Basic Principles in Fishing Gear Designs and Fish Capture

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Many factors enter into the choice of the fishing method and gear used to catch particular species of fish in a particular area. Principally the choice will depend on:

1. The species being fished.
2. Individual value of the species.
3. The depth of water.
4. The characteristics of the seabed.

Species being fished: The various species of commercially important fishes have different habitates, movements and reactions to stimuli. For example shellfish, such as prawns, lobsters, crabs etc. are found living on or in the sea bed. Some species of fish such as sciaenids, perches, groupers, skates, rays and flat fishes are often found near the sea bed or will be lying on the bottom. These are demersal fishes or ground fishes, which are usually caught by fishing gear operating on the sea bed like the bottom trawls/ demersal trawls.

Pelagic species, such as sardine, mackerel, anchovy, tuna etc. may be found anywhere between the sea bed and the surface. These fishes are normally taken by fishing gear that are not in contact with the bottom like drift gillnets, pelagic and mid-water trawls, purse seines and other seinenets, lines etc. Some fish, such as sardine and mackerel congregate in dense schools and are caught by fishing gear such as seines, ring seines and pelagic trawls.

Individual value of fish

The fishing gear used must also take into account the use and value of the individual fish caught. For instance, both seer and tuna can be caught by trolling. This is a viable means in the case of large seer and tuna of high individual value, but would be uneconomical gear to catch for bulk processing methods. Depending on the way in which it is marketed and processed a certain type of fish may have a high, medium or low individual value. Example of high individual value are seer, pomfret, hilsa, tuna, prawns, lobsters etc. and of medium value are elasmobranches, catfishes, large sciaenids etc. and of low individual value are sardine, mackerel, bombay duck, anchovy, small sciaenids etc.

Depth of water

Depths of water exert considerable influence on the choice of suitable fishing gear. Fishing gear are designed to be operated with in particular depths of water as in the case of surface drift gillnets, bottom drift/set gillnets, bottom/demersal trawls, pelagic/mid-water trawls, surface troll lines, drift/set long lines etc.

Characteristics of Sea bed

Some types of fishing gear like bottom trawls are susceptible to damage due to hard, uneven or rough sea beds. In such grounds heavy duty bobbin trawls are used and in many cases static gear like traps, pots etc. are employed.

Principal types of Fishing Gear

a) Towed types of fishing gear

1. Trawls - Bottom : Otter trawl
   Beam trawl
   Pair trawl and Multi-rig trawl

2. Mid water/pelagic trawl.
3. Dredging

b) Encircling gear

1. Purse seines, Ring seines etc.
2. Seine nets - Danish seine
   Scottish seine
   Beach seine and
   Boat seine

c) 1. Gill nets and entangling nets.
2. Set nets
3. Traps, pots etc.
4. Long lines

d) Other mobile gear

1. Trolling lines
2. Pole and line
3. Harpoons

The most important commercial fishing methods are purse seines and trawls.

Factors relating to design of fishing gear

Following are the factors which determine the design of fishing gear:

1. Kinds of fish aimed for
2. Sizes of fish School
3. Size and shape of fish body
4. Behaviour of fish School
5. Density of Schooling
6. Swimming speed of fish and School
7. Fish migration etc.

The mesh size of nets is decided according to the size of fish body.

Fishing grounds are generally classified into two main types

a) Coastal or inshore and

b) Offshore or distant water fishing grounds.

Again as

a) Pelagic (running) fish fishing grounds

b) Bottom (Demersal) fish fishing grounds.

The continental shelf which is generally 200 m in depth is most suitable for demersal fish or those living near the bottom.

Fish behaviour in relation to fishing gear

Efficiency of fishing gear is in accordance with the behaviour of fishes in relation to visibility of the net, colour of net, sound and diurnal movements of fish etc. For example, in drift nets the twine should be invisible to the fish, hence the wide use of monofilament nylon. But in the case of set nets, the leader net has the function of guiding the fish and it would be as visible as possible. Sounds produced by netting may also be as thin as possible to reduce noise levels and turbulence. In leader net of set net vibration could be advantageous.

A species of fish may be available to a fishery in general, it may be accessible to a certain type of gear, and the success of operation of that gear will depend upon the vulnerability of the fish to that gear. Vulnerability is determined by those particular features of the behaviour mechanisms of the organisms. For example, the appetite of a certain species of fish for certain types of bait makes it vulnerable to fishing by means of hooks baited with the particular bait; its vulnerability to a net gear, might at that time be negligible.

Fishing management

Fisheries resources appear to be in exhaustible at first sight. But if they were left to the aggressive exploitation by the latest mechanised fishing operation without

regard to the proper conservation measures to be taken for the resources, all fishing grounds would be laid waste. Further more, an unrestricted catch of spawning fish, finger lings and young fish would destroy their stocks themselves. Therefore, preventive measures against over fishing are absolutely necessary for the maintenance and preservation of various fisheries.

Overfishing: has both an economic and a biological meaning. Economically it may mean that the fish density has been reduced by fishing to the level where the cost of a particular quantity of the product is less than its sale value. Biologically over fishing would mean taking more catch per year than the maximum that the stock can replace through breeding and growth.

The maximum annual catch should be not more than the maximum that will accrue to the population by way of breeding and growth per year. This is what the biologists call the maximum sustainable yield (MSY) and there are methods of estimating it. Once we cross the level of maximum sustainable yield, the total annual catch would also decrease. So the important symptoms of over fishing from the biological point of view would be that with increased fishing effort, there would be decreases in the total annual catch, in the annual catch per unit effort and in the average size of the fish landed.

Attempts to manage fisheries by means of legislation have been going on all over the world for a long time. Whenever a fishery reaches a low ebb there is a cry for some sort of a regulation. The purpose of any fishery regulation is to provide for a better and greater harvest of fish. It is necessary to have a large number of matured fish for a fairly good spawning stock to replenish and sustain the natural stock. All young and juveniles of all species of commercially important fishes must be fully protected. It is very essential to protect fish during spawning season.

The most important types of fishing gear restrictions that are widely used to protect young and juveniles are:

1. Minimum sized meshes in the cod ends of trawl.
2. Minimum sized meshes in pots, traps and pound nets.
3. Use of minimum sized hooks in hook and line fishery.
4. Minimum sized meshes in gill nets.

Mesh Regulation: is based on the concept of an optimum harvesting strategy. By mesh regulation, certain portions of a population is protected by restrictions on the gear. This is effected by fixing minimum sized meshes in the cod end of trawls to allow escape of young juveniles.

Selective fishing: Selective shrimping is very complicated and delinking of shrimp from other demersal fin fishes is difficult for socio-economic and political reasons. The recent FAO Expert consultation on the development of selective shrimp trawling to avoid/minimise by-catch for the conservation of fin fish species held in Mazatla, Mexico, during November, 1986 has also endorsed this view.

Principle of fixing minimum mesh size:

The mesh size is fixed at the 50% escape level for a length group of fish leaving a portion of fishes of smaller length groups to be protected from the standing stock. The catch composition is often taken to indicate the structure of the population. In general, any population must show a continuous decrease in number with age (size)

Escape factor: This is a factor relating the length of the fish escaped to the size of mesh from which they escape.

$$E.F. = \frac{\text{Length of fish excaped in mm}}{\text{average actual value of mesh size in mm}}$$

Fifty Percent Point: It is the fifty percent escape or retention length i.e. the length of fish at which 50% are retained or allowed to escape by a particular gear.

Selection: It is the mechanism by which fishes with certain characteristics are captured and others escape.

Selection Factor: Index related to escapement factor expressing relation between 50% point and the size of mesh involved.

$$S.F.= \frac{50\% \text{ point}}{\text{average actual value of mesh size in mm}}$$

Selection ranges: Ranges in fish length over which the gear exercises selection i.e. 25% to 75% escape/retention

Selectivity: It is the selection properties of a fishing gear and refers to the size of fish selected from the population. Most fishing operations are selective. The inherent selectivity of trawls arises mainly from the ability of some fish to pass through the open meshes of the netting. Escape of fish through the meshes can take place in any part of the trawl but experimental evidence suggests that the most important area of escape is in the cod end. The length of fish at which 50% are retained in the cod end and 50% escape is the 50% retention length (50% point). Selection range is the length of fish between 25% and 75% retention lengths.

Resources specific fishing gear and fishery management

Selection factor: The relation between the 50% retention length and the mesh size of cod end is approximately linear. The constant of proportionality has been termed the selection factor.

$$S.F. = \frac{50\% \text{ retention length in mm}}{\text{mesh size in mm}}$$

The selection factor is thus a dimension less quantity, its value varying with the species of fish.

Normal Selection and Catch Composition

In a normal selection, the catch composition shows a general pattern of 5% escape of a particular size group and as the size group increases, the escape percentage decreases proportionally to reach a stage of no escape or 100% retention. Similarly the escape rate increases with the downward trend in the fish size in an inversely proportional manner to reach a stage of all escape or no retention.

Effect of Selective Fishing

When fishing is introduced, the fishing mortality is also introduced in the making of the population. If there is no restriction imposed on fishing mortality, the entire population structure can change to a condition of imbalance leading to depletion and even extinction of the species. Any population requires a minimum stock of spawneres to replenish the stock and the selective fishing is on by helping in this regard. The selectivity of fishing gear differs from species to species and the potential escape index differs from species to species and from gear to gear for the same species.

Fishing regulations

Fishing regulations are implemented like limitation on the number of fishing units, limitation on the total quantity (Quota) of fish that can be harvested, closure of certain fishing areas, restriction of fishing to selected seasons, restriction on the size of fish that can be marketed etc. Restriction on the size or type of fishing vessels can be implemented based on the length overall or tonnage and horsepower of the engine. Restriction on the type of fishing gear is the most universal type of control as purse seines or trawls are often banned from specified inshore areas usually fished by artisanal fishermen.

Selective Shrimp Trawls

Selectivity shrimp trawls were developed to separate shrimps from demersal fin fishes. But none of them enjoys acceptance due to the reason that about 10 - 15% shrimps also escaped during the process of separation and exclusion of by catch through these designs and are 80 - 90% efficient in separating and excluding by-catches. The loss of shrimps is not acceptable for factory shrimp trawlers, while small and medium class vessels in the coastal area find it uneconomical as they can not afford to lose by-catch, an important source of their additional income and the loss of shrimp due to escape.

Some of the designs of shrimp fish separator trawls are (1) V panel separatory trawl with escape chute for by-catch (2) selective electric shrimp trawl and (3) By-catch excluder device.

Separator trawls were developed in America for the gulf of Mexico shrimp trawling. These special shrimp trawls are provided with additional panels of bigger meshes placed differently from wing to cod end leading to two distinct cod ends, for shrimp and by-catch.

Sustainable yield and potential yield

In many discussion of fishery management problems, the terms "Sustainable yield" and "Maximum sustainable yield" are used. The attainment of the maximum sustainable yield is a reasonable objective of management, so that if the stock abundance is less than that corresponding to the maximum sustainable yield, it should be allowed to increase, i.e. less than the sustainable yield should be taken. Conversely, if the abundance is above this level, more than the sustainable yield should be taken.

The "potential yield' is the greatest average annual yield that can be taken over a period with any pattern of fishing. The actual average yield over a period will be generally less than the potential yield