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REVIEW ARTICLE

IMPACT OF BYCATCH IN FISHING AND ITS MANAGEMENT

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ABSTRACT

Bycatch is the global concern and it is causing number of problems to the fisheries. Recent WWF report estimates that 40% of marine catches and discards are juveniles. Higher level of bycatch has impact on diversity, community structure and biomass. Banning the destructive fishing practices is the very good approach for managing the fisheries. Nowadays bycatch reduction devices based on different aspects are being developed to make the fishing practices, environment friendly but it needs to be implemented properly. Regulations and guidelines are needed to be properly followed by all the fishers to recover the future stock. FAO has given the Code of Conduct for Responsible Fisheries which encourages the nations to make policies for the management of fisheries. This article details the impact of bycatch in fisheries and regulations and guidelines needs to be followed for managing the fisheries.

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INTRODUCTION

Most fisheries are unselective to some degree, in that they incidentally catch unwanted organisms along with their target catch during the process of fishing. This non-target catch is known as 'bycatch'. The diversity and quantity of non-target catches can vary significantly over space and time. Bycatch is therefore dynamic, reflecting variations in marine communities, fishing methods used, and changes in the target catch of fisheries. In some cases bycatch is predictable and straightforward to manage; in other cases it is unpredictable and more difficult to control. If bycatch is minimal, does not deplete populations of vulnerable species or undermine the productivity of fish stocks, it doesn't necessarily cause ecological harm. Unfortunately, on a global scale, bycatch is significantly exacerbating the threats posed by the commercial over-exploitation of the oceans: around 7.3 million tonnes of bycatch are discarded every year (Kelleher, 2004). This was not always the case; the tremendous growth of the fishing industry in the last few decades has meant not only expanding fishing fleets, but the development of vessels which are larger, faster and able to cover greater areas of ocean. Unfortunately, these vessels are often less selective than their predecessors. And as fisheries are rapidly reaching their limits of exploitation, wastage of marine life is coming under greater scrutiny.

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Why is bycatch discarded?

Bycatch may be kept, if it can be eaten, used or sold. However, much bycatch is disposed of, and this unwanted portion of the catch is known as the 'discards' or 'discarded catch'. Survival rates of discarded organisms are generally low. Fish and other bycatch species are usually killed during the process of capture or are so damaged/ traumatized they are unlikely to survive once returned to the sea. In some cases, bycatch is discarded because fishing regulations prevent it from being landed. This may be due to imposed quotas for certain commercial species, or outright bans for prohibited species. Alternatively, there may be insufficient mechanisms in place to process, store and transport non-target species to market. Yet, in most cases, discarding takes place because bycatch has:

i. No economic value, being the wrong species, small/immature, inedible or damaged
ii. A much lower economic value than the target catch, so fishermen prefer to retain only the high value target species. This is known as 'high grading'.

iii. In general, discarding should be discouraged where bycatch can provide a sustainable source of protein, particularly in the developing world. However, in some cases discarding may be inevitable and then efforts should focus on increasing the survival rates of discarded species.

Marine bycatch can include

- Species of little or no commercial value.
- Protected or endangered species, such as fish, sharks,turtles, dolphins, seals and sea birds.
- Species caught 'out of season', unwanted species, and animals that are the wrong size (too big or too small) or of too large a quantity.
- Plants and animals that may have been dislodged from the bottom of the ocean floor, such as corals, seagrass, algae and sponges.
- Debris such as rocks and rubbish.

Impacts of bycatch

- High levels of bycatch can cause reductions in biomass, and may alter the ecological structure and diversity of the oceans. Populations of marine mammals, sea turtles, sharks, seabirds and commercial fish species have been impacted by poorly selective fishing gears, and for some endangered species this represents a leading cause of mortality.
- The economic costs of discarding bycatch are considerable. The incidental captures, sorting, and eventual discarding of nontarget catches takes time and yields few financial rewards. In addition, the bycatch of commercially valuable species (particularly at juvenile stages) can lead to reduced profits, declining yields and premature closures of fisheries.
- Poorly-selective fishing in developing countries can impact food security and employment, by undermining the productivity of traditional fishing grounds. This can directly affect artisanal fisheries and the local communities they support.

Measuring the impact of bycatch

a.Based on target species

It measures how many tons of the resources are used (catch + bycatch) to bring one ton to the consumer. This measure includes the impact of bycatch plus other losses due to transportation, storage and production losses.
Target utilization efficiency (TUE) = yield target species / (catch target species + bycatch target species)

b.Based on ecosystem

It measures how many tons of biomass (catches + bycatches of all species) are needed to produce one ton of target species to the consumer.

Biomass Transfer Efficiency (BTE) = yield of all species / (catch all species + bycatch all species).

Benefits of reducing bycatch in fishing

- Keeps species within the natural marine food web.
- Protection of endangered and vulnerable species such as turtles, dolphins and albatrosses.
- Sorting catches and discarding bycatch can be expensive and dangerous. Fishing crews are also safer through keeping out large, thrashing and potentially dangerous animals, such as sharks and stingrays.

How can bycatch be minimised?

Bycatch can be reduced by decreasing overall fishing effort and/or by reducing bycatch per unit of effort (BPUE). Key methods to reduce BPUE include:

- Technological changes (e.g. the use of bycatch Reduction Devices (BRDs) in trawl fisheries).
- Operational changes (e.g. avoiding areas where bycatch tends to be high).
- Training (e.g. training in the application of the 'backdown procedure' to release dolphins from purse seine nets).
- Management actions (e.g. setting bycatch limits for individual vessels and rewarding fishers who succeed in reducing bycatch).

One way to reduce bycatch is to transfer responsibility for bycatch reduction to the individual fisher/vessel, within an appropriate management framework. This provides fishers with motivation to modify their gears and change their fishing practices. Often they, more than anyone, know how this can best be done. As part of such a scheme, those fishers who are successful should be appropriately rewarded. In turn, penalties should be issued to those who are not. This process has been described by Hall (cited in Norris, 2002) as a 'Darwinian selection' of fishermen, eventually leading to the evolution of more sustainable fisheries.

Methods of Bycatch reduction

a. Using devices

A bycatch reduction device is considered to be any mechanism which is added to fishing gear with the intention of providing escapement to unwanted organisms without harm to their health. With its potential for conservation and fisheries management implications, the idea of reducing bycatch came to the forefront of fisheries management in the mid-1990s. Most BRDs rely on one of two methods of excluding bycatch. The first is mechanical or physical exclusion, achieved by blocking the passage of bycatch into the cod end and guiding it towards an escape opening. This is the most common method of excluding large animals from prawn trawls. The second method utilises differences in behaviour between the bycatch and prawns. Fishes for example, are capable of swimming in a moving net, orientating to the direction of tow and swimming through an escape opening. Prawns on the other hand generally exhibit little directional swimming and are passively filtered into the cod end. The reduction of bycatch has the potential to improve the efficiency of the fishing operation because:

- The gear would stay on the bottom longer and time wasted during deployment and hauling would decrease.
- Otter board spread may be maintained for longer periods.
- Net damage from large animals would be reduced.
- Sorting time may be shortened.
- Injuries to crew from dangerous animals might be reduced.

The initial choice of BRD depends on the type of bycatch that fisherman wants to exclude. The choice of BRD is made more difficult by variations in catch composition, size and type of prawn and bycatch, and amount of bycatch caught throughout the season and between fishing grounds. When looking at bycatch Reduction Devices and how they are designed, there are a few major aspects which should be kept in mind. Firstly, one should take into consideration that between 25% and 64% of global bycatch could be reduced as a result of the implementation of reduction technologies. Secondly, it should be considered when developing or implementing a bycatch Reduction Device that such technology is not without its governing principles. Finally, one final aspect of BRDs to consider before implementing or developing your own technology is that there are two primary types of BRD. These can be grouped into those which utilize specific behavioural characteristics of the species to be removed and those which utilize deflection via a barrier such as a Turtle Excluder Device.

Excluder device

The implementation of a juvenile finfish excluder or Sort-X grid stands to be useful in the overall advancement of fishery health as it reduces mortality among the younger stage classes and ultimately leads to increased recruitment in many finfish species. One particular example of a juvenile exclusion device incorporates the use of three rectangular panels with hinges. Two of the three panels are angled off of a flat panel on the bottom to prevent entanglement in the net during escape. The reduction of crustacean bycatch can be a tricky measure. Due to the awkward size of some crustaceans, allowing for their escapement can also lead to some loss of target species. There are two major types of crustacean reducing techniques. The first of these involves the utilization of varying mesh size and shape during net construction near the cod end. A second method for reducing the unwanted catching of crustaceans in bottom trawls involves the construction of a blocking grid across the mouth of the net.

Turtle excluder device

It is an escape hatch for turtles and other species, such as sharks and rays; they also help to remove unwanted debris. If turtles cannot escape from a trawl net, they cannot reach the surface to breathe and may drown. Turtle excluder devices are made of a metal grid across the cod end of the net, which forces turtles and other large objects out of the net while allowing prawns and other target species to be captured.

Square-mesh panels

It consists of a panel of square mesh within the trawl net that provides a passage for nontarget or smaller fish to escape before they are caught in the codend. Often the whole codend is constructed from square-mesh netting, hung to maintain open meshes when the codend fills with catch. The construction of the 'square mesh' means that the meshes do not close up under pressure, as observed in traditional net constructions.

Tori lines

Tori lines (also called streamer lines) are bird-scaring devices towed behind the vessel. They are usually attached from a high point at the stern and consist of a backbone from which streamers hang down at regular intervals. Underwater setting chutes allow hooks to be deployed below the sea surface, and therefore out of the reach and sight of foraging seabirds. This has traditionally been achieved by setting through a chute attached to the stern of a vessel that opens 1–2 metres below the surface. Line weighting is used in demersal longline fisheries to deliver hooks to the target fishing depth as efficiently as possible, minimising the time that the hooks are within sight of seabirds. Electronic monitoring systems are a form of fisheries surveillance in which equipment that is installed on fishing vessels provides information about the vessels' position and activity. More recent technology uses global positioning system (GPS) sensors and cameras to record and store video data of fishing activity. Video data can be used to observe interactions with threatened, endangered and protected species, such as seals, sea lions and dolphins. Observations made from the data have seen management changes introduced into a number of fisheries, which offer further protection for these species.

Behaviour Based Exclusion Devices

The Use of Visual Illusion

Bycatch can also be minimized through the use of behavioral characteristics of a species. One of the most common uses of this method is the use of a visual illusion such as a section of the net being covered in black or white canvas. Having a section of canvas in the net creates a contrasting image in the eye of the fish, which scares them and causes them to seek an escape. When constructing such an illusion, literature suggests that a band of canvas (black works best) 2m in length is attached to the net in an area surrounded by moderate diameter mesh to facilitate escape. Another method for reducing bycatch via behavioural traits of fish is the utilization of a separator trawl. Separator trawl nets combine the utilization of varying mesh size in net construction with the implementation of visual illusions and a central plane separating the net into two main compartments. When the fish become frightened during the canvas portion of the net, they tend to separate out by size into the upper and lower chambers of the net where a corresponding mesh size either permits escape or entraps them.

Change of Fishing Tactics and Seasonal Closures

The utilization of changing fishing tactics and/or the implementation of seasonal fisheries closures is perhaps the least technologyof the bycatch reduction techniques but also one of the more effective. In changing fishing techniques from

drift gillnets to fix gillnets, the number of small cetaceans and seabirds which are captured can be greatly reduced. Other ideas in the change of fishing tactics include a change in netting material from traditional monofilament to a more visible netting was able to reduce the capture of marine turtles without significant loss in capture efficiency. The utilization of seasonal closures within a fishery also stands to provide bycatch relief in many fisheries.

Regulations and guidelines

The first and most obvious set of regulations and guidelines are the UN FAO Code of Conduct and the Kyoto Convention.

FAO code of conduct for responsible fisheries:

The FAO code of conduct for responsible fisheries (FAO, 1995) encourages nations to establish principles and criteria for the elaboration and implementation of national policies for responsible conservation of fisheries resources and fisheries management and development, and states precisely that discarding should be discouraged. But besides its obvious good intentions, implementation faces many challenges. The fisheries sector in many countries constitutes powerful lobbies, or groups large numbers of participants (i.e. artisanal small-scale fishers). As many restrictions concerning by-catch affect the productivity of the fishery, at least initially, there is a strong resistance to the constraints that should be imposed. The economic costs of gear modifications or replacements add to the costs of the fisheries, and unless major incentives are offered or significant outside pressures exerted, changes will not happen. In some of the relevant articles, the Code states:
8.4.5 States, with relevant groups from industry, should encourage the development and implementation of technologies and operational methods that reduce discards. The use of fishing gear and practices that lead to the discarding of catch should be discouraged and the use of fishing gear and practices that increase survival rates of escaping fish should be promoted.

8.4.6 States should co-operate to develop and apply technologies, materials and operational methods that minimize the loss of fishing gear and the ghost fishing effects of lost and abandoned fishing gear. 8.4.8 Research on the environmental and social impacts of fishing gear and, in particular, on the impact of such gear on biodiversity and coastal fishing communities should be promoted. 11.3.3 States should simplify their laws, regulations and administrative procedures applicable to trade in fish and fishery products without jeopardising their effectiveness. 11.1.8 States should encourage those involved in fish processing, distribution and marketing to: (a) Reduce post harvest losses and waste, and (b) improve the use of by-catch to the extent that this is consistent with responsible fisheries management practices. 12.4 States should collect reliable and accurate data, which are required to assess the status of fisheries and ecosystems, including data on by-catch, discards and waste. Where appropriate, this data should be provided, at an appropriate time and level of aggregation, to relevant State and sub regional, regional and global fisheries organizations.

12.10 States should carry out studies on selectivity of fishing gear, the environmental impact of fishing gear on target species and on the behaviour of target and non-target species in relation to such fishing gear as an aid for management decisions and with a view to minimizing non-utilized catches as well as safeguarding the biodiversity of ecosystems and the aquatic habitat. 12.12 States should investigate and document traditional fisheries knowledge and technologies; in particular those applied to small-scale fisheries, in order to assess their application to sustainable fisheries conservation, management and development.

Some individual nations are developing their own versions of a Code of Conduct. Of particular interest is the case of Norway, which has adopted a policy of `No discards'. Fishers are not allowed to discard anything caught in the net, and that forces them to fish selectively by avoiding periods, areas or times of the day with high by-catches, and by developing technology that contributes to that goal. Norway is the only country that has prohibited discards by law and fishermen are obliged to bring all their catch ashore (Olsen, 1995; Isaksen, 1997). Fishermen also have to keep logbooks with detailed records of their operations. This is controlled by frequent inspections, but the success of efforts like this depends on the good faith of the fishers, or on a very extensive and costly monitoring system based on onboard observers. Without being too pessimistic about human nature, the need for monitoring stands as a clear pre-requisite to the implementation of this type of programme. These programs

(a) Encourage research on by-catch reduction gear and techniques with a clear economic disincentive, which is to fill the boat with low-value fish;
(b) Encourage behavioural changes in fishers with regard to avoiding areas and seasons of high by-catches;
(c) Help reduce the waste of life and protein caused by the fishery, by forcing the utilization of what was already harvested. However, they are costly; and may result in the development of markets for undersized fish, juveniles, etc.

The Kyoto declaration and plan of action

The States that met in Kyoto for the International Conference on the sustainability contribution of fisheries to Food security in December 1995 endorsed the provisions of the FAO Code of Conduct and in Declaration 15 stated that `they would promote fisheries through research and development and use of selective, environmentally safe and cost effective fishing gear and techniques'. This resulted in the following being included in the plan of action (Clucas, 1997):

- To increase efforts to estimate the quantity of fish, marine mammals, sea birds, sea turtles and other sea life which are incidentally caught and discarded in fishing operations;
- To assess the effect on the populations or species;
- To take action to minimize waste and discards through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost effective fishing gear and techniques;
- To exchange information on methods and technologies to minimize waste and discards.

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