Recent Developments in Gillnet Fishing

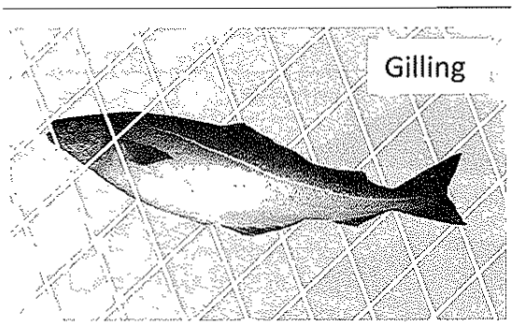
Sandhya K. M*. and Saly N. Thomas
Fishing Technology Division
ICAR- Central Institute of Fisheries Technology, Cochin
*sandhyafrm@gmail.com

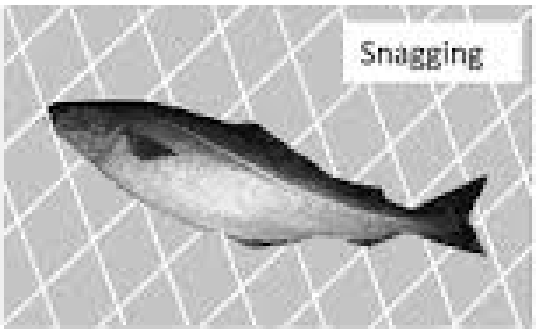
Introduction

Gillnets, an efficient, selective type of passive fishing gear operated world wide both in inland and coastal waterbodies. Simplicity in design, construction, operation and low operating costs, the ability to operate from different vessel types make it a favourite choice among artisanal fishers . The gear is a vertical wall of netting, which is kept erect in water by means of floats and sinkers. Among the various fishing methods, it consumes between 0.15 and 0.25 kg fuels compared to trawl (0.8kg fuel/kg) to catch 1 kg of fish (Brandt, 1984, Gulbrandson, 1986). Gillnet is a highly selective gear compared to other gears. It can be operated in the surface, column or bottom layers of the water column in inland, coastal and deep seas. Gillnets of varying mesh sizes, target a variety of fishes such as sardine, mackerel, anchovies, tuna, shark, seer fish, prawns, lobsters etc. Gillnet operations contribute to more than 15% of total landings of India (Sathianandan, 2013). Currently in India, gillnets provide livelihoods for an estimated 0.86 million people in fisheries, and contribute significantly to fish catches, income and food security, as well as the local and national economy (Thomas *et al*., 2020)

Mechanism of capture in gillnets

Gilling is the basic mechanism of fish capture in gillnet where in the mesh size is selected in such a way that the fish can only partly penetrate the mesh and on sensing the obstruction it tries to pull back (Pinngue He, 2010). In its struggle to free itself the twine slips back over the gill cover and prevents the fish from escaping. Thus, the fish is gilled and hence called ‘gillnet’. Fishes are also caught in gillnets by (1) snagging, when the fish is held tight by the twine of the mesh around its head, (2) wedging, when the fish is held tight around its body, and (3) entangling when the fish is held in the net by the teeth, opercular spines or other protruding appendages of the body without actually entering the mesh (Fig 1.).





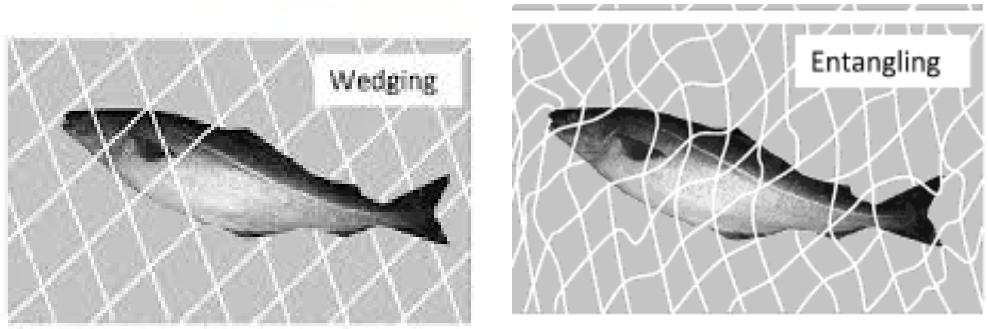


Fig 1: Mechanism of capture in gillnets (Source**:** Pingguo He. 2010.)

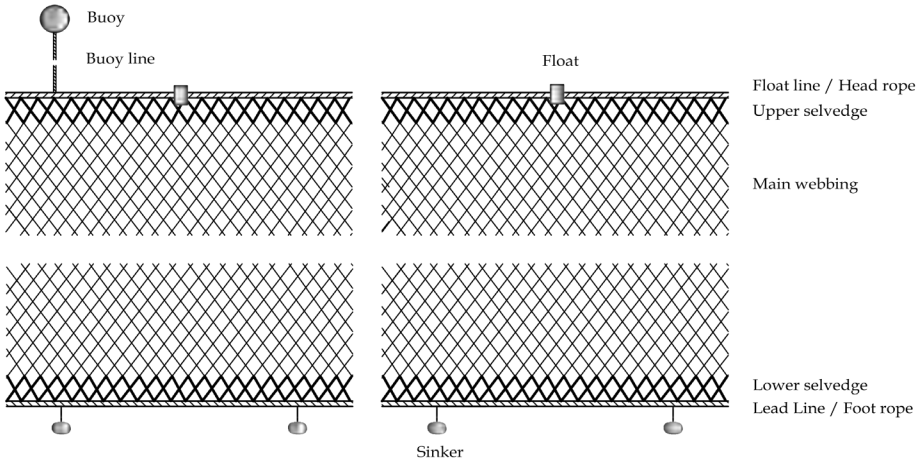
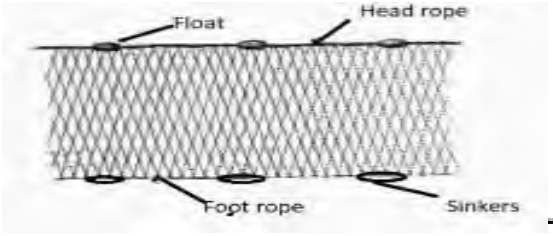


Fig 2: Typical design of gillnet (Source: Thomas., 2010)

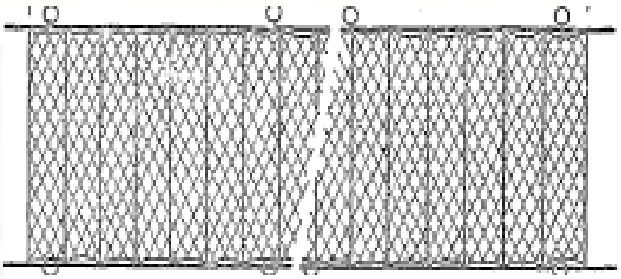
A typical simple gillnet consists of a main netting panel of specific dimensions, twine size and mesh size, selvedge (top and bottom), float line, lead line, gavel line/ side ropes, floats, sinkers, buoys and buoy lines depending on the target fishery (Fig.2). Selvedge, generally of thicker material than the main netting is provided along the edges to give protection to the main webbing during handling and operation. Floats are attached either directly to the head rope or to a separate float line, which runs along with the head rope. Sinkers are also attached likewise, either to the footrope or to a separate sinker line. Buoys attached through buoy lines to the head rope are for adjusting the floatation of the mounted net. The required numbers of units are tied end to end depending on the size of the target species and area of operation.

Types of gillnets

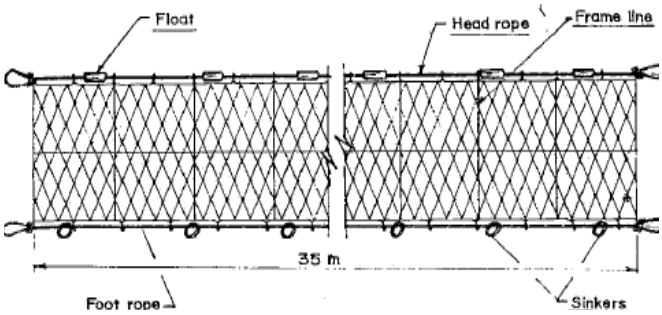
Gill nets can be classified into different groups depending upon the type of construction, area of operation, fish targeted and method of operation. Based on construction there are single walled and multiple walled gillnets. Simple gill nets , vertical line gill nets and frame nets are single walled nets (Fig 3) while trammel nets (double or triple walled) come under the multi walled nets. The vertical line nets are simple gill nets, which are divided into different sections by passing vertical lines from the head rope to the foot rope through the meshes of the webbing. Frame nets are single walled nets whose slackness is increased by attaching vertical and horizontal lines between the main lines dividing the main webbing to compartments of 1 to 1.5 sq.m.



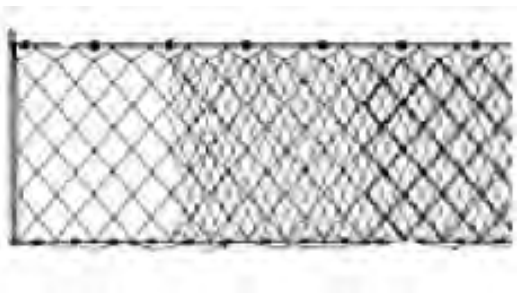
Simple gillnets



Vertical line gill nets



Framed gillnets



Trammel net

Figure 3: Types of gillnets based on construction (Source: Kuriyan. 1971**)**

Trammel nets are triple walled nets having a loosely hung center wall of small mesh netting which is bordered on each side by tightly hung walls of large open meshes. Fish swimming through the outer meshes encounter the center netting and push their way through the opposite outer meshes. Fish become trapped in the resulting pockets that are formed (Fig 4). The outer meshes on one side of the net must be a mirror image of the outer meshes on the opposite side. Semi trammel nets are same as that of trammel nets except that only one layer of outer webbing is present instead of two.

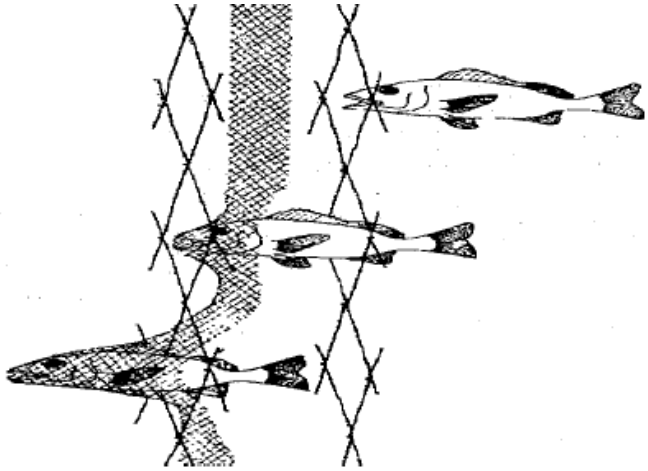
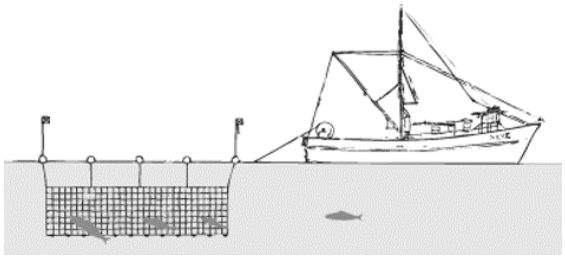


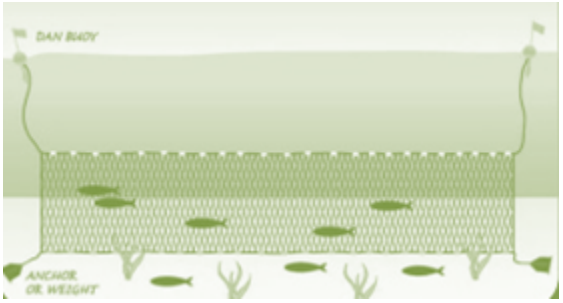
Figure 4 : Method of capture in trammel net (Source: Thomas., 2010)

Depending on the method of operation there are 1) drift gill nets Drifting freely according to wind force or current and kept more or less vertically by floats on the headrope and sinkers on the foot rope. They may be attached at one end to the boat which is fishing them, or they may be left to drift free of the boat 2) Set gill nets which are set in water either surface subsurface or bottom and anchored or stalked to sea bed by means of anchors or stakes

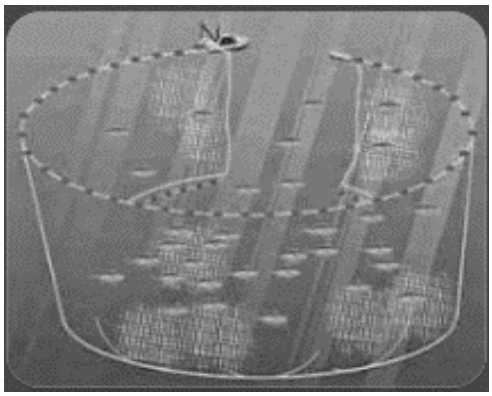
to prevent them from moving with water 3) Encircling gillnets where the fishes are surrounded and driven from the centre by noise and other means (Fig 5).



Drift gillnet



Set gillnet



Encircling gillnets

Figure 5: Types of gillnets based on operation

Based on area of operation, which is dependent on the depth of water column at which they are operated gillnets are classified as surface, column and bottom gillnets. Based on target species nets are also classified viz; nets for anchovy, lesser sardine, sardine, mackerel, prawn, mullet, crab, lobster, pomfret, hilsa, ghol, seer, tuna, shark, catfish, perch, snapper, rock cod etc.

Design aspects

The design of a gillnet depends on target species, its characteristic body shape, behaviour and swimming layer. The main parameters to be considered while designing a gillnet are: (i) size of mesh in relation to the size of the targeted fish, (ii) diameter of the twine in relation to mesh size, (iii) hanging coefficient (looseness of the net, (iv) visibility of the net, (v) softness of the material and the (vi) buoyancy and ballast given. The mesh size is the most critical factor as it selects the fish by body size or shape. Gillnet is the only gear in which the mesh itself serves the dual function of catching fish and selecting the fish to be caught. The mesh size, the material the net is made of, its thickness and colour and the hanging ratio of the nets perform these two functions. Any fish which is too small for the mesh size will be able to slip through the net and escape, while any fish that is too large on the other hand will not pass through and be able to escape the way it came (Thomas, 2010).

Recent Developments in gillnet fishing

Introduction of synthetic fibres

Introduction of man-made synthetic fibres in the late 1950s replaced the natural fibres used for the fishing gears mainly due to their highly positive properties such as highly non-biodegradable nature, high breaking strength, better uniformity in characteristics, high abrasion

resistance, low maintenance cost and long service life. Earlier, nettings used to be fabricated manually, which is laborious and time consuming while the introduction of synthetic fibres paved way for machine made nettings which revolutionized the fishing industry. Introduction of nylon monofilament material in early 1990s was a remarkable technological intervention adopted instantly by fishers. By late 1990s it became very popular and by early 2000 it almost replaced all gillnet types except large mesh nets targeting large pelagics. Monofilament nets last hardly for a season (2 – 6 months) and unless properly discarded, these nets will end up in ocean adding to plastic pollution, ALDFG and ghost fishing (Thomas, 2019).

Motorization and Mechanization

Introduction of out-board motors (OBMs) and mechanisation of propulsion in fishing vessels revolutionized the Indian gillnet fishing industry. The increase in vessel size, engine power, volume of net deployed per operation, fishing time and soaking time all of which collectively increased the total fishing effort. Over the past 6 to 7 decades, there has been a substantial increase in the fishing effort by all the three gillnet categories viz., non-motorized, motorized and mechanized sub-sectors. In India, the length and depth of gill net increased from 150x3 m in 1950s to 18000x20 m at present. Currently, the mechanized gillnetters categorized as small (<12.0 m L OA) medium (12.1-16 m L OA) and large (16.1 -24.6 m L OA) with 60, 120 and 193 hp engines respectively, are deploying large net fleets of 5 to 16 km long and 8 - 20 m deep (weighing upto 3 tonnes). In the non-motorized sector; and motorized sub- sectors also, there was corresponding increase in net volume (Thomas, 2019). However, intensification of fishing capacity through use of very large volume of nets extending to 100s of kilometres gave more chances of non-target organisms including cetaceans and turtles getting entangled in the nets during fishing as well as through ghost fishing by lost nets.

Optimum mesh size

Gillnets were considered as resource specific, eco-friendly having very low environmental impacts as the sea bed interaction is bare minimum in most circumstances. Besides, being a highly selective gear catching a narrow size range of fishes, it was considered as a very responsible fishing gear till two to three decades before. However, these attributes given to gillnets started losing by early 1990s due various issues associated with gillnets such as incidental catch of juveniles and non-target species due to loosely hung drift gillnets and use of multi-mesh and non-optimum mesh sizes. Many coastal states of India have come out with minimum mesh size regulation for gillnet fishery under the Marine Fishing Regulation Acts while Kerala has enacted it for seven gillnet types.

Maximum allowable dimensions of gillnet

The deployment of long nets and extensive use of monofilament gillnets by Indian fishers, pause high risks of gear loss and consequent ghost fishing in Indian waters. Monofilament nets last hardly for a season (2 – 6 months) and unlike nylon multifilament, it is difficult to mend monofilament netting. Once these nets or their parts are either abandoned, lost, or otherwise discarded (ALDFG) into the marine environment causes considerable threat to marine species and also add to marine plastic pollution. The uncontrolled increase in volume of gillnet, demands restriction as it may give more chances of entanglement and ghost fishing also. Though mesh size regulation is enacted by many maritime states, maximum allowable dimension (length and hung depth) of gillnets is not specified by any of the states. Kerala, for

the first time in the country, amended the KMFRA Act and Rules in 2018, and brought out regulations on the dimensions of the gear for gillnets targeted for seven important commercial fishes. The maximum dimensions prescribed for small mesh gillnets are 2000 m length x 10 m hung depth and for large mesh gillnets are 5000 m length x 18 m hung depth (Thomas, 2019).

Minimum legal sizes of fishes

For the first time in the country, Kerala state has prescribed minimum legal size for 58 species of fish and shellfish to be landed. By following optimum mesh size, minimum size of fish to be landed by gillnets can be decided. Gillnets being highly size selective, strict adherence to optimum mesh size for specific fishery would help in reducing juvenile by catch.

Biodegradable netting

As synthetic fibres are non- biodegradable, the environmental threats it causes due to ghost fishing is an important problem. Entanglement and subsequent mortality of non-target and endangered species due to derelict and lost gillnets can be lessened using easily degrading materials (e.g., thinner net twine diameter and weaker material) which reduces the floatation capacity of lost gillnet, which in turn decreases the vertical profile of nets and allow larger organisms to break free of the gear and escape (Gilman *et al*., 2010). Carr *et al*. (1992) tested degradable plastic plates for attaching floats to the headrope of gillnet. Biodegradable gillnets made of polybutylene succinate (PBS) resin blended with polybutylene adipate-co-tere-phthalate (PBAT) resin have been widely studied (Bae *et al*., 2012).

Measures to reduce interactions/entanglement of marine mammals and turtles in gillnets

Marine mammal/turtle entanglements in gillnets are a widely reported problem worldwide. Chances of entanglement are more in surface drift nets. Acoustic pingers and alarms are used to reduce marine mammal bycatch in gillnets and other fishing gears (Koschinski *et al*., 2006). Technical modifications in gillnets such as acoustically reflective nets or incorporating reflective components such as barium sulphate or metal compounds into the nets can help cetaceans to detect gillnet and avoid becoming entangled (Larsen *et al*., 2007). Attachment of visual mitigation measures like shark shaped silhouettes and light sticks and light emitting diode lamps in gillnets have shown reduction in number of turtles caught (Wang *et al*., 2013). Making the nets more visible especially the upper portion by using thicker twine, attaching corks, colouring the net etc. will help to reduce turtle interactions. Other technical measures include increasing net hanging ratio, using buoyless floatlines and/or reducing the number of floats (Gilman, 2010).

Conclusion

Gillnets have great scope in sustainable harvesting of resources, being a highly size selective gear. Enforcement of regulations by proper monitoring and surveillance is necessary for the continued harvesting of resources in a sustainable way. If proper care is taken to responsibly design and operate, gillnetting can continue to be a very sustainable fishing method.

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