Overview of gillnet operation, bycatch issues and mitigation measures

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Gillnetting

Gillnet, remains as the most popular fishing gear in the small-scale fishing sector due to its simplicity in design, construction, operation and low investment. It is a highly size selective gear and causes relatively less harm to the biota and to the environment. It is a highly energy efficiency gear (low energy gear) compared to active gears such as trawls.

Gillnet basically is a vertical wall of netting (length and height varying from 30m x 0.5m to >100 km x 50 m), rectangular in shape, kept erect in water by means of floats and sinkers. Large number of units placed in line ('fleets' of nets) are deployed in water for a certain period (soaking time) and later hauled. The net basically consists of a main netting panel (mostly made of polyamide/nylon monofilament or multifilament) of specific twine size and mesh size; selvedge, float line, lead line, floats, sinkers, buoys and buoy lines. Nets are operated as drift nets (drifting freely with one end attached to a vessel), set nets (anchored or staked to sea bed) and encircling nets (the fishes are surrounded). Once deployed in water, drift nets are generally soaked for 30 min to 6 h and set gillnets for 12 to 24 h.

Catching process

In gill net, fish is caught in one of the meshes of the net, normally by the gill region. The mesh size is selected in such a way that the fish can only partly penetrate the mesh and when it tries to pass through the mesh further forward, senses an obstruction and tries to pull back. 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’. There are other methods of capture like wedging, when the fish is held tight by the twine of the mesh around its body; snagging, when the fish is held tight around the head; and 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.

Design & operational parameters

The main parameters considered for designing a gillnet are: size of mesh in relation to the size of the targeted fish, diameter of the twine in relation to mesh size, hanging coefficient (looseness of the net), visibility of the net, softness of the material, buoyancy and ballast (weight) given. Netting is rigged to head rope with 0.4-0.7 hanging coefficient, generally around 0.5 which determines the looseness of the netting and thereby the shape and opening of the mesh.

Operational parameters: Nets, particularly those operated in shallow or moderate depth and nets which are not too large in size are operated manually while large nets operated in deeper waters are operated using powered net haulers. Large mechanized vessels carrying out gillnet cum longlining are very common and they are equipped with net haulers for handling the net.

Gillnets are either set on stern and hauled over side or are set and hauled over stern. Non-motorized and motorized vessels undertake single day trips while mechanized vessels operating large sized nets targeting large pelagics carry out multiday fishing ranging from a week to more than a month.

Gillnets were considered as resource specific, eco-friendly and responsible fishing gears without imparting any damage to the ecosystem. Of late, unscrupulous expansion of the gear, use of very small mesh sizes and very thin monofilament material are making gillnets a threat to the ecosystem. This selective gear too lands sizeable bycatch including endangered species. This necessitates monitoring and intervention in the design and operation of gillnets

Bycatch issues in gillnets

Bycatch occurs virtually in all fisheries. Bycatch is the unintended catch of species other than the target species, or individuals of the target species that are of undesirable size. Long-lived marine megafauna including turtles, birds, mammals, and sharks are highly susceptible to fisheries bycatch as they reside across geopolitical boundaries and oceanographic regions.

Wide spread use of large-scale gillnets, especially drift gillnets resulted in `gillnet bycatch'. Gillnet selectivity is influenced by the looseness of the net. Drift gillnets which are loosely hung (Hang. Coeff. < 0.5) and that too without head rope when drift with wind and current, tend to gill, entangle and enmesh a wide range of organisms including endangered species. Gillnet bycatch include non-target organisms such as marine turtles, marine mammals, sea birds, sharks & rays, juveniles of target species etc. Lost gillnets can also be highly disadvantageous to these organisms due to ghost fishing.

Incidental catch of marine turtles

Marine turtle interactions with fishing gears have been reported across the world since 1970s and have become an area of critical importance. Turtle interaction and capture occurs both in active and lost gillnets. Aabandoned and lost pieces of net drifting in water interfere with their feeding and nesting areas. Turtles entangling with nets often die due to drowning as entangled turtles cannot easily come to the surface for breathing.

In India too, incidental capture in gill nets and trawls has become a serious threat to sea turtle populations. Due to an increase in the number of fishing units, and size of gear, incidental bycatch has increased in recent years to the extent that it is the most significant cause of sea turtle mortality in Indian waters. In India, 76.5% of the incidental turtle capture occurs in gillnets. It is more pronounced in the east coast: Orissa, Tamil Nadu & Andhra Pradesh.

India is a signatory to the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and a party to the 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS). In September 1977, all the five species of marine turtles found in Indian waters are protected under the Indian Wildlife Protection Act 1972 which provides total legal protection to turtles from being hunted or traded. As a consequence of the implementation of regulatory measures, the threat from targeted capture and trade decreased

while incidental capture of sea turtles in gear operated for other species of fish and shellfish has become more significant over the years.

Marine mammal bycatch

Mammals get entangled in active as well as lost gillnets, especially in invisible monofilament gillnets. As early as in 1994, there were reports on fishing gear and cetacean interaction. Dolphins, whales and other cetaceans used to get entangled in fishing nets especially tuna gillnets. Cetaceans mostly get entangled in gillnets when they deprade on the catch. It is estimated that 84% of global cetacean bycatch was due to gillnetting.

From Indian waters, 26 species of cetaceans have been recorded which are protected under the Indian wildlife protection act, 1972. The incidence of cetacean bycatch in tuna and seer fish gillnet fishing has been recognized since 1980s in India. Around 98% of mammal mortality is due to entanglement in gillnets.

Seabird bycatch

Gillnets have been the cause of some of the highest recorded mortalities of seabirds. Incidental catch of sea birds in drift gillnets has been widely reported from certain regions of the world viz., from Pacific, Atlantic oceans and Baltic Sea while there are no records from Indian ocean.Seabird bycatch is generally poorly documented from different regions.The introduction of monofilament netting has increased seabird bycatch rates as a result of reduced net visibility. There are no reports from India on sea bird bycatch in marine gillnets.

Juvenile catch

Though gillnet shows high size selectivity, species selectivity is rather poor. In tropical seas where multispecies fishery exists, juveniles of target and non-target species are often caught when multi-mesh gillnets are operated. In India, majority of the species caught in gillnets with 30- and 32-mm mesh size comprise of juveniles.

Shark bycatch

Coastal and deep water gillnets cause negative impacts on several species including sharks. When these nets are lost or abandoned they lead to “ghost fishing” and sharks especially sawfish species are caught.

Indian sharks are classified under IUCN categories with24% of the species in Indian waters as “Near Threatened”, 26% - “vulnerable” and 3% critically endangered”. Targeted gillnet fishing for sharks and rays exists in some areas. Large mesh bottom set gillnets -Thiranivalai or Thirukkuvalai targeting rays are operated in Kanyakumari coast of Tamil Nadu.

Coastal gill nets are still used in huge numbers in most parts of the world and are responsible for massive bycatch mortality of sharks and rays.

Reasons for gillnet bycatch

- Increased fishing effort: Due to change of material and due to mechanization/motorization there was a tremendous increase in the quantity of net

deployed per operation. In the last 5-6 decades, in India, gillnets of length 180-300 m in 1960s, increased to 2 – 16 kilometres.

- Use of loosely hung drift nets: Using nets rigged with low hanging coefficient (<0.4) increased the chances of entangling non-target organisms.
- Widespread use of nylon monofilament gillnets: Use of gillnets of very thin nylon monofilament yarn viz., diameter of 0.12 to 0.20 mm lasts only for 3-4 months increased the chances of gear loss. These nets easily break and are almost invisible in water due to which entangling with non-target organisms is on a very high side.
- Use of multi-mesh and non-optimum mesh size: Selectivity is affected when multi-meshed gillnet units are operated as a single fleet of net. In tropical seas, due to multi species nature of the fishery, different size groups of species including juveniles are caught in multi-mesh gillnets.

Mitigation measures

Unlike trawl fisheries, gillnet bycatch issue received global attention rather late and hence less progress has been made on control measures. Mitigation measures include management measures and gear &operation-based technical measures.

Management measures:

- Implementation of fishing gear regulation (to control fishing capacity), mesh size regulation and minimum legal size would enable reduction in bycatch and sustainable operation of gillnets.
- Implementing minimum legal size of fish - For the first time in India, Kerala state has prescribed minimum legal size for 58 species of fish and shellfish to be landed.

Technical measures

1. **Turtle bycatch control:**
   - Spatial and/or temporal restriction as turtles show preference to specified areas and seasons for nesting. Seasonal and area wise ‘no fishing zones. Ex; banning of gillnets within 5 km of the 3 mass nesting beaches of Olive Ridley turtle in Orissa, India for 3 months
   - Reduction in gillnet profile (vertical height) causes reduction in amount of webbing in demersal gillnets which in turn reduces or eliminates the bag of slack webbing and decreases the chances of sea turtle entanglement.
   - Combined effect of stiffer and shorter net reduces chances of turtle entanglement
   - 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
   - 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.
   - Increasing net hanging ratio, using buoylessfloatlines and/or reducing the number of floats

- Use of easily degrading materials (e.g. thinner 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.
- Survival rate of entangled turtles can be improved by facilitating their reach to the surface to breathe during net immersion by setting the net in shallow waters, reducing the soaking time and frequent patrolling of nets deployed.

2. Mammal bycatch control

- Reducing the number and capacity of vessels and volume of net (length x height)
- Use of *acoustic pingers* and alarms causes cetaceans to avoid the sound source. It can reduce bycatch of marine mammals by 70-90%.
- Subsurface deployment of nets reduces the chances of cetacean bycatch in gillnets.
- Incorporating weak ropes and weak gillnet webbing made of biodegradable natural material help entangled mammals to escape, thereby reducing mortality and serious injury.
- *Acoustically reflective nets*- Incorporating reflective components such as barium sulphate or metal compounds into the nets. These materials causes increase in acoustic reflectivity, net's visibility or twine stiffness.
- *Tie-downs* in bottom-set, midwater or driftnet gillnet fisheries by reducing the profile of the gillnet and by giving a vertically curved shape to the net reduce the bycatch of small cetaceans. These are lines that are shorter than the height of the fishing net, with terminal ends attached to the float line and lead line along the net, at equal horizontal distances.
- Increasing the visibility & stiffness of the net by using thicker yarns, colouring the net etc
- Using alternate panels of small mesh is helpful in alerting the dolphins about the presence of gillnets as dolphins are able to detect small mesh than large mesh webbing.

3. Seabird bycatch

Very little research has been carried out to explore technical means of reducing avian bycatch in gillnets. Few suggested options are:

- Spatiotemporal closures such as seasonal closure of gillnet fishery during the arrival of migratory birds.
- For diving sea birds: ensuring a minimum fishing depth and minimum distance from the coast.
- For surface feeding birds: using scaring lines, avoiding release of wastewater from the vessel during fishing operation
- Visual alerts: increased visibility of the upper net panel reduces seabird bycatch though it affects the catch efficiency of the net too.
- Attending deployed nets frequently during fishing, and safely removing and releasing caught birds alive.
- Illuminating fishing nets with green light emitting diodes (LEDs) –particularly useful as it is suitable for multiple taxa (seabirds and sea turtles)
- Regulating the depths at which gillnetting occurs could substantially reduce bird mortalities as seabird bycatch occurs in depths of less than 20 m and hence with increasing water depth this can be reduced.

4. Preventing juvenile catch by

- Seasonal use of resource specific gillnets using optimum mesh size can limit juvenile catch to a great extent.
- Mesh sizes below 32 mm should not be used on a regular basis.
- As the successful spawning period of most of the fishes is during May to July, fishing during this period has to be regulated
- The use of mesh sizes in succession as per the availability of the resource render gill netting a more ecofriendly fishing method for the inshore waters.
- Fishermen may be made aware of the importance of meeting MLS during gillnetting and the need for sustainability of the resource.

5. Control of shark bycatch

- By adopting mesh size regulations, reducing soaking time of net and by making nets stiffer- (shark bounce off the netting) shark bycatch can be reduced.

Other operational issues

Apart from bycatch, large scale operation of gillnets, use of synthetic netting and widespread use of monofilament gillnets lead to a relatively new problem of gear loss and consequent ghost fishing.

ALDFG: Abandoned, lost or otherwise discarded fishing gear (ALDFG) is the internationally recognized name for abandoned, lost or otherwise discarded fishing gear, derelict fishing gear. ALDFG drifts and entangle with animals including endangered species (ghost fishing) leading to their mortality. Fishing gear loss became an issue due to the shift from natural gear materials to synthetics. Gillnets are more prone to become ALDFG and to ghost fish than many other gears. Increased volume of gear deployed and widespread use of monofilament nets aggravate the chances of gear loss in gillnet fishing sector.

ALDFG in India: The first study on ALDFG relating to gillnets and trammels nets in Indian waters by ICAR-CIFT in 2017 covering 4 states and 583 fishing vessels indicated that around 25% of the total gear used per gillnet vessel is lost per year. So, the chances of ghost fishing of marine mammals, turtles, sharks etc due to lost gillnets are very high in India. Gear loss can be prevented by:

- Fishing gear marking for authenticity and trace back purposes.
- Providing offshore collection facilities for damaged gear
- Discouraging use of damaged or old gear
- Reduction of gear volume
- Reduction in soaking time of gear
- Procedures for reporting of lost fishing gears
- Plastic free gear (Use of biodegradable and less durable gear)

Conclusion

Gillnet dimensions are increasing continuously in terms of length and height. Even in India, gillnet sector has showed a significant growth in terms of the size of the fishing unit. Gear exclusively operated manually till one decade ago, is switching over to mechanized means. Increased gear size, widespread use of monofilament yarn etc were instrumental in occurrence

of gillnet bycatch. There is a lack of information in India on the severity of gillnet bycatch problem. Regular monitoring and documentation are essential for controlling gillnet bycatch specially mammal and turtle bycatch in the Indian gillnet fishery. A strong database generated from continuous monitoring and evaluation of incidental mortality is necessary for the adoption of spatial and temporal restrictions. Once vulnerable areas and seasons are identified, it should be possible to evolve and adopt suitable measures with the active participation of fisher folk. Fishermen may be made aware of the need for sustainable operation of the gear. If proper care is taken to responsibly design and operate, gillnetting is a very sustainable fishing method. Precautionary measures along with effective regulatory mechanisms could ensure judicious exploitation of the resources using this fishing system.