewage and industrial chemical wastes is a glaring example. Excess capacity and destructive fishing practices are other major reasons for declining fishery resources in inland waters.



Chilika Lake

Chilika lake

Since the capture fish production from the marine waters are declining inland sector is in the focus. Further aquaculture activities, especially shrimp and carp farming are taken up in a big to meet the increasing demand for fish.



Pulicat Lake

Pulicat lake

Among the native fauna most of the fishes are permanent dwellers and others are migrant species coming from the marine or fresh water bodies. Most of the fishes are native species and others are exotic which are accidentally or otherwise introduced into the system. Exotic species are harmful to the native fauna. Occurrence of African catfish in the inland water bodies is a good example. Immediately after the flood in Kerala fishermen had a good catch of several exotic fishes like paccu, gourami and arapaima.

Fishing craft

Variety of fishing craft are in operation in the inland waters, which include a piece of log or an inflated rubber tube to motorized FRP boats, depending on the type of fishing and nature of water body. In reservoirs bamboo raft, coracles and inflated tubes are common. In larger water bodies like Pulicat , catamarams are used for cast netting and motorized FRP canoes are used for seine netting. In Chilika lake, sail is used for wind-assisted navigation in wooden canoes.



Catamaram in Pulicat lake

Raft

Bamboo poles are tied together with help of rope keeping all the lower end of the trunk towards the stern side. These rafts are about 6-10 m in length and 1.5 to 5.0 m wide. It is

operated with the help of bamboo poles or oars in the sluggish rivers, floodplain lakes and in some reservoirs. The life span of this raft is about 1 to 2 years. Wooden raft and banana rafts are also made in some areas.



Fig.3. Bamboo raft

Coracles

Coracles (Fig. 5 and 6) are primitive, light, bowl-shaped boats with a frame of woven grasses, reeds, bamboo or saplings covered with sheets. Coracles are mainly used in reservoirs and backwaters in the southern regions of the country. Coracles are about 2-2.5 m in diameter with the greatest diameter across the centre. The bottoms of the boats are covered with few layers of plastic gunny bags or with plastic sheets and are tarred to make it waterproof. Coracles are steered and propelled using a single paddle.



Fig.4. Coracle of a migrant fishermen family from Karnataka

Canoes

Dugout canoes are mainly made from a single large log by scooping out the wood with the help of a small hand spade. The length of this boat ranges from 4 to 8 m. In shallow water bodies, it is operated either by a bamboo pole or by an oar by 2 to 3 persons. Fishing gears like traps, gill nets and hook and lines are operated from this canoe. Plank-built canoes are predominantly used in rivers and reservoirs. They are of different types and vary widely in size and shape depending on where they are used and the type of fishing to be carried out. These types of canoe are operated by oar and in the case of shallow water bamboo poles are also used. Sometimes canoes are provided with arch-shaped roofing made of bamboo mat or polythene sheet which provide shelter to the fishermen. Coat tar, indigenous preservatives and FRP sheathing is used in canoes to extend the life. FRP canoes are also used for fishing in the inland waters. Its smooth finish and light weight enables the fishermen to manoeuvre easily in the river.



Fishing craft in Ganges (Credit: H. KOLDEWEY)

Fishing gears

Diversity of fishing gears are more in inland waters than in the sea. Hook and line, cast net, traps, drag nets, gill nets and seine nets are the most popular gears. Hand picking and other primitive tools like spears and arrows are still in use in some pockets. Nylon monofilaments gillnets are the most predominant fishing gear across the sector. Fish traps are usually made of natural biodegradable materials, whereas all kinds of nets are made synthetic materials. Proliferation non-selective fishing gears like small mesh gillnets, seines and stationary bag nets is a major concern in most of water bodies.

Seine nets are roughly rectangular in shape without a distinct bag and are set vertically in water; to surround the school of fish generally pelagic. Shore seine is a large net operated near the bank of a river, reservoirs or beels. The net usually has two wings and a middle landing part. The net is payed in the form of an arc from the shore using a boat and a number of fishermen pulls the net from the shore. The foot rope of the net always touches the bottom and the net is pulled towards the shore and the fishes are collected from shore. Do-Dandi of Ganga river, Bori of Gujarat and Gorubale of Karnataka and Pattuvala or Chavittu vala of Kerala. Tana jaal, Ghayala jaal, Raja-rani jaal, Gheesa jaal, Ber jaal, Chati jaal, Ghon jaal, Moshori jaal, Fesi jaal, and Pet-kasi jaal operated in the north eastern regions are some shore seine nets of the country.



Large seine net in Pulicat lake

Boat seines are also operated in inland water bodies. Its construction is similar to the bag net and is operated from boats. The net is released from one or two boats to form an arc. After

encircling the fish, the net is hauled from the boat. Buro jaal and Koni jaal are single boat seines operated in backwaters of West Bengal. Pesi jaal is another small boat seine. operated in Assam. Patua-jaal is a boat seine operated in Chilika lake for small clupeids and beloniforms. **Stow net** is a bag net conical in shape similar to a trawl net. It is known by different names in different regions. The mouth of the net is fastened to the opposite river banks against the current using ropes or wire ropes. The upper edge of the net mouth is kept open with the help of bamboo poles fixed at both ends of the wing and near the mouth region of the net. The fishes are collected in the cod end as the current of water takes the fish inside the net. These nets are used only when there is sufficient flow of water. Baghjaal and Bion jaal of Assam are examples of stow nets.

Push nets are operated in shallow water bodies. It has a 'V' shaped bamboo frame to which the webbing is attached. The net is pushed through water by man wading and during operation it scrapes the bottom. It is hauled at frequent intervals. Some scoop nets have a cod end to facilitate collection of catch. The net is also operated from boats. Pelni of Narmada, kamjaal and kursung jaal of Assam, Schiki of Hoogly and Kuppu valai of Tamil Nadu are some examples.

Stick held drag net is operated in Orissa, Madhya Pradesh, Andhra Pradesh and Kerala. Mesh size of the gear ranges from 10-15mm. Webbing is fixed to bamboo stick of 70cm to 90cm length at regular intervals to form a pouch. The net is dragged by two persons in shallow areas which are devoid of bottom obstruction. While hauling the net fishes are driven into the net from both sides by splashing water with one hand. A drag net thandevala with two poles on either side of the rectangular mouth are operated in backwaters of Kerala.

Scoop net or small bag nets with rectangular mouth or circular mouth with frame used to scoop fish out of water. Net is operated in beels, backwaters and other inland water bodies. Vadivala and koruvala of Kerala Bachra jaal and hatjaal of Assam are some examples Trawl fishing has been carried out on experimental basis in reservoirs and rivers. Otter trawling has been tried in Hoogly estuary, Hirakud reservoir, and in Gandhisagar reservoir. Operations of mini trawl in Kerala has been recommended as an active fishing method in reservoir for the control / capture / elimination of cat fishes, uneconomical fishes and trash fishes. It is not recommended in rivers.

Hand operated dredges (kuthi vaaral) are used in backwaters in Kerala to harvest clams. The dredge is made of slightly inwardly curved horizontal plate of about 50 cm length having about 40 spikes pointing downward at the lower edge of the plate. To this curved plate an arch shaped bamboo frame of about 30 cm height at the center is attached. A small bag net of about 50 cm length is attached to this frame. The net and the dredge are attached to a wooden pole of approximately 10 m length. The dredges are operated by two or more fishermen using two canoes.

Lift net is a sheet of net, usually square, but may sometimes be conical, is stretched either by several rods, ropes, or a frame. The fishing principle is to keep the net submerged for an interval of time and then pull it rapidly out of water so as to catch any fish, which happen to be over it. A variety of nets, employing the above principle of fishing, are operated in inland water bodies. A lure and lift net techniques is practiced in Tamil Nadu.

Hand lift net operated along the shore in shallow waters. Four corners of the net are attached to poles tied at the center and is operated by dipping and quickly lifting the net out of water. Panjaal of Assam khora jai, kabjai and pah jaal are lift nets operated from boat or flat forms

built in shallow waters of Brahmaputra. Kacha of Tamil Nadu, kurli of Punjab, Arippuvala and hoop nets of Kerala, Maharashtra and Tamil Nadu and Jamdajaal of Gujarat are examples.

Falling gear is usually a cone-shaped net or other devices, which is dropped to cover aquatic animals and enclose them. Generally, they are hand-operated in shallow waters, but some are operated from a boat. The stick-held cast net is an example. The principle is to catch the fish by covering from above. The gear is cast over the area where the fish is available and the trapped fish are caught by hand. Cover pots, lantern net and plunge baskets are examples

Cast net is found throughout India. Cast nets are conical bag-shaped net. It is the most widely used gear in the inland sector by a single fisherman. Three types of cast nets are operated in inland waters viz. with closing strings, with peripheral pockets and without strings, pockets and hauling rope. Iron sinkers are fixed in the lower periphery of the net. The net is thrown in a circular fashion over the water and due to the presence of sinkers the net sinks to the bottom. It is then hauled up with the help of the hauling rope tied to the apex of the net. Fishes that come within the area covered by the gears enter the pockets while hauling. The cast nets vary in their sizes. Based on the size and different mesh size, the nets are named differently. The cast nets are mostly made of PA multifilament. Khewali jaal of Assam, chakar jaal of Gujarat and veesuvala of Kerala are some examples of cast nets.

Gill nets are long walls of webbing hung vertically in water that are either set in one spot or allowed to drift with the current (Fig. 27). Gill nets are used in rivers, reservoirs, beels and other inland water bodies. Gill nets can be operated in the bottom, midwater or surface targeting desired fish. These nets are also used as encircling gear. It is highly selective and can be used judiciously by using the optimum mesh size to capture the right size of the fish. Gill nets are also named by the target fish they capture. Gochail jaal of Allahabad, thangadi of Hoshangabad, kuto jaal of Hoogly, current jaal, langi jaal and phansi jaal of Assam and ozhuku vala of Kerala are examples. The rampant use of very thin polyamide monofilament materials, discarded and lost nets in the inland water bodies could lead to ghost fishing and can also cause environmental and ecological problems. Proper selection of mesh sizes, hanging ratio, and mode and time of operation can make gill net an eco-friendly, low energy and sustainable fishing method.

Traps are passive fishing gears into which the fish can enter voluntarily in such a manner that the entrance then becomes a non-return passage of the device. Trap fishing is highly fuel-efficient both in terms of returns and biomass per unit of fuel consumed. Traps can fish continuously during day and night with periodical checking and the organisms can be retrieved alive without any damage. Traps are mostly made of bamboo, Palmyra fibres, coconut tree, coconut leaves etc. Kankada khadia and Khonda screen traps in Chilka lake, Orissa Chempally koode of Kerala, Kumini of Madhya Pradesh, Sepa and Dingora of Assam are some examples of fishing traps.

Fish barriers are long leaders of converging screens erected in shallow waters to lead the fishes into the chambers fixed in the end. Net barriers are slowly replacing the bamboo barriers as these are cost affective and saves labour and lasts longer than the bamboo screens. The gear consists of leaders, gathering ground, channels and filter platforms. The leaders guide the fish into the trap. The length varies from 10 to 50 m depending on the width of the river stream or canal. Water seep through the platform, leaving the fish. These gears are very effective in capturing nearly all fish moving downstream. The fish reaching inside the barriers are captured by using lift nets. Roak used in river Yamuna in Agra during summer to catch major carps,

jano khonda or disco net of Chilka lake, banamara and betamara of northeastern states are some examples.

Hook and line fishing: Different lines such as hand line, pole and line, set line lone, drift line, long line, drop line, multiple baited lines, etc are also operated in inland waters. Some lines are operated without bait.

Purse net: It is a semi-circular purse net extensively used in catching Hilsa (Fig. 17). The net consists of an elliptical frame by tying two-split bamboo on either side or a bag shaped net attached to it. The net with its mouth opened vertically is towed along the river bottom by 1 to 2 fishers while being steered by 2 more. The frame of the net consists of two long slender arched bamboo strips about 6 to 7 m long tied together at both the ends in the form of hinges. To this frame is attached a rounded bag shaped net having a mesh of 22 to 70 mm made of PA about 3 to 3.5 m deep. The mouth is kept open by a brick, iron ball or a stone weight of 1.5 to 4.0 kg tied to the center of the lower lip. There is a feeler cord fixed to the upper portion of the net to transmit the disturbance caused by the entrance of fish. The stout haul rope is paid out to the desired depth. This haul rope passes through a ring or Y-shaped piece of wood in the upper lip and attached to the middle of the lower lip immediately above the weight. Net is operated from a boat moving with the current. When any fish enters the net it causes certain jerk which is felt by the fisherman holding the rope, which immediately close the net by pulling the rope and haul the net. Illishashangala jaal' and karal shangala jaal are very popular purse nets in the lower Brahmaputra, the former for hilsa and the latter for migratory carps. This net is also seen in West Bengal.

Brush parks are the most common fishing method employed in the beel (Fig.18). These parks mainly act as shelter areas. Two different types of brush parks locally known as katal / jeng and pit / chek, are erected in the beels of Assam. Katal fishing or katalmara is a method, which is extensively used in the beel fisheries of Assam. Katals are prepared by erecting tree branches in the bottom with a collection of water hyacinth, in the form of a circle. Pit / chek is a very large brush park (0.5 to 2.0 ha) erected in beels heavily infested with floating water hyacinth. Similar type of bush parks known as Phooms are seen in Loktak lake, Manipur. Fishes take shelter in this. During winter when the water level goes down, katal is surrounded using screen or net. Fishes are collected after removing the weeds

In the case of **drive-in-nets**, the technique of this fishing method is to drive the fishes into fixed fishing gear from a distance. Sometimes gill nets are used for this purpose. The operation is done in the shallow areas. Scare lines can be made by inserting tender coconut leaves into the twists of a long coir rope or with broken pieces of bricks and thin strips of turtle shell similar to a stick held seine net. The net is fixed in the form of "U" and the fishes are driven into the net using the scare lines. In the final stage of operation of the net two ends are brought together and the confined fishes are captured. Beppevala in rivers of Kerala, gopal jaal in Allahabad, sone jaal and tik tiki khedani of Assam are examples.

Above described are major fishing gears and methods of inland waters in India and there may be some other indigenous fishing methods in certain pockets, which is likely to be insignificant in terms of catch or employment. Major issues in the sector are given below.

- Habitat degradation due various anthropogenic activities
- Siltation

- Land reclamation
- Profuse weed infestation
- Aquatic pollution
- Construction of check dams/barricades
- Destruction of mangrove forest
- Sand mining
- Water abstraction in smaller water bodies
- Invasive predators/exotic species
- Large scale prawn seed collection from natural water bodies for farming
- Destructive fishing methods
- Bycatch/discards
- Climate change

Towards Sustainable Fishery

Excess capacity and over exploitation are major problems. Licensing of fishing craft and gear is required with periodic checking to control destructive fishing practices. Small meshed gears and use of mosquito net for fishing gear making should be banned. Gillnet with less than 90mm mesh size should not be used for hilsa fishing. Huge quantities of juveniles and post larvae are being landed in the stationary bag nets including juveniles of priced fishes like hilsa and pomfret. Such gears should be phased out or replaced with more selective gears. A buyback scheme can be introduced to purchase the licence of destructive gears. Completely ban the destructive fishing technique like blast fishing, electrical fishing and fishing using poison and chemicals. Trading of juvenile fishes need to be discouraged. Almost all gillnets are presently made of very thin nylon monofilament. Within 1-3 months time the net get damaged and it is discarded as the fishermen usually does not mend the monofilament nets. The discarded non-biodegradable nets in the water bodies leads to ghost fishing.

CIFT has optimised mesh sizes for different gears based on the extensive field trials conducted in different water bodies and the recommendations have been communicated to the respective States for enacting. As the fisheries resources in open water bodies are common wealth, people utilising the same have the responsibility to conserve the same to prevent Tragedy of the commons proposed by British economist William Forster Lloyd. Responsible fishing practices using optimised fishing gears developed by CIFT should be adopted. It is believed that self-regulation by the fishermen and community managing the resources is better than master and slave approach for sustainable fishery.

Fisheries management measures for sustainable fishery in inland waters

1. Fishing capacity regulation/ license for craft and gear
2. Prevention of destructive fishing gears and practices
3. Mesh size regulation
4. MLS for inland fishes
5. Observing closed season and closed areas
6. Discouraging use of mosquito nets/ destructive fishing gears
7. Community pond/cages for fattening live juveniles of fishes landed in fishing gear
8. Species enhancement in selected water bodies
9. Prevent habitat degradation process

10. Banning of fish seed collection from natural waters
11. Stocking and ranching
12. Restoring connection between isolated ponds and open water bodies for facilitating breeding migration
13. License for all aquaculture units to control the introduction of exotic predatory fish