CHAPTER

17

Assessing the Externalities of Marine Fish Trade in India

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Fisheries is one of the fastest growing food sector in the world economy, which provides livelihood for more than 200 million people around the globe. India, being the second largest producer of fish in the world, contributes about 5.43 percent of the world production. Fisheries sector plays a very important role in the socio – economic development of the country by providing a source of livelihood with direct employment to over one and a half million people, besides the indirect employments, contributes much to the food security and export earnings of the country as well. Eventually, there are wide-ranging variations in marine fish landings, which might have serious impacts on the economy of the country. Even though the quantity of landings is depreciating in thirteen major marine areas out of fifteen there is almost a fivefold increase in the case of India, since 1950.Over the years, the sector continues to play strategic role in food security, international trade and employment generation. Indian economy has grown consistently post-liberalization with higher purchasing power and consistent demand for diversified food products. With changing consumption pattern, emerging market forces and technological developments, the fisheries sector has assumed added importance in India with rapid transformation. The present fish production is 11.04 Mt with a contribution of 3.83 Mt from marine sector and 7.21 Mt from inland sector. The fish prices in domestic market are rising leading to issues of fish availability, accessibility and affordability. Global capture fishery production has been plateauing and has more or less stabilized at around 80 million t. (FAO, 2012a). Trend in the state of marine fish stocks shows that proportion of overexploited and fully exploited marine fish stocks are increasing with simultaneous decrease in fish stocks that are not fully exploited. Studies from five ocean basins revealed 90% decline in numbers of large predatory fishes since the advent of industrialized fishing (Myers and Worm, 2003; Worm et al., 2006). Fishing down the web effect is pervasive in world fisheries, including Indian fisheries. World per capita food fish consumption hits a record high of 20 kg per year from an average of 9.9 kg (live weight equivalent) in the 1960s to 18.4 kg in 2009. With the increasing global population, in order to maintain at least the current level of per-capita consumption of aquatic foods, an additional 23 million tonnes of fish will be required by 2020.

Marine population relies upon the great biodiversity of habitats and resources for food, materials, breeding and larval disposal environment. This interdependence is essential and maintaining a balance between them is cardinal. But the marine ecosystems are deteriorating at an alarming rate mainly due to over exploitation of species, introduction of exotic species, pollution from urban, industrial, and agricultural areas as well as habitat loss and alteration of water diversion, and excessive use of water resources. As a result, valuable marine aquatic resources are becoming increasingly susceptible to both natural and anthropogenic driven environmental changes.

Widespread impacts of human activities on the oceans continue to cause declines in species diversity and abundance. As recognition of the benefits that healthy marine ecosystems provide to people increases protecting biodiversity and the essential ecosystem services supports has become a priority for the scientific community, resource managers, and national and international policy agreements, including the Convention on Biological Diversity (CBD). Decreases in species richness or abundance can threaten ecosystem services such as fisheries or nutrient cycling, and can reduce overall ecosystem stability and resilience. These declines have been documented for numerous marine ecosystems and can sometimes lead to major shifts in food web dynamics. Many of these changes can be attributed to human impacts such as climate change, overfishing, and pollution. However, limited capacity and financial support for conservation and management necessitate that resources be directed to regions where investment could best sustain areas of high marine biodiversity and their associated ecosystem services. Overfishing, irresponsible and destructive fishing practices, and illegal, unreported and unregulated (IUU) fishing have long been recognized as leading causes that have reduced biodiversity and modified ecosystem functioning. Marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality, and recover from perturbations. Recent studies indicate that investing to achieve sustainable levels of fishing by strengthening fisheries management, financing a reduction of excess capacity on the conventional resources and adoption of a responsible fishing regime are required to rebuild the overfished and depleted conventional fish stocks.

Marine fish capture in India

Marine fish production of India increased to 3.83 million ton in 2017 contributing 38 per cent of the total fish production. About 1, 94,490 fishing crafts of various sizes and classes are under operation in marine fisheries, consisting of 72,559 mechanized, 71,313 motorized and 50,618 non-mechanized fishing vessels. Shelf resources are subjected to high intensity of fishing pressure and

are exploited at levels close to or exceeding optimum sustainable limit. Problems of juvenile finfish mortality and bycatch discards increased with the intensification of shrimp trawling. Plateauing of catches from mid 1990s, economic and growth overfishing at several centres, and inter-sectoral conflicts in the coastal belt have highlighted the need for regulation of fishing capacity, adoption of responsible fishing practices and caution in marine capture fisheries development. Overfishing and fishing down the web effect is evident in Indian fisheries. Removal of excess fishing capacity and adoption of responsible fishing gear and practices and a conducive fisheries management regime would contribute to the long-term sustainability of the resources, minimize negative environmental impacts, protect biodiversity and facilitate rebuilding of the depleted marine fish stocks.

Species composition and Fisheries trade in India

The marine fish landings across the years had increased and the landings were estimated at 3.83 million tonnes in 2017. The total valuation of marine fish landings at the landing centre (point of first sales) was estimated at 52431 crores and that of the retail centres was found to be 78408 crores during 2017-2018. The markets had been the major driving force behind the realization of the huge value of landings. It is also important to note that the marketing efficiency was found to be quite high with the fishermen share in the consumer's rupee of 63.88 per cent. Nevertheless the producer share in the consumer's rupee has varied sizeable based on the commercial value of fish, seasons, landings source and proximity to consumption centres.The valuation of Indian fisheries vis a vis Landings – Major species is given in Table 1.Although the Oil sardines registered the highest landings, they contribute 8.87 per cent of value of share in the landings. Due to reduced share of the Threadfin breams landings in 2017 their share in value came to a low of 4.13 per cent.

Table 1. Species wise share in Landings (in per cent)

Species	Landings (tonnes)	Share (%)
Oil sardine	338,029	8.87
Indian mackerel	295,246	7.75
RIBBON FISHES	240,502	6.31
Other sardines	236,668	6.21
Penaeid prawns	211,749	5.56
Non-penaeid prawns	202,216	5.31
Other perches	194,118	5.10
Threadfin breams	157,170	4.13

Markets had been the major drivers for the fisheries production system channeling the fish landed/ produced in realizing the value. The functional growth of the markets in terms of its size, designs, infrastructure, realm of functioning, degrees of competition, nature and volume of transactions, periodicity played a major role in the realization of such high value at the different constituents of the value chain. With the changing economic scenario and fish being a vital commodity being traded at the domestic and international markets, importance of fish in the food and nutritional security, employment generation and income earning the marketing of fish plays a very important role in the fishing business. The marketing system also poses a scope for more institutional interventions .The current level of marketing couldn't ensure high quality of fish on account of unhygienic practices and doesn't offer much option for the consumers. The fish needs to reach the different nuke and corners of the country for which the market potential is to estimate .It is important to note that the fish consumption is restricted mostly within the near vicinity of less than 50 km of the production centers. There if found to be movement of fish across the different districts/ states which could solve the seasonality issues of fish in the country. Nevertheless the demand patterns have improved much and the increased fish consumption was found mostly among the existing fish consumers rather than adding new consumers into the fish consuming population. It is estimated that 56 per cent of the population eat fish with a per capita consumption of 4kg/ annum.

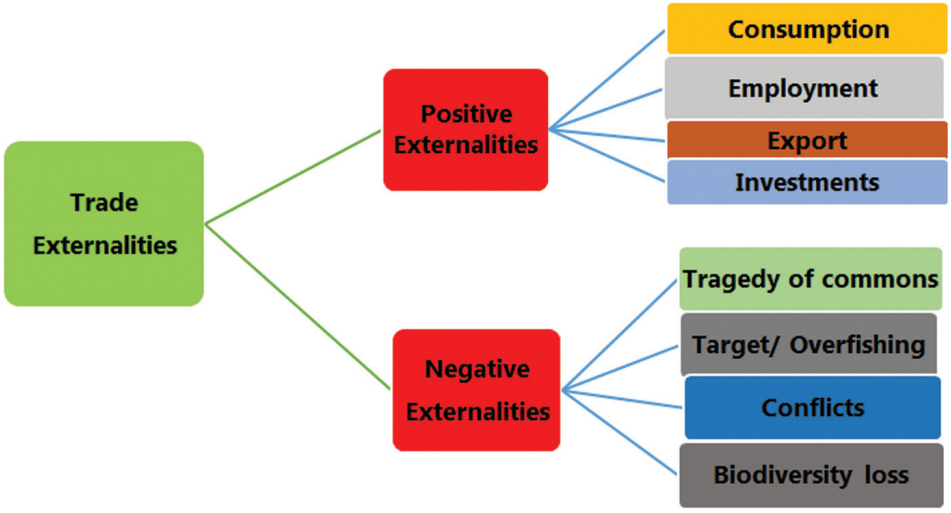
The technological innovations, improvements in the infrastructure over the years the marine fish marketing is grappled with numerous bottlenecks at the production, distribution and consumption centres. These had been due to the inelastic nature of supply and distress sale, seasonality of landings during peak and lean seasons, huge amount of by catch/ discards due to non-efficient marketing systems and latent markets, distress sales due to the geographical differentiation of the production and consumption centre, indebtedness to the middlemen(traders), lack of institutional and policy support, Inadequate cold chain facilities, lack of value addition, poor marketing infrastructure ,improper fish handling, seasonal variations in demand & supply, unhygienic handling and poor quality control, unethical trade practices and highly localized preferences.

Amidst of these now according to fishers, fishing activity substantially evolved in the area with time, expanding towards deeper grounds and towards areas more distant from the coast. The maximum amount of catch ever caught and the weight of the largest species ever captured inversely

declined with time. The fish marketing and trade are crucially affected by the depletion of fishing grounds where depletion occurred. The ecological changes of marine biodiversity during the last half of the century cause the decline of commercially important fish .Declines and extirpations were in line with available quantitative evaluations from stock assessments and international conventions, and were likely linked to fishing impacts. These changes were likely related to trophic cascades due to fishing and due to climate change effects. The species composition of depletions, local extinctions and proliferations showed differences by region suggesting that regional dynamics are important when analyzing biodiversity changes and there by fish trade. *However the WTO fisheries negotiations are often said to provide the single greatest opportunity for the marine fishery. The focus is on cutting the subsidies that allow for the overexploitation of fisheries, and thus on safeguarding the resource itself and the significant economic and livelihood gains. In addition, the phase-out of destructive subsidies would open up the possibility of re-channeling subsidies into carefully crafted management schemes, as well as into conservation initiatives such as Marine Protected Areas. As such, the benefits for ocean biodiversity as a whole could be rich and generate positive outcomes for generations to come.*

Externalities in Fish trade

An externality is a positive or negative consequence of an activity experienced by unrelated third parties. Externality occurs in an economy when the production or consumption of a specific good impacts a third party that is not directly related to the specific production or consumption. In fisheries, externalities are defined as every external effect caused by individual fishers but not included in their accounting system. Externally imposed benefit of trade is a positive externality and those imposed cost is a negative externality. Externalities in fish trade are in evitable. There are positive as well as negative externalities exists for fish trade. Fish consumption, employment, export and trade are considered as the positive externalities. of fishers whereas MSY, sustainability, target fishing, over fishing etc. are noted as the common negative externalities.



Fish has become an indispensable part in the food basket of the as it is considered as a healthy food which is rich in edible protein. It is considered as the poor man's protein and it is a source of cheap and nutritious food assuring food security. Due to the increased fish trade people consume more fish despite of the price. During the early 70's fish consumption pattern stood at 15kg per annum were it declined, but the reality is that at each household there is at least one meal with fish every day. About 80-85 percent of India's population are non – vegetarians and with the shift in lifestyle and upsurge in the cost of meat, the fish intake in is flourishing and also the fish consumption in rural areas is higher than the urban area. The high fish consumption and trade imparts fish investments in the fisheries sector showing the best positive externality in fish trade. The increased investments thereby enhance the sustainability of the trade promoting high employment opportunities and also export. Kerala is considered as the greatest fish consuming state in the country and the average per capita fish consumption is 27-30 kg. The hike in fish consumption is mainly associated with the upsurge in income, increasing health consciousness and changing life style of the people. While considering the domestic fish market which is managed not only by the purchasing power of the consumers but also mostly by their taste and preferences.

Fisheries sector contributes significantly to the national economy while providing livelihood to approximately 14.49 million people in the country. It has been recognised as a powerful income and an employment generator as it stimulates growth of a number of subsidiary industries and is a source of cheap and nutritious food besides being a source of foreign exchange earner. Among the nine coastal states of India, Kerala holds the second position in terms of fisher folk population. The fisheries sector in India has undergone rapid changes over the last six decades to develop from a sustenance fishing to the status of a multi-crore fishing industry. The Indian economy has relies sufficiently on fishing for subsistence, livelihood and employment. Within Kerala, consumption of fish is four times the national average and the state produces 16.6% of the shares of India's total marine exports, the second largest in the country. The fisheries sector offer promising future for the livelihood, employment and food security. There also exists a wide competition among the buyers for fish. It was noticed that for certain species like sardine, mackerel, seer fish, squid, cuttle fish and ribbon fish the domestic market price is higher when compared to the export market price. Even though the export earns us a valuable income, the diversification of fish and fishery from local communities thus there is a prevailing question on the availability and affordability of fishes in the domestic market.

Fishing externalities are commonly negative and occur when fishers can freely enter and capture a resource, and where a voluntary agreement of co-operation does not exist; in these cases, resource users do not consider the external effects impose on others. Tragedy of commons, target fishing, conflicts and biodiversity loss are considered as the major negative fish trade externalities. Too many boats running for few fishes create a high negative externality and thereby increasing the chance of tragedy of commons. The increased target fishing and over fishing also promotes the tragedy of commons and thereby biodiversity loss. Due to the increased fish trade majority of the fish trade is with the drawlers despite of others creates conflicts among fishers. The entry of new vessels reduces stock availability and hence the harvesting costs of others. Fishers do not consider these costs because they only take into account their private fishing trip costs (internal); ignoring

the external costs imposed to others by stock reduction. Vessel aggregation on the fishing grounds increases marginal catch costs. Occurrence of such externalities depends on the extension of the fishing ground and the stock magnitude. Fishing effort will not be perfectly allocated in space (*e.g.*, over the greatest resource concentrations) and time (*e.g.*, they would wait to have access to a limited fishing ground). This externality is commonly seen in sedentary species with patchy distribution, where the exploiting strategy tends to sequentially deplete the most profitable beds.

Moreover technological externalities also arise when the fishing gear changes the population structure dynamics of the target species and associated by catch, imposing negative effects to other fishers, and affecting the abundance of incidental species which might constitute the target of other fisheries. Two types of technological externalities could be distinguished:

(i) Sequential externalities: Occur when artisanal and industrial fleets exploit different components of the population structure of the same species, thus affecting each other. Artisanal vessels tend to apply their fishing effort close to the coastal zone where juveniles inhabit, while the industrial fleet generally operates in deeper waters, exploiting the adult component of a stock. Thus, a substantial increase in fishing effort of the artisanal fleet would cause recruitment overfishing and a decrease in stock availability for the industrial fleet in subsequent periods, *i.e.*, a negative externality for the industrial fleet. Analogously, an increase in fishing effort of the industrial fleet will diminish the spawning stock, affecting subsequent recruitment and thus stock availability for the artisanal fleet.

(ii) Incidental externalities: These arise in technological interdependent fisheries, when fleets use non-discriminatory fishing gears, *e.g.*, a by catch in fishery A diminishes the abundance of those species that constitute the target for fishery B. The non-accounted negative external effect for fishers belonging to fishery A constitutes an incidental externality. It is commonly observed in shrimp and demersal fisheries, where the shrimp fishery generates incidental catches of demersal species, a non-accounted negative effect that generates and externality to the demersal fishing fleet.

Overcapacity

Overcapacity or overcapitalization can be defined as a long term problem in a fishery whereby the size of the fishing fleet, its harvesting ability or fishing power exceeds what is necessary to harvest an optimum yield. Since most fisheries are fully exploited or overexploited, existing fishing capacity exceeds what is necessary to harvest the maximum sustainable yield (MSY) and/or maximum economic (MEY). Optimum harvesting levels are set as part of the management objectives for a given fishery. For instance, food security objectives are best met at MSY, whereas profitability and economic efficiency objectives are met at MEY. The adoption of United Nation Convention Law of the Sea (UNCLOS) ascertained the “level which can produce the Maximum Sustainable Yield (MSY) as qualified by relevant ecological and socioeconomic factors”. Nonetheless, MSY and its proxies and variants are still enshrined as quantitative management benchmarks in national, regional, and global legal fishery frameworks. Although as part of the Convention, the norm is fully binding, its qualification by unspecified “relevant ecological and socioeconomic factors” allows for flexible interpretation and implementation, such that the mandatory norm is still loosely applied in most

countries .The UNCLOS provides also that States should take measures "with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened". While not referring to MSY, this requirement still implies de facto that non-target species should not be overfished either.

Marine debris and pollutants

Abandoned, lost or otherwise discarded fishing gear (ALDFG), generally known as 'derelict fishing gear' and related marine debris of plastic origin are recognized as a critical problem in the marine environment and for living marine resources in terms of the long-term sustainability of fish stocks and biodiversity conservation, due to ghost fishing and habitat loss and impact on endangered species such as marine mammals. Approaches to minimize plastic debris due to abandoned, lost or discarded fishing gear include (i) use twines, ropes, netting, connectors and shackles of correct specifications and breaking strength, in fishing gear fabrication; (ii) introduction of a system of marking fishing gears and procedures for reporting of lost fishing gears and their retrieval; and (iii) compliance of International Convention for the Prevention of Pollution from Ships (MARPOL) regulations which prohibits at sea disposal of plastics and other synthetic materials. Pollution of the marine environment by ships of all types, in terms of garbage, waste oil and oily mixtures and engine emissions is strictly controlled by the International Convention for the Prevention of Pollution from Ships (MARPOL). The discharge of oily mixtures having oil content above 15 ppm, into the sea, is prohibited and all vessels over 400 tons are required to be fitted with oil filtering/separating equipment to comply with this regulation.

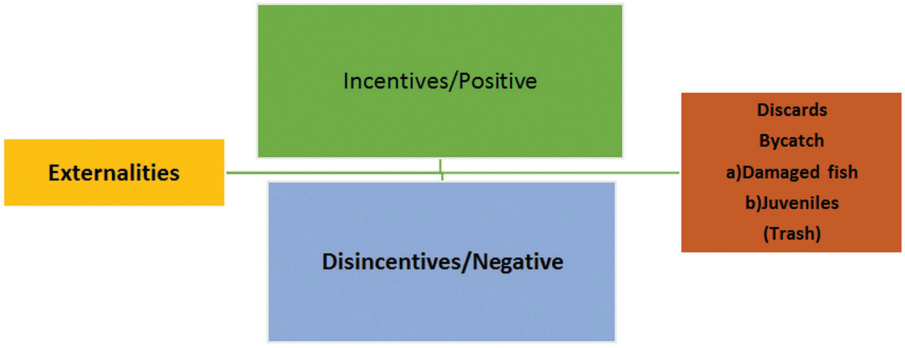
Economic externalities of fishing operations

Fisheries over the years evolved from subsistence fishing towards a capital intensive enterprise. There has been structural transformation in the fishing fleet with motorization and mechanization. The current scenario of marine fisheries in terms of fishing fleets clearly indicates a situation "too many boats chasing too few fishes". Due to the tragedy of commons in operation, increasing fleet size as well as costs of fishing and the decreasing catch per unit efforts, the fishing operations have taken a toll. The mechanized sector is venturing into multiday fishing which negate the losses of fishing cost. Sizeable amount of low value fishes are landed across the landing centres on account

of targeted fishing. Low value fishes include juveniles, bycatch, trash fishes and discards and it is estimated that around 30% of the mechanized landings constitute low value fishes which has a huge untapped economic value. Economic loss due to low value catch could be reduced by implementing mesh-size regulations to avoid juvenile catch, prevent discards and utilizing bycatch. Appropriate utilization strategies are to be developed with respect to discards, regulating multiday fishing operations or innovative measures may be adopted to land the catches on frequent intervals. There exists a huge consumer demand on account of the escalating domestic market prices of fish.

Externalities in trawl operations due to low value fishes

There exist positive and negative externalities in the trawl fishing operations with reference to low value fishes. Discards are thrown back due to non-realization at the landing centers. Bycatch that includes trash fish, damaged fish and juveniles are brought back to the landing centres because of its economic utilities. Thus the low value landing possesses considerable incentives (positive externalities) and disincentives (negative externalities). The positive and negative externalities have been calculated to find net economic losses due to low value fish catch. Damaged fishes are marketable but at very low price. Juveniles of many commercial fishes are being sold at less than '10 per kg. If it is harvested at the table size or with superior quality or caught in proper gears, it may fetch a higher price. So the negative externality was calculated with regard to discards, damaged fish and juveniles. Trash fishes, which were discarded earlier and fetching good market price now are being used for fish meal which has generated an incentive. Based on the incentives and disincentives, the net economic loss/gain by trawl fishing and the landings of low value fishes are worked out.



Technologies to reduce biodiversity loss

Some of the fishing technologies to reduce by catch and discards include the

Gillnetting

By catch in drift gill nets may include marine mammals, sea turtles and sea birds, in addition to non-targeted fish species. Optimization of gill net mesh size and hanging coefficient according to the target species and size group and judicious deployment of gill net in terms of fishing ground, fishing depth and season in order to minimize the gear interaction with the non-targeted species

are important bycatch mitigation measures for gill net fisheries. Recent innovations have attempted to make the gill nets detectable by marine mammals having echolocation abilities, using acoustic pingers and specially treated netting. Lost gill nets continue to gill and entangle fish and other marine organisms which is generally termed ghost fishing. One approach to minimize ghost fishing by lost gill nets, is to use biodegradable natural fiber twines or time release elements to connect the netting to floats. When floats are separated due to the disintegration of these links, the gill nets lose their fishing attitude and consequently lose the ability for ghost fishing. Another approach to prevent ghost fishing is to locate and retrieve lost fishing gear.

Hook and line fishing

Optimized hook design and size and selection of bait type and bait size appropriate for the target species and size class, proper choice of fishing ground, depth and time of fishing are approaches for mitigation of bycatch issues in hook and line fisheries and minimize gear interaction with other species. Interaction with sea birds during long line operation are minimized using dyed bait, deploying bird scaring devices (streamers) in the area where bait is set and by using sub- surface setting chutes for deployment of branch lines. Sub-surface setting chutes, blue-dyed bait, weighted baits and side-sets were reported to have reduced the bycatch of seabirds in the longline fisheries.

Reducing bottom impacts of towed gears

Bottom trawling caused direct and indirect impacts on marine environment and benthic communities .Approaches to minimize environmental impacts of bottom trawling such as semi-pelagic trawl systems, benthic release panels and ground gear modifications in bottom trawls, otter board designs with narrower footprint, smart trawling techniques and low impact and fuel efficient (LIFE) fishing have been discussed by a numerous studies. Semi-pelagic trawls have comparatively low impact on the benthic biota, as it operates a little distance above the sea bottom. Use of lighter ground gear and use of rollers, wheels and bobbins with their axes perpendicular to the direction of towing has been known to reduce bottom impact during trawling, without significantly affecting the catch rates. High aspect ratio vertically cambered otter boards typically have lower angle of attack and narrower footprint compared to traditional otter boards .The area of seabed affected by high aspect ratio otter boards is typically 40% of the area affected by low aspect ratio otter boards with similar board area. Use of shorter and lighter bridles and sweeps, where herding effect is not important in the catching process, could reduce the impact on seabed. Smart trawling systems have been under development in which the distance of otter boards and ground gear from the sea bed is constantly and automatically measured and adjusted by special instrumentation.

Capture based aquaculture

Capture based aquaculture (CBA) is another alternative method to cope up with the externalities of fish trade. Since there occurs high fish trade and consumption capture based aquaculture will enable to increase those positive externalities to a great extent. CBA is an economic activity that is anticipated to expand in the short term, and is very likely to continue into the long term for many species. CBA is practiced because it has become necessary or desirable as a livelihood, as an alternative means of controlling access to fishery resources, to meet market demand and, if practiced properly, to enhance yield.CBA is typically practiced with high value species, often for export or luxury markets, rather than inexpensive food alternatives for local use. One other factor that makes CBA appealing is the belief that taking fishes or invertebrates when they are small and young and placing them into captivity for feeding and protection from predators reduces their natural mortality. In this way, the practice is widely assumed to increase productivity by enhancing survivorship relative to natural levels at a given size or age. Moreover, the degree of bycatch and discards and the mortalities of wild seeds during and after capture (i.e. from capture and during culture) can be extremely high, factors rarely considered when examining the culture of such species. As the demand for seafood grows and over-fishing and competition for fishery resources increase, CBA is inevitable and must be addressed directly to ensure sustainable practices.

Value Addition

The fishery sector is in its hike in the fish trade and consumption however large quantities of fishes are discarded because of size, species, uneconomic to preserve etc. It has been estimated that the global amount of discard of by-catches is in the range of 17-39 million tons/year with an average of 27 million tons/year. Factors discouraging the landing of the by-catch are the low market value of the material, the size and species composition, the lack of suitable refrigerated storage space on-board and the possible reduction in marketing efficiency. Consumption of fish may be greatly increased there by raising the positive externalities of fish trade by making better use of the existing catch. Due to lack of infrastructural facilities like ice plants, landing facilities etc. the quality of the fish is downgraded particularly in developing countries leading to their use as aquaculture feed. Through improvement in infrastructure facilities, the quality of the landings can be upgraded for direct human consumption. The up gradation of these species may be achieved by use of improved handling and processing techniques on one hand and developing different products by the preparation of value added products on the other hand. The seafood industry in many countries is undergoing a rapid transformation to process more ready-to-cook and ready-to-eat food in convenient packs. Indian seafood industry, by and large, still remains a supplier of raw materials to the pre-processors in foreign countries and 90 per cent of it goes in bulk packs, which is the prime reason for lower unit value realization. So interventions should be made to promote the production of value added fish products to increase the consumption rate as well as the export rate and thereby decreasing the negative externalities such as over fishing and biodiversity loss.

Conclusion

Fisheries management is a complex process that requires the integration of resource biology and ecology, with socio-economic and institutional factors affecting the behavior of fishers and

policy makers. The purpose of this is to aid a decision-making to achieve a sustainable development of the activity, by analyzing the measure to improve the positive externalities and to reduce the negative externalities in fish trade, so that future generations can also benefit from the resource .Consumption studies show that fish consumption has increased to its peak and consumers are pay more money than producers get. The development of a real time fish market grid to act as a decision support system would ensure fish market and price information dissemination about availability, accessibility and affordability of fish. Government interventions should be made in regulating fish exports and substituting exports with increased value added fish products. Hence the employment opportunities on the same could also be enhanced. Moreover the investments in the post harvesting sector should be increased to reduce the spoilage losses. Governmental measures for the manufacturing of boats, registration, color codes etc. could reduce the tragedy of commons. Also earmarking fishermen as the primary stakeholders are one of the best method to reduce conflicts among the fishers. Sustainability has been far more difficult to achieve that is commonly thought almost 70% of the individual fish stocks around the world are fully to heavily exploited, overexploited or depleted .Indeed, depressed yields, coupled with a rise in demand and prices, determined a systematic decreasing trend in catch rates and global landings. Conventional management measures, such as minimum size limits and reductions in catch or in fishing effort, have been used to promote stock rebuilding by reducing fishing mortality and increasing survival of spawning stocks.

The Adoption of ecosystem based fisheries management which incorporates responsible fishing practices along with strict regulation of fishing capacity at sustainable levels and establishment of marine protected areas (MPAs) would facilitate protection and restoration of biodiversity and enhance the resilience of the fish stocks and ecosystem services. A wide range of proven technologies and procedures are readily available for minimizing the direct and indirect impacts of harvesting operations on biodiversity. Adoption of such technologies may only be successful with the active involvement of stakeholders in the process, supported by a system of incentives and disincentives and training, under a participatory management regime. BRDs and TEDs need to be adopted and enforced legally, under a participatory management regime, in order protect the biodiversity and prevent trawling. Ecofriendly practices are to be promoted in purse seining, gillnetting, lining and trap operations, to minimize the impact on non-target species and environment. Technologies and procedures for minimization of GHG emissions from the fishing fleet need to be promoted through legislation, stakeholder education and training. Procedures for minimization of plastic waste originating from abandoned, lost or discarded fishing gear, need to be adopted. Strict regulations for safe disposal of garbage, oil, oily mixtures and other residues originating from fishing vessels operations, need to be promoted and implemented, for protecting the health of fisheries environment.