

# **Fisheries Management**

# Fisheries Management

## Overfishing

### Introduction

Overfishing is generally defined as action of exerting a fishing pressure (fishing intensity) beyond the agreed optimum level. According to Pauly (1983) overfishing is indeed primordial sin, bankruptcy of fishing management.

Overfishing may occur as Growth overfishing. Recruitment overfishing and ecosystem overfishing.

### Growth overfishing

Growth overfishing occurs when too many small fish are being harvested by excessive effort and poor selectivity. The young fish that became available to the fishery are caught before they can be grown to the harvestable sizes. Right selectivity i.e. optimum mesh size should be used so as to allow the smaller size to escape. This will allow the smaller ones to grow to attain maturity.

## **Recruitment overfishing**

This is a situation in which the parent stock is reduced by fishing to the extent that not enough recruits are produced to ensure that the stock will maintain itself. To avoid recruitment overfishing, the young ones (the recruits) are allowed to grow and they should attain the maturity and at least they should reproduce once or two times in its life cycle. The parents should not be caught for which mesh size should be optimized to allow the spawners to escape from the net. The prolonged recruitment overfishing can also lead to stock collapse. These also occurs under unfavorable environment conditions.

The stock-recruitment relationship is worked by three methods. Refer chapter on stock-recruitment relationships may appear good for on temperate spawner in which the spawning is synchronized. For most of the tropical species, where the spawning season is extended and species are prolific breeders, the relationship between the stock and recruitment appears not consistent.

## **Ecosystem overfishing**

This is a type of overfishing which occurs by the competition and predation between taxa. This type of overfishing occurs in a mixed fishery. The ecosystem overfishing would be transformation of a relative mature, efficient system into an immature, inefficient system.

## **Regularly measures**

To avoid overfishing, the fishing effort and optimal use of mesh size are to be monitored.

To regulate fishing effort by all year at optimum level could be accomplished by

- (i) Limiting entry and restricting be number of vessels in the fishery
- (ii) Limiting the quantity caught in one period of time i.e. quotas and
- (iii) Prohibiting fishing in certain areas and or in certain seasons.
- (iv) Control of age or size at first capture once this is accomplished the overfishing of stock can be avoided and the stock could be sustained.

## **Eumetric fishing**

This scheme calls for gear restrictions to achieve a right age composition of the catch function for a given level of effort. The demerits of eumetric fishing is that it forces the fleet on to a higher cost curve dissipating thereby the potential economic benefits. Further there will not be any economic gains by allowing fish to grow to a size that in eumetric with gear because the marginal revenue from growth is affected by marginal cost of programme implementation and also by  $M$ , i.e. national mortality (Crutchfield, 1979).

# CPUE

## Introduction

An understanding of fishing effort is fundamental to understanding the assessment and management of fish stocks. Effective management involves deciding directly or indirectly upon the amount of effort which should be applied to the stock and therefore requires a proper measure of effort. In general, the effort put by a fisher for fishing should conceptually be defined as fishing effort.

## Fishing effort

Fishing effort is the product of the amount of gear in use times and the duration of the fishing activity. e.g. trawling hours, pot or trap days, diving hours, hook hours, etc. Clearly each type of gear (trawl, seine, trap, etc.) catches fishes differently. Even within a given gear type, there can be enormous variability. For example, there may be hundreds of different types of traps or nets in use in a particular area. Further more, not all fishermen are equally skilled. Skills change continuously, and improvements in gear are constantly being introduced.

For example, if 15 boats, each fish for 10 days, the fishing effort is 150 days.

## Catchability coefficient

For a fishery manager to estimate the amount of fishing effort, it is not sufficient to count the amount of gear. One must count or estimate the amount of gear-days (or other measure) for each type of gear and derive empirical correction factors to express all the fishing effort in terms of one (or a few) standardized fishing gears. The task is indeed formidable. Careful gear comparisons are an important part of fishery management.

The fishing mortality,  $F$ , is almost assumed to be proportional to fishing effort. Mathematically, this is expressed as

$$qf = F$$

Where  $f$  is the amount of fishing effort (e.g in boat-days) and  $q$  is the proportionality coefficient, frequently referred to as the catchability coefficient. The more the efficient the gear is, the higher the value of 'q' because 'q', is the measure of the ability of the gears to catch the fish.

In the estimation of mortality parameters in surplus production models and in prediction models, the catch and effort statistics are taken as an input data. According to Rothschild (1970), the current estimation of the quantity of fishing effort is not only invaluable in following changes in abundance through CPUE index, but fishing effort is

also used in (i) the relation between total catch and effort (ii) the inter-relation between yield per recruit and size of the fish caught (particularly the smallest fish caught) and fishing effort (iii) the measurement of the relation between stock and recruitment.



## Standardisation of fishing effort

In tropical fisheries, different gears are used to capture the same resources. For instance, the sharks are captured by gillnets, trawls, hook and lines, etc. The catching efficiency between these gears differs widely. It is also difficult to compare effort of different vessels operating a single gear. For example, horsepower of trawler engines ranges from 80 to 150 , and hence, fishing hours multiplied by horsepower may a suitable measure of effort in trawl fisheries. In a gillnet fishery, the engine horsepower and fishing hours are less important compared to the number of gillnets set per day. In a hook and line fishery, it may be appropriate to consider the number of fishermen multiplied by the number of hooks used.

An attempt to combine the effort of these gears encounters intricate problems. Sparre and Venema (1992) suggested a method in which the quantities of yield and CPUE are proportional to effort.

(i) Relative effort

$$\frac{\text{Yield}}{\text{CPUE}} = \text{Effort as CPUE} = \text{Yield} / \text{Effort}$$

(ii) Relative CPUE

The effort of a particular gear (gear i) in year is defined as relative catch per unit effort

$$R_i = \frac{CPUE_i(Y)}{CPUE_i(Y_1, Y_2, \dots)} \dots \dots \dots (1)$$

Relative CPUE is calculated as follows,

Add CPUE for different years

$$9 + 5.7 + 4 + 3.9 + 3 = 25.6 \text{ (cumulative CPUE for five years)}$$

Divide the cumulative CPUE with the number years of observation (say five years)

$\frac{25.6}{5} = 5.12$ , Using the equation 1 the relative CPUE for the years in observation could be calculated.

In reality some gears are less important than others. For example, if two gears namely Purse seine, Beach seine and Pole and line and Trolling line are taken into account, the relative CPUE is calculated as follows.

Y	Yield y/1	f	CPUE1- Ri	Yield y/f	f (Y)	CPUE2 (Y) (y/f)	Ri
2005	50		10	1.02	250	20	0.94
2006	200	20	10	1.02	200	15	1.002

2007	400	43	9.30	0.95		350	25	14.0	1.055
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Mean CPUE for purse seine

$$\frac{10+10+9.30}{3} = \frac{29.3}{3} = 9.78$$

Mean CPUE for beach seine

$$\frac{12.5+13.3+14}{3} = \frac{39.8}{3} = 13.2$$

Relative CPUE

$$R(1980) = \frac{50 \times 1.02 + 250 \times 0.94}{50 + 250} = 0.95$$

Similarly calculate relative CPUE for both the gears for the year of observation.

Assuming  $Y_T$  (Total yield of all gear – including gears for which effort is not known) is taken as 3000 for the year 2005, 4000 for the year 2006 and 7500 for the year 2007, the relative effort of year  $Y_T / R$  for 2005 is calculated as  $3000 / 0.95 = 3158$  and for the year 2006 the relative effort is  $4000 / 1.011 = 3957$ .

The normalized relatively effort  $E$  for the particular year is calculated by

$$E = \frac{Y_T / R}{\text{mean } Y_T / R}$$

## Open access fishery

### Introduction

The open access fishery is one where there is no restriction placed upon utilization of the resource. When property rights for natural resource is not enforced, overexploitation of the resources frequently occurs. Hence in open access fishery the resource is highly exploited down to the level at which marginal profit equals zero that is no harvest beyond the highly exploited level.

### Open access catch

At open access catch the cost equals revenue however there will be normal return on capital in open access fishery, the fishery is characterized by overcapitalization, overcapacity, low return on investment and dissipation of rents that would have accrued to the industry (Disery 1983). However consumer's surplus will be at its maximum as shown in b, q, r in the figure.

The maximum economic yield is less than OAL as MSY. However the surplus production will be maximum and boatmen will be making profit on the consumer surplus will be reduced as shown p, a, b in the figure.

The most important characteristic is the of open access fishery in that profits are zero. Though the characteristic of open access is termed as tragedy of commons, the open access and common property are not the same. Common property resources, tend to display restrictions on who may exploit the resource and also the execution of the exploiting resource open access will be a good representation of the exploitation of a resource for a certain time period.

The good example is whale fishing. Whale fishing has potential effects of open access and at the same time by recognising that resource at global level becomes common property.

The supply – demand curve at MEY, SaY, OAL and MSY is given in following figure.

Fig...

- i) In open access catch, (OAL) consumer's surplus will be at its maximum C Shown in p.q and r in the figure.
- ii) In MSY the cost of fishing at a point 'p' for MSY is higher than the corresponding revenue (at t) and also the cost at open access (q). In MSY the advantage the stock will be fished at its maximum sustainable level and there will be a high enough catch in the consumer with a super normal cost in the industry.

If at MSY is needed to be a policy, the demand curve should shift upwards interacting the cost curve at its backward bending portion so that the cost of MSY is less than at open access.

In Socially optimal catch also called socially optimal yield (Soe) equitable distribution of rent is achieved by reducing the private profit to the area e, f, g, h and by increasing the consumer surplus to p, e, f at the level of MEY.

# Fisheries Regulations

## Introduction

The regulation of fishing is one of the three major activities of fishery management; the others are environmental management and artificial stock enhancement. All the three differ in many respects.

The first and major difference among the activities is that each is regarded by the public in a very different way. A fishing regulation restricts people from their use of a public resource, which many regard as a right. It is a legal action and, if it is to be effective, it must be acceptable to a majority of the people who are being restrained. Proposals for regulation are usually controversial and must be supported by sound information on their need. Proposals must be discussed in detail with people who are affected or with their representatives. After a regulation is promulgated, it must be enforced and monitored.

The purpose of environmental management is partly to improve the aquatic environment. Artificial stock enhancement by aquaculture is other type of management.

The second difference among fishery management activities is in the scope and kind of scientific studies that support the decisions. Fishing is regulated on the basis of recurring assessment of the condition of the stocks and the condition of the fisheries. If

the stock is a major oceanic one, the assessment may require a large continuing scientific investigation; if it is a minor domestic stock, it may require only an opinion survey among the people using it. The aquatic environment is managed on the basis of hydrological, limnological or oceanographic studies and detailed studies of the life of the organisms involved, plus studies of the feasibility of alternatives for change. Artificial stock enhancement though public aquaculture requires support from aquacultural sciences.

### **Origins of public policy**

The present functioning of fishery resource agencies develops basically from public attitudes that have evolved for a very long time. It must be presumed that the earliest people who subsisted largely by hunting and fishing originated the concepts that the game and fish belong to no one until after they are killed and physically possessed. Such wild animals were important to everyone who depended upon them yet.

In most countries, fishing laws are still based on the assumption that the fish belong to no one until caught, except for those in certain government waters and for fish grown in private aquaculture.

Since fish commonly been considered to belong to no one, fishing has been regarded by everyone as a right. In ancient China, all waters were free and open to fishing with the exception of a few imperial reserves. Under Roman law, the sea and public waters



were open for fishing by anyone. However, private waters were recognized and granted by governments in such situations as coves, backwaters, small lakes, and aquacultural ponds. Exceptions were also made in some places in favor of the fisherman who first occupied a site with fixed gear, such as a trap. He was allowed exclusive use of the shore or water for a reasonable distance around his gear, even though he did not own the fish until he caught them.

Today, most domestic waters remain open to fishing by all citizens of the country having jurisdiction. In countries with large numbers of recreational fishermen, this right may be exercised by a large proportion of the population.

Those fished in international waters, namely the sea and a few large boundary or rivers, went beyond the limits of domestic authority into an area that, in early times, was shared universally. It was an area of no law, an area of freedom from all domestic authority. But since 1300 that area has been gradually reduced, and now we have a new Law of the Sea, of which control of the fisheries is an important part.

## **Principles of Public Action**

Almost all public action that involves common property resources embodies three fundamental principles.

1. Every social change produced by an individual, company, or government decision gives an advantage to some person or group and a disadvantage to others. Even when its purpose is to correct a disadvantage, the benefits cannot be assumed to be uniformly distributed.
2. Every ecological change caused by man in his use of water or living resources gives an advantage to some organisms and a disadvantage to others, as long as the changes are within the physical and chemical limits tolerated by some living organisms. The disadvantages are frequently overlooked when action is taken in order to improve conditions for something we value.
3. Advantages and disadvantages to segments of either society or the organisms in the environment seldom become evident simultaneously, a fact that complicates the decision process when either benefit or damage is long postponed.

Another set of practical democratic principles governs the action in regulation of fishing.

1. Most of the people being regulated must agree about the need for regulation, and they must understand how the regulation is supposed to work. This requires knowledge of the resources and a respected forecast of the likely consequences of the obvious alternatives.
2. The regulation must be enforced, or the action of a few violators will destroy any confidence in its effectiveness.
3. Legal authority for the action must be secure and, if more than one political authority is involved, firm cooperation must be the rule. If the stock migrates between political jurisdictions, only joint action will be effective.

When the resource is divided among political entities, the first step toward collective decision making is usually an agreement among them that identifies the problem, specifies goals, and creates an organization with defined responsibilities. Usually the organization's responsibilities are primarily technical, i.e., they involve determining the facts to be considered and coordinating the negotiations. Authority to make regulatory decisions is usually reserved for the governmental partners in the agreement.

The extension of national authority to 200 mi under the new law of the sea is certain to require many new international fishery agreements. These will involve extension of national boundary lines, allocation of fishing on stocks that are shared by countries, permits for foreign fishing, and investigation of the status of the resources.

## **Current regulatory objectives**

Fishing is regulated for many reasons, the oldest of which are probably allocation of the right to fish and protection of public health. The more recent goals have come from the realization that the resources are limited and that the people will benefit if waste is avoided, if the stocks are conserved, provided if fishing is orderly.

## **Conservation**

Since the occurrence of widespread public acceptance of the facts that fishery resources are exhaustible and that controlled fishing is essential for conservation, fishery scientists have been asked how much and what kind of fishing should be allowed. They have been studying the dynamics of wild animal populations since early in this century. The most useful concept they have developed is that of Maximum Sustainable Yield (MSY), a value that can be calculated in various ways if the fish stock is assumed to be in a steady state.

After successful application of MSY's to some relatively stable fisheries, the concept was widely accepted as an objective for fishery regulation. But regulation according to the MSY concept does not always protect the stock or satisfy the users. Some very large stocks have collapsed while being regulated under the concept; the assumption of a steady state was invalid. Some commercial fisheries have become uneconomical even though the stocks have been sustained at maximum levels. And maximum

catches do not reflect the concept of a quality experience for most groups of recreational fishermen.

The objective of regulating fisheries for MSY has been abandoned, although MSY continues to be a useful computation during the assessment of the condition of fish stocks. Instead, MSY is modified by biological, economic, social and political values in order to produce the maximum benefit to society (Roedel, 1975). The resulting objective, called optimum yield (OY) may be (1) equal to MSY in some stable commercial fisheries used entirely for food, (2) zero catch for an endangered species or a species in a fragile environment, (3) near zero if the species is an essential food for a more desirable species, (4) a moderate fraction of MSY in order to produce fish for a recreational stock, and (5) a catch rate greater than MSY if the species is an unavoidable component of a multispecies fishery.

International acceptance of OY as the meaning of conservation came about at the Convention of Fishing and Conservation of the Living Resources of the High Seas that was negotiated at Geneva in 1958, but this was only one step toward a comprehensive Law of the Sea that required many more years to negotiate.

Throughout the decade of the 1970s a new and comprehensive Law of Sea was negotiated, and the fishery provisions of that law have been widely accepted. The major thrust of the law gives coastal states authority over fishing and fishery resources

out to 200 mi and the obligation to conserve the resources on the basis of scientific studies and in collaboration with neighboring states.

National fishery laws preceded the New Law of the Sea by thousands of years, with many objectives other than conservation. The conservation objectives that have been developed around the concept of OY in the Law of the Sea have been or will be adopted by most countries. But the other objectives of fishery regulation are constantly before the fishery agencies and may be their major activity.

### **Allocation of fishing rights**

Allocation means reduction of the right of some nations or people of fish where and how they please. It is a dominant feature of fishery law in most countries, simply because there are not enough fish for all fishermen to fish in the way they please.

Allocation is always controversial when it is begun. The decisions about who gets the rights to fish are political decisions. The laws are difficult to devise in a democratic manner and difficult to enforce (Stroud, 1980).

Allocation started centuries ago with kings' decrees to reserve fish for themselves or to protect their subjects from foreign fishermen. Now the new Law of the Sea gives coastal national the right to control access to their 200mi fishing zones and allocate the catches between their nationals and foreigners.

Allocation within countries is widespread. Treaties with Indian tribes have provided special fishing rights for the Indians. In addition, many laws that set closed seasons, closed areas, catch quotas, and restrictions on gear are really for the purpose of both allocation and conservation.

Some allocations among nations and among fishermen using different kinds of gear have been established and accepted for a long time, but as commercial stocks become fully exploited, further allocation will be needed. So many fishermen and so much gear enter the fisheries that the fishermen barely make a living, and conservation becomes difficult.

If the fluctuation has been caused by the application of so much fishing effort to the stock that its abundance has been depressed to the level of maximum sustainable yield or below, then a reversal cannot be expected without a reduction in fishing effort.

The reduction is accomplished by licensing only part of the fishermen and, in effect, allowing them to own an exclusive right to fish. Such limited entry has been tried in numerous fisheries around the world, usually with a mixture of social, economic and conservation goals. When limits have been imposed on a fishery during its period of growth they have been reasonably successful, but attempts to impose them after fisheries have become unprofitable have created difficult social, legal, economic, and

political problems (Rettig and Ginter, 1980) that have usually prevented achievement of the objectives of limited entry.

### **Orderly fishing**

Many provisions of fishery laws help to identify fishermen or to avoid conflict. Licenses or regulations may specify locality, period, or kind of gear in ways that keep rival fishermen apart or that avoids physical interference, such as destruction of crab pots by trawl gear. Licenses identify fishermen or dealers and the privileges that they have received. Laws and regulations may specify enforcement procedures or record-keeping requirements.

### **Prevention of waste**

In fisheries, there were no early regulations designed to protect spawning females and young fish. Common sense led to regulations to prevent capture of animals in poor condition, such as some crustaceans immediately after moulting. Other regulations attempt to prevent gluts of fish in excess of the ability of facilities to handle them or catches by recreational fishermen in excess of their ability to consume them. An increasingly common regulation in some sports fisheries is a requirement for barbless hooks, which allow release of small fish with less risk of injury.



## **Protection of public health**

There are a few fish and shellfish that may carry toxins or human disease organisms, and catches may be inspected and controlled by fishery agencies. For example, mollusks from polluted waters may transmit gastrointestinal diseases. Mollusks and fish may contain deadly toxins due to natural causes or to pollutants. A few aquatic animals may be venomous and should be avoided. Still others may transmit parasites to humans if they are not well cooked.

## Regulatory decisions

The process of making regulatory decisions depends on the existence of a legal basis, the objectives and technical reasons for the proposed decisions, the experience of people being regulated with past decisions, the perceptions of people about how the proposed regulations will affect them, the nature of the stock, and the administrative structure of the regulating agency.

Several aspects of the stocks must be considered during the regulatory process. If consistent regulations on many small stocks are needed, as in most domestic fresh water habitats, the regulations should be tailored to average conditions rather than to individual stocks. If a single large oceanic stock is being regulated, the regulations must be tailored to the stock. If the abundance of the stock is unpredictable, regulation of the catch may be modified on the basis of within season experience. If the stock migrates into another political jurisdiction, regulation should be based on agreement with the other government.

Regulation is more important for the recreational fishing system than for the subsistence or commercial systems.

### **Regulation of a large oceanic fishery**

At the other extreme in terms of complexity, time required, and cost is regulation of a large oceanic fishery. Regulation for conservation that is required by the new law of the sea must be based on continuing scientific assessment of the condition of each stock and the effects of fishing on it. Regulation must be consistent on the part of all political entities that share in the fishing (most large oceanic stocks migrate across political boundaries) and, in addition, regulation must meet all of the normal needs of flexibility according to the variations in social and environmental conditions, enforceability in all jurisdictions, and practicality within organizational and budgetary restraints.

The government must not only act in the interest of the fishermen, but it also must be perceived to do so. It must know the condition of the fish stocks and their environment, protect them from abuse, and allocate them fairly. The allocations involve use of the water for all its competing purposes as well as use of the fish stocks by all kinds of fishermen.

The resource information base for such regulation may vary from collection of fishermen's opinions about trends in catches to continuing statistical systems such as routine "creel" sampling in the field or an annual report required as a condition of a license. The stocks are usually far too numerous to permit individual attention, and the role of the fishery scientist is usually judgmental rather than analytical. Detailed field studies of sample stocks may be undertaken and used as a guide to regulation of a group of similar stocks.

## Methods of regulation

The question of management essentially is concerned with the means of rationalization of an open access fishery. Rationalization schemes popularly followed in fisheries management are: direct limitation of output, eumetric fishing, taxation and direct limitation of input through licensing. The merits and demerits of these schemes are dealt with below.

- i. **Direct limitation of output** : This scheme is exemplified by the traditional closed seasons and quota system followed in many developed countries. They place a direct limitation on the output through individual quotas. Nevertheless, the scheme is disadvantageous since it is very difficult to enforce and also creates a disruption in supplies.
- ii. **Eumetric fishing** : This scheme calls for gear restrictions to achieve a right age composition of the catch for a given level of effort. The demerit of this scheme is that it forces the fleet on to a higher cost curve dissipating thereby the potential economic benefits. No economic gains can be obtained by allowing the fish to grow to a size that is eumetric with the gear since the marginal revenue from growth is just offset by: (a) the marginal cost of programme implementation, and (b) the marginal losses to natural mortality (Crutchfield, 1979).

iii. **Taxation** : Taxation plays a dual role in the rationalization of a overcapitalized fishery. One of the uses of taxation is that it can act as a means of offsetting the effects of an otherwise efficient management regime (e.g., licence limitation programme) on the distribution of wealth, income and employment. A highly successful limited entry programme unaccompanied by any tax measure to capture a part of the economic rent created may effect transfer of income and wealth in a direction unacceptable to the society. Any measure that confers substantial gains on private enterprises at considerable social costs is not favoured. The major advantage of a tax on the remaining participants in an efficient fishery is its ability to convert the social costs of management to an explicit charge on the productive activity that gives rise to them. The other use of taxation is its ability to influence the level and composition of effort; it can be so devised as to convert the several types of externality plaguing an open access fishery into contractual costs to the individual decision maker.

iv. **Direct limitation of input** : This scheme may be implemented through a licence limitation programme which is preferred to all other schemes, for, it is easily enforceable and causes no disruption in supplies. Yet, it is confronted with certain important issues as: (a) the controversy over licensing the vessels or fishermen; (b) allocation of licences between different and conflicting interests (e.g., different gear or vessel types operating on a single stock); (c) number of licences to be made available; and (d) criteria for basing the issue of licences.

## **International Plans of Actions (IPOAs)**

International Plans of Action (IPOAs) have been developed by FAO in order to facilitate effective implementation of CCRF. These are voluntary instruments elaborated within the framework of the CCRF and apply to all states and stakeholders. IPOAs developed so far pertain to the following areas:

- i. Reducing incidental catch of seabirds in long line fisheries (FAO, 1999a)
- ii. Conservation and management of sharks (FAO, 1999a)
- iii. Management of fishing capacity (FAO, 1999a) and
- iv. Prevention of illegal, unreported and unregulated (IUU) fishing (FAO, 2001).

## **Bycatch reduction technologies**

‘Target catch’ is the species or species assemblage primarily sought in a fishery, ‘incidental catch’ is the retained catch of non-targeted species and ‘discarded catch’ is that portion of catch returned to the sea because of economic, legal or personal considerations (Alverson et al., 1994). Bycatch includes both discarded and incidental catch. In addition to the non-targeted finfishes and invertebrates, bycatch also involve threatened and protected species like sea turtles.

Different types of bycatch reduction technologies have been developed in the fishing industry around the world (Prado, 1993; Eayrs, 2005; Boopendranath et al.,2006; Gibinkumar et al., 2005; Sabu et al.,2005; Boopendranath et al., 2007 a; Kennelly, 2007; Boopendranath et al., 2008;2009;Boopendranath and Pravin, 2009). Devices developed to exclude the endangered species like turtle and to reduce the non-targeted species in shrimp trawling are collectively known as Bycatch Reduction Devices (BRDs). These devices have been developed taking into consideration variation in the size and differential behaviour pattern of shrimp and other animals inside the net. BRDs can be broadly classified into three categories based on the type of materials used for their construction, viz., Soft BRDs, Hard BRDs, and Combination BRDs. Soft BRDs make use of soft materials like netting and rope frames for separating and excluding bycatch. Hard BRDs are those, which use hard or semi-flexible grids and structures for separating and excluding bycatch. Combination BRDs use more than one BRD, usually

hard BRD in combination with soft BRD, integrated to a single system. Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) is a Smart Gear award winning design (WWF) developed by CIFT for protecting juveniles and for pre-sorting of the catch (Boopendranath et al., 2008; WWF, 2009).



## **Pointers from CCRF and IPOAs for responsible fishing**

FAO Code of Conduct for Responsible Fisheries provides the following pointers for responsible fishing and sustainable fisheries development:

- Evolve regionalized consensus of Code of Conduct for Responsible Fishing, in close participation with all stakeholders (traditional, motorized and mechanized fishermen organizations), fisheries research organizations and fisheries managers.
- Maintain a registry of all fishing vessels in waters under State jurisdiction with all essential details.
- Take measures to control open access by strict enforcement of a system of licenses (authorization to fish) in traditional, motorized and mechanized sectors.
- Periodically revalidate maximum sustainable yield of resources in the existing fishing grounds and determine fishing units of specific capacity in each category, for sustainable harvesting of resources.
- Standardise the capacities, dimensions and specifications of fishing units in each category.
- Address the question of excess capacity and take steps to remove excess capacity over a time schedule.
- Identify and delimit Protected Areas in marine and inland water ecosystems.
- Conduct periodic audit of fishing craft and gear combinations, their economics of operation, ecological and environmental impacts.

- Evolve regulations for mandatory survey of mechanized fishing vessels.
- Evolve a system for marking fishing vessels and fishing gears.
- Evolve regulations and promote use of life saving, fire fighting and communication equipment for safety of fishermen.
- Evolve regulations for mandatory survey of mechanized fishing vessels.
- Promote selective fishing gear and practices.
- Develop and implement National Plans of Action (NPOAs) for (i) management of fishing capacity, (ii) prevention of illegal, unreported and unregulated (IUU) fishing, (iii) conservation and management of sharks, and (iv) reducing incidental catch of seabirds in long line fisheries.
- Evolve an efficient Monitoring, Control and Surveillance (MCS) system.
- Make effective use of Geographical Information System for fisheries management; monitoring and control of fishing effort and energy use.
- Evolve and promote a package of practices of energy conservation in fish harvesting.
- Develop a Fisheries Information System for providing easy access to authentic information and facilitating fisheries research, management and business.
- Evolve a mandatory programme of training and certification for non-motorised, motorized and mechanized fishermen in safe navigation, fisheries regulations, responsible fishing, log keeping and reporting

## Implementation of the New Law of the Sea

### Introduction

All coastal countries now have a recognized right to use and regulate the fishing in their coastal zones. The new Law of the Sea created a massive reallocation among nations of the right to fish. The 200-mi zone along coasts and around islands contains about 99% of the world's land. Much of the catches from these stocks had been taken by the distant-water fishing fleets of about two dozen countries that traditionally had fished in many areas without restraint and without even maintaining the records of catch and effort that are essential for tracking the condition of the stocks. Particularly damaging had been the practice of "pulse" fishing, in which some fleets fished an area intensively until the fishing became unprofitable and then moved to another area.

Now coastal countries have the resources allocated to them. They have the opportunities to obtain optimum yield, to allow their citizens to fish the coastal waters, to lease any part of the fishing rights to foreign fishermen, and to use access to the resources as part of a bargain, such as a joint venture in which the country receives a fish processing facility and part of the catch in return for the fishing rights.

Along with the opportunities come obligations. The law requires control of fishing to ensure conservation, which requires scientific knowledge of the resources and statistical information on the fishing. The law also requires granting of access to foreign fishermen if the coastal state does not harvest the optimum catch.

Taking advantage of the opportunities and complying with the obligations will require most countries to form new or enlarged fishery regulatory and development organizations. Regulatory organizations will need competence to perform research, collect statistics on the fishing, negotiate with foreign countries about fishing and fishing boundary zones, make decisions about regulations, and enforce regulations. Development organizations will need competence to perform economic, social, and organizational planning, as well as knowledge of the business of fishing processing, and marketing. All countries will have boundary problems with their neighbours and will probably join regional fishery organizations. Implementation will be a long and continuing process.

## **Excerpts Pertaining to Fisheries from the law of the Sea**

After centuries of piecemeal development of the Law of the Sea, a process began in 1969 under the United Nations to prepare a comprehensive legal code. It was agreed to cover 25 main subjects, most of which involve several issues.

The subjects pertaining especially to fisheries included

- No.5, continental shelf;
- No.6, Exclusive Economic Zone beyond the territorial sea;
- No.7, coastal state preferential rights or other nonexclusive jurisdiction over resources beyond the territorial sea;
- No.8, high seas;
- No.9 landlocked countries;
- No.10, rights and interests of shelf-locked states and states with narrow shelves or short coastlines;
- No.12, preservation of the marine environment;
- No.13, scientific research.

After several arduous meetings, a convention was adopted on 30 April 1982 [Simmonds K.R. (1983), "United Nations Convention on the Law of the Sea, 1982. "Oceana, Dobbs Ferry, New York. It is a complex document containing 320 articles plus annexes that deal with virtually all human activities outside the territorial sea. When it was presented to member countries for a vote, a large majority approved, several obtained, and four, including the United State, declined to ratify. (The U.S. Disagreed with the provisions regarding marine mining.) Many matters often remain difficult or abstruse and debate will continue, but the provisions with respect to fisheries have been widely agreed upon. The principal articles (much abbreviated) are as follows.

56. Rights , jurisdiction and duties of the coastal State in the exclusive economic zone. In the exclusive zone, the coastal State has: (a) sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living.

57. Breadth of the exclusive economic zone. The exclusive economic zone shall not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

## **Conservation of the living resources**

- The coastal State shall determine the allowable catch of the living resource in its exclusive economic zone.
- The coastal State. Taking into account the best scientific evidence available to it. Shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation. As regional, regional or global, shall cooperate to this end.
- Such measures shall also be designed to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield. As qualified by relevant environmental and economic factors, including the economic needs of coastal fishing communities and the special requirements of developing States, and taking into account fishing patterns. The interdependence of stocks and any generally recommended international minimum standards whether subregional, regional or global.
- In taking such measures the coastal State shall take into consideration the effects on species associated with or dependent upon harvested species above levels at which their reproduction may become seriously threatened.
- Available scientific information, catch and fishing effort statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on regular basis through competent international organizations, whether subregional,

regional or global where appropriate, and with participation by all states concerned, including States whose nationals are allowed to fish in the exclusive economic zone.

### **Utilization of the living resources**

- The coastal state shall promote the objective of optimum utilization of the living resources in the exclusive economic zone...
- The coastal State shall determine its capacity to harvest the living resources of the exclusive economic zone. Where the coastal State does not have the capacity to harvest the entire allowable catch, it shall ..... give other States access to the surplus of the allowable catch.....
- In giving access to other states....the coastal State shall take into account all relevant factors including.....the economy of the coastal State concerned and its other national interests----the requirements of developing States.....and the need to minimize economic dislocation in States whose nationals have habitually fished in the zone or which have made substantial efforts in research and identification of the stocks.



- Nationals of other States fishing in the exclusive economic zone shall comply with the conservation measures.....and regulations of the coastal State. These.....may relate .....to the following:

- a) Licensing of fishermen, fishing vessels, and equipment including payment of fees...
- b) ...species which may be caught.... Quotas of catch during any period;
- c) Regulating the seasons and areas of fishing, the types, sizes and amount of gear and the numbers, sizes and types of fishing vessels that may be used.
- d) Fixing the age and size of fish....that may be caught.
- e) Specifying information required of fishing vessels, including catch and effort statistics and vessel position reports:
- f) Requiring....fisheries research programmes...and reporting of associated scientific data.
- g) The placing of observers or trainees on board such vessels...
- h) The landing of all or any part of the catch..in the coastal State.
- i) Terms and conditions relating to joint ventures or other cooperative arrangements.

j) ...training of personnel and the transfer of fisheries technology, including...fisheries research.

k) Enforcement procedures.

63. Stocks occurring within the exclusive economic zones of two or more coastal States or both within the exclusive economic zone and in an area beyond and adjacent to it.

1. Where the same stock or stocks of associated species occur within the exclusive economic zones of two or more coastal States, these States shall seek...to agree upon the measures necessary to...ensure the conservation and development of such stocks.....High migratory species.

1....States whose national fish.....for highly migratory species.....shall cooperate with a view to ensuring conservation.....and optimum utilization of such species.....both within and beyond the exclusive economic zone.....Marine mammals.

Nothing.....restricts the right of a coastal state.....to regulate the exploitation of marine mammals more strictly than provided for in this part. States shall co-operate with a view to Anadromous Stocks.

1. States in whose rivers anadromous fish originate shall have the primary interest in and responsibility for such stocks.

## 2. Right of the coastal State over the Continental Shelf

3. The natural resources referred to in this part consist of the mineral and other non-living resources of the sea-bed together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the sea-bed or are unable to move except in constant physical contact with the sea-bed or the subsoil.

### 207. Pollution from land-based sources.

1. States shall.....prevent, reduce, and control pollution from....rivers, estuaries, pipelines and outfall structures.....

### 210. Pollution by Dumping

States shall....prevent, reduce and control....dumping