

Overexploitation of fishery resources, with particular reference to Goa

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Marine living resources are not infinite. Overexploitation is a pervasive problem in fishery the world over. Landings of major fisheries resources in the Indian Ocean region have declined significantly, and the Goan coast is no exception. In many cases, the rate of harvesting has exceeded the natural rate of renewal, resulting in biological overfishing. Such overexploitation leads to stock collapse or severe depletion. This paper documents overexploitation of fishery resources, with particular reference to Goa.

Fish production in Goa has significantly increased from 17 000 tonnes in 1963 to a maximum of 102 922 tonnes in 1993 due to mechanization. The analysis of data suggests that catches have exceeded maximum sustainable yield, resulting in negative growth in subsequent years.

The rich fish diversity of the Goan coast is boosted by high landing of penacid prawns. The estuaries of Goa are a rich source of different species of prawns (13 species). The occurrence of solar prawns in tonnes for a short period during July-August is an important feature of the Goan coast. High demand coupled with the fact that too many people are dependent on these resources have led to overexploitation. Sustainable development in fisheries requires careful consideration of physical reforms such as resource rent from which economic benefits can be derived in the form of value-added local employment, income, and food security, although these are highly location specific. Opportunities exist to review progress in fisheries management and to exchange ideas on sustainable development through resolute policy decision on a long-term basis.

Introduction

Inaugurating the *Reykjavik Conference on Responsible Fisheries in Marine Ecosystem* on 3 October 2001, Dr Jacques Diouf, Director-General of FAO (Food and

Agriculture Organization) of the United Nations said, 'Countries could get more fish from the oceans if they allowed overfished stocks to recuperate, reduced wastage, and managed fisheries resources better.' He also warned that the world oceans are exhaustible.

The wealth of marine resources was assumed to be an unlimited gift of nature. However, this myth has faded in the face of realization that marine living resources, although renewable, are not infinite and need to be managed on a sustainable basis for the future requirement of our growing population. Notwithstanding the general concern over environmental degradation in recent years, fishery stocks and aquatic resources have been heavily overexploited. In many capture fisheries in the Indian Ocean, the rate of harvesting has exceeded the natural rate of renewal, resulting in biological overfishing. FAO (1997) estimated that 69% of the world's marine stocks, for which data are available, are in need of urgent corrective conservation and management measures: 44% are fully to heavily exploited, 16% overexploited, 6% depleted, and 3% very slowly recovering from overfishing. More than 69% of the stocks of demersal and pelagic fish, crustaceans, and mollusks in various areas of the world's oceans need rehabilitation.

Overexploitation of marine resources is a worldwide problem. It takes place when the maximum amount of fish that can be taken from the sea is exceeded. The improvement in efficient fishing technology, that is becoming available to even smaller fishing operators, is really not giving the fish in the sea much chance to escape the fishing gear and time to reproduce. Biological overexploitation of fishery resources leads to collapse of certain fisheries or their severe depletion. According to Hutchings (2000), with the exception of a few species, recovery of most fishing stock after collapse is very little. National and international efforts are, therefore, needed to protect fish stocks under threat of overexploitation and to allow depleted stocks to recover.

Marine fish production of Goa: present status

About 73% of the total marine fish catch of India comes from the west coast for which several attributes have been reported (Madhupratap, Nair, Gopalakrishnan, *et al.* 2001). These attributes are equally applicable to all maritime states of west coast of India. Goa with a sea coast of about 105 km (kilometres) and a continental shelf of about 10 million ha (hectares) has an actively fished area of about 20 000 km² (square kilometres). It is endowed with rich pelagic and demersal fisheries resources (Ansari, Chatterji, Ingole, *et al.* 1995; Doiphode 1984). Fish is generally considered an affordable source of protein by the people in the state. The progress in total marine fish production of Goa is shown in Figure 1. Fish production is exclusively from the capture fisheries, barring a limited production mostly through traditional aquaculture. It constitutes a highly productive sector, a source of valuable food and employment,

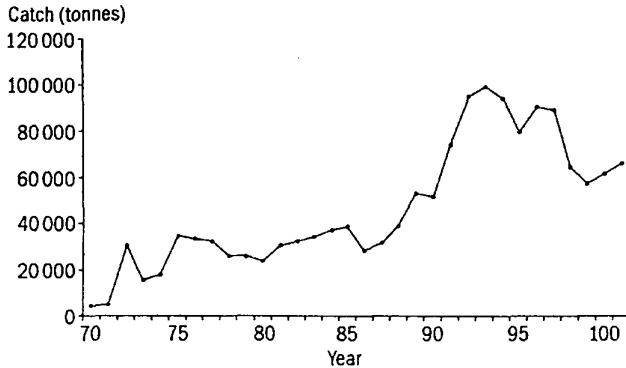


Figure 1 Fish catch of Goa

and contributor to the balance of payment. Today, the marine fisheries sector of Goa has attained the status of a capital-incentive industry. It represents one of the examples of exploitation of natural resources. About 75% of the marine fish production comes from the mechanized sector and 25% from the traditional sector. A number of oceanographic parameters are responsible for the overall abundance and seasonal variation of marine fisheries resources (Ansari, Sreepada, Dalai, *et al.* 2003).

A review of marine fish production in Goa and growth of fisheries suggests wide fluctuations in total catches (Table 1). According to Sardesai (1999), the marine fish landing in Goa was only about 17 000 tonnes until 1963. The catch

Table 1 Growth in marine fish production in Goa

Year	Total fish catch (tonnes)	Growth
1963	17 000	-
1970	36 616	+ 115.3
1980	25 715	-29.77
1990	56 225	+ 118.6
1991	75 622	+34.5
1992	96 333	+27.3
1993	10 1922	+4.76
1994	95 840	-5.0
1995	81 856	+ 45.58
1996	92 737	+ 13.29
1997	91 277	-1.57
1998	67 236	-26.33
1999	60 075	-10.65
2000	64 563	+7.47
2001	69 386	+7.47
2002	68 462	-1.3

Source Directorate of Fisheries, Government of Goa

increased to 36 616 tonnes in 1970. It came down to 25 715 tonnes in 1980, showing a negative growth of about 29% between 1970 and 1980. The catch increased to 56 225 tonnes in 1990 and showed a positive growth of 118%. However, maximum catch was achieved in 1996. Between 1963 and 1999, when the average annual marine fish production of India grew by 3.5%, that of Goa grew by 6.02%. The pronounced increase in fish catch during late 1980s and early 1990s could be attributed to the mechanization and phenomenal increase in the number of fishing trawlers as well as advancement in gear technology. From 1996 onwards, till 2000, the growth has generally been on the negative side. The last five years have seen stabilization in the catch to about 65 000 tonnes. The fisheries are characterized by increased fishing pressure in the highly fished in-shore waters of Goa.

The marine fisheries of Goa are multi-species fisheries wherein several commercially important species of fish and prawns constitute the pelagic and demersal fisheries resources (Mohanta and Subramanian 2001). The prominent and most important groups are mackerel and oil sardine, which form bulk of pelagic catches. Similarly, the shrimps form bulk of demersal resources. Average contribution of pelagic resources is over 50% of the total landing. Most of the catch from coastal fisheries is used for local consumption. However, varieties such as seerfish, ribbonfish, squids, cuttle fish, and shrimps are targeted for the export market.

Exploitation of prawn fisheries resources of Goa

Marine prawn fishery

The marine prawn landing in Goa is one of the lowest among the coastal states of India. The average landing for over a decade is only 2.1% of the total landings in India, which is of the order of about 4000 tonnes (Figure 2). Most of the fishing activities for exploitation of the marine prawns are carried out in shallow coastal waters within the 50 m (metres) depth contour. Although there is a law stipulating that only traditional fishing be allowed within 8 m depth, many trawlers operate in the shallow coastal waters, even at the mouth of the estuaries fishing for juvenile prawns.

Seventeen species of marine prawns have been reported from the coast of Goa, including the estuarine and inshore waters (George 1980). However, the fishery is mainly sustained by species such as *Metapenaeus dobsoni* (locally known as the solar prawn), *Parapenaeopsis stylifera*, *Metapenaeus affinis*, and *Parapenaeopsis merguensis* (Achuthankutty and Parulekar 1986). Some species such as *Metapenaeus monoceros*, *Metapenaeus moyebi*, *Penaeus indicus*, *Penaeus monodon*, *Penaeus japonicus*, and *Prapenaeopsis hardtuckii* also contribute in small shares.

A comparison of state-wise marine prawn landings made for the years 1989/90, 1993/94, and 1999/2000 indicated a tremendous reduction in the

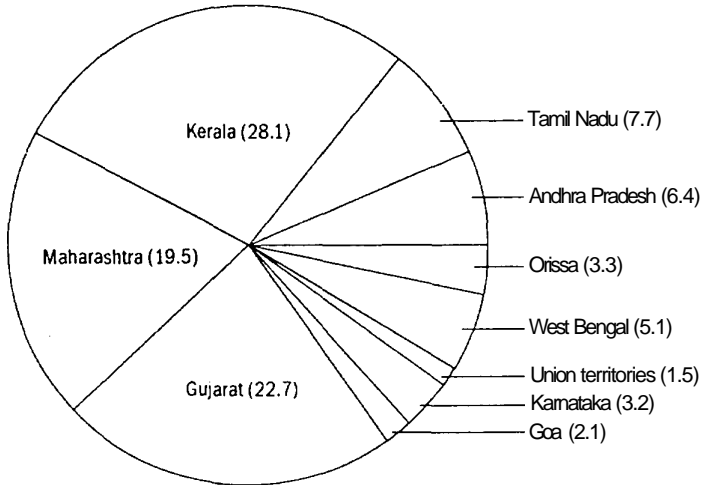


Figure 2 Mean annual state-wise contribution of penaeid prawn landing (%) for the period 1989-2000

contribution to the total landings from Goa coast which is in the order of 3.9%, 2.1%, and 0.8%, respectively (Figure 3).

In the Goa coast, *P. japonicus* (Bate) has also started appearing in fairly good numbers in the commercial catches. This species was recorded for the first time from the Goa region by Achuthankutty and Nair (1993). Similarly, the juvenile stages of another penaeids species, viz. *Penaeus canaliculatus* (Olivier) was also recorded from the juvenile prawn catches in the estuaries of Goa (Achuthankutty and Nair 1993). *P. japonicus* generally occurs in deeper waters

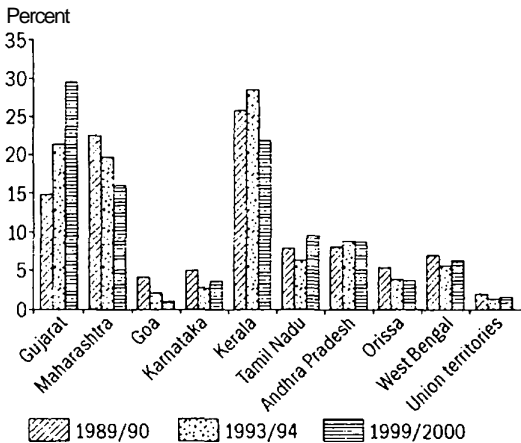


Figure 3 Comparison of state-wise penaeid prawn landing (%) for three years

(Holthuis 1980) and in Bombay waters this species is being caught in commercial scale between 40 and 60 m depth (Aravindakshan and Karbari 1983). *P. canaliculatus*, on the other hand, has been identified as a potential fishery along the Neendakara coast (southwest coast of India), in the deeper waters immediately after the south-west monsoon season (Suseelan, Thomas, Kurup, *et al.* 1982). Another noteworthy aspect of this fishery is that adults of this species were caught in commercial scale only during the night trawling. It is, therefore, apparent that a change of fishing strategy may be required for commercial exploitation of these two species from the Goa coast. The changed fishing strategy may also possibly lead to tapping of other species of prawns, which normally do not constitute the fishery of Goa.

Estuarine prawn fishery

Estuarine fishing is a traditional occupation of the Goan fisherfolk. Most of the estuarine fish catch is composed of the juvenile stages of the marine prawns. The gear used for the fishing is the stake net (locally known as the *Aari*). The stake nets are deployed all through the length of the estuary. Fishing is dependent on the lunar cycle. Invariably, fishing activities go on for 15-16 days in a month. During the early monsoon season, the catches are fairly good, but as the monsoon progresses, the fishing activities come to a halt, mainly due to unfair weather conditions and also decline in the catch. No realistic estimates have been made for the prawn catches from the estuarine environment of Goa.

About 13 species of marine prawns have been reported from the estuaries of Goa. Among them *M. dobsoni* and *M. monoceros* form the bulk of the catch (Figure 4). These are followed by *Metapenaeus moyebi*, *M. affinis*, and *Penaeus*

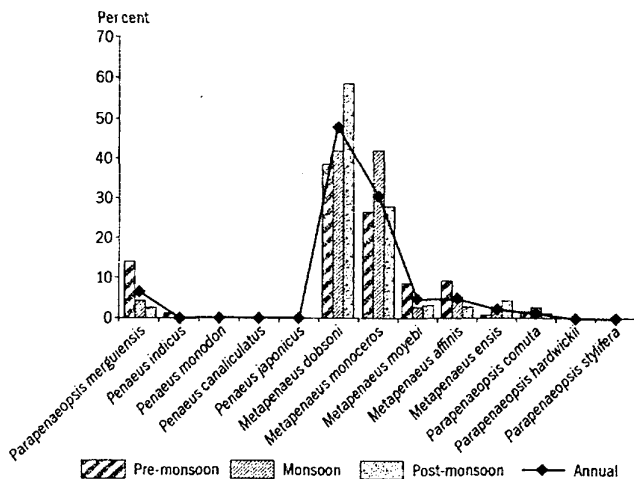


Figure 4 juvenile shrimp composition in the estuarine fishery of Goa

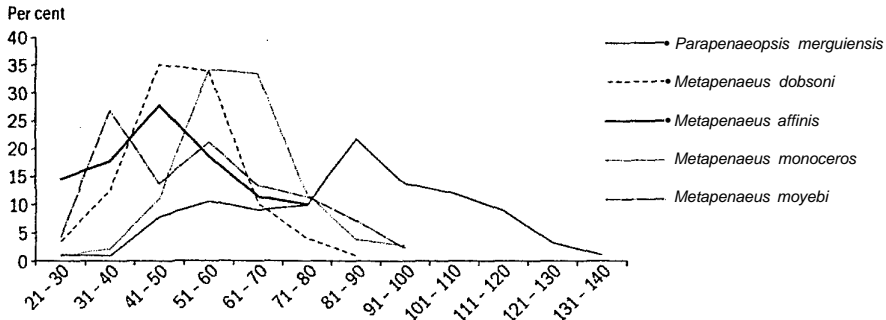


Figure 5 Size class of shrimps in the estuarine fishery of Goa (in mm)

merguensis. A few species such as *P. mondon*, *P. canaliculatus*, *P. japonicus*, *Parapenaeopsis stylifera*, *P. hardwickii*, etc., form minor components in the catch. Seasonal pattern in the catch is also clearly visible in the catch composition. For instance, *M. dobsoni* was more abundant during the post-monsoon season while *M. monoceros* formed the major share during the monsoon season. In case of *P. merguensis*, *M. moyebi*, and *M. affinis*, the catch was better during the pre-monsoon season.

The size composition of the five major species in the catch (Figure 5) indicates that all these species are caught very young from the estuaries. The minimum size class of all these species in the catch is 21-30 mm (millimetres) and the maximum is 81-90 mm. In case of *P. merguensis*, the maximum size range is up to 131-140 mm, but beyond 81-90 mm, the percentage occurrence is negligible. The size classes from 41 to 70 mm form the mainstay of the juvenile fishery of marine prawns in the estuary. However, for *P. merguensis*, the size class that dominates the catch is 81-90 mm. Exploitation of juvenile marine prawns needs to be done with adequate precaution because overexploitation would adversely affect the recruitment of these species to the adult stock and thereby the breeding population.

Maximum sustainable yield and resource rent

The MSY (maximum sustainable yield) is the maximum production possible for sustained fishing and has often been used to limit the efforts for catchable stock. Figure 6 presents a simple model of a fishery based on Schaefer biological growth function. On the assumption that fish is independent of the quantity sold, the parabola shows that with the increase in effort sustainable yield increases up to a MSY at effort level E2. Beyond this point, further increases in effort result in reduction in sustainable yield. Although use of MSY as a management goal has long been criticized by both biologists and economists (Larkin 1977), replacing it has been difficult however, and it continues to occupy an important place in the fisheries management. More recently, the need for an

ecosystem approach to fisheries exploitation and management has been proposed. However, Sissenwine and Mace (2003) in a presentation to the ecosystem approach conference argued that although conceptually the ecosystem approach is correct, it is difficult to use it as a practical tool.

A workshop on *Fiscal Reform in Fisheries*, conducted by FAO in Rome from 13 to 15 October 2003, was conceived towards promoting growth, poverty eradication, and sustainable management. Achieving sustainable development outcomes in fisheries requires careful consideration of the economic benefits that result from fisheries and the extent to which they are effectively realized. In particular, careful consideration should be given to the resource rent which fisheries are capable of generating. It is, however, important to mention here that economic benefits from fisheries are derived not only from rents, but also from fishing impacts such as local employment, incomes, and food security. Relative importance of both types of benefits is highly location specific. The issue of resource rent is strongly related to access condition in the fishery. The free and open access to many fisheries leads to their overexploitation. It, therefore, raises question of defining ownership and property and use rights. Ownership issue, in turn, leads to various problems: who is able to charge for the use of the resources, who bears the cost of use, and who reaps the benefits. The objective of resource rent revolves around making policy decisions about how the wealth from the fishery is collected and how that wealth is distributed.

As shown in Figure 6, resource rent is the vertical difference between revenue (shown by the parabola marked R) and cost (shown by a straight line from the origin marked C). Resource rent also increases initially as effort increases, attaining the maximum at effort level E1. It is a key concept in fisheries exploitation and management because it is the driving force behind the widespread overexploitation of fisheries. Since fishery is usually undertaken in pursuit of profit, it might be logical to think that fishers would use fishing efforts so as to maximize resource rent. At levels of effort below the point where revenue and cost are equal, fishers will be earning more than the normal profit.

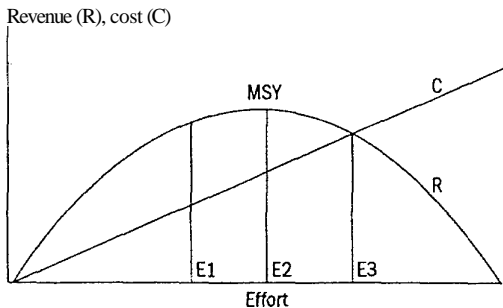


Figure 6 Simple model of Schaffer growth function showing MSY (maximum sustainable yield) against E (effort)

Such profit will attract new entrants and if access is free and open, this will continue till all resource rent is dissipated at effort level E3. At equilibrium, the fishery will operate at a point where revenue equals cost (Figure 6). At this point the fishers will earn normal profit but the fishery would be overexploited both economically and biologically. Fish resources are clearly inherently very valuable, but this value is often hidden due to their overexploited state. If a single person, or company, were to be given control of a fish resource, he or she would be able to charge people to use the resources, in exactly the same way as people do for their property or as government does for the use of many other natural resources such as oil. The amount that could be charged depends on the implicit resource rent: the amount that is left when all exploitation costs have been deducted from revenue. The gains from generating resource rents will be more than adequate to compensate losers and ensure that there remains a positive balance. It seems the management has paid insufficient attention to resource rent in fisheries sector.

Calculation of resource rent

As given in the key sheets of Fiscal Reform in Fishery (SIFAR 2003), a basic formula for calculating resource rent might be

$$RR = TR - (IC + CE + CFC + NP)$$

where,

$$NP = r \times K$$

RR = resource rent

TR = local revenue

IC = the intermediate consumption

CE = compensation of employees

CFC = consumption of fixed capital

NP = normal profit

r = opportunity cost of capital

K = value of fixed capital stock invested in the fishery

Each element in this equation may be treated as a module capable of further development. Relatively few estimates of resource rent exist, and one important policy goal must be to develop many more such estimates in the future. Rules of thumb suggest that rents are in the order of 10%-60% of gross revenue, usually at the higher end of the rent. An interesting example of resource rent can be seen in a study of Namibia, presented by Lange and Motinga (1997).

The key issue is to establish who is the owner of the resource and who is the user. With the advent of 200 mile (8046 kilometres) Exclusive Economic Zone, many states have declared the owners of the fish resources contained

therein, but relatively few have acted as if they were the owners. Nevertheless, it is the duty of the state to ensure that resources be used in an economically rational manner to achieve social objectives. Another alternative suggested by Hannesson (1993) would be to establish a coastal Commission to collect resource rent. This commission could be set up at various levels - local, coastal, or regional - depending on objectives, nature, and the importance of the fisheries involved. Yadava (2003) in his paper on fiscal reforms for Indian fisheries suggested resource rent as an important contributor.

Overexploitation of resources

An analysis of the catch data of the earlier years suggests that during the peak fishing season, the catches exceeded MSY after which there was a decrease in fish production (Figure 7). A negative growth trend could be seen after 1996. A parallel change in the catch composition has also been reported. While the pelagic catches have been over 50% all these years, the demersal catches have shown a declining trend. It is worth mentioning here that hypoxic conditions develop in the bottom waters of the Goa coast (Naqvi, Jayakumar, Narvekar, *et al.* 2000) and this may also have an adverse effect on the demersal fisheries resources.

When the fish catch data was plotted against the number of vessels, an interesting picture emerged (Figure 8). In early 1960s, the vessels were very few and the catch was less. With an increase in vessels, a corresponding increase in the catch was recorded. We can see that as the number of boats increased further, the catch slowly started decreasing. There are also reports of reduction in CPUE (catch per unit effort) and diminishing economic returns. This clearly shows that adding more vessels to the present fleet in the same fishing zone may not increase the total catch. The depth of fishing operations has also been

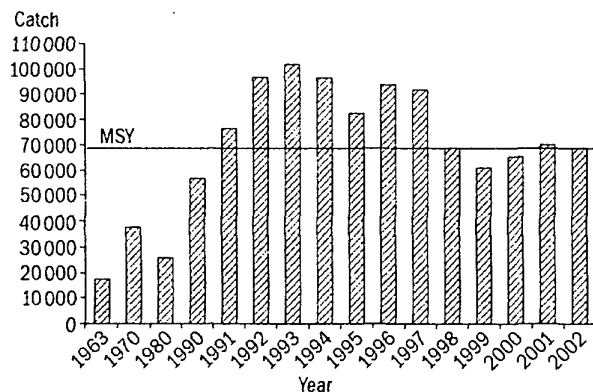


Figure 7 Marine fish catch and maximum sustainable yield for Goa

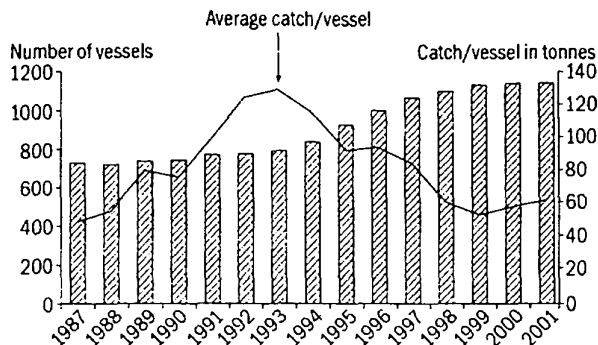


Figure 8 Average fish catch per vessel for Goa

increasing and cost of operation is mounting. The negative growth in fish catch and lowering of CPUE may be attributed to greater fishing pressure and overfishing of the stock.

It is very clear from the account given above that present number of fishing fleets in Goa is double the capacity needed to exploit the current fisheries population. The result is a vicious circle: as catches per vessel fall, profit plummets, and fishers overfish to maintain supplies, causing serious depletion of stock and thus endangering long-term availability. With falling returns, the asset value of vessels goes down, compelling owners to continue fishing at uneconomic rate of return, incurring losses and damaging the resource base. This problem is aggravated through recurring cost on maintenance of the vessel.

The major biotic constraints to marine fisheries resource production are as follows.

The capture fisheries resources are finite and limited; they face depletion (losses from their maximum potential) because of the following biotic and abiotic factors.

- Overexploitation by fishers
- Reduction of high value species
- Reduction in biodiversity from intense fishing
- Pollution
- Habitat destruction

The economic factors that cause overexploitation include the following.

- Too many people dependent on the resources
- High demand, especially for high-value species by the developed countries (for example, shrimps and prawns)

To overcome the problem of overexploitation and unsustainability, we need to address the following questions.

- What are the key factors contributing to fisheries overexploitation and unsustainability?
- What are the untapped resources and how to exploit them judiciously?
- How do these factors interact in general and under major fisheries management system?
- Which are the priority issues in addressing fisheries overexploitation?
- What are the best practical approaches to address the factors that may be important for responsible fisheries management?

Role of state fisheries department

State fisheries department plays a major role in the development and implementation of regulatory measures. The state of Goa was among the first in the country to implement the marine Fisheries Regulation Act adopted by the United Nations Convention of 1982. Goa does not have a fully developed fishing harbour and receives the fish catches from Malim, Coutbona, Vasco Marmugoa, and Panaji. There are six fishermen societies functioning and the Directorate of Fisheries provides subsidy to the fishermen community through these societies.

The infrastructure facilities are very important and support the industry. The state government has committed to provide all the required facilities such as auction shed, water supply, parking areas, net mending sheds, and workshops at the jetties with cold storage facilities round the clock. The development of these facilities by the Directorate of Fisheries has seen a 300% increase in the fish production since 1963. Various schemes have been proposed by the fisheries department for further improvement in fisheries sector.

The industry also faces several problems for the sustainable development.

- 1 Indiscriminate increase in the size of fleet in the recent past and problem of overexploitation.
- 2 Unchecked mechanized fishing in the river mouths and prohibited areas up to 5 km from the coast, and serious conflict between traditional and mechanized sector.
- 3 Catching of brood stock during the monsoon season.
- 4 Use of non-selective gear.
- 5 A lot of by-catch along with the target species.
- 6 Depletion of commercially important species.
- 7 Escalating fuel cost.
- 8 No proper fish drying yard/processing unit.

Fisheries management world over is unfortunately politically influenced and not based on scientific information. Goa is no exception to this. By far, the most important role of state fisheries department is to ensure that appropriate local systems of resource management operate in a legal framework, which

provides legally enforceable recognition of their identity and rights. The department must also provide the framework within which they must be able to protect themselves from within, from encroachment by neighbouring states or external intruders, and from other economic sectors such as tourism. High variability in fish catch makes it both a potential opportunity and a threat. Therefore, the state must develop a system that takes advantage of the opportunity and minimizes threat.

Need for sustainable fisheries management

With marine catches stagnating due to overexploitation of commercially important stocks, rising demand can only be met through more rational fisheries management and resource development. The state fishery has several social and economic implications. Therefore, reducing fish stock to biologically and ecologically harmful levels will result in a loss of potential benefits as food, income, and employment in the long run. This necessitates for the sustainable management of this renewable resource. According to Fishery Survey of India (personal communication), coastal water of less than 50 m depth is home to more than half MSY. The conservation and management should ideally refer to all the fisheries legislation, regulations, methods, etc., which are required to build, restore, and/or maintain the fishery resource and the marine environment of Goa. In order to ensure sustainability, it is important that factors contributing to fisheries overexploitation and unsustainability are understood clearly. A focus on allocation of fish resources both within and between nation states is needed to avoid cross-jurisdictional fight. A focus on the entire ecosystem, and not only on individual stock, is urgently needed to protect all marine resources. The regulation becomes more pertinent in the light of the restrictions imposed in the form of fishing ban during the monsoon period.

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