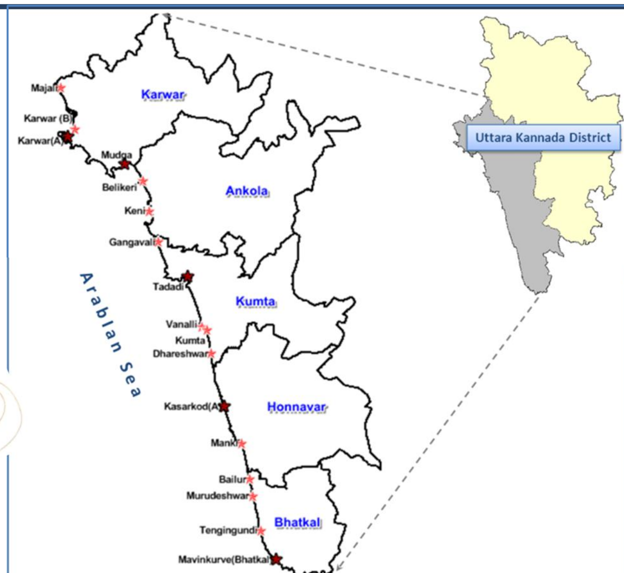
Sahyadri Conservation Series 39

Status of Marine Fishery in Uttara Kannada

Ramachandra T.V.　　**Subash Chandran M.D.**　　**Joshi N.V.**

Prakash Mesta



Western Ghats Task Force, Government of Karnataka
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The Ministry of Science and Technology, Government of India
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ENVIS Technical Report: 69

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Environment Information System [ENVIS]
Centre for Ecological Sciences
Indian Institute of Science
Bangalore-560012, INDIA

Web: http://ces.iisc.ernet.in/energy/
http://ces.iisc.ernet.in/biodiversity
Email: cestvr@ ces.iisc.ernet.in
energy@ ces.iisc.ernet.in

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Sl.No	Content	Page No

Status of Marine Fishery in Uttara Kannada

1.0 SUMMARY

India has a coastline length of 8,121 km long coastline is the world's third largest fish producing nation, and an Exclusive Economic Zone of 2.02 million km². Fish and fishery products are a vital and affordable source of high-quality protein, especially in the economically disadvantaged regions. Karnataka State has 300 km of coastline and 27,000 sq km of continental shelf area, rich in pelagic fishery resources. Fisheries sector contributes 0.7% of gross SGDP and 3.18% of Net SGDP to Karnataka State's economy at current prices. Uttara Kannada, the district situated along the north-west of Karnataka, has a coastline of 190 km bordering the Arabian Sea. Coastal fishery is one of the most important subsistence and economic activity in the district, perhaps next only to farming. Mackerel and Oil sardine are the main components of the pelagic fishery wealth of Uttara Kannada coast. Pelagic fish live near the surface or in the water column of coastal, ocean and lake waters, but not on the bottom of the sea or the lake. 331 fish taxa occur in the coastal and marine areas of Uttara Kannada and 89 fish taxa associated with the coral formations of Netrani Island, 12 nautical miles off Bhatkal coast. The district has 11,141 families engaged in fishing activities, bulk of them settled along the coastline fringed with estuaries and salt marshes, sandy and rocky beaches. These families together account for about 61,036 of members, of whom 10,260 men and 2,733 women are engaged in marine capture fishery operations. In coastal fish culturing activities are engaged 784 men and 195 women. In inland capture fisheries are engaged 2731 men and 221 women and in involved inland fish culturing are 308 men and 228 women.

It is necessary to increase the contribution of marine fisheries to the food security, economies and the well-being of coastal communities. It requires effective management plans to rebuild overexploited stocks. Recommendations for the sustainability of marine fishery in a broader context of west coast and national fisheries are:

1.0 Strengthened governance and effective fisheries management: Promoting sustainable fishing and fish farming can provide incentives for wider ecosystem stewardship. This requires

1. **Adoption of an ecosystem approach to fisheries and aquaculture**

- ***Ocean and linked coastal water bodies*** like estuaries, creeks, lagoons, salt marshes, mangrove areas etc. are to be considered as interconnected and valuable ecosystems producing rich food without practically any inputs from humans. These coastal and marine aquatic habitats need to be considered holistically for integrated management.
- ***Pollution, reclamation, misuse or degradation*** of such ecosystems are to be strictly monitored and prevented.
- ***Places of fish breeding*** within the marine areas and coastal backwaters are to be identified and demarcated as protected zones, in the interest of sustainability of marine fisheries.
- ***To promote the breeding stocks of fishes***, it is necessary to know the breeding months of various commercial fish species. Regulations should be imposed on capture especially of breeding stock of fish species by targeted fisheries sector. For instance peak spawning of mackerel was observed during July-August. The percentage of this fish with mature ovaries was 60% of the total in purse-seine operations in late August (Rohit and Gupta, 2004). The ban on mechanized fishing during this period will be helpful in stock recovery of mackerel and many other fishes. Stoppage of intake of such fishes by cold storage units for export purpose may be prevented so that adequate stocks remain. However, there need not be ban on artisanal fishery and capture by small mechanized crafts
- ***Estuarine integrity*** is very critical for several kinds of marine fishes and prawns which enter the estuaries for breeding or multitudes of their juveniles (fish and prawn seeds/larvae) enter the estuaries to feed and grow in the estuarine habitats like mangroves, sedge areas, mudflats, molluscan beds etc. Integrity of these habitats should be safeguarded through strict implementation of CRZ and considering such areas as ecologically sensitive areas. Involvement of local Village Forest Committees, Biodiversity Management Committees etc. will be of help in keeping vigilance at local level. These committees may be extended financial assistance under the existing forestry schemes or provisions of Biodiversity Act -2002. The Nushikote VFC in the Aghanashini

estuary of Kumta, helping the Forest Department in planting and protection of mangroves, is a notable example.

- ***Multi-species mangrove vegetation*** need to be raised in all areas of estuaries suitable for the respective species combinations.
- ***Estuarine rice fields*** of Uttara Kannada, especially of Aghanashini estuary, where salt tolerant Kagga rice used to be grown, are locally well known as natural feeding grounds of marine shrimps and various marine/coastal fishes because the farmers used to harvest the tall paddy by cutting only the head portions leaving the rest in the field to degrade and become manure. The paddy stumps in post-harvest fields flooded with salt water are ideal places for juveniles of shrimps as anchoring places. These residues eventually become rich nutrients. However, because of intensification of aquaculture in recent decades many of these estuarine fields or *gaznis* are badly affected, and abandoned for cultivation. The Government should initiate steps to repair the *gazni* bunds and install sluice gates wherever damaged and desilt the *kodi* channels in the interest of not only marine and estuarine fishing but also for boosting the sagging production of rice.
- ***Destruction/degradation due to damming of rivers*** for power generation has severe adverse consequences on coastal fishery, including bivalve production through reduction in post-rainy season salinity. This has been noticed in Sharavathi and Kali estuaries, most severe collapse of fishery happening in the former where estuarine water has turned almost into fresh water with salinity less than 0.5 ppt.
- ***Likely diversion of rivers*** will have adverse consequences on estuarine salinity and ecology and on marine and estuarine fisheries.
- ***Need for removal of estuarine mouth siltation*** is necessary for Sharavathi, Aghanashini and Gangavali estuaries where siltation has affected the free movement of tides and therefore of marine fishes entering these estuaries for breeding/feeding.
- ***Regulation of sand and shell mining*** in the estuaries is very important for revival of estuarine and marine fishery. Shell extraction may be limited to the needs of local lime makers and large scale mining may be prohibited in the estuaries for at least the next ten years and the positive influence on coastal fishery studied throughout the period.

2 Rebuilding collapsed/declining stocks: The Government of India should adopt a dynamic marine fishing policy through prohibiting periodically export of any fish species the fishery of which is in collapsed/declined state (catches less than 5% of historical maximum), or those species which are seriously depleted or declining to less than 50% of their historical maximum catches, through a comprehensive evaluation system. Such ban may be lifted after the recovery of the stock of such populations to healthy levels. Fishery of all species with collapsed stocks has to be carefully monitored. In the interest of species survival and sustainability

3 Need for more responsible fishing: Consensus should prevail that fishing (aquaculture excluded) is not an industrial or business activity but more of an output of ecosystems, which need to be harvested strictly within sustainable limits. Fisher-folks, from time immemorial, depended on fishing for their livelihoods and over-exploitation never happened until commercial, mechanization dominated fishery in the recent times. Wild genetic stock of fish in the marine areas has to be maintained even for the success of aquaculture, where the cultured prawns and fishes are prone to diseases, pollution problems etc. for the surroundings including the marine areas.

4 Impose uniform monsoon fishing ban in consultation with CMFRI: The Government of India, through State Governments of respective maritime States, should implements a fishing ban during the monsoon every year, which is a peak season for breeding of many fishes. August is considered peak breeding season for Mackerels for which Karnataka coast is famous. The existing ban on fishing during monsoon by mechanized boats in Uttara Kannada by the State Government for 2013 is from June 15 to July 31, and in Dakshina Kannada from June 15 to August 10. According to CMFRI scientists Rohit and Gupta (2004) 60% of the total Mackerel catch in purse-seine operations during late August were with mature eggs; such catches are likely to have adverse effects on the future stocks. Although there could occur some variability in dates and duration of fishing ban in different states, disparities need to be reduced.

The fishing ban lasts for 45-60 days with each State using a different time period or criteria such as advancement of monsoon as an indicator. Absence of a uniform ban period throughout the coastline has led to fishing trawlers of several States using this legal technicality to fish where fishing ban exists and land in an adjacent State where there is no ban. Fishermen in Goa, Karnataka and Maharashtra along the west coast, complained that the very essence of the fishing ban is flawed as vessels from neighbouring States continue to catch from one State's territorial waters and land in another, leading to low catches during the post ban period. With most of the coastal States having weak enforcement, due to huge gaps in allocated infrastructure, manpower and monetary resources, illegal fishing persists through domestic fishing vessels in inshore waters. Moreover, it also leads to problems in misreported catches where fish caught in one jurisdiction is reported as caught in another location.

To reduce such anomalies it is recommended that the fishing ban from Kerala to Gujarat should be during the same period, with maximum flexibility between any two neighbouring States not exceeding five days.

The artisan fisherman may be permitted to fish in near-shore waters during the fishing ban period, using their traditional fishing gadgets. Fishing concessions to a limited extent may be given to indigenous crafts with outboard engines within a five km distance from the shore.

5 Strict regulations on mesh sizes of nets: majority of the depleted and collapsed stocks of South-west India are those species which are mainly caught in trawls. As a first step for rebuilding stocks, trawl effort has to be reduced in both Kerala and Karnataka and strict implementation of the mesh restriction policy on trawl and purse-seine nets is very necessary. Serious thought should be given to revival of Cat fish population which is very badly affected by indiscriminate pure-seining using nets with small meshes where even eggs cannot escape. Karnataka Marine Fisheries Regulation Act requires all mechanized trawlers operating along the coast to use a cod end mesh size of at least 30 mm but, most of the trawlers use 10-15 mm cod end mesh size resulting in indiscriminate capture of juveniles of fish and shrimps. This has also contributed to substantial discards during the monsoon season.

6 Reducing the carbon footprints of marine fishing boats: Unrestrained mechanization of the Indian marine fishing sector has not only nearly destroyed traditional artisanal fishery and resulted in imminent collapse of numerous commercially exploited fishes but also caused the release of phenomenal quantities of CO_2 emission. This requires:

- Improving fuel efficiency of marine fishing boats

- Reducing the mechanized fleet size to half the present number, limiting to sustainable catches, in a gradual process through not giving new licenses until targets (sustained yields) are achieved
- Strict enforcement of reserving about 5 km zone from the coastline for non-mechanized fishery and for operation of traditional *rampani* nets etc.
- A shift from fuel-intensive active fishing methods such as trawling to passive methods such as seining, lining and gillnetting.

7 Promotion of artisanal fisheries: estimates indicate that illegal fish catches by trawlers in the inshore traditional zone resulting in annual loss of 1200 - 1950 tons. This loss, needless to say, affects the artisan fishers using canoes and plank built boat, cast nets, shore-seine nets and long lines. The operation of mechanized crafts in the inshore waters (5 km zone) needs to be prohibited to alleviate poverty and underemployment among artisanal fisherfolks.

8 Reducing fishing by-catches/discards: Introduction of modern fishing methods and targeted fisheries have resulted in wasteful by-catches of juvenile fishes, non-targeted species like turtles, other fishes, marine invertebrates etc. Such by-catches also have very serious food security implications on one billion people who depend on fish as their principal source of food. Results from this study shows that discards have increased for two main reasons. Firstly, the number of trawlers operating along the Indian coastline has increased over the past four decades. Secondly, the duration of fishing trips by multiday trawlers is in the order of 10-12 days, with trawlers along the Kerala, Karnataka and Maharashtra coastlines increasingly targeting deep sea stocks at 150-350 meters during most of the year. Increasingly, longer fishing trips in deeper waters means that non-commercial species of fish and shrimps are encountered in larger numbers. The operators of these trawlers cannot store trash fish from all the hauls during each trip, a good part of which are discarded into the sea. Gujarat has a more efficient trash fish collection as they are purchased for higher prices for fish meal factories. More and more landing of trash fish is reported to compensate for decline of commercial fishes. The following are recommendations to reduce by-catches:

- From a sustainability point of view, limitation of fishery production to safe biological limits is necessary before seeking export markets for the products.

- Given the dynamic complexity of marine ecosystems and the often inter-mingling of various types of species, the practical reality, however, is that selecting and catching only that which is managed will not be solved solely through selective fishing gear. Consequently, the most pressing priority for bycatch reduction and over-fishing, should be reducing the amount of fishing, to meet more the domestic needs than catering to the global demands.
- Trawler fishing should be phased out to reach sustainable numbers by limiting licenses for new ones.

9 Advisability of aquaculture: The marine fishery resources are on the brink of collapse with most fishes and seafood in demand having already reached declined, depleted or collapsed states. Aquaculture, one of the fastest growing enterprises in the world, is considered as a strong solution to reducing pressure on marine fishery allowing for recovery of depleted stocks. A variety of chemicals used to inhibit the growth of other organisms may also affect other organisms. The fishing communities of Uttara Kannada coast have complained that the use of bleaching powder and lime in estuarine aquaculture ponds create massive deaths of juveniles of prawns and fishes.

10 Eco-friendly aquaculture: Government of India enacted the Coastal Aquaculture Authority Act, 2005, enabling the establishment of the Coastal Aquaculture Authority for enforcing proper regulatory measures for carrying out coastal aquaculture in a more sustainable and eco-friendly manner. The awareness levels of coastal shrimp farmers were inadequate and neither the State Government nor the farmers were geared to meet the challenges that were posed by issues such as pollution, viral diseases, etc. The National Fisheries Development Board (NFDB) has allocated funds for training, awareness and enhancing skills for coastal aquaculture, for shrimp and finfish farming. There is a need to set up a dedicated Monitoring and Evaluation Cell in the Department of Fisheries to periodically monitor and evaluate activities implemented under the NFDB.

1.0 INTRODUCTION

Fish and fishery products are a vital and affordable source of high-quality protein, especially in the world's poorest nations – in 2008, fish food was used by more than three billion people. In 2010, people consumed about 128 million tons of fish. In the last five decades, world fish food supply has outpaced global population growth, and today fish provides more than 4.3 billion people with about 15% of their intake of animal protein. In 2010 fish consumption was estimated to be at an all-time high of 18.6 kg per person. The oceans being the major source of fisheries, maintaining the long-term prosperity and sustainability of marine fisheries is not only of political and social significance but also of economic and ecological importance. To meet the food and nutrition needs of an expanding population, to alleviate poverty and to enhance economic growth the fisheries and aquaculture sector offer increased opportunities. (FAO, 2010, 2012; Yimin Ye & Cochrane, 2011).

Stimulated by higher demand for fish, world fisheries and aquaculture production is projected to reach about 172 million tons in 2021, with most of the growth coming from aquaculture. Aquaculture will remain one of the fastest-growing animal food-producing sectors. Fisheries and aquaculture are growing faster than agriculture providing about 55 million jobs. Including ancillary activities (e.g. processing and packaging) and dependents, the sector supports the livelihoods of 10–12 percent of the world's population. Fish and fishery products continue to be among the most-traded food commodities worldwide. Following a drop in 2009, world trade in fish and fishery products has resumed its upward trend driven by sustained demand, trade liberalization policies, globalization of food systems and technological innovations. Estimates for 2011 indicate that exports of fish and fishery products exceeded US$125 billion, with average prices increasing by more than 12 percent (FAO, 2012).

While projecting such a rosy picture FAO (2012) also warned on over-exploitation stressing more responsible fisheries. Climate change impacts will increase uncertainty in fisheries sector also. Illegal, unreported and unregulated fishing is an obstacle to sustainable fisheries in developing countries with limited technical capacity. High energy prices and greater ignorance on ecosystem impacts present major challenges to the viability of fisheries, particularly in developing countries where access to and promotion of energy efficient technologies have been limited. UN (2012) emphasizes the need for transitioning to a green economy, through measures like the elimination of harmful subsidies and the use of greener production and processing methods. Better information management and conservation measures, including monitoring, control and surveillance systems also need to be developed and implemented.

Economically important marine organisms may be grouped into:

i. **Demersal fish**. These are bottom-living fish such as cod and shark. These species tend to concentrate on broad continental shelves.

ii. **Pelagic fish**. These are species that inhabit the upper parts of water column, such as sardines, mackerel, anchovy, and tuna. The most spectacular fish catches are made of surface-shoaling pelagic species. Demersal fishes and pelagic fishes combines make up the majority of the fish catch - about 72 million tons per year.

iii. **Crustaceans**: This group consists of bottom-dwelling species (crabs and lobsters) as well as swimming invertebrates (krill, shrimp).

iv. **Molluscs and Cephalopods**: These include various species of squid, cuttlefish, and octopus. About 2.5 million tons of cephalopods are harvested each year.

v. **Marine mammals**: This group has been heavily exploited for oil and meat, although they make a relatively small portion of the global fish catch. Following the commercial extinction of the large baleen whales such as the blue, humpback, and fin, smaller species such as the minke and sei are being taken. Dolphins and porpoises are hunted locally. (India, however, is an exception in harvesting marine mammals).

1.1 Global absolute and per capita fish catch, 1950-2000: Global marine fish harvest history for the period 1950-2000 shows that total catch has climbed fairly steadily since the 1950's from about 20 million tons to 100 million tons where it seems to be stabilizing (Figure 1.1). However, the harvest per capita has grown little and has stabilized around 20 kg/head from late 1960's, because of population expansion. Seafood availability per person will shrink as population expands, leading to rising prices. World over over-exploitation of marine fishery resources is happening leading to tremendous decline in fishery of much sought after fishes.

(http://www.globalchange.umich.eduglobalchange2/current/lectures/fisheries)

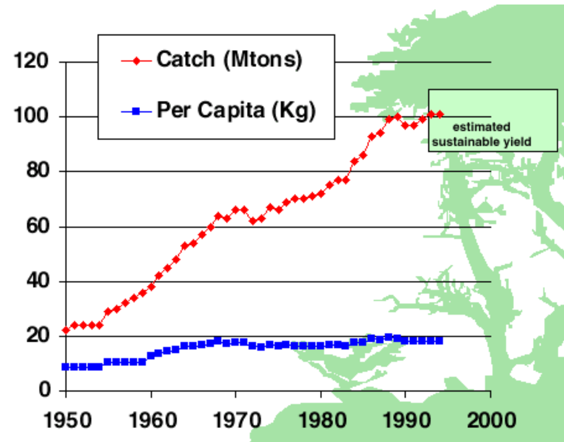

Figure 1.1. Global absolute and per capita fish catch, 1950-2000 (http://www.globalchange.umich.eduglobalchange2/current/lectures/fisheries)

India is the world's third largest fish producing nation and second in inland aquaculture (World Bank, 2010). India has a coastline length of 8,121 km long coastline, and an Exclusive Economic Zone of 2.02 million km². India's continental shelf is 0.5 million km². Its inshore area of <50 m depth is 0.18 million km². India's estimated 3.5 million marine fishers population live in 3,202 villages. Of these 0.9 million are active fishers population. Of these 20% are associated with motorized and 20% with mechanized boats, while 60% are artisan fisher folks. Fishing vessels are owned by 30% of this population. From infrastructural point of view the country has 1,332 fish landing centres, 6 major and 27 minor fishing harbours. The marine fishing sector uses 58,911 mechanised vessels, 75,591 motorised vessels, and 104,270 non-motorised crafts. Gross value of marine fishery at landing centres was estimated at Rs.19,753 crore, at retail point Rs.28,511 crores and export earnings US $2.8 billion; 3% of total export earnings from marine fisheries (Source: Zacharia - (http://www.cmfri.org.in/uploads_en/divisions/files/Present%20and%20future%20scenario%20of%20Indfian%20marine%20fisheries.pdf)

In the Indian domestic market 81% of marine fishery products are used fresh, 5% frozen in frozen state, 6% as dry and 5% as fish meal. Per capita fish consumption ranges from 2.58 kg in the range of 39 kg to minimum of 0.3kg. The pelagic or surface and shallow water fishery of north-west fishing region of Gujarat and Maharashtra are noted for fishes like Bombay duck, Sciaenids, Sardines, Ribbonfish, Carangids, Perches, etc. The region is good for fishery of penaeid and non-penaeid Prawns and Cephalopods. The south-west region from Goa to Kerala is noted for Sardines, Indian Mackerel, Carangids, Sciaenids, P. prawns and Cephalopods. The Tamil Nadu to Andhra coast mainly produces Sardines, Mackerels, Ribbon fish, Silver bellies, Perches and Sciaenids. The north-east fishing region of West Bengal-Orissa is known for Hilsa, Sciaenids and P. prawns. Whereas Lakshadweep is known for Tunas, the Andaman Nicobar Islands are associated with Cluepeids, Carangids, Mackerels, Tunas and Perches. The South Indian west coast is considered more productive than the east coast (-ibid-).

1.2 Marine fisheries in Karnataka: In Karnataka, fisheries sector contributes 0.7% of gross SGDP and 3.18% of Net SGDP to the State's economy at current prices. The State has 300 km of coastline and 27,000 sq km of continental shelf area, rich in pelagic fishery resources. Out of the Indian Exclusive Economic Zone (EEZ) of 2.02 million sq km, Karnataka has a share of 87,000 sq km. Traditionally, Karnataka coast is known as "Mackerel Coast". The marine fisheries resource potential of the

State was estimated at 4.25 lakh metric tons, of which 2.25 lakh metric tons was expected from inshore areas up to a depth of 70 m and remaining, 2.0 lakh metric tons from the off shore/deep sea zone. The mechanization of fishing operation was initiated with the introduction of 30 ft. to 43 ft. trawlers in 1957 for exploiting inshore demersal fishery including shrimps. Introduction of purse-seines in 1970s extended the area of fishing operation and pelagic fish landings. At present, there are about 1,176 trawlers, 263 purse-seiners, 1,708 multiday trawlers, 5,652 gill-netters, 393 long-liners and 7,365 traditional boats are operating in the State. In recent years, fishermen are being trained in operation of sophisticated electronic equipments both for fishing and navigation (Fisheries Policy of Karnataka – Draft-, 2010).

Marine fish production in Karnataka came to stagnation in the recent years. In the first decade of the current millennium the lowest production of marine fish (1.28 lakh tons) was in 2001-02. However, the marine fish production during 2009-10 was higher at 2.49 lakh tons. Of this production 57,359 tons of marine products worth Rs.391.12 crore were exported from the State. The draft Policy admitted "lot of post-harvest loss" because of poor fish handling practices as well as lack of on board and on shore cold storage facilities". It emphasized the need for value added products. There are 203 ice plants with a production capacity of 3,225 tons of ice per day, 42 cold storages with a storage capacity of 2,715 tons, 14 freezing plants with a capacity of 117 tonnes and 13 frozen storages with a storage capacity of 1,730 tons per day. There are 8 canning plants and 15 fish meal plants in the State (ibid.)- see Table 1.1.

The fisheries sector plays an important role in the socio economic development of Uttara Kannada District, in view of its contribution to the livelihood, employment generation, food basket, nutritional security, large foreign exchange earnings, and income. Marine fish production during 1972-73 to 2010-11 was characterized by wide fluctuations. In fact the trend of total marine fish landings in the State of Karnataka used to be set by the landings of two prominent sea fishes Oil sardine (Kan: tarle,turi) and Mackerel (Kan:bangade). The mechanized fishing crafts which staged their appearance from early 1960's totally dominated the marine fishery by the 1980's. The trawlers, purse-seiners and gill-netters asserted their superiority over the fishing by non-mechanized sector, accounting for major share of the catch. Some basic details regarding Uttara Kannada marine fishery are given in the Table 1.1.

Table1.1: Marine fishery resources in Uttara Kannada

S.n	Particulars	No
1	Coastal length	190 km.
2	Fishing villages	132
3	Fishing population	132959
4	Active fishermen population	59448
5	Fishermen households	18096
6	Harbours	6
7	Fish landing centers	25
8	Mechanized boats	2387
9	Non-mechanized boats	7804
10	Fishing nets	23179
11	Ice plants	38
12	Cold storages	8
13	Freezing plants	4
14	Frozen storages	4
15	Canning plants	1
16	Fish meal plants	2
17	Boat building yards	11
18	Net making plants	0
19	Fisheries Co-operative Societies	43
20	Fishery Co-op. Federations	1
21	Research centers in Marine Biology	3

Source: Deputy Director of Fisheries, Karwar

2.0 MARINE FISHERY: UTTARA KANNDA SCENARIO

From south-west coast, from Kanyakumari to Goa, 184, mostly commercially important, fin fish species have been reported. The most specious family was Serranidae (20 sp.), followed by the Acanthuridae (18 sp.), Labridae (18 sp.) and Pomacentridae (16 sp.) (Sluka, 2013). The CMFRI (2007) has listed 331 fish taxa as occurring in the coastal and marine areas of Uttara Kannada (Annexure-1). Also inventroised was 89 fish taxa associated with the coral formations of Netrani Island, 12 nautical miles off Bhatkal coast, Uttara Kannada (Annexure-2). Details of major gears operated in Uttara Kannada are given in (Annexure-3).

Uttara Kannada, the district situated along the north-west of Karnataka, has a coastline of 190 km bordering the Arabian Sea. Coastal fishery is one of the most important subsistence and economic activity in the district, perhaps next only to farming. Mackerel and Oil sardine are the main components of the pelagic fishery wealth of Uttara Kannada coast. Pelagic fish live near the surface or in the water column of coastal, ocean and lake waters, but not on the bottom of the sea or the lake. They can be contrasted with demersal fish, which do live on or near the bottom.

The marine fish production in Uttara Kannada was around 16,371 tons in 1972-73, with very little mechanization at that time and reached to a peak of over 88,028 tons in 2010-11 (Annexure-4). The average marine fish production in the last 30 years was about 38,651 tons. The fish production from the district contributed about 22 % of Karnataka State's total fish production (2009-10). The current level of per-capita marine fish availability in the district is 6.5 kg/year. Traditionally, Karnataka coast is known as "Mackerel Coast" for the abundance of Mackerels (Kan: Bangade), of which the highest landings were in Mangalore and Malpe ports (Rohit and Gupta, 2004). Mackerel is the most favourite food fish of Karnataka and the success of its fishery determines the marine fishery scenario of the state. The coast was also notable for the Indian oil sardine, *Sardinella longiceps* (Kan: *Tori*) an important pelagic fish species which contributes to about 15% of the total marine fish production in India. It is nutritionally rich and affordable table fish occurring abundantly almost throughout the year, it also serves as a source for valuable by-products like sardine oil used in several industries and fish-meal for cattle and poultry feed production. Although it is distributed along both and east and west coast of India, its highest abundance and large scale shoaling are observed off Kerala and Karnataka coasts (Pillai, et al., 2003). Details regarding the households and people depending on fishery in the district for their livelihoods, based on 17th and 18th Livestock Census are given in the Table 2.1.

Table 2.1: Details regarding fishery dependent households and people in Uttara Kannada

	Details: 17th Livestock census (2002)	Details: 18th Livestock census (2007)	
No. of households engaged in fishing activity	11141		
Males	21049	21934	
Females	19430	20357	
Children (below 5 years)	20557	25944	
TOTAL	**61036**	**68235**	**% increase:11.79**
Males in inland capture fishery	2731	1845	% decrease: 32.44
Males in inland culture fishery	221	123	% decrease: 44.34%
Males in marine capture fishery	10260	7117	% decrease: 30.6
Females in inland capture fishery	308	936	% increase: 203.89%
Females in inland culture fishery	228	104	% decrease: 54.38%
Females in marine capture fishery	2733	2526	% decrease: 7.57%
Males in marketing	639	1699	% increase: 165.88%
Females in marketing	2227	8096	% increase: 263.53%

Source: Department of Animal Husbandry and Fisheries, Ministry of Agriculture, Government of India (www.dahd.nic.in)

The district has 11,141 families engaged in fishing activities, bulk of them settled along the coastline fringed with estuaries and salt marshes, sandy and rocky beaches. These families together account for about 61,036 of members, of whom 10,260 men and 2,733 women are engaged in marine capture fishery operations. In coastal fish culturing activities are engaged 784 men and 195 women. In inland capture fisheries are engaged 2731 men and 221 women and in involved inland fish culturing are 308 men and 228 women. A good number of men and women are engaged in fish marketing, fish processing, net repairing, prawn seed collection etc. (Department of Fisheries, Uttara Kannada).

2.1 Decline of males engaged in marine capture fishery: There is 30.6% decline of male members engaged in marine capture fishery. This could be ominous indication of the following:

- Imminent collapse of artisan fishery involving non-mechanized crafts such as *pathis* (canoes) and *Dhonis*
- Collapse of traditional *rampani* net (shore-seine) fishery, which involved huge, hundreds of meters long, manually laid nets and involving community efforts, including of even women and children, for every haul of the net.
- Under-employed men going to other fishing districts/states- Goa, for instance.
- Over-exploitation of marine fishery through overuse of mechanized crafts, creating surplus labour.
- Growth of mechanized fishery involving trawlers and purse-seines, which has reduced the need for manpower.

2.2 Decline of males in inland culture fishery: The 44.34% decline in inland culture fishery reflects two things: 1. The overall decline of aquaculture in the estuarine areas, due to fish diseases, environmental pollution and unexpectedly poor returns. 2. The declined state of inland water bodies, due to siltation problems, other environmental problems and due to lack of initiatives from inland water body owners.

2.3 Increase in females in inland capture fishery: The 203.89% increase in the number of females in inland capture fishery, obviously, could be on account of greater number of women getting involved in shell-fish (bivalve) gathering in the coastal estuaries for family nutritional security and sale of surplus collection. Such sudden surge in the number of women in shell-fishery, in a short span raises questions of sustainability of the resource.

2.4 Abnormal increase in persons (males and females) in fish marketing: Viewed against the backdrop of dwindling marine fish production the number of persons, both men and women, engaged in fish marketing has gone up by 165.88% and 263.55% respectively. This shows greater competition in the marketing of available resources as the latter are getting increasingly scarcer. Currently 38 ice plants with a capacity of 547 metric tons of ice per day, 8 cold storages with a capacity of 622.5 metric tons, 4 freezing plants with a capacity of 17.5 metric tons per day, 4 frozen storages with a capacity of 600 metric tons, 1 canning plant with a capacity of 2.5 metric tons per day and 2 fish meal plants with a capacity of 50 metric tons operate in the district.

2.5 Marine fishery resources: Table 2.2. Marine fishery resources in Uttara Kannada

Table 2.2: Marine fishery resources in Uttara Kannada

S.n	Particulars	No
1	Coastal length	190 km.
2	Fishing villages	132
3	Fishing population	132959
4	Active fishermen population	59448
5	Fishermen households	18096
6	Harbours	6
7	Fish landing centers	25
8	Mechanized boats	2387
9	Non-mechanized boats	7804
10	Fishing nets	23179
11	Ice plants	38
12	Cold storages	8
13	Freezing plants	4
14	Frozen storages	4
15	Canning plants	1
16	Fish meal plants	2

17	Boat building yards	11
18	Net making plants	0
19	Fisheries Co-operative Societies	43
20	Fishery Co-op. Federations	1
21	Research centers in Marine Biology	3

Source: Deputy Director of Fisheries, Karwar (2010-11)

2.6 Growth of mechanized fishery in Uttara Kannada: The mechanization of fishing operation in the State was initiated with the introduction of 25'-4'-6' ft. trawlers in 1961-62 for exploiting inshore demersal fishery including shrimps. Introduction of 26'-48' ft. purse seines in 1976-77 extended the area of fishing operation and for shoaling pelagic fish. Motorization of traditional crafts like gill- netters and long- liners from 1980-81 onwards and encouragement of offshore fishing beyond 50 meters depth using bigger vessels for a duration of 7-8 days, have effectively increased the range and efforts of fishing operations. Further, financial institutions have extended the required loan facilities for acquiring fishing boats, which has helped in increasing the fleet strength. At present (2010-11), there are about 2,387 mechanized and 7,804 traditional boats operating in the district. Trawlers reached a peak of 752 in 1986-87 and thereafter decline to 678 in 1989. Thereafter With minor fluctuations in the middle the trawler number shot up to 1153 in 2000-2001, and steadily declined to 687 in 2010-11. The purse-seiners were introduced to the fishing arena in 1975-76. Their numbers grew steadily to 192 in 2000-01 and thereafter suffered steady setback to 82 in 2010-11. The district has 1610 gillnetters and few other mechanized crafts (Table-2.3).

There are 5 fishing harbors (including Mudga, Seabird) and 9 fish landing centres in the district. In recent years, fishermen are being trained in operation of sophisticated electronic equipment's both for fishing and navigation, such as GPS, Eco-sounder, Fish Finder, Radio, Mobile, Potential Fishing Advisories etc. Use of more technology along the coast has made fishing more effective and at the same time led to overfishing, destruction of non-target species, greater, overall depleting catches and hardships to the entire fishing communities. The worst affected are the artisanal fishermen. It was reported in 2010 that traditional crafts and motorized crafts were concentrated more in the east coast (69% and 56% respectively) whereas the mechanized vessels were more along the west coast (58%) (Ministry of Statistics and Programme Implementation, 2011).

Table 2.3. Growth of mechanized fishery in Uttara Kannada

S.n.	Year	Trawlers	Purse-seiners	Gillnetters	Others	Total
1	1961-62	3	0	0	0	**3**
2	1962-63	17	0	0	0	**17**
3	1963-64	24	0	0	0	**24**
4	1964-65	44	0	0	0	**44**
5	1965-66	62	0	0	0	**62**
6	1966-67	100	0	0	0	**100**
7	1967-68	141	0	0	0	**141**
8	1968-69	192	0	0	0	**192**
9	1969-70	244	0	0	0	**244**
10	1970-71	308	0	0	0	**308**
11	1971-72	315	0	0	0	**315**
12	1972-73	317	0	0	0	**317**
13	1973-74	336	0	0	0	**336**
14	1974-75	341	0	0	0	**341**
15	1975-76	369	2	0	0	**371**
16	1976-77	377	12	0	0	**389**
17	1977-78	418	15	0	0	**433**
18	1978-79	484	40	0	0	**524**
19	1979-80	492	55	0	0	**547**
20	1980-81	538	64	66	0	**668**
21	1981-82	558	91	266	0	**915**
22	1982-83	652	100	377	0	**1129**
23	1983-84	737	114	400	0	**1251**
24	1984-85	751	114	410	0	**1275**
25	1985-86	751	114	468	0	**1333**
26	1986-87	752	114	474	0	**1340**
27	1987-88	712	115	505	0	**1332**
28	1988-89	712	115	529	0	**1356**

29	1989-90	678	118	519	57	**1372**
30	1990-91	706	122	526	60	**1414**
31	1991-92	721	123	557	73	**1474**
32	1992-93	722	127	543	108	**1500**
33	1993-94	722	127	543	108	**1500**
34	1994-95	769	133	544	70	**1516**
35	1995-96	807	125	600	60	**1592**
36	1996-97	817	132	792	83	**1824**
37	1997-98	725	130	831	76	**1762**
38	1998-99	748	149	891	66	**1854**
39	1999-2000	820	159	1252	66	**2297**
40	2000-2001	1153	192	1358	53	**2756**
41	2001-2002	NA				
42	2002-2003	994	158	1363	55	**2570**
43	2003-2004	NA				
44	2004-2005	970	155	1408	65	**2598**
45	2005-2006	738	133	1455	70	**2396**
46	2006-2007	713	128	1563	58	**2462**
47	2007-2008	735	118	1727	67	**2647**
48	2008-2009	674	115	1799	58	**2646**
49	2009-2010	737	125	1797	67	**2726**
50	2010-2011	687	82	1610	8	**2387**

2.7 Growth beyond carrying capacity: Way back in 1972-73, when the mechanization of fishing fleet was in its infancy, the district had a total fish production of 16,371 tons. The demand in those days was mostly local and the fish was in abundance to cater to local needs and even exported to other States. Production from marine capture fishery reached the peak of 85,798 tons in 1985-86, coinciding with increasing mechanization (with 751 trawlers, 114 purse-seiners and 468 gill-netters in addition to large number of artisanal fishermen operating their pathis and *donis* and hook and line). Obviously depletion of fishery stock was in sight as the use of mechanized crafts and gears had already overshot the carrying capacity by then. Fishing crash and high levels of uncertainties haunted the fishing sector thereafter. High value fishes declined and the total fish production figures was propped up, often by increasing quantities of trash and low value catches (Table 2.4 for total marine fish production)

Table 2.4. Marine fish landings in Uttara Kannada during 1972-73 to 2010-11.

Year	Marine Fish landings	Year	Marine fish landings
1972-73	16371.0	1992-93	34863.4
1973-74	21165.0	1993-94	34193.0
1974-75	14408.0	1994-95	36471.0
1975-76	30628.0	1995-96	53611.7
1976-77	21663.0	1996-97	71776.5
1977-78	49315.7	1997-98	46991.4
1978-79	39310.0	1998-99	47818.1
1979-80	46045.5	1999-00	30667.7
1980-81	34278.2	2000-01	36942.2
1981-82	30871.6	2001-02	28038.0
1982-83	30783.1	2002-03	32877.0
1983-84	35381.7	2003-04	27574.4
1984-85	39426.3	2004-05	27137.1
1985-86	85798.4	2005-06	25075.7
1986-87	35510.4	2006-07	17731.0
1987-88	43533.6	2007-08	20727.7
1988-89	48912.1	2008-09	33010.2
1989-90	59507.1	2009-10	59143.5
1990-91	37564.3	2010-11	88028.7
1991-92	34014.5	2011-12	90588.0

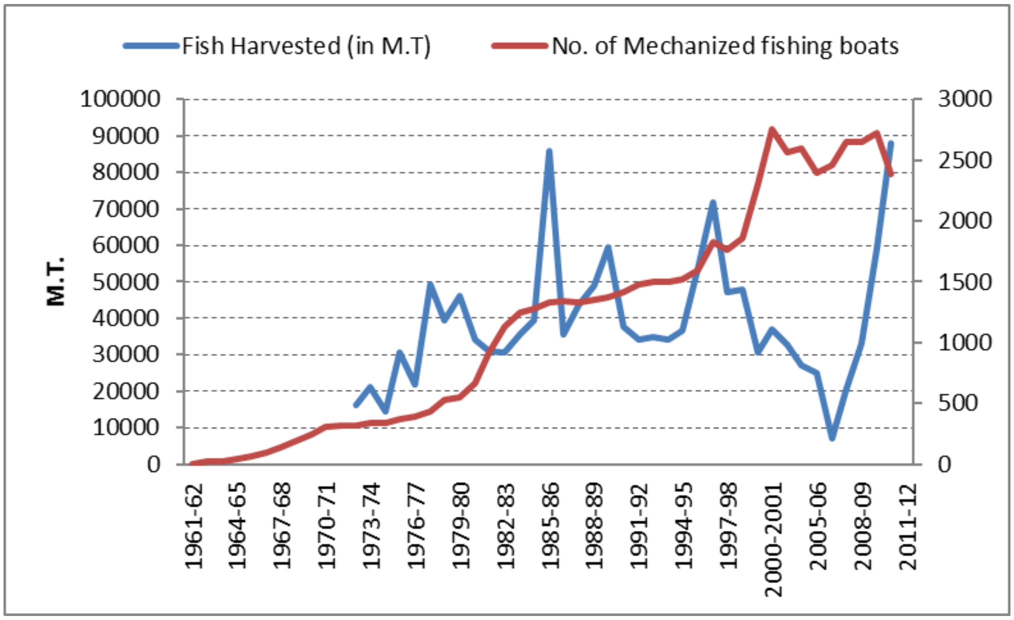

Figure 2.1. Growth of mechanization versus fish catches in Uttara Kannada (1961-62 to 2011-12)

Figure 2.1 shows how a period of uncertainty set in the marine fishing sector after almost steady production until 1985-86 (total catch: 85,798 tons), with increased introduction of mechanized crafts (1,275 for 1985-86). Thereafter, the total number of mechanized crafts, after some fluctuations, reached the peak at 2,756 in 2000-01, when the fish production plummeted to 36,942 tons only. This was an ominous sign of depletion and losses that made many fishers, especially artisanal, to go in search of better jobs elsewhere. From very next year many trawlers and purse-seines were laid off with only 687 and 82, respectively of them, operating in 2010-11. The nadir in fish catches was reached in 2006-07 with just 17,731 tons. The fish production improved with more crafts, except the gill-netters, going off the sea. The latter being boats fitted with out-board/inboard motors, and operated more by small scale fishers, did not pose major challenges unlike trawlers and purse-seines. The same year witnessed capture of 88,029 tons. The catch analysis, however, is not satisfactory as good percentage of the catch was trash, juveniles and low value fish, bulk of which going for poultry feed. Mohamed et al. (1998) consider the production peaks in Karnataka's marine fishery, after 1978, as the result of introduction and expansion of purse-seiners. They also referred to a steep decline in production since 1989 (which holds good for Uttara Kannada as well up to at least 1994-95, and thereafter a moderate recovery until 1998-99 and suffering yet another setback from 1999-2000 to 2008-09).

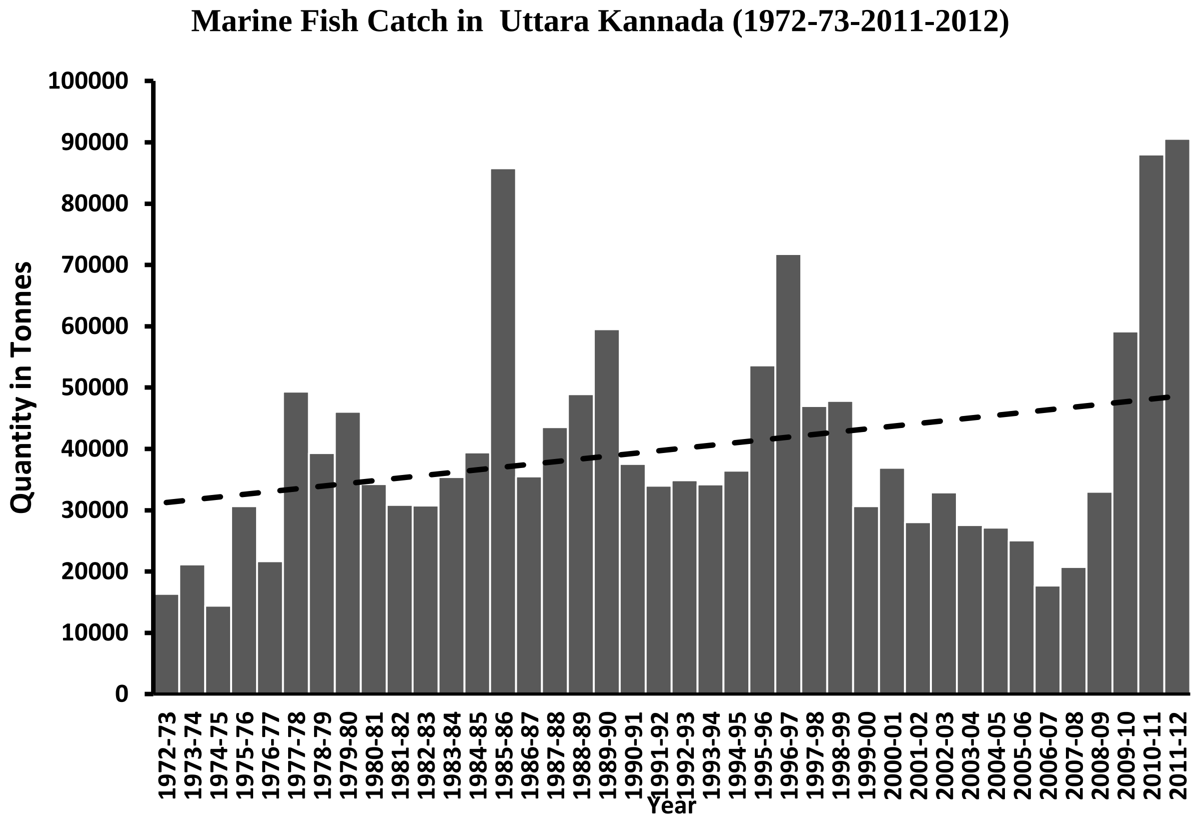

Figure 2.2. Marine fish catches in Uttara Kannada 1972-73 to 2011-12

2.8 Contribution of oil sardine to catch statistics: Oil sardine is a pelagic phytoplankton feeding low value fish, much in demand, due to its affordability for even the lower income groups. The South-west Indian coast of Karnataka-Kerala was traditionally the highest producer of oil sardines. The peak of fishery in 1985-86 saw oil sardine catch of 24,217 tons in Uttara Kannada. May be due to over-fishing, oil sardine catches crashed to less than 1000 tons/annum during 1992-1996 period. Being at the bottom of marine food chain the decline in oil sardine meant a state of overall fishery collapse, as happened during the same period, when the total annual catches hardly exceeded 30,000 tons, although fishing fleet mechanization was at its peak. However, a decline in purse-seiners, and probably shoal migration into Arabian Sea waters caused oil sardine recovery which touched 28,971 constituting 32% of total catch of 90,588 tons of fish in 2011-12. However, the catches of mackerel, another phytoplankton feeding fish, were far from satisfactory throughout, with exceptional spurs in production (Figure 2.3). Mohamed et al (1998) considers the fluctuations in the catches of small pelagics like oil sardine as a worldwide phenomenon due to reasons yet to be known fully. Anyway, to capitalize on oil sardine recovery, for benefitting entire fishery, we need to impose a rigorous marine fishing regulation code in the coming years, such as restricting licenses to mechanized boats to sustainable limits, total ban on trawling and purse-seining up to August 15 instead of the present 1st August, strict imposition on mesh sizes etc.

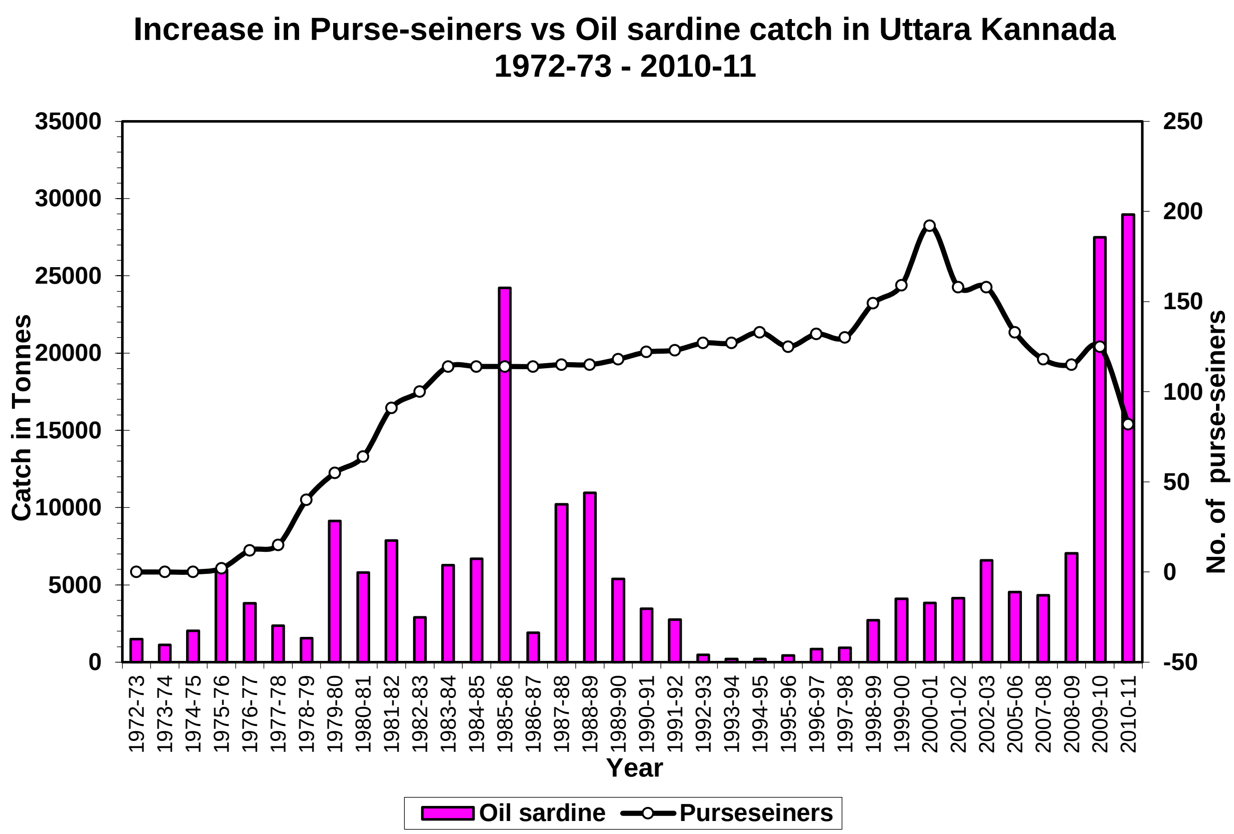

Figure 2.3. Number of purse-seiners vs. Oil sardine catches in Uttara Kannada

2.9 Mechanization and mackerel fishery: South Indian west coast was traditional stronghold of mackerel fishery. Purse-seiners contributed much of it, although various other crafts and nets were also in used. Mackerel is a much sought after fish, fresh or dried. The pre-mechanization period was one of sustainable use as the surplus was only dried rather than canned or kept in cold storage. Nothing was known about what quantity could be caught as the catches were sufficient to meet the demand. Introduction of mechanized crafts and gear, setting up of ice factories and cold storage facilities changed the scenario drastically. Large number of traditional crafts and few mechanized ones in operation (especially 15 purse-seiners) in the year 1977-78 brought 15,151 tons of this priced fish from the sea. Increased fishing efforts, correlated to introduction of more purse-seiners and scant knowledge on carrying capacity, caused downfall in mackerel fishery from 1978-79 to 1984-85, when the district's fishing fleet had 114 purse-seiners. Until 1989-90 hardly any addition of purse-seiners was made. There were sporadic jumps in catches during 1985-86 (31,694 tons), a record forever for Uttara Kannada. However, hardly any lessons learnt about carrying capacity the catches began dwindling with occasional lesser peaks 27,513 tons in 1996-97 (132 purse-seiners) and 14,968 tons in 1998-99 (149 purse-seiners). Thereafter was a major crash, despite increased efforts from ever increasing mechanization process so much so only 3091 tons of mackerels landed in 2000-01 despite the huge amount of fuel and other efforts, when 192 purse-seiners and other crafts were in operation. The use of purse-seiners dwindled since then, due to losses suffered, signaling probably a recovery process. With 82 purse-seiners in 2010-11 mackerel catch was 18,475 tons (Figure 2.4). However, all the south-western States, especially Kerala, Karnataka and Goa together have to meet and develop norms for sustainable mackerel fishery.

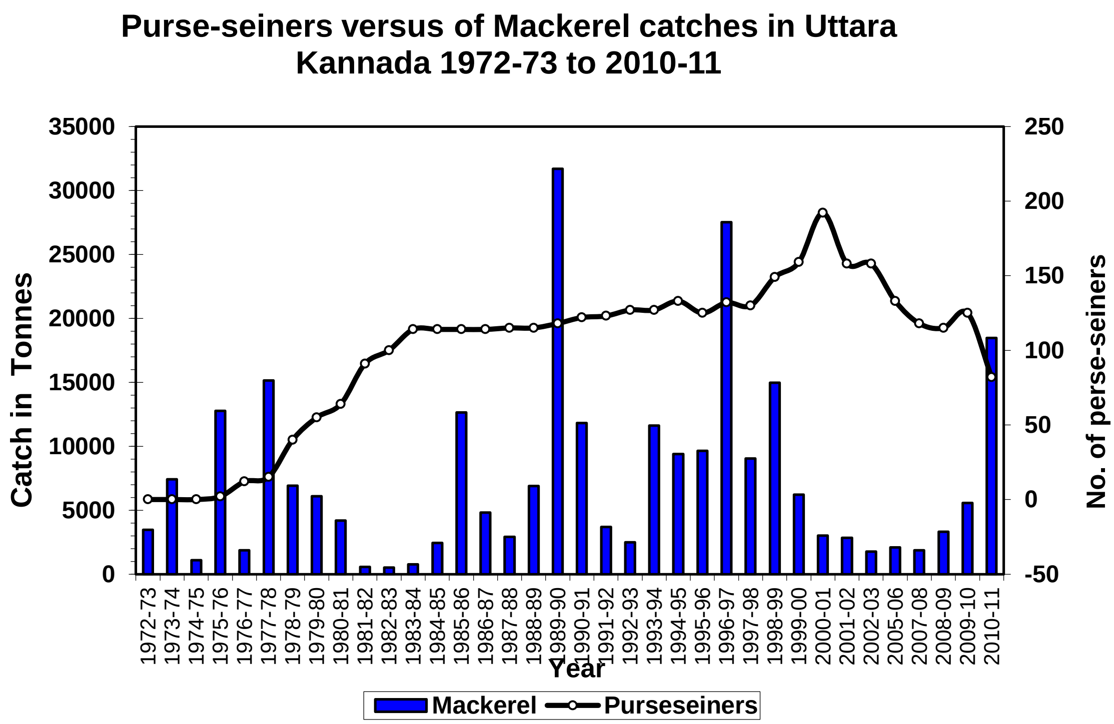

Figure 2.4. Growth of purse-seiners vs. Mackerel fishery in Uttara Kannada

2.10 Growth of marine prawn fishery: The South Indian Arabian Sea coast has been traditional stronghold of marine prawn fishery. Prawns are high value commodities which brought substantial income to the fishery sector especially through export earnings. In the pre-mechanization times prawns were caught from the sea mainly using native crafts and gears. The introduction of trawlers intensified prawn fishery, production crossing 5000 tons in 1977-78, when the trawler number was 418. There has been no further growth since then although the trawler number reached 1153 in 2000-01, when the production slumped to less than 2,000 tons. When many trawlers were laid off due to losses there are signs of recovery of prawn fishery, with the production crossing 6,000 tons in 2010-11 when the trawler number declined to 687. Keeping the trawler number in check is therefore likely to bring sustainability in marine prawns.

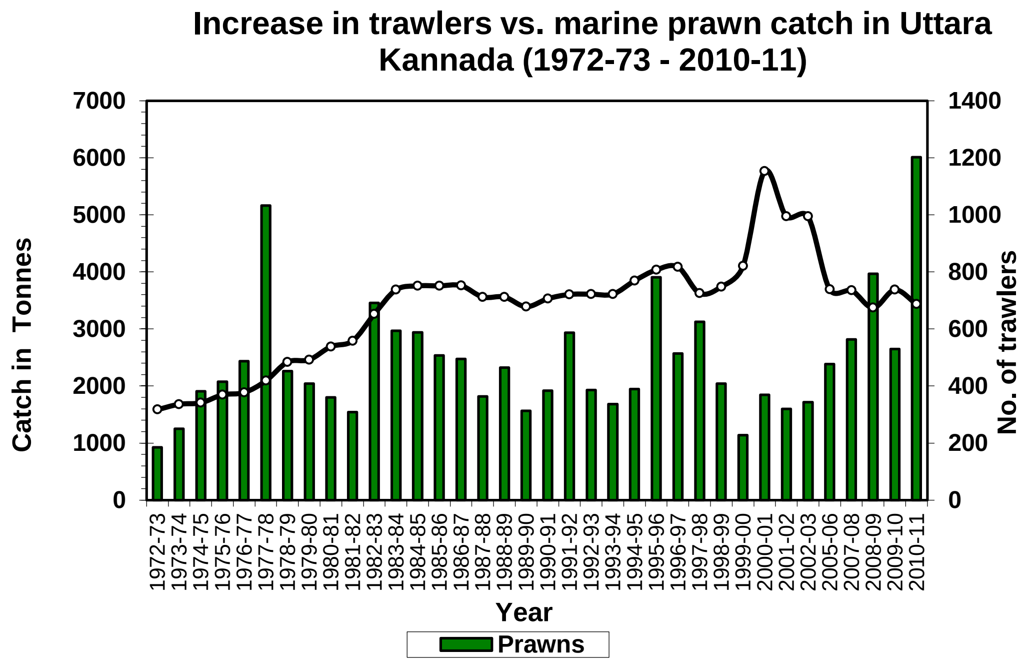

Figure 2.5. Growth of trawlers vs. marine prawn fishery in Uttara Kannada

2.11 The decline of the cat fish: The catfish *Arius* sp. are large carnivorous fishes, available at one time in larger quantities along the west coast, especially to meet the local demand, either fresh or dried. They were among the leading 10 fishes during the 1930s and 1940s and number one in 1937. Its position started declining in 1950's. After the start of seining for fish and eggs, the ranking slipped to below 100 in Kerala and was near 100 in Karnataka. It is exceptionally slow-growing and has low fertility. To compensate for low fecundity, the male catfishes incubate the eggs in their mouth (mouth brooder). However, when schools of catfishes were caught by purse seines and ring seines, the males spit out the large eggs in order to save them, but, because of the small mesh size of the seines, even eggs were not spared. It is exceptionally slow-growing and has low fertility. To compensate for low fecundity, the male catfishes incubate the eggs in their mouth (mouth brooder). (Devaraj and Vivekanandan, 1999; Menon, 2003). Silas et al. (1980) estimated the total number of eggs destroyed by Mangalore purse seiners in one month as 25 million! The catfish, whose recent average catch in Kerala, was only 2.86% of the maximum, was classified as a collapsed stock by Mohammad et al. (2010). The Government of Karnataka was repeatedly advised (1989-92) by CMFRI regarding the negative impact of purse seining of catfish stocks particularly with regard to recruitment (Menon, 2003). The increased catches in

Uttara Kannada during 1977-78 to 1985-86 (Figure 2.6) can be correlated to increased mechanization, and collapse thereafter obviously on account of overharvests. With 15.7% catch of the historical maximum the Uttara Kannada Cat fish fishery may be considered as badly declining.

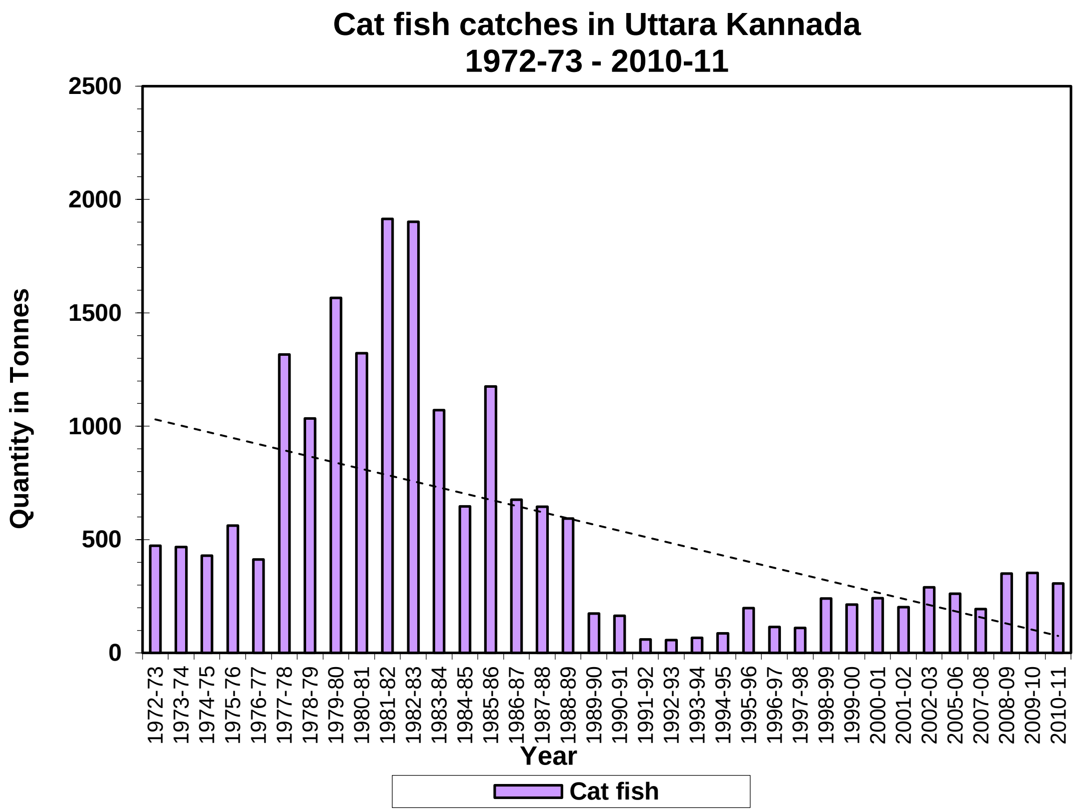

Figure 2.6. Decline of Cat fish production in Uttara Kannada

2.12 Status of pomfrets: Pomfrets (both white and black) are among the highest priced fishes from India. They are much in demand from rich segment of consumers, hardly ever within the purchasing power of the poor and the middle classes. Their fluctuating catches (Figure 2.7) are a matter of much concern. Silver pomfret, *Pampus argenteus*, contributed on an average1.7% to the total marine fish landings of Gujarat during 2002–2006 and landings of the species in Gujarat decreased by 27% from 2002 (8,000 t) to 2006 (5800 t) (Mohanraj et al., 2007). Maximum sustainable yield of the white or silver pomfret Gujarat, was only 90 tons, the average annual catch for 2003-07 was 114.5 tons. An increase in relative yield by 17.18% would be obtained by decreasing the present level of fishing by 60% (Zala and Bhint, 2009). Despite combining quantities of both black and white pomfrets in Uttara Kannada the total annual catches from 1972-73 to 2010-11 have been fluctuating between less than 100 tons to barely 1000 tons (Figure). Being a plankton feeder there could have been greater quantities of pomfrets available but for heavy fishing pressures. In view of the fluctuating landings of pomfrets along Uttara Kannada coast we need to exercise extreme caution as well and stop immediate steps to ban exports from the country until stock recovery. The recent average being 30.9% of maximum historical catch the pomfret situation may be termed as "Declining".

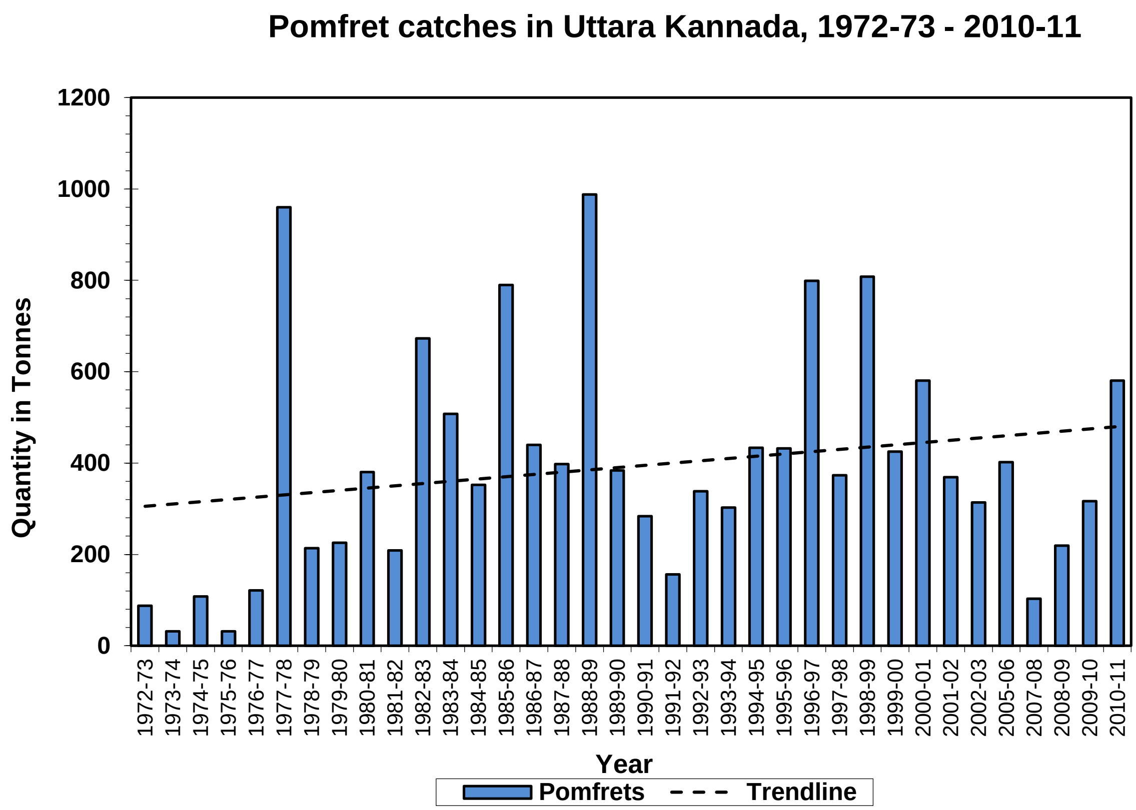

Figure 2.7. Fluctuations in Pomfret production in Uttara Kannada

2.13 Seerfish: The seerfish (*Scomberomorus commerson*) is one of the most sought after marine fish. Also known as King seer, or Spanish mackerel (*Ison* in Kannada) its exploitation along the Indian coast is mainly by gillnets (>60%), followed by trawls (20%) and to lesser extent by seines and hooks and lines. The fishery of seerfish is under high fishing pressure and there is a need to reduce the effort so as to exploit the available resource optimally (Rohit and Abdussamad, 2013). In Uttara Kannada waters, after a slump in catches from 1985-86 to 2001-02 there are signs of recovery. This could be, in tune with overall Indian catches, attributed to overfishing and catch of undersized ones. Increase in gillnetters from 468 in 1985-86 to 1610 in 2010-11 could be the main reason for the spurt in Uttara Kannada landings (Figure 2.8).

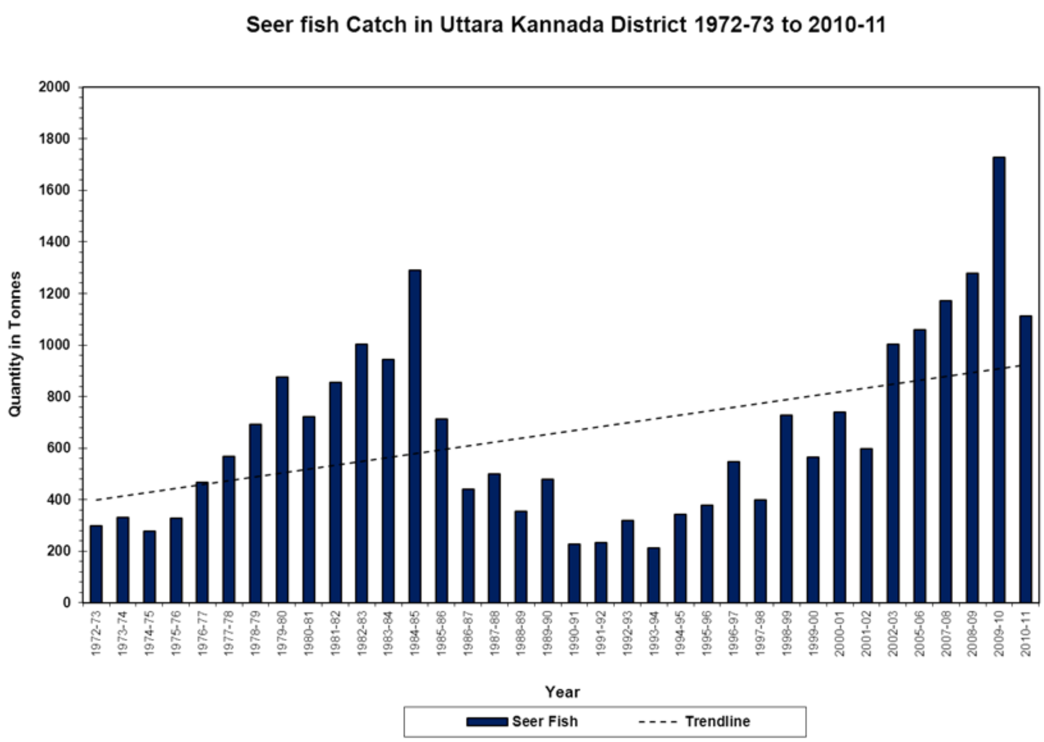

Figure 2.8. Fluctuations in Seer fish production in Uttara Kannada

2.14 Collapse of Elasmobranch (Sharks, Rays and Skates) fishery: About 49% of Ealsmobranchs are demersel or deep water fishes. Prior to 1960's various species of Sharks, Rays and Skates were caught all along the Indian coast using different kinds of traditional gears such as shore seines, boat seines, gillnets, hooks and line, etc. These were employed only in shallow waters and captured only small sharks and young of larger sharks. Trawl and longline fishing in contrast, landed mostly larger sharks, including whale sharks which could weigh up to several hundred kilograms. Subsequent to the introduction of the mechanized boats and modern gears using synthetic yarns during the 1960s and 1970s a change in the landings of sharks occurred and the trawlers landed more and more small sized sharks. Traditional crafts fitted with outboard motors also resulting in higher catches (Hanfee, 1997). The annual production of Elasmobranchs in India was around 70,000 tons, of which sharks constituted about 60 to 70%. Sixty-five species of shark have been sighted in Indian waters and over 20 of these, contribute to the fishery (Dholakia, 2004). Much of the trade in sharks was restricted to the west coast of lndia (Varma 2002). Most sharks are long-lived, have relatively slow growth, low fecundity and low natural mortality, resulting in limited reproductive output, and therefore most vulnerable to collapse in population unlike most of the pelagic fishes. In Uttara Kannada shark fishery was more at a subsistence level, by artisanal fishermen, and bulk of the catch was used for drying as dried shark had a good demand in domestic markets. The introduction of mechanized fishing in a big way can be correlated to the current state of collapse of Elasmobranch fishery, of which sharks formed major share (Figure 2.9)

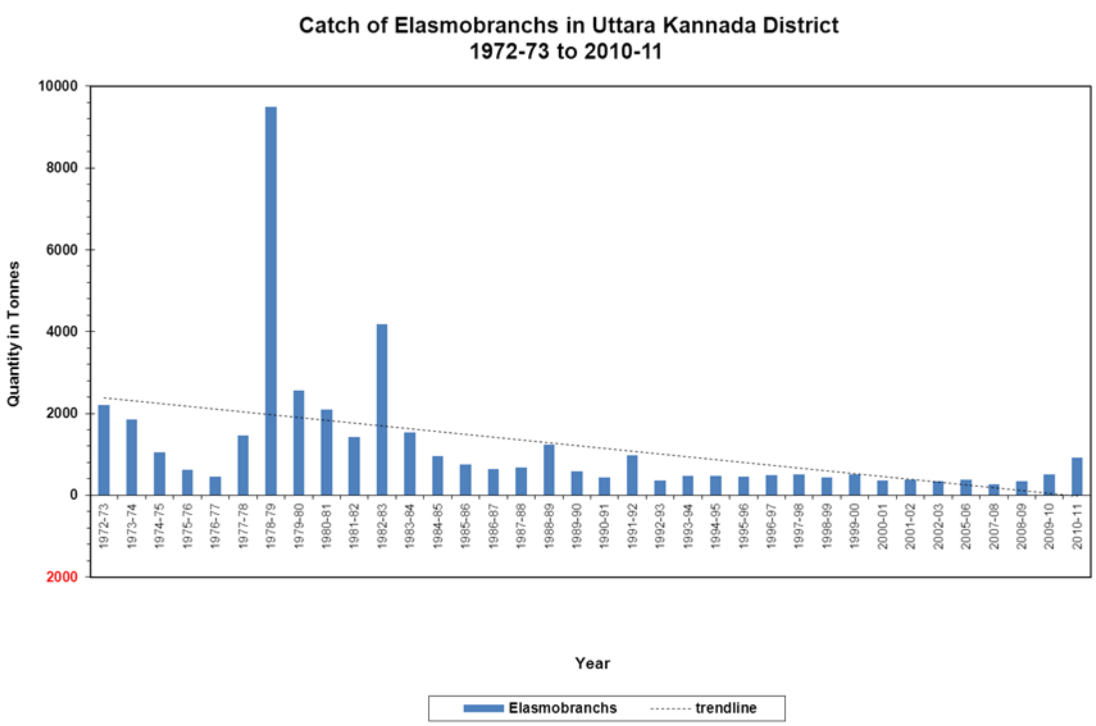

Figure 2.9. Collapse of Ealsmobranch (Shark, Rays and Skates) fishery in Uttara Kannada

2.15 Marginalisation of traditional fishery: Traditional artisanal fisher people in the South Indian west coast have been, over the last several years, struggling against the havoc created by mechanized fishing vessels such as trawlers and purse seiners. These fisher-folks' livelihood is being directly threatened by these rival and powerful fishing methods. They are apprehensive of the environmental hazards and threats to their livelihoods from inshore mechanized fishing. Analysis by Mohamed et al. (1998) showed that more than 95% of annual average catch in Karnataka during 1990-95 was obtained by mechanized gears, of which the purse-seine (44.8%) and the trawler (43.5%) together accounted for over 88% of the total.

The artisanal fishermen formed and still continue to be a big segment of Uttara Kannada's coastal fishing population. They used a variety of non-mechanized crafts such as *dhoni* (plank built boats), *pandi* (boat that carries the *rampani* or shore-seine net) *pattebale* units, *pathi* (dugout canoe used by a single person) and few other types of crafts. Totally there were 16,153 traditional boats in coastal Uttara Kannada, during 1999-2000 according to the Deputy Director of Fisheries, Karwar. Several thousand families were dependent on these boats for their livelihoods. Their nets varied from the largest *rampani* to small *goru-bale* (scoop nets). The *rampani* used to be the most spectacular kind of fishing net in operation along the Karnataka coast. These shore-seine nets of 300-500 m or more and were mainly used in sheltered bays and particularly suited to sheltered bays. About 50 to 100 people, including women and children of the hamlet, used to gather along the shore taking active part in hauling the net and gathering the fish. The increased use of mechanized crafts in the inshore waters has depleted them of fishes leaving very little for the *rampanikars.* Even in 1976-77, well after the introduction of 1407 trawlers and 31 purse-seiners in Karnataka, about 150 *rampanis* contributed 80.4% of the traditional and 47.7% of the total fish catches. By 1986-87, with over 3,000 mechanized crafts in operation, the *rampani's* output plummeted to just about 5.6% of the total marine fish catches causing the near extinction of this ancient artisanal fishing net (figure 2.10). However, a smaller version the hand-*rampani* or *kai-rampani* is still being used in some places. It is disconcerting to note that the livelihoods of artisanal fishers are seriously affected as over a period of last two decades the relative catches by this sector accounts for less than 20% of the total catches (Figure 2.11)

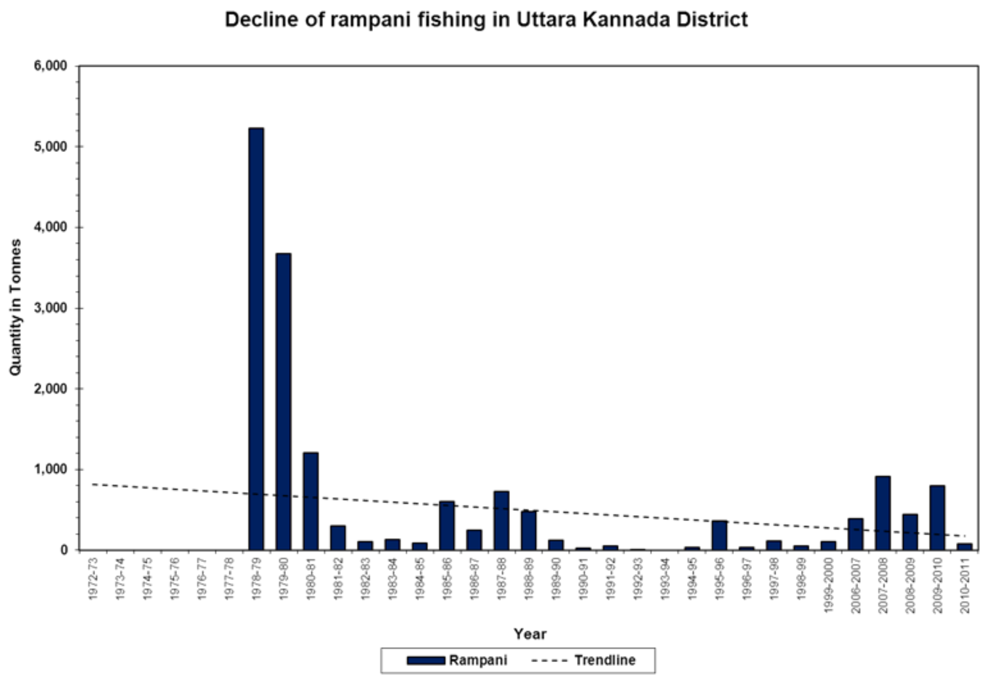

Figure 2.10. Collapse of traditional *Rampani* net fishery in Uttara Kannada

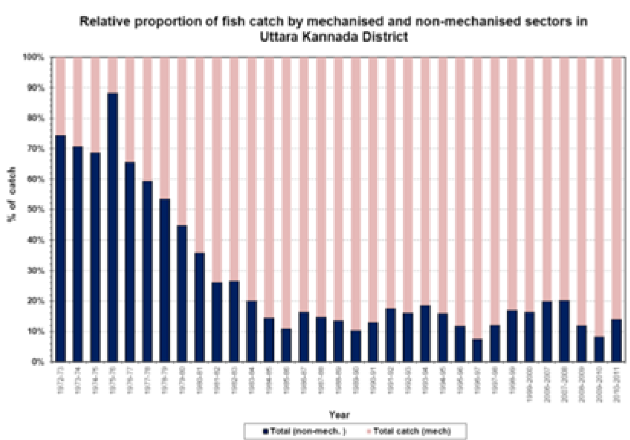

Figure 2.11. Marginalisation of artisanal fishery sector in coastal Uttara Kannada

2.16 Making up by the miscellaneous and by-catches; Overfishing and destruction of fish breeding locations on the sea bed are leading to severe depletion of marine stocks. Globally the trawl net is the most destructive type of mobile fishing gear as it is dragged through the sea bottom, gathering a wide array of organisms as by-catch. Shrimp trawling contributes to the highest level of discard/catch ratios of any fisheries, ranging from about 3:1 to 15:1 (Kumar and Deepthi, 2006). Andrew and Pepperel (1992) estimated total global discards of 16.7 million tonnes by-catch from shrimp fisheries alone. Alverson et al. (1994) documented the quantity of fisheries by-catch and discards in various oceans and seas around the world; the report revealed that commercial bottom trawling contributes about 27 million tons of discards (based on data from the 1980s and early 1990's- as quoted by Kumar and Deepthi (2006), which is more than half of all fish produced annually from marine capture fisheries for direct human consumption. Such catches, at the expense of high efforts (fuel and manpower), will have a heavy impact on the future of marine fishery. Bulk of the trash fishes (including juveniles of many commercial fishes) will end up in fishmeal factories, sounding a suicidal note on Indian marine fishery. As far as nature of disposition of Uttara Kannada's marine fish catches are concerned it is noticeable that 23657.38 tons of fish (40% of total catches of 2009-10) and 35211.47 (40% of total catches of 2010-11) have been utilized for fish meal production (Table 2.5). This does not show the discards in the ocean of surplus trash caught by multi-day trawlers and purse-seines.

Table 2.5. Nature of disposition marine fishery catches during 2007-08 to 2010-11

Nature of disposition	2007-08	2008-09	2009-10	2010-11
Marketing Fresh	119385	148333.33	20700.21	30810.04
For Freezing	17995	22359.1	2134.2	3176.5
For Curing	19312	23995.1	7978	11874.4
For Canning	12553	15597	8.5	12.65
For Misc. purpose	614	763.481	1783.31	2654.19
For Fish manure	5267	6544.2	0	0
Unspecified	439	545.34	2881.85	4289.43
Fish meal			23657.38	35211.47

Source: Deputy Director of Fishereis, Karwar

2.17 Need for reducing marine fish product exports: After the remarkable increase in both marine and inland capture of fish during the 1950s and 1960s, world fisheries production has leveled off since the 1970s. This leveling off of the total catch follows the general trend of most of the world's fishing areas, which have apparently reached their maximum potential for fisheries production, with the majority of stocks being fully exploited. It is therefore very unlikely that substantial increases in total catch will be obtained in the future. Due to fullest exploitation of marine fish resources and remarkable growth of marine and inland aquaculture production, the average apparent per capita consumption increased from about 9 kg per year in the early 1960s to 16 kg in 1997. The per capita availability of fish and fishery products has therefore nearly doubled in 40 years, outpacing population growth. By 2030, annual fish consumption is likely to between 19-20 kg per person (WHO, 2013). Uttara Kannada district's annual fish consumption per capita is only 6.5 kg/year. If we aim at sustainable fishery and raising the per capita consumption to at least 16 kg/year the fish export policy from the whole country itself has to be re-examined. On the contrary, against dwindling marine fishery catches the export of marine fish products has gone up from 139,419 tons from the base year 1990-91 to 541,701 tons in 2007-08, an increase of 3.88 times increase in a span of just 17 years. Marine fish depletion being a serious matter of concern, and also in view of the high degree of malnutrition prevailing in the country, marine fish export should be limited to only those species that are abundant and not favoured as human food in the country.

The flagship nutrition scheme of India ICDS came in for a word of praise from the Finance Minister for having spent the allocated amount of Rs 15,850 crore. However, the increase of 11.7% to Rs 17,700 crore barely keeps up with inflation. According to an estimate made by nutrition experts, effective implementation of ICDS requires nearly Rs 3 lakh crore over the current plan period while allocation has been for Rs 1.23 lakh crore (Union Budget 2013, Times of India, March 1, 2013) for Nirbhaya fund to support women-centric plans. Despite such huge funding is required for tackling malnutrition among the Indian women and children, and the Central Government is aiming at boosting exports of protein rich fish and fishery products from India, which has merely gained Rs. 7621 crore in the year 2007-08 (Table-

Table 2.6. Year-wise export of marine fish products from India

Year	Quantity (tons)	Value (Rs. Crore)
1990-91	134419	893.37
1991-92	171820	1375.89
1992-93	209025	1768.56
1993-94	243960	2503.62
1994-95	307337	3575.27
1995-96	296277	3501.11
1996-97	378199	4121.36
1997-98	385818	4697.48
1998-99	302934	4626.87
1999-00	343031	5116.67
2000-01	440473	6443.89
2001-02	424470	5957.05
2002-03	467297	6881.31
2003-04	412017	6091.95
2004-05	482223	6459.89
2005-06	551282	7018.68
2006-07	612641	8363.53
2007-08	541701	7620.92

Source: Handbook of Fishery Statistics, 2008 (Government of India, 2009)

2.18 Current status of marine fishery in Uttara Kannada: saga of decline, depletion and collapse: Quantities of marine fish catches, based on landings in Uttara Kannada, from early 1970's to 2011-12, reveal much fluctuations in the total catch. The catch was between 14-21 thousand tons during 1972-73 to 1974-75 period. It shot up to over 49,000 tons in 1977-78 and maintained an average annual production of just over 36,500 tons during 1978-79 to 1984-85. The total picked up thereafter attained highest peak of about 85,800 tons during 1985-86. Very next year it crashed to 35,500 tons and thereafter the production was unsteady between 45,000 tons to just less than 53,600 tons during 1995-96. The production almost touched about 71,800 tons in 1996-97 and thereafter steadily declined and reached lowest of barely 18,000 tons in 2006-07. The production picked up thereafter and reached over 59,000 tons in 2009-10 and climbed to an all-time record of nearly 88,000 tons in 2010-11, the second highest peak after 1985-86.

The fluctuations in fishing, according to (James, 2010), are due to results of increased fishing efforts and due to the fluctuations in the catches of pelagic fishes. Pelagic fishes are seen more towards the water surfaces in deeper parts of oceans and in shallow depth coastal waters, as they feed mostly on phytoplankton, which are microscopic photosynthetic algae. They have short life span, grow very fast and breed continuously almost throughout the year with overlapping of generations. They move in large shoals from one region to another shedding the ova (eggs) in batches. Certain fisheries like those of the Oil sardine and Mackerel highly fluctuate from year to year depending on several environmental factors, mainly the onset and intensity of the monsoon, sunspot activity, sea surface temperature, current patterns, variations in salinity, dissolved oxygen, sinking of offshore waters, sea level and availability of nutrients in coastal waters. Marine pelagic fishes migrate in large shoals. Targeting such shoals of pelagic fishes create immense quantity of yields. Unpredictability in fishery is often caused by the migration paths or direction of just one or two species like the oil sardine and the mackerel. In fact the trend of total marine fish landings in the State of Karnataka used to be set by the landings of these two prominent sea fishes oil sardine (Kan: tarle,turi) and mackerel (Kan:bangade), which alone can easily tilt the marine fish production of the country in any year creating wide oscillations in catches (ibid.)

While on one side technological innovations in the marine fishery are welcome developments, these can be baneful on livelihoods of artisanal fisher-folks, and fish biodiversity itself if not balanced against fish stocks in the Indian continental waters. Technology has brought in multiday trawlers and purse-seines and fishermen are knowledgeable or trained in the use of GPS, Eco-sounder, Fish Finder, Radio, Mobile, Potential Fishing Advisories etc.

2.19 Catch-trend based status of stocks of important marine fishes: Using a simple methodology Mohammad *et al*., (2010) determined the status of fish stocks from the southwest coast of India. Historical maximum catch during a 35 year period was taken as the baseline catch on the assumption that abundance would be close to the figure for maximum catch. The latest average catch of a 3 year period, at the time of study (2003-05) was compared to that of the baseline catch in percentage. Species identified as occurring rarely were not considered for evaluation. Details regarding the cut-off percentage to classify the stocks in terms of their abundance status are given in the Table 2.7. As fish production in Uttara Kannada was found to exhibit greater fluctuation, ever since mechanization became a dominant factor, applying the method developed by Mohammad *et al* (-ibid-) used a four year average for comparison with historical maximum. The details of the situation analysis are given in Table 2.8.

Table 2.7. Criteria used for fish stock classification

Stock classification	**Recent average catch as percentage of historical maximum**
Abundant	>70
Less abundant	50-69
Declining	11-49
Depleted	6-10
Collapsed	<5

Table 2.8. Stock status of commercially important marine fishes based on average fish catches as % of the historical maximum catch (baseline catch) during 1972-2011 in Uttara Kannada District (based on method by Mohammad et al., 2010)

Sl.No	Name of the Fish	Historical maximum catch (t)	Recent 4-year average catch (t)	% of maximum catch	Stock status
1	Seer Fish	1728.4	1323.0	76.5	Abundant
2	Prawns	6008.3	3860.3	64.2	Less abundant
3	Crabs	1501.2	917.4	61.1	Less

					abundant
4	Garros	263.3	155.3	59.0	Less abundant
5	Oil sardine	28970.5	16960.6	58.5	Less abundant
6	Silver bar	516.3	253.5	49.1	Declining
7	Squids	1526.0	710.5	46.6	Declining
8	Mullets	449.4	205.9	45.8	Declining
9	Lactrices	1495.6	676.5	45.2	Declining
10	Others (Miscell)	18490.6	8302.1	44.9	Declining
11	Other sardine	2993.1	1179.5	39.4	Declining
12	Lady fish	471.0	182.2	38.7	Declining
13	Silver bellies	2111.2	666.8	31.6	Declining
14	Tuna	1459.2	454.4	31.1	Declining
15	Pomfrets	988.0	304.9	30.9	Declining
16	Eels	3635.7	912.7	25.1	Declining
17	Flat fish	4212.7	972.0	23.1	Declining
18	Mackerel	31694.3	7307.8	23.1	Declining
19	Squilla	8503.6	1953.9	23.0	Declining
20	Other Cupieds	4102.1	939.2	22.9	Declining
21	Sciaenids	4215.6	914.2	21.7	Declining
22	Karangids	3372.0	641.8	19.0	Declining
23	Cat fish	1914.1	300.9	15.7	Declining
24	White sardine	840.8	86.6	10.3	Depleted
25	Ribbon fish	7720.0	334.6	4.3	Collapsed
26	Shark	9044.0	381.7	4.2	Collapsed
27	Skates & Rays	3151.6	126.1	4.0	Collapsed
28	Anchovilla	9975.0	383.1	3.8	Collapsed
29	Jew fish	1536.3	40.1	2.6	Collapsed

30	Soles	324.1	NA	NA	
	Total	88028.7	50227.5	57.1	Less abundant

More than 70%= Abundant	50-69% = Less abundant	11-49% = Declining
6-10% = Depleted	< than 5% =collapsed	

The marine fishing scenario of Uttara Kannada is in a dismal state. Whereas total fishery catch has gone "Less abundant" fishery of five taxa/groups (including shark and skates & rays) has "Collapsed" and 18 taxa/groups in "Declining" condition; the latter included mackerel, cat fish, pomfrets etc.

2.20 Impact of climate change on fishery: Climate change also poses threats to marine and freshwater species and habitats. Fluctuations in water temperature, ocean currents, upwelling and biogeochemistry are leading to productivity shocks for fisheries (Sumaila et al. 2011). According to FAO scientists, "Change is expected to result in elevations in sea surface temperature, global sea level rise, reductions in sea-ice cover and changes in salinity, wave conditions and ocean circulation. On land, climate change will affect the availability of water, river flow regimes (particularly in flood plains), size of lakes, etc." (FAO, 2012).

3.0 CONCLUSION AND RECOMMENDATIONS

It is necessary to increase the contribution of marine fisheries to the food security, economies and the well-being of coastal communities. It requires effective management plans to rebuild overexploited stocks. We have presented here several recommendations for the sustainability of marine fishery which needs to be viewed more in a broader context of west coast and national fisheries as the sea has no boundaries.

3.1 Strengthened governance and effective fisheries management: Promoting sustainable fishing and fish farming can provide incentives for wider ecosystem stewardship.

2. **Adoption of an ecosystem approach to fisheries and aquaculture**

- ***Ocean and linked coastal water bodies*** like estuaries, creeks, lagoons, salt marshes, mangrove areas etc. are to be considered as interconnected and valuable ecosystems producing rich food without practically any inputs from humans. These coastal and marine aquatic habitats need to be considered holistically for integrated management.
- ***Pollution, reclamation, misuse or degradation*** of such ecosystems are to be strictly monitored and prevented.
- ***Places of fish breeding*** within the marine areas and coastal backwaters are to be identified and demarcated as protected zones, in the interest of sustainability of marine fisheries.
- ***To promote the breeding stocks of fishes***, it is necessary to know the breeding months of various commercial fish species. Regulations should be imposed on capture especially of breeding stock of fish species by targeted fisheries sector. For instance peak spawning of mackerel was observed during July-August. The percentage of this fish with mature ovaries was 60% of the total in purse-seine operations in late August (Rohit and Gupta, 2004). The ban on mechanized fishing during this period will be helpful in stock recovery of mackerel and many other fishes. Stoppage of intake of such fishes by cold storage units for export purpose may be prevented so that adequate stocks remain. However, there need not be ban on artisanal fishery and capture by small mechanized crafts
- ***Estuarine integrity*** is very critical for several kinds of marine fishes and prawns which enter the estuaries for breeding or multitudes of their juveniles (fish and prawn seeds/larvae) enter the estuaries to feed and grow in the estuarine habitats like mangroves, sedge areas, mudflats, molluscan beds etc. Integrity of these habitats should be safeguarded through strict implementation of CRZ and considering such areas as ecologically sensitive areas. Involvement of local Village Forest Committees, Biodiversity Management Committees etc. will be of help in keeping vigilance at local level. These committees may be extended financial assistance under the existing forestry schemes or provisions of Biodiversity Act -2002. The Nushikote VFC in the Aghanashini

estuary of Kumta, helping the Forest Department in planting and protection of mangroves, is a notable example.

- ***Multi-species mangrove vegetation*** need to be raised in all areas of estuaries suitable for the respective species combinations.
- ***Estuarine rice fields*** of Uttara Kannada, especially of Aghanashini estuary, where salt tolerant Kagga rice used to be grown, are locally well known as natural feeding grounds of marine shrimps and various marine/coastal fishes because the farmers used to harvest the tall paddy by cutting only the head portions leaving the rest in the field to degrade and become manure. The paddy stumps in post-harvest fields flooded with salt water are ideal places for juveniles of shrimps as anchoring places. These residues eventually become rich nutrients. However, because of intensification of aquaculture in recent decades many of these estuarine fields or *gaznis* are badly affected, and abandoned for cultivation. The Government should initiate steps to repair the *gazni* bunds and install sluice gates wherever damaged and desilt the *kodi* channels in the interest of not only marine and estuarine fishing but also for boosting the sagging production of rice.
- ***Destruction/degradation due to damming of rivers*** for power generation has severe adverse consequences on coastal fishery, including bivalve production through reduction in post-rainy season salinity. This has been noticed in Sharavathi and Kali estuaries, most severe collapse of fishery happening in the former where estuarine water has turned almost into fresh water with salinity less than 0.5 ppt.
- ***Likely diversion of rivers*** will have adverse consequences on estuarine salinity and ecology and on marine and estuarine fisheries.
- ***Need for removal of estuarine mouth siltation*** is necessary for Sharavathi, Aghanashini and Gangavali estuaries where siltation has affected the free movement of tides and therefore of marine fishes entering these estuaries for breeding/feeding.
- ***Regulation of sand and shell mining*** in the estuaries is very important for revival of estuarine and marine fishery. Shell extraction may be limited to the needs of local lime makers and large scale mining may be prohibited in the estuaries for at least the next ten years and the positive influence on coastal fishery studied throughout the period.

3.2 Rebuilding collapsed/declining stocks: The Government of India should adopt a dynamic marine fishing policy through prohibiting periodically export of any fish species the fishery of which is in collapsed/declined state (catches less than 5% of historical maximum), or those species which are seriously depleted or declining to less than 50% of their historical maximum catches, through a comprehensive evaluation system. Such ban may be lifted after the recovery of the stock of such populations to healthy levels. Fishery of all species with collapsed stocks has to be carefully monitored. In the interest of species survival and sustainability

3.3 Need for more responsible fishing: Consensus should prevail that fishing (aquaculture excluded) is not an industrial or business activity but more of an output of ecosystems, which need to be harvested strictly within sustainable limits. Fisher-folks, from time immemorial, depended on fishing for their livelihoods and over-exploitation never happened until commercial, mechanization dominated fishery in the recent times. Wild genetic stock of fish in the marine areas has to be maintained even for the success of aquaculture, where the cultured prawns and fishes are prone to diseases, pollution problems etc. for the surroundings including the marine areas.

3.4 Impose uniform monsoon fishing ban in consultation with CMFRI: The Government of India, through State Governments of respective maritime States, should implements a fishing ban during the monsoon every year, which is a peak season for breeding of many fishes. August is considered peak breeding season for Mackerels for which Karnataka coast is famous. The existing ban on fishing during monsoon by mechanized boats in Uttara Kannada by the State Government for 2013 is from June 15 to July 31, and in Dakshina Kannada from June 15 to August 10. According to CMFRI scientists Rohit and Gupta (2004) 60% of the total Mackerel catch in purse-seine operations during late August were with mature eggs; such catches are likely to have adverse effects on the future stocks. Although there could occur some variability in dates and duration of fishing ban in different states, disparities need to be reduced.

The fishing ban lasts for 45-60 days with each State using a different time period or criteria such as advancement of monsoon as an indicator. Pramod (2010) states absence of a uniform ban period throughout the coastline has led to fishing trawlers of several States using this legal technicality to fish where fishing ban exists and land in an adjacent State where there is no ban.

Fishermen in Goa, Karnataka and Maharashtra along the west coast, complained that the very essence of the fishing ban is flawed as vessels from neighbouring States continue to catch from one State's territorial waters and land in another, leading to low catches during the post ban period. With most of the coastal States having weak enforcement, due to huge gaps in allocated infrastructure, manpower and monetary resources, illegal fishing persists through domestic fishing vessels in inshore waters. Moreover, it also leads to problems in misreported catches where fish caught in one jurisdiction is reported as caught in another location.

To reduce such anomalies it is recommended that the fishing ban from Kerala to Gujarat should be during the same period, with maximum flexibility between any two neighbouring States not exceeding five days. It would mean that if July first is considered the start of fishing ban in Kerala, it could end earliest by 15th August. For the entire Karnataka the fishing ban could come into force latest by July 5th and continue up to August 20. Goa being in almost same climatic regime may accept the same ban period. In Maharashtra coast the ban could be latest from July 10th and end by August 25th. Gujarat being a drier zone the ban period could be decided not differing more than five days with Maharashtra. The Coast Guard may be empowered to enforce more effective implementation of the fishing ban, through random checks, if the Fishery department of any State is ineffective in this matter. It is suggested that the fishing ban imposition be in consultation with CMFRI.

The artisan fisherman may be permitted to fish in near-shore waters during the fishing ban period, using their traditional fishing gadgets. Fishing concessions to a limited extent may be given to indigenous crafts with outboard engines within a five km distance from the shore.

3.5 Strict regulations on mesh sizes of nets: According to Mohammad *et al*. (2010) the majority of the depleted and collapsed stocks of South-west India are those species which are mainly caught in trawls. As a first step for rebuilding stocks, trawl effort has to be reduced in both Kerala and Karnataka and strict implementation of the mesh restriction policy on trawl and purse-seine nets is very necessary. Serious thought should be given to revival of Cat fish population which is very badly affected by indiscriminate pure-seining using nets with small meshes where even eggs cannot escape. According to Pramod (2010) whereas the Karnataka Marine Fisheries Regulation Act requires all mechanized trawlers operating along the coast to use a cod end mesh size of at least 30 mm, most of the trawlers were using 10-15 mm cod end mesh size resulting in indiscriminate capture of juveniles of fish and shrimps. This has also contributed to substantial discards during the monsoon season.

3.6 Reducing the carbon footprints of marine fishing boats: Unrestrained mechanization of the Indian marine fishing sector has not only nearly destroyed traditional artisanal fishery and resulted in imminent collapse of numerous commercially exploited fishes but also caused the release of phenomenal quantities of CO2 emission. According to Vivekanandan *et al*. (2013) the last five decades has resulted in substantial increase in diesel consumption, equivalent to CO2 emission of 0.30 million tons in 1961 to 3.60 million tons in 2010. For every ton of fish caught, the CO2 emission has increased from 0.50 to 1.02 t during the period. Large differences in CO2 emission between craft types were observed. In 2010, the larger mechanized boats (with inboard engine) emitted 1.18 t CO2/t of fish caught, and the smaller motorized boats (with outboard motor) 0.59 t CO2/t of fish caught. Among the mechanized craft, the trawlers emitted more CO2 (1.43 t CO2/t of fish). Our recommendations in this regard include:

- Improving fuel efficiency of marine fishing boats
- Reducing the mechanized fleet size to half the present number, limiting to sustainable catches, in a gradual process through not giving new licenses until targets (sustained yields) are achieved
- Strict enforcement of reserving about 5 km zone from the coastline for non-mechanized fishery and for operation of traditional *rampani* nets etc.
- A shift from fuel-intensive active fishing methods such as trawling to passive methods such as seining, lining and gillnetting may provide a sustainable long-term solution (Vivekanandan *et al*., 2013).

3.7 Promotion of artisanal fisheries: Based on interviews with small-scale fishermen along Karnataka coast Pramod (2010) estimated illegal fish catches by trawlers in the inshore traditional zone resulting in annual loss of 1200 - 1950 tons. This loss, needless to say, affects the artisan fishers using canoes and plank built boat, cast nets, shore-seine nets and long lines. The operation of mechanized crafts in the inshore waters (5 km zone) needs to be prohibited to alleviate poverty and underemployment among artisanal fisherfolks.

3.8 Reducing fishing by-catches/discards: Introduction of modern fishing methods and targeted fisheries have resulted in wasteful by-catches of juvenile fishes, non-targeted species like turtles, other fishes, marine invertebrates etc. Such by-catches also have very serious food security implications on one billion people who depend on fish as their principal source of food. Global by-catches are estimated to be 40.4% of total marine catches (Davies et al., 2009). A study of India's marine fisheries in the early 1990s found that the bulk of marine landings consisted of juvenile fish due to the use of extremely small cod-end mesh size (as low as 8–10 mm—only one-fourth of the required 35 mm size that is legally required. Bycatches in shrimp fishing by trawlers ranged between 56 percent and 82 percent (Kumar and Deepthi, 2006). Jayaraman (2004) based on a study in 2003 estimated trash fish to constitute 10-20% of total catches (271,000 tons) landed by trawlers operating along Indian coastline. Sathiadas et al (1994) estimate a discard rate of 5% for marine fisheries in India. Pramod's (2010) based on observations during 2008-9, estimated average discards at sea by mechanized trawlers in India to be in the order of 1,217,931 tons, (in the range of 924,974 to 1,510,893 tons). Of this Karnataka's share would be 161,042 tons per year (in the range of 111,985 to 210,099 tons). Results from this study shows that discards have increased for two main reasons. Firstly, the number of trawlers operating along the Indian coastline has increased over the past four decades. Secondly, the duration of fishing trips by multiday trawlers is in the order of 10-12 days, with trawlers along the Kerala, Karnataka and Maharashtra coastlines increasingly targeting deep sea stocks at 150-350 meters during most of the year. Increasingly, longer fishing trips in deeper waters means that non-commercial species of fish and shrimps are encountered in larger numbers. The operators of these trawlers cannot store trash fish from all the hauls during each trip, a good part of which are discarded into the sea. Gujarat has a more efficient trash fish collection as they are purchased for higher prices for fish meal factories. More and more landing of trash fish is reported to compensate for decline of commercial fishes. The following are recommendations to reduce by-catches:

- From a sustainability point of view, limitation of fishery production to safe biological limits is necessary before seeking export markets for the products.

- Given the dynamic complexity of marine ecosystems and the often inter-mingling of various types of species, the practical reality, however, is that selecting and catching only that which is managed will not be solved solely through selective fishing gear. Consequently, the most pressing priority for bycatch reduction and over-fishing, should be reducing the amount of fishing, to meet more the domestic needs than catering to the global demands.
- Trawler fishing should be phased out to reach sustainable numbers by limiting licenses for new ones.

3.9 Advisability of aquaculture: The marine fishery resources are on the brink of collapse with most fishes and seafood in demand having already reached declined, depleted or collapsed states. Aquaculture, one of the fastest growing enterprises in the world, is considered as a strong solution to reducing pressure on marine fishery allowing for recovery of depleted stocks. Plagued with many problems its sustainability however is not assured as problems of pollution, destruction of sensitive coastal habitats, threats to aquatic biodiversity and significant socio-economic costs must be balanced against the substantial benefits (Emerson, 1999). Whereas China dominates in aquaculture with 83% of world production India's contribution is only 6%.

One major problem from aquaculture is from the use of artificial feeds increasing pollution from farm effluents. Overfeeding in fish farms has caused changes in benthic community structure (Stenton-Dozey et al., 1999) because a high food supply may favour some organisms over others. Moreover, sedentary animals may die in water depleted of oxygen resulting from microbial decomposition, while the mobile population may migrate to other areas. Antibiotics and other therapeutic chemicals added to feed can affect organisms for which they were not intended (Grant and Briggs, 1998). A variety of chemicals used to inhibit the growth of other organisms may also affect other organisms. The fishing communities of Uttara Kannada coast have complained that the use of bleaching powder and lime in estuarine aquaculture ponds create massive deaths of juveniles of prawns and fishes.

3.10 Eco-friendly aquaculture: Government of India enacted the Coastal Aquaculture Authority Act, 2005, enabling the establishment of the Coastal Aquaculture Authority for enforcing proper regulatory measures for carrying out coastal aquaculture in a more sustainable and eco-friendly manner. The awareness levels of coastal shrimp farmers were inadequate and neither the State Government nor the farmers were geared to meet the challenges that were posed by issues such as pollution, viral diseases, etc. The National Fisheries Development Board (NFDB) has allocated funds for training, awareness and enhancing skills for coastal aquaculture, for shrimp and finfish farming. The State Governments shall set up a dedicated Monitoring and Evaluation Cell in the Department of Fisheries to periodically monitor and evaluate activities implemented under the NFDB. The Fisheries Department of the State should undertake these programmes, and facilitate small scale, ecofriendly aquaculture to reduce the pressure on marine fishing, to reduce consumption of fuel, and to save marine fisheries from a likely collapse (http://ahd.bih.nic.in/Docs/NFDB-Guidelines-for-Coastal-Aquaculture.pdf).

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ANNEXURE-1

Marine Fish Diversity of Uttara Kannada District

(Source: Coastal & Marine Biodiversity of Karnataka, CMFRI, 2006)

	Family	Scientific Name	Common Name	Economic importance
1	Acanthuridae	*Acanthurus blochii*	Ringtail surgeon fish	Consumed
2		*Acanthurus mata*	Elongate surgeon fish	Consumed
3		*Acanthurus xanthopterus*	Yellow fin surgeon fish	Consumed
4		*Naso annulatus*	White margin unicorn fish	Consumed
5	Alopiidae	*Alopias pelagicus*	Pelagic /small tooth thresher	Consumed/dried/fins/ liver oil/fishmeal
6		*Alopias vulpinus*	Thin tail thresher	Consumed/dried/fins/ liver oil/fishmeal
7	Amarsipidae	*Amarsipus carlsbergi*	Amarsipidis	Ornamental
8	Ambassidae	*Ambassis natalensis*	Slender glassy	Ornamental/baits
9	Antennariidae	*Antennarius pictus*	Painted frogfish	Trash/used in fish meal plant
10	Apogonidae	*Apogon aureus*	Ringtailed cardinalfish	Ornamental
11		*Apogon fragilis*	Fragile cardinal fish	Ornamental
12		*Apogon kiensis*	Rifle cardinal	Ornamental
13		*Cheilodipterus quinquelineatus*	Five-linedcardinal fish	Ornamental
14	Ariidae	*Arius caelatus*	Engraved catfish	Consumed/isin glass
15		*Arius dussumieri*	Black tip sea catfish	Consumed/isin glass
16		*Arius jella*	Blackfin sea catfish	Consumed/isin glass
17		*Arius platystomus*	Flatmouth sea catfish	Consumed/isin glass

18		*Arius tenuispinis*	Thinspine sea catfish	Consumed/isin glass
19	Ariommatidae	*Ariomma indica*	Indian ariomma	Consumed
20	Atherinidae	*Hypoatherina temminckii*	Samoan silverside	
21	Balistidae	*Abalistes stellaris*	Starry triggerfish	Ornamental/Fishmeal
22		*Odonus niger*	Red toothed triggerfish	Ornamental
23		*Pseudobalistes fuscus*	Yellow-spotted triggerfish	Ornamental
24		*Sufflamen fraenatum*	Masked triggerfish	Ornamental
25	Batrachoididae	*Austrobatrachus dussumieri*	Flat toadfish	Ornamental
26		*Batrichthys felinus*	Pleated toadfish	Ornamental
27	Belonidae	*Ablennes hians*	Flat needlefish	Ornamental
28		*Strongylura leiura*	Banded needlefish	Consumed
29		*Strongylura strongylura*	Spot tail needle fish	Consumed
30	Bembridae	*Parabembras robinsoni*	Deep water flathead	Ornamental
31	Bothidae	*Arnoglossus aspilos*	Spotless lefteye flounder	Ornamental
32		*Bothus myriaster*	Indo-Pacific oval flounder	Consumed
33		*Bothus pantherinus*	Leopard flounder	Consumed
34	Callionymidae	*Callionymus sagitta*	Arrow dragonet	Consumed
35	Carangidae	*Alectis ciliaris*	African pompano	Consumed
36		*Alectis indicus*	Indian threadfish	Consumed/Ornamental/Sport
37		*Alepes djedaba*	Shrimp scad	Consumed/Sport
38		*Alepes melanoptera*	Blackfin scad	Consumed
39		*Carangoides chrysophrys.*	Longnose trevally	Consumed/Sport

40		*Carangoides equula*	Whitefin trevally	Consumed/Sport
41		*Carangoides malabaricus*	Malabar trevally	Consumed/Sport
42		*Carangoides oblongus*	Coachwhip trevally	Consumed/Sport
43		*Carangoides praeustus*	Brownback trevally	Consumed
44		*Caranx ignobilis*	Giant trevally	Consumed/Sport
45		*Caranx melampygus*	Bluefin trevally	Consumed/Sport
46		*Decapterus kurroides*	Redtail scad	Consumed/Canned/ Fishmeal
47		*Decapterus macrosoma*	Shortfin scad	Consumed/Canned/ Fishmeal
48		*Decapterus russelli*	Indian scad	Consumed/Canned/ Fishmeal
49		*Decapterus tabl*	Roughear scad	Consumed/Canned/ Fishmeal
50		*Elagatis bipinnulata*	Rainbow runner	Consumed
51		*Gnathanodon speciosus*	Golden trevally	Consumed/Sport/Ornamental/Culture
52		*Megalaspis cordyla*	Horse mackerel	Consumed/Canned
53		*Parastromateus niger*	Black pomfret	Consumed
54		*Scomberoides commersonnianus*	Talang queenfish	Consumed/Sport
55		*Scomberoides lysan*	Double spotted queenfish	Consumed/Sport
56		*Scomberoides tala*	Barred queenfish	Consumed/Sport
57		*Scomberoides tol*	Needle scaled queenfish	Consumed/Sport
58		*Selar crumenophthalmus*	Big eye scad	Consumed
59		*Seriolina*	Blackbanded trevally	Consumed/Sport

		nigrofasciata		
60		*Trachinotus baillonii*	Small spot dart	Consumed/Sport
61		*Trachinotus blochii*	Snub nose pompano	Consumed/Sport
62		*Trachinotus mookale e*	Indian pompano	Consumed/Sport
63		*Uraspis helvola*	White tongue jack	Consumed
64		*Atropus atropos*	Cleftbelly trevally	Consumed
65		*Atule mate*	Yellow-tail scad	Consumed
66		*Carangoides armatus*	Longfin trevally	Consumed
67		*Carangoides fulvoguttatus*	Yellowspotted trevally	Consumed/Sport
68		*Carangoides coerule opinnatus*	Coastal trevally	Consumed/Sport
69		*Caranx sexfasciatus*	Bigeye trevally	Consumed/Sport
70	Carcharhinidae	*Carcharhinus amboinensis*	Pigeye shark	Consumed/dried/fins/ liver oil/fishmeal
71		*Carcharhinus dussumieri*	Whitecheek shark	Consumed/dried/fins/ liver oil/fishmeal
72		*Carcharhinus hemiodon*	Pondicherry shark	Consumed/dried/fins/ liver oil/fishmeal
73		*Carcharhinus limbatus*	Blacktip shark	Consumed/dried/fins/ liver oil/fishmeal
74		*Carcharhinus longimanus*	Oceanic whitetip shark	Consumed/dried/fins/ liver oil/fishmeal
75		*Carcharhinus macloti*	Hardnose shark	Consumed/dried/fins/ liver oil/fishmeal
76		*Carcharhinus melanopterus*	Blacktip reefshark	Consumed/dried/fins/ liver oil/fishmeal
77		*Carcharhinus sealei*	Blackspot shark	Consumed/dried/fins/ liver oil/fishmeal
78		*Carcharhinus sorrah*	Spottail shark	Consumed/dried/fins/ liver oil/fishmeal

79		*Galeocerdo cuvieri*	Tiger shark	Consumed/dried/fins/ liver oil/fishmeal
80		*Rhizoprionodon acutus*	Milk shark	Consumed/dried/fins/ liver oil/fishmeal
81		*Rhizoprionodon oligolinx*	Grey sharpnose shark	Consumed/dried/fins/ liver oil/fishmeal
82		*Scoliodon laticaudus*	Spadenose shark	Consumed/dried/fins/ liver oil/fishmeal
83		*Psenopsis cyanea*	Indian ruff	Consumed/Trash/Fishmeal
84		*Psenopsis intermedia*	Medusae fish	Trash/Fishmeal
85		*Lates calcarifer*	Barramundi	Consumed
86	Cepolidae	*Acanthocepola limbata*	Bandfish	Trash/Fishmeal
87	Chaetodontidae	*Chaetodon collare*	Red tail butterfly fish	Ornamental
88		*Chaetodon decussatus*	Indian vagabond butterfly fish	Ornamental
89		*Chaetodon jayakari*	Indian golden -barred butterflyfish	Ornamental
90	Chanidae	*Chanos chanos*	Milkfish	Consumed
91	Chirocentridae	*Chirocentrus dorab*	Dorab wolf-herring	Consumed/Sport
92	Chlorophthalmi dae	*Chlorophthalmus bicornis*	Spinyjaw greeneye	Trash/Fishmeal
93		*Chlorophthalmus aga ssizi*	Shortnose greeneyes	Trash/Fishmeal
94	Clupeidae	*Anodontostoma chac unda*	Chacunda gizzard shad	Consumed
95		*Dussumieria acuta*	Rainbow sardine	Trash/Fishmeal
96		*Escualosa thoracata*	White sardine	Consumed
97		*Hilsa kelee*	Kelee shad	Consumed
98		*Illisha megaloptera*	Big eye ilisha	Consumed
99		*Nematalosa nasus*	Bloch's gizzard shad	Consumed
100		*Opisthopterus*	Tardoore	Consumed

		tardoore		
101		*Pellona ditchela*	Indian pellona	Consumed
102		*Sardinella albella*	White sardinella	Consumed
103		*Sardinella brachysoma*	Deep bodied sardinella	Consumed/dried
104		*Sardinella dayi*	*Mauritian sardinella*	Consumed/dried
105		*Sardinella fimbriata*	Fringescale sardinella	Consumed/dried
106		*Sardinella gibbosa*	Goldstripe sardinella	Consumed/dried
107		*Sardinella longiceps*	Indian oil sardine	Consumed/dried /Canned/Fishmeal/Fish oil
108		*Tenualosa ilisha*	Indian shad	Consumed
109	Congridae	*Conger cinereus*	Longfin African conger	Commercial,game,aquarium
110		*Uroconger lepturus*	Slender conger	Consumed
111	Coryphaenidae	*Coryphaena hippurus*	Common dolphinfish	Consumed
112	Cynoglossidae	*Cynoglossus arel*	Largescale tonguesole	Consumed
113		*Cynoglossus bilineatus*	Lined tonguesole	Consumed/dried
114		*Cynoglossus macrostomus*	Malabar tonguesole	Consumed/dried
115		*Cynoglossus punticeps*	Speckled tonguesole	Consumed/dried
116	Dactylopteridae	*Dactyloptena orientalis*	Oriental flying gurnard	Trash/Fishmeal
117		*Dactyloptena peterseni*	Starry flying gurnard	Trash/Fishmeal
118		*Dactyloptena peterseni*	Starry flying gurnard	Trash/Fishmeal
119	Dasyatidae	*Dasyatis microps*	Annandale's stingray	Consumed/fishmeal
120		*Dasyatis zugei*	Pale edged stingray	Consumed/fishmeal
121		*Himantura bleekeri*	Whiptail stingray	Consumed/fishmeal
122		*Himantura imbricata*	Scaly whipray	Consumed/fishmeal

123		*Himantura uarnak*	Honeycomb stingray	Consumed/fishmeal
124	Drepaneidae	*Drepane punctata*	Spotted sicklefish	Consumed
125	Echeneidae	*Echeneis naucratus*	Live sharksucker	Consumed/Ornamental/Sport
126		*Coilia dussumieri*	Gold spotted grenadier anchovy	Consumed/dried
127		*Encrasicholina devisi*	Devi's anchovy	Consumed/dried
128		*Encrasicholina punctifer*	Buccaneer anchovy	Consumed/dried
129		*Stolephorus indicus*	Indian anchovy	Consumed/dried
130		*Stolephorus insularis*	Hardenberg's anchovy	Consumed/dried
131		*Stolephorus waitei*	Spotty face anchovy	Consumed/dried
132		*Stolephorus commers onnii*	Commerson's anchovy	Consumed/dried
133		*Thryssa dussumieri*	Dussumier's thryssa	Consumed/dried
134		*Thryssa malabarica*	Malabar thryssa	Consumed/dried
135		*Thryssa mystax*	Moustached thryssa	Consumed/dried
136		*Thryssa setirostris*	Longjaw thryssa	Consumed/dried
137		*Thryssa vitrirostris*	Orangemouth anchovy	Consumed/dried
138	Ephippidae	*Platax orbicularis*	Orbicular batfish	Consumed/Ornamental
139		*Platax teira*	Tiera batfish	Consumed/Ornamental
140	Exocoetidae	*Exocoetus monocirrhus*	Barbel flyingfish	Consumed/Ornamental
141	Fistulariidae	*Fistularia commersonii*	Bluespotted cornetfish	Trash/Fishmeal/Ornamental
142		*Fistularia petimba*	Cornet fish	Trash/Fishmeal/Ornamental
143	Gerreidae	*Gerres limbatus*	Saddle back silver biddy	Consumed
144		*Gerres filamentosus*	Whip-fin silverbiddy	Consumed
145		*Gerres longirostris*	Longtail silverbiddy	Consumed

146		*Gerres oyena*	Common silverbiddy	Consumed
147	Gobiidae	*Ctenotrypauchen microcephalus*	Comb goby	Trash/Fishmeal
148	Haemulidae	*Diagramma pictum*	Painted sweetlips	Consumed
149		*Plectorhinchus chubbi*	Dusky rubberlip	Consumed
150		*Plectorhinchus gibbosus*	Hairy hotlips	Consumed
151		*Plectorhinchus picus*	Spotted sweetlips	Consumed
152		*Plectorhinchus plagiodesmus*	Barred rubberlip	Consumed
153		*Plectorhinchus schotaf*	Grey sweetlips	Consumed
154		*Plectorhinchus vittatus*	Indian ocean oriental sweetlips	Consumed
155		*Pomadasys argyreus*	Blue cheek silver grunt	Consumed
156		*Pomadasys maculatu s*	Saddle grunt	Consumed
157	Harpadontidae	*Harpadon nehereus*	Bombayduck	Consumed
158		*Hemiramphus archipelagicus*	Jumping half beak	Consumed
159		*Hemiramphus far*	Black-barred half beak	Consumed
160		*Hyporhamphus limbatus*	Congaturi halfbeak	Consumed
161	Hemiscylliidae	*Chiloscyllium griseum*	Grey bambooshark	Consumed/dried/fins/ liver oil/fishmeal
162		*Chiloscyllium indicum*	Slender bambooshark	Consumed/dried/fins/ liver oil/fishmeal
163	Holocentridae	*Sargocentron rubrum*	Red coat	Consumed/Ornamental
164	Istiophoridae	*Istiophorus*	Sailfish	Consumed/Canned

		platypterus		
165		*Makaira indica*	Black marlin	Consumed/Canned
166	Kyphosidae	*Kyphosus cinerascens*	Blue sea chub	Trash/Fishmeal
167	Lactariidae	*Lactarius lactarius*	False trevally	Consumed/dried
168	Leiognathidae	*Gazza achlamys*	Small toothed pony fish	Consumed/dried
169		*Gazza minuta*	Toothpony	Consumed/dried
170		*Leiognathus bindus*	Orangefin ponyfish	Consumed/dried
171		*Leiognathus blochii*	Twobloch ponnyfish	Consumed/dried
172		*Leiognathus brevirostris*	Shortnose ponyfish	Consumed/dried
173		*Leiognathus equulus*	Common ponyfish	Consumed/dried
174		*Leiognathus lineolatus*	Ornate ponyfish	Consumed/dried
175		*Leiognathus splendens*	Splendid pony fsh	Consumed/dried
176		*Secutor ruconius*	Deep pugnose ponyfish	Consumed
177		*Secutor insidiator*	Pugnose ponyfish	Consumed/dried
178	Lethrinidae	*Gymnocranius griseus*	Grey large-eye bream	Consumed/dried
179		*Lethrinus mahsena*	Mahasena emperor	Commercial
180		*Lethrinus microdon*	Smalltooth emperor	Commercial
181		*Lethrinus ornatus*	Ornate emperor	Commercial
182	Lobotidae	*Lobotes surinamensis*	Tripple tail	Commercial
183		*Lophiodes mutilus*	Smooth angler	Trash/Fishmeal
184		*Lophiomus setigerus*	Blackmouth angler	Trash/Fishmeal
185	Lutjanidae	*Aprion virescens*	Green jobfish	Consumed
186		*Lutjanus argentimaculatus*	Mangrove red snapper	Consumed
187		*Lutjanus bohar*	Two spot red snapper	Consumed

188		*Lutjanus bohar*	Two spot red snapper	Consumed
189		*Lutjanus fulvus*	Black tail snapper	Consumed
190		*Lutjanus gibbus*	Humpback red snapper	Consumed
191		*Lutjanus guilcheri*	Yellowfin red snapper	Consumed
192		*Lutjanus kasmira*	Common bluestripe snapper	Consumed
193		*Lutjanus lemniscatus*	Yellow streaked snapper	Consumed
194		*Lutjanus lutjanus*	Bigeye snapper	Consumed
195		*Lutjanus madras*	Indian snapper	Consumed
196		*Lutjanus malabaricus*	Malabar blood snapper	Consumed
197		*Pristipomoides filamentosus*	Crimson jobfish	Consumed
198		*Pristipomoides typus*	Sharptooth jobfish	Consumed
199	Malacanthidae	*Malacanthus sp*	Blanquillo	Consumed/Ornamental
200	Megalopidae	*Megalops cyprinoides*	Indo pacific tarpon	Consumed
201	Menidae	*Mene maculata*	Moonfish	Consumed
202	Mobulidae	*Manta birostris*	Devilray	Consumed/fishmeal
203		*Mobula mobular*	Horny ray	Consumed/fishmeal
204	Molidae	*Mola mola*	Sunfish	Trash
205	Monacanthidae	*Aluterus monoceros*	Unicorn leather jacket	Trash/Fishmeal
206	Monodactylidae	*Monodactylus argenteus*	Silver moony	Consumed
207	Mugilidae	*Liza macrolepis*	Giantscale mullet	Consumed
208		*Liza melinoptera*	Otomebora mullet	Consumed
209		*Liza parsia*	Goldspot mullet	Consumed
210		*Liza tade*	Tade mullet	Consumed
211		*Mugil cephalus*	Flathead mullet	Consumed
212	Mullidae	*Parupeneus indicus*	Indian goatfish	Consumed

213		*Upeneus moluccensis*	Goldband goatfish	Consumed
214		*Upeneus taeniopterus*	Finstripe goatfish	Consumed
215		*Upeneus vittatus*	Yellow striped goatfish	Consumed
216	Muraenesocidae	*Muraenesox cinereus*	Diggertooth pike conger	Consumed/Ornamental/Sport
217		*Congresox talabonoides*	Indian pike conger	Consumed
218		*Muraenesox bagio*	Common pike conger	Consumed
219	Muraenidae	*Echidna nebulosa*	Snowflaked murray	Trash/Fishmeal
220	Myctophidae	*Diaphus splendidus*	Lanternfish	
221	Myliobatidae	*Aetobatus narinari*	Spotted eagleray	Consumed/fishmeal
222		*Rhinoptera javanica*	Javanese cowray	Consumed/fishmeal
223	Narcinidae	*Narcine indica*	Large spotted numbfish	Consumed/fishmeal
224	Nemipteridae	*Nemipterus japonicus*	Japanese threadfin bream	Consumed/Surumi preparation
225		*Nemipterus mesoprion*	Mauvelip threadfin bream	Consumed/Surumi preparation
226		*Parascolopsis aspinosa*	Smooth dwarf monocle bream	Consumed/Surumi preparation
227		*Parascolopsis boesemani*	Redfin dwarf monocle bream	Consumed/Surumi preparation
228		*Scolopsis vosmeri*	White cheek monocle bream	Consumed/Surumi preparation
229	Nomeidae	*Cubiceps squamiceps*	Indian driftfish	
230	Ophidiidae	*Monomitopus conjugator*		
231	Paralichthyidae	*Pseudorhombus arsius*	Largetooth flounder	Commercial,game
232		*Pseudorhombus elevatus*	Deep flounder	Consumed

233		*Pseudorhombus triocellatus*	Three spotted flounder	
234	Pempheridae	*Pempheris adusta*	Dusky sweeper	
235	Pinguipedidae	*Parapercis alboguttata*	Whitespot sand smelt	
236	Platycephalidae	*Cociella crocodila*	Crocodile flathead	
237		*Grammoplites scaber*	Rough flathead	Consumed
238		*Grammoplites suppositus*	Spotfin flathead	Consumed
239		*Platycephalus indicus*	Bartail flat head	Consumed
240	Pleuronectidae	*Paralichthodes algoensis*	Peppered flounder	Consumed
241	Plotosidae	*Plotosus lineatus*	Striped eel catfish	
242	Polynemidae	*Eleutheronema tetradactylum*	Four finger threadfin	Consumed
243		*Filimanus heptadactyla*	Seven thread tasselfish	Consumed
244		*Leptomelanosoma indicum*	Indian threadfin	Consumed
245		*Polydactylus sextarius*	Black spot threadfin	Consumed
246	Priacanthidae	*Heteropriacanthus cruentatus*	Glassy eye	Consumed
247		*Priacanthus hamrur*	Moontail bullseye	Consumed
248	Pristidae	*Pristis microdon*	Small toothed sawfish	Consumed/dried/fins/ liver oil/fishmeal
249	Psettodidae	*Psettodes erumei*	Indian turbot	Consumed
250	Ptereleotridae	*Ptereleotris evides*	Blackfin dartfish	
251	Rachycentridae	*Rachycentron canadum*	Cobia	Consumed
252	Rajidae	*Rhinobatos thouiniana*	Shaw's shovel nose guitarfish	Consumed/dried/fins/ liver oil/fishmeal

253	Rhincodontidae	*Rhincodon typus*	Whale shark	Consumed/dried/fins/ liver oil/fishmeal
254	Rhinobatidae	*Rhina ancylostoma*	Bow mouthed guitarfish	Consumed/dried/fins/ liver oil/fishmeal
255		*Rhinobatos djiddensis*	White-spotted shovelnose guitarfish	Consumed/dried/fins/ liver oil/fishmeal
256		*Rhinobatos granulatus*	Granulated shovelnose ray	Consumed/dried/fins/ liver oil/fishmeal
257		*Rhinobatos obtusus*	Whitenose guitarfish	Consumed/dried/fins/ liver oil/fishmeal
258		*Rhinobatos typus*	Grey guitarfish	Consumed/dried/fins/ liver oil/fishmeal
259	Scatophagidae	*Scatophagus argus*	Spotted scat	Consumed
260	Sciaenidae	*Johnius belangerii*	Belanger's croaker	Consumed/isin glass
261		*Johnius carouna*	Caroun croaker	Consumed/isin glass
262		*Johnius dussumieri*	Bearded croaker	Consumed/isin glass
263		*Johnius glaucus*	Pale spot fin croaker	Consumed/isin glass
264		*Nibea maculata*	Blotched croaker	Consumed/isin glass
265		*Otolithes cuvieri*	Lesser tigertooth croaker	Consumed/isin glass
266		*Otolithes ruber*	Tigertooth croaker	Consumed/isin glass
267		*Protonibea diacanthus*	Spotted croaker	Consumed
268	Scombridae	*Acanthocybium solandri*	Wahoo	Consumed
269		*Auxis rochei rochei*	Bullet tuna	Consumed
270		*Auxis thazard thazard*	Frigate tuna	Consumed
271		*Euthynnus affinis*	Kawakawa	Consumed
272		*Katsuwonus pelamis*	Skipjack tuna	Consumed
273		*Rastrelliger kanagurta*	Indian mackerel	Consumed
274		*Sarda orientalis*	Striped bonito	Consumed

275		*Scomberomorus commerson*	Narrowbarred spanish mackerel	Consumed
276		*Scomberomorus guttatus*	Indo-Pacific king mackerel	Consumed
277		*Thunnus albacares*	Yellowfin tuna	Consumed
278		*Thunnus tonggol*	Longtail tuna	Consumed
279	Scorpaenidae	*Dendrochirus zebra*	Zebra turkeyfish	Ornamental
280		*Neomerinthe procurva*	Scorpion fish	Ornamental
281	Serranidae	*Cephalopholis formosa*	Bluelined hind	Ornamental
282		*Epinephelus chabaudi*	Moustached grouper	Consumed
283		*Epinephelus chlorostigma*	Brownspotted grouper	Consumed
284		*Epinephelus diacanthus*	Spinycheek grouper	Consumed/Surumi preparation
285		*Epinephelus epistictus*	Brokesn-line grouuper	Consumed
286		*Epinephelus fasciatus*	Blacktip grouper	Consumed
287		*Epinephelus flavocaeruleus*	Blue and yellow grouper	Consumed
288		*Epinephelus longispinis*	Streakyspot grouper	Consumed
289		*Epinephelus merra*	Honeycomb grouper	Consumed
290		*Epinephelus tauvina*	Greasy grouper	Consumed
291		*Epinephelus coeruleo punctatus*	White-spotted grouper	Consumed
292		*Variola louti*	Yellow edged lyretail	Consumed
293		*Variola louti*	Yellow edged lyretail	Consumed
294		*Cephalopholis urodeta*	Darkfin hind	Subsistence fisheries/aquarium

295	Siganidae	*Siganus canaliculatus*	White-spotted spinefoot	Consumed
296		*Siganus javus*	Streaked spinefoot	Consumed
297		*Siganus vermiculatus*	Vermiculated spine foot	Consumed
298	Sillaginidae	*Sillago sihama*	Silver sillago	Consumed
299		*Sillago vincenti*	Vincent's sillago	Consumed
300	Soleidae	*Brachirus orientalis*	Oriental sole	Consumed
301		*Solea bleekeri*	Black hand sole	Consumed/Ornamental/Sport
302		*Solea elongata*	Elongate sole	Consumed
303		*Synaptura commersonnii*	Commerson sole	Consumed
304	Sparidae	*Acanthopagrus berda*	Picnic seabream	Consumed
305		*Acanthopagrus bifasciatus*	Twobar seabream	Consumed
306		*Argyrops spinifer*	King soldierbream	Consumed
307	Sphyraenidae	*Sphyraena barracuda*	Great barracuda	Consumed/Sport
308		*Sphyraena jello*	Pickhandle barracuda	Consumed/Sport
309		*Sphyraena obtusata*	Obtuse barracuda	Consumed/Sport
310	Sphyrnidae	*Sphyrna mokarran*	Great hammerhead	Consumed/dried/fins/ liver oil/fishmeal
311		*Sphyrna lewini*	Scalloped hammerhead	Consumed/dried/fins/ liver oil/fishmeal
312	Stegostomatidae	*Stegostoma fasciatum*	Zebra shark	Consumed/dried/fins/ liver oil/fishmeal
313	Stomiidae	*Stomias nebulosus*	Alcock's boafish	Trash/fishmeal
314	Stromateidae	*Pampus argenteus*	Silver pomfret	Consumed
315	Synanceiidae	*Minous monodactylus*	Grey stingfish	Ornamental
316	Syngnathidae	*Hippocampus histrix*	Thorny seahorse	Medicine
317	Syngnathidae	*Hippocampus kuda*	Spotted seahorse	Medicine
318	Synodontidae	*Saurida tumbil*	Greater lizardfish	Consumed/dried

319		*Synodus indicus*	Indian Lizardfish	
320		*Trachinocephalus myops*	Snakefish	Consumed/dried
321		*Saurida undosquamis*	Brushtooth lizardfish	Consumed/dried
322	Terapontidae	*Terapon jarbua*	Jarbua terapon	Consumed/Culture
323		*Terapon puta*	Small-scaled terapon	Consumed
324		*Terapon theraps*	Largescaled therapon	Consumed
325	Tetraodontidae	*Lagocephalus inermis*	Smooth-backed blow fish	Trash/Fishmeal
326	Torpedinidae	*Torpedo sinuspersici*	Marbled electric ray	Consumed/fishmeal
327	Triacanthidae	*Triacanthus biaculeatus*	Short-nosed tripodfish	Consumed
328	Trichiuridae	*Lepturacanthus saval a*	Savalani hairtail	Consumed
329		*Trichiurus lepturus*	Largehead hairtail	Consumed/dried
330	Uranoscopidae	*Uranoscopus archionema*	Stargazer	Trash/Fishmeal
331		*Uranoscopus guttatus*	Stargazer	Trash/Fishmeal

ANNEXURE 2

Annexure 2. Coral associated fish diversity of Netrani Island off Uttara Kannada coast

(Source: Coastal & Marine Biodiversity of Karnataka, CMFRI, 2007)

Sl.n	Scientific name	Common Name
1	*Acanthurus xanthopterus*	Yellowfin surgeonfish
2	*Zebrasoma desjardinii*	Surgeonfish
3	*Apogon aureus*	Ringtailed cardinal fish
4	*Balistoides viridescens*	Titan trigger fish
5	*Odonus niger*	Redtoothed trigger fish
6	*Sufflamen fraenatum*	Masked trigger fish
7	*Caesio teres*	Yellow and blueback fusilier
8	*Carangoides chrysophrys.*	Longnose trevally
9	*Caranx melampygus*	Bluefin trevally
10	*Elagatis bipinnulata*	Rainbow runner
11	*Megalaspis cordyla*	Torpedo scad
12	*Scomberoides tol.*	Needlescaled queenfish
13	*Trachinotus bailloni*	Smallspotted dart
14	*Chaetodon auriga*	Threadfin butterflyfish
15	*Chaetodon collare*	Redtail butterflyfish
16	*Chaetodon decussatus*	Indian vagabond butterflyfish
17	*Chaetodon dolosus*	African butterflyfish
18	*Chaetodon plebeius*	Bluespot butterflyfish
19	*Heniochus diphreutes*	False moorishidol
20	*Heniochus monocerrus*	Masked Bannerfish
21	*Himanthura imbricata*	Scaly whipray
22	*Diodon holocanthus*	long-spine porcupine fish
23	*Diodon liturosus*	Blackblotched porcupine fish
24	*Echeneis naucrates*	Live sharksucker
25	*Amblyeleotris fasciata*	Red banded prawn goby

26	*Amblyeleotris guttata*	Spotted prawn goby
27	*Amblyeleotris periophthalma*	Periophthalma prawn goby
28	*Amblyeleotris triguttata*	Triple spot shrimp goby
29	*Amblyeleotris wheeleri*	Gorgeous prawn goby
30	*Elacatinus genie*	Cleaner Goby
31	*Valenciennea Sexguttata*	Sixspot goby
32	*Valenciennea strigata*	Blueband goby
33	*Plectorhinchus chubbi*	Dusky rubberlip
34	*Plectorhinchus vittatus*	Indian ocean oriental sweet lips
35	*Sargocentron rubrum*	Redcoat squirrelfish
36	*Cheilinus undulatus*	Humphead Wrasse
37	*Coris aygula*	Clown coris
38	*Coris formosa*	Queen coris
39	*Labroides dimidiatus*	Bluestreak cleaner wrasse
40	*Thalassoma lunare*	Moon wrasse
41	*Lutjanus argentemaculatus*	Mangrove red snapper
42	*Lutjanus bohar*	Two-spot red snapper
43	*Lutjanus dodecacanthoides*	Sun beam snapper
44	*Lutjanus fulvus*	Blacktail snapper
45	*Lutjanus lemniscatus*	Yellow streaked snapper
46	*Lutjanus rivulatus*	Blubberlip snapper
47	*Malacanthus* sp.	Blanquillo
48	*Eubalichthys caeruleoguttatus*	Blue spotter leather jacket
49	*Mugil cephalus*	Flathead mullet
50	*Parupeneus indicus*	Indian goatfish
51	*Gymnothroax eurostus*	Abbotts moray eel
52	*Gymnothroax favagineus*	Laced moray
53	*Gymnothroax flavimarginatus*	yellow-edged moray
54	*Gymnothroax javanicus*	Giant moray
55	*Gymnothroax thyrsoideus*	Greyface moray
56	*Ostracion cubicus*	Yellow boxfish
57	*Platax teira*	Tiera batfish

58	*Pomacanthus striatus*	Yellow bar angel fish
59	*Abudefduf sordidus*	Blackspot sergeant
60	*Amphiprion perideraion*	Pink anemon fish
61	*Dascyllus carneus*	Cloudy dascyllus
62	*Dascyllus trimaculatus*	Threespot dascyllus
63	*Pomacentrus coelestis*	Neon damsel fish
64	*Pomacentrus philippinus*	Phillippine damsel
65	*Apolemichthys kingi*	Tiger angel fish
66	*Ptereleotris evides*	Blackfin dartfish
67	*Rachycentron canadum*	Cobia
68	*Rhincodon typus*	Whale shark
69	*Cetoscarus bicolor*	Bicolour parrot fish
70	*Chlorurus bleekeri*	Bleeker's parrot fish
71	*Chlorurus troschelii*	Troschel's parrot fish
72	*Scarus globiceps*	Globehead parrotfish
73	*Scarus hoefleri*	Guinian parrot fish
74	*Dendrochirus zebra*	Zebra turkeyfish
75	*Pterois antennata*	Broadbarred firefish
76	*Pterois volitans*	Red lionfish
77	*Scorpaenopsis gibbosa*	Humpback scorpionfish
78	*Cephalopholis formosa*	Bluelined hind
79	*Ephinephelus coeruleopunctatus*	White-spotted grouper
80	*Ephinephelus flavocaeruleus*	Blue and yellow grouper
81	*Epinephelus merra*	Honeycomb grouper
82	*Epinephelus tauvina*	Greasy grouper
83	*Siganus javus*	Streaked spinefoot
84	*Spyraena jello*	Pickhandle barracuda
85	*Synodus indicus*	Indian Lizardfish
86	*Arothron hispidus*	White-spotted puffer
87	*Arothron* sp.	Puffer
88	*Triplerygion tripteronotus*	Threefin blenny
89	*Zanclus cornutus*	Moorish idol

ANNEXURE 3

Annexure 3: Major gears operated in Uttara Kannada District

Sl.No.	Gear	Material used	Mesh size	Length	Sinker	Floats	Depth (m)	Man power	Catch	Rope	Cost of Gear	Wt. Of Net
1	Patta bala	Kurlone / Nylone	20-22mm	150 m	stone/ lead 50grms	Thermocol/Cork	5	2	Sardines, Sciaenids, flatfish, prawns, crabs, mackerels, other miscellaneous	4mm	1500	5kg
2	Castnet	Nylone	1-2 inch	5-9 m	lead 10grms		4-5	1	Siligo sihma, Tetradon sps, Gerrour sps, Prawns, Etroplus sps, Mugil sps	1-2mm	1200	6kg
3	Purse-seine	Nylone	16-18-20mm	high 50-60	lead 200-250 grams	Thermocol/ plastic	40-50	20-25	Sardine, White Sardine, Mackerels, Tuna, Sciaenids, Lactarius & Miscellaneous	6mm	6-7 lakhs	2 tones or more
4	Trawlnet	Kurlone	14-16-20 mm	40-60 m	Iron chain 60-70kg, 40(sinker) lead 200grms	Plastic 20-30	40-50	5	Prawns, crabs,	10-12 Steel, 12-16mm Nylon	15-60,000	50-60
5	Pole&Line	Tangase		3-4m	Hook 22-18 & 16 No		3-4	1	Gerrous sps, Siligo sihma, Mugil sps, catfish		15rs	

									& Epineplous			
6	Gill net	Nylon	40-85 mm	1200 nets	Lead 250gr	Cork/ Thermocole	30	3-4	Seer fish, shark, mackerels	6mm	1 lakhs	2 tonnes
7	Yendi	Nylon	0.5 - 1.0 inch	750 m	Lead 250gr	Cork/ Thermocole	8 - 10	15-20	Sardine, mackerels, seer fish, Anchovies, Sciaenids, flat fish, molluscans & miscellaneous	7-10 mm	1 lakhs	2.5 tonnes
8	Cast net	Tangase	0.5 - 0.75 Inch	9ft	Lead 10 gram		6 -7	1	Siligo sihma, Epineplous, prawns, lobster, etc.	1 mm (Cotton), 2 mm (Noilon)	1200	5-7 Kg
9	Patta bala (Tarli & Bangada jal)	Kurlone	20 -22 mm	150 - 200	Lead 60 gram/ stones	Cork/ Thermocole	5	2	Sardine, mackerels, Sciaenids, Anchovies, flat fish, Nemplus & crabs	2-4mm	1500	5 Kg
10	Long line	Tangase	Mono filament	1 Full roll/100 m	Hook 22/28/30/40	Thermocole/Piece	15 - 20	1	Siligo sihma, catfish		15	

Source: Deputy director of Fisheries, Karwar

ANNEXURE-4

Annexure-4: Marine fish catch in Uttara Kannada during 1972 to 2011

Year	Marine Fish Production (tons)	Year	Marine Fish Production (tons)
1972-73	16371.0	1991-92	34014.5
1973-74	21165.0	1992-93	34863.4
1974-75	14408.0	1993-94	34193.0
1975-76	30628.0	1994-95	36471.0
1976-77	21663.0	1995-96	53611.7
1977-78	49315.7	1996-97	71776.5
1978-79	39310.0	1997-98	46991.4
1979-80	46045.5	1998-99	47818.1
1980-81	34278.2	1999-00	30667.7
1981-82	30871.6	2000-01	36942.2
1982-83	30783.1	2001-02	28038.0
1983-84	35381.7	2002-03	32877.0
1984-85	39426.3	2003-04	27574.4
1985-86	85798.4	2004-05	27137.1
1986-87	35510.4	2005-06	25075.7
1987-88	43533.6	2006-07	17963.0
1988-89	48912.1	2007-08	20727.7
1989-90	59507.1	2008-09	33010.2
1990-91	37564.3	2009-10	59143.5
		2010-11	88028.7

Source: Deputy Director of Fisheries, Karwar

ENERGY AND WETLANDS RESEARCH GROUP, CES TE15
CENTRE FOR ECOLOGICAL SCIENCES,
New Bioscience Building, Third Floor, E Wing
Near D Gate, INDIAN INSTITUTE OF SCIENCE, BANGALORE 560 012

Telephone: 91-80-22933099/22933503 extn 107
Fax: 91-80-23601428/23600085/23600683[CES-TVR]
Email: cestvr@ces.iisc.ernet.in, energy@ces.iisc.ernet.in
Web: http://ces.iisc.ernet.in/energy
http://ces.iisc.ernet.in/biodiversity
Open Source GIS: http://ces.iisc.ernet.in/grass