Trawls and trawling

Remesan M. P.
Fishing Technology Division
ICAR- Central Institute of Fisheries Technology, Cochin
mpremesan@gmail.com

Introduction

Bottom or demersal trawling continues to be one of the most important fishing methods of the world. In India, more than 35,230 trawlers of various sizes ranging from 9 to 24 m LOA with engine power ranging from 45 to 450 hp @ 2000 rpm are in operation. Trawl is a bag net towed through water to filter out fishes, the mouth of which is kept open horizontally by means of a beam or otter boards and vertically by means of floats, kite and sinkers. Horizontal mouth opening is also affected by dragging the net from two boats known as bull trawling or pair trawling. The main principle of trawling is the movement of the net underwater filtering the water through the mesh in the netting, without either permitting the fish to escape or gilling them. Trawl net is fabricated using polyethylene netting after cutting and shaping the panels as per the design.

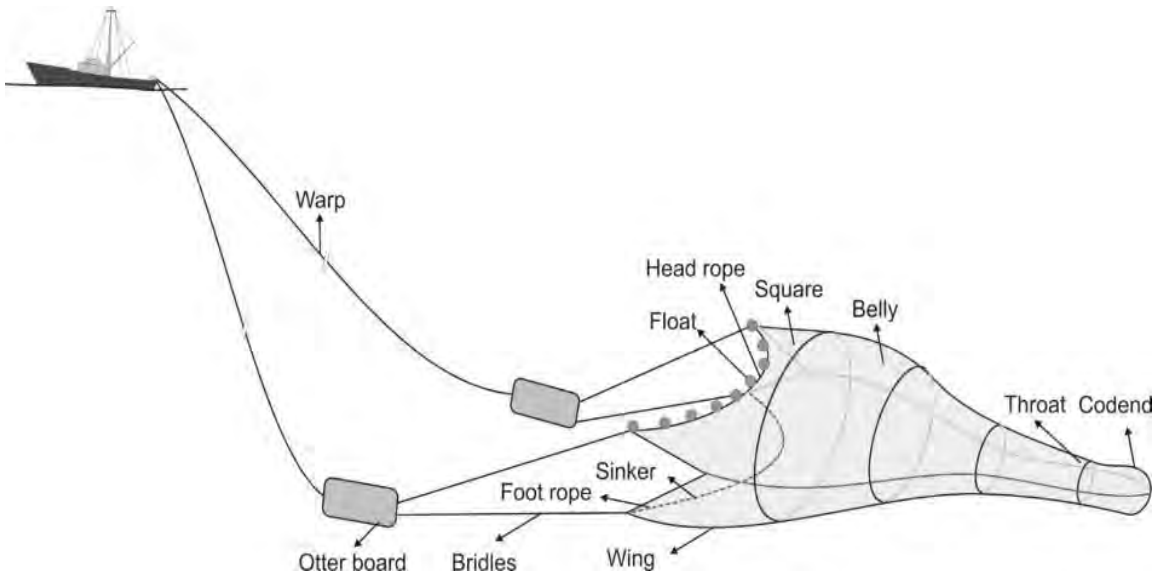


Fig.1. A demersal trawl in operation

In India, trawling was first attempted during exploratory surveys conducted from S.T. Premier off Bombay coast in 1902. Several designs of demersal trawls have been introduced in Indian fisheries in subsequent years.

The most important issue in this sector is the excess capacity in terms of number of trawlers. The size of the trawlers has also increased over the years. Since the introduction of Chinese engines in the Indian waters, the horsepower of the vessel has also increased tremendously and as a result of these changes, there is tough competition out at sea within and between the sectors, which is leading to overexploitation of the resources.

Classification of trawls

Trawls are classified based on the device used for mouth opening, number of panels used for fabrication, depth of operation and based on target species.

1. **Beam trawl**

Beam trawl was the forerunner of all trawl gears. In beam trawls, mouth of the net is kept open using a rigid and curved metal frame with a shoe at the bottom known as beam. This is the simplest method of bottom trawling practiced mainly in the North Sea for flatfish and shrimps. Since the shoe penetrates the seabed and the marks remain for a long period, beam trawling adversely affects the bottom ecosystem. Due to the plowing effect, resistance is high resulting in more fuel consumption than otter trawling. Moreover, a large net requires a large beam which is very difficult to safely handle onboard a fishing boat.

2. **Otter trawl**

In otter trawls, the most popular method of trawling, the mouth opening of the net is achieved by the attachment of two otter boards, through bridles, on each side of the net. The towing warps are attached to these boards at an angle so that while towing the water forces acting on them tends to diverge them resulting in the opening of the net mouth.

3. **Pair trawls**

In pair trawling or bull trawling the net is towed by two boats cruising on a pre-arranged parallel course and speed. The distance between the two boats is also maintained constant, so that the diverging warps keep the mouth of the net open. The main advantage of this method is that a much larger net can be used, as two boats are engaged. As the vessels are operated from a distance from each other scaring effect due to vessel noise is also minimal. Pair trawling is banned in many countries as it generates huge quantity of bycatch.

Trawl types based on number of panels:

Two-seam nets have only two major parts i.e., upper and lower panels and these two are seamed together laterally to form the two seams. The upper part invariably includes the overhang or square. The Cross-section of the net is elliptical in shape and since the vertical opening is comparatively less, these nets were mainly operated for shrimps. Presently all the trawls are two seem.

Four-seam nets are having upper, lower and two side panels with or without overhang. The Cross section of the net is rectangular in shape and hence the vertical opening of the trawl may be influenced by the width of the side panels.

Six seam nets have six panels and cross-section of the net generally acquires oval shape. The six and eight-seam nets are designed to have more vertical openings and hence suitable for catching fishes.

Design of trawls

The efficiency of a trawl mainly depends on the symmetry of the construction of the body and mouth configuration. A trawl is designed in such a way that (i) it offers minimum resistance during tow (ii) total drag matches the available towing force of the trawler, (iii) it achieves maximum mouth opening, and (iv) offers the least hindrance to the movement of fish within the net towards the codend. While designing new gear, different factors have to be taken into consideration such as strength and elasticity of webbing, resistance to the water flow, weight and bulk, speed of operation, cost of materials and conditions of fishing ground. A selective, environment-friendly and energy-efficient trawl system is generally the aim of the design process. Important design considerations in the design of trawl gear involve biological and behavioural characteristics of the target species; fishing conditions in the trawling ground where the system is to be used; and characteristics of the fishing vessel from which the gear is

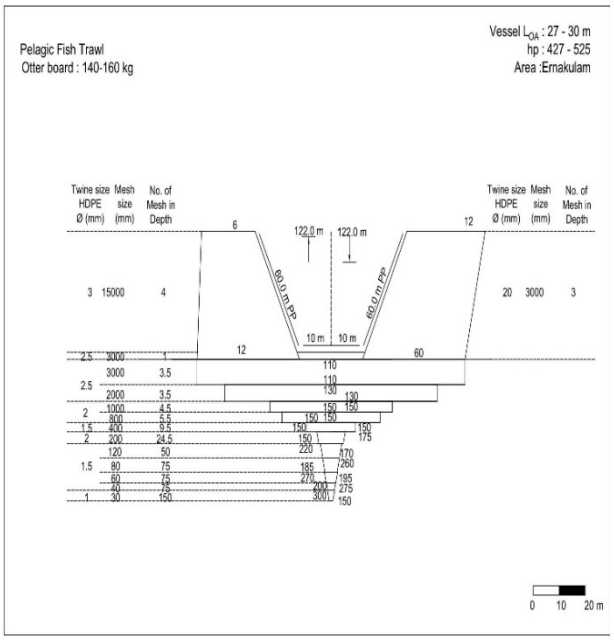
to be operated. The length of the trawl is measured along the last ridges (side lines) from wing (jib) end to tip of codend and it varies from 1.1 to 1.5 times the head rope length. The right size of a trawl for a particular vessel can be selected according to the total twine surface area or by comparison with a trawl of the same type used by a vessel in the same horsepower. Design drawing of the trawl net is prepared to provide all information relating to the size, shape, material and construction using recognized nomenclature and symbols, prior to the fabrication of the net.

Shrimp trawls

Shrimp trawls in the Cochin coast are smaller than fish and cephalopod trawls, with head rope lengths ranging from 50.0 to 53.50 meters and polypropylene is used as a rope material. A diameter of 14 mm for the head and foot ropes were used on the Cochin coast, HDPE twines with a diameter of 0.5 to 2.5 m are used for the fabrication of the net. The shrimp trawl mesh size ranged from 1000-1500 mm at the wing end to 18-25 mm at the codend (Table 1). The most common shrimp trawls cochin coast is poovalan vala, and karikkadi vala (Fig.12, Fig.13)

Cephalopod trawls

Cephalopod trawls have a head rope length of 106.0–114.0 m and are made of HDPE webbing with a diameter of 1.0–3.0 mm. The wing region has a mesh size of 4000-15000 mm, whereas the codend has a mesh size of 20-40 mm. The head rope and foot rope were made of Poly Propylene rope with a diameter of 14 to 16 mm. (Table 1). Trawl net designs used most commonly along the coast of Cochin coast is Kanava vala, a cephalopod trawl that targets cuttlefish is the most prevalent cephalopod trawl on the Cochin coast. (Fig.14, Fig.15, Fig.16)



A large mesh fish trawl design from Kochi

Trawling operation

Demersal trawls can be operated from a few meters to more than around 1000 meters in the sea. The demersal trawl is designed and rigged to have bottom contact during fishing and is, depending on the bottom substrate equipped with different kinds of ground rope rigging. This is for the purpose of shielding the lower leading margin of the trawl from ground damage

whilst maintaining ground contact and easy move on the bottom. The trawlers must have sufficient towing force for towing the gear and require a winch or mechanical hauling system. However, in some small-scale operations hauling is done manually. The methods adopted for demersal trawling are beam trawling, side trawling, stern trawling, double rig trawling, bull trawling and multi-rig trawling. Stern otter trawling is the most popular method in India.

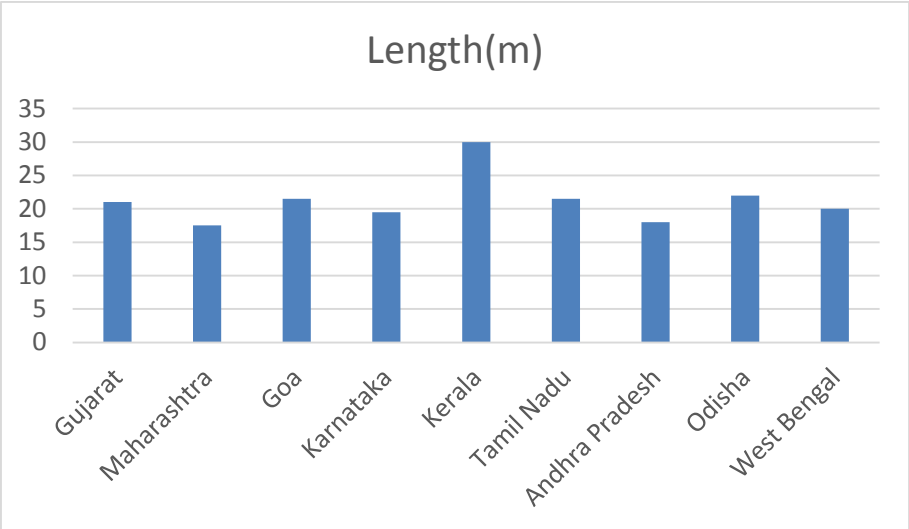
1. Beam trawling:

On arrival at the fishing ground, the beam trawls are hoisted on the booms which are then swung out. The operation is undertaken while the fishing vessel sails on a straight course. When hauling, the net is heaved in until it is at the boom tips. The cod end is taken by the line attached to the cod end strap and the catch is emptied out directly.

2. Otter trawling:

The Vigneron-Dahl system was introduced during 1920s where the otter boards were attached to the wings by means of sweep lines and bridles. This helped in increasing the effective swept area and thus increased the catch due to the herding effect of sweep lines and otter boards. In larger trawls, in addition to the weight on the foot rope, iron bobbins or rubber discs are attached depending upon the nature of the fishing ground. The towing warps are provided with markers at distinct intervals for facilitating the release warp, in small-scale operations. In large scale operations it is hydraulically or electrically controlled with metering arrangements. The length of warp released in bottom trawling depends on the depth of the fishing ground and nature of sea bottom. The ratio of depth of fishing ground and the warp released is known as scope ratio or in other words, it is the warp-length ratio. The length of warp to be released is generally (i) 5-6 times the depth in shallow waters below 50 m, (ii) 4-5 times the depth in off shore waters of 50-100 m, (iii) 3- 4 times the depth in deep waters of 100-200 m and (v) 2-3 times the depth in the deep sea of 200 m and more. The speed at which the trawl is towed over the bottom range from about 2 to 2.5 knots for slow swimming species to 3- 4½ knots for fast swimming fish. Towing a particular trawl too slowly may cause the otter boards to close together, providing insufficient spreading power to the net which tends to sag onto the bottom. Towing too fast may result in the net lifting off the bottom and floating which may lead to fouling of gear. Winches are used to pay out and haul the warps. The winches have two drums, one for each of the two warps; an additional drum is provided for the operation of the try net in shrimp trawling. In larger trawlers, single drum split winches are used for each of the warps. Hauling speeds could vary from 30 to 60 m.min-1. Stern ramps are provided in larger stern trawlers, which facilitate the shooting and hauling up of the large trawl gear with less manpower. In large trawlers net drums are used to haul up, pay out and store the sweeps, bridles and net with its rigging. The factors such as (i) availability of fish (by using echo-sounders, fishery charts and fishery forecasts), (ii) depth and nature of sea bottom of the fishing ground, (iii) current and wind speeds are to be taken into consideration before the commencement of fishing operation. On reaching the ground, the warps are attached to the net and the codend is closed properly. The codend is the first part to be released, followed by the main body of the net. The vessel steams forward slowly releasing the net and the otter boards. The winch is stopped after releasing few meters of the warp to ensure the proper spreading of the bridles and otter boards. The gear is then lowered to the desired fishing depth by releasing sufficient length of warp. The net is dragged for a duration of about 1 to 4 hours, depending on the concentration of catch. The net is hauled by heaving in the trawl warps evenly on to the

winch drums, until the otter boards reach the gallows. Sweeps and bridles are then hauled up followed by the main body of the net and finally the codend. In small trawlers, the sweeps and the net are shot and hauled in manually and sweeps may remain connected to the otter boards. In large trawlers, a Kelley‘s eye, independent wire and back-strop is used for facilitating the hauling of the sweep lines and net on to the net drum after the otter boards have reached the gallows.



Length of trawlers in different states of India

Conservation Strategies

Large mesh trawls: In these trawls, the front trawl sections are made using large mesh panels which results in a reduction of trawl resistance. The reduced drag permits greater trawling speed and operation of a large trawl with the available installed engine power. Trawls with a mesh size up to 5 m is now under operation in Kerala. Such a trawl uses only 3 large floats for lifting the headline.

Rope trawl: In rope trawl, the front trawl sections are replaced by ropes, which as in the case of large mesh demersal trawl, results in a reduction of trawl resistance with the same advantages as in large mesh trawls. Finfishes are retained due to the herding effect of the ropes.

High opening trawls: High opening demersal trawls are designed to harvest off-bottom fishes, which are beyond the reach of conventional demersal trawls, along with bottom resources. It has been reported that the large mesh high opening trawls offer 18% lesser resistance compared to conventional bottom trawls which in turn results in utilization of lesser horsepower.

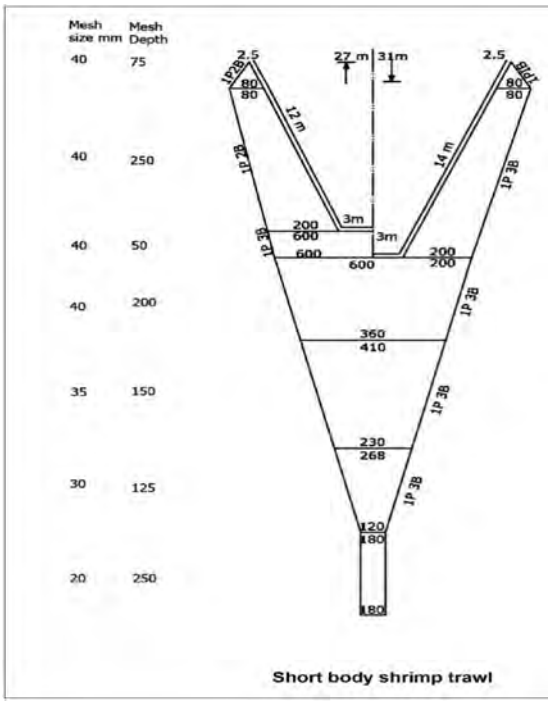
High-Speed Demersal Trawls: Commercial exploitation of active fishes with low population density fishery resources requires high-speed trawling. High-speed demersal trawls (HSDTs) have been developed with light material, large meshes, smooth tapering along the belly facilitating even distribution of stress along the framing and strengthening ropes facilitating smooth filtration and herding.

Bulged belly trawl: In the bulged belly design, wide side panels are provided to increase the vertical opening, and at the same time tapering of the belly is streamlined so as to improve herding and filtration efficiency. The improved bulged belly trawl fitted with tapering jibs consistently landed better shrimp catches. Technological Strategies Increasing awareness on responsible fishing methods has resulted in studies to improve the selectivity of the trawls. Size

selectivity in bottom trawls can be achieved by controlling the mesh size and shape. Species selectivity can be achieved using separator panels and grids by making use of the behavioural differences in species in the fishing area.

Separator trawls: It is designed to separate shrimp from fishes based on the difference in their swimming behaviour. Insertion of a horizontal panel in the separator trawl, separates the fish and shrimp catch, leading them to separate codends. The selection process of this device is based on the fact that shrimps which are usually distributed close to the bottom move to the lower codend while the high swimming species usually end up in the upper codend. Separator trawls reduce the sorting time, as the catch is landed in a pre-sorted condition.

Short body shrimp trawl: CIFT has developed and successfully field tested a 27 m shrimp trawl with a relatively short body and large horizontal spread suitable for selective retention of shrimp. The width and length of the trawl funnel have been reduced by increasing the tapering ratio and the vertical opening of the mouth has been reduced to eliminate bycatch. Because of the larger horizontal spread of the mouth, the effective sweep area is more, which is the most vital requirement for a shrimp trawl. Trials carried out along the coastal waters off Cochin with a prototype of short body shrimp trawl reveal considerable reduction in the catch fish due to the behavioral difference of the targeted species.



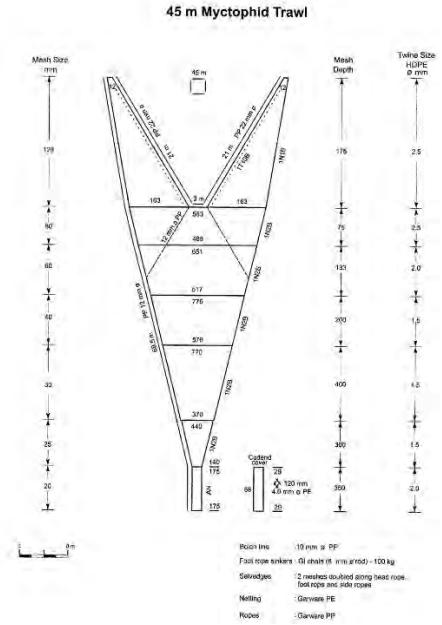
Short body shrimp trawl

Cut-away top belly shrimp trawl: A shrimp trawl without a top belly has been developed and field tested at CIFT. Results reveal that considerable reduction in the quantity of bycatch landed. The net was able to cover more area within the stipulated speed and time due to reduced drag.

Semi-pelagic trawls: 27m four panel CIFT-SPTS in combination with high aspect ratio Suberkrub otter boards weighing 85kg each with front weights are designed to catch fishes, which are up to 4 m above the ground, with minimum impact to the sea bottom.

Krill trawl: Krill (*Euphausia superba*) is a small crustacean found in the Antarctic waters of the Southern Ocean. Large trawls with small mesh inner lining is operated in Antarctic waters for krill fishing.

Mesopelagic trawls: Mesopelagics are small fishes in the size range of 3 to 30 cm inhabiting the disphotic oxygen minimum zone in world oceans in the depth range of 200 to 1000 m. Large trawls are used in Oman and South Africa for commercially harvesting mesopelagic mainly for making fishmeal and fish oil.



Mesopelagic trawl

Environmental impact of bottom trawling

Bottom otter trawls interact physically with the bottom sediment, which might result in the removal or damage of sedentary living organisms (including seaweed or coral) and in the case of uneven bottom surface displacement of stones or other larger objects. On flat sandy/muddy bottom, the sediments might be whirled up into the water masses and suspended. The short and long-term impact on the bottom environment is still poorly documented. The major negative impact of bottom trawling is the capture and discarding of huge quantity of juveniles of fishes and other aquatic organisms.

Conclusion

Trawls are non-selective fishing gears creating ploughing effect on the sea bottom leading to the destruction of the benthic ecosystem. In trawl design and improvement, the aim should be to produce a trawl system which can selectively and efficiently catch the target fish, eliminating juveniles and other aquatic organisms with minimum environmental impacts. Since trawling is an energy-intensive fishing method, development of low drag trawl systems to save energy and cost of operation is imperative. Resource-specific trawls like semi-pelagic trawls should be popularized to minimize the impact on ecosystem. Excess capacity in terms of a number of trawlers, size, engine power and trawl efficiency are major issues that need to be addressed to make trawling economical and sustainable.

Further reading

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