



# Documenting Coastal Fish Biodiversity of India : Status, Issues and Challenges

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## Introduction

Almost 25% of the global vertebrate diversity is accounted for by fish and is concentrated in this meager 0.01% of the earth's water. Amongst the world's biological resources, India is one of the 17 mega biodiversity hotspot contributing to the world's biological resources from the greater Himalayan range on the northern plains, long stretches of eastern ghat on the east and western ghat on the west. The coastal locations have been the favorite destination of population in movements for defense, commercial and other economic reasons. About 20% of the population of India lives in coastal areas, a larger percentage of this being in coastal cities, such as Mumbai, Chennai and Kolkata. One of the major factors responsible for the degradation of coastal ecosystems is the growth in human population that requires space for settlement and other resources. Most importantly, among the Asian countries, India has a long record of inventories of coastal biodiversity. Coastal lines provide rich source of

food for local inhabitants and of major economical value in terms of commercial exploitation. India has a coastline of about 8,129 km, an exclusive economic zone of 2.02 million km<sup>2</sup> adjoining the continental regions and the off shore islands and a very wide range of coastal ecosystems such as estuaries, lagoons, mangroves, backwaters, salt marshes, rocky coasts, sandy stretches and coral reefs which are characterized by unique biotic and abiotic properties and processes. A network of 14 major, 44 medium and numerous minor rivers along with their tributaries cover practically the entire country except for the western arid regions of Rajasthan desert. In India, considerable work on collection, cataloguing of the coastal biodiversity was done by several researchers, International Indian Ocean Expedition, 1960-65, Qasim 1998, Venkataraman and Wafar 2005). However, the coastal biodiversity of India has become a major concern due to constant environmental changes, over exploitation of resources, habitat loss, uncontrolled developmental activities in the coastal zone, over



extraction of resources and pollution and high population density (Wafar *et al.* 2011) are serious constraints, which are major causes of species loss. A healthy biodiversity provides a number of ecosystem services, such as protection of water resources, soils formation and protection, nutrient storage and recycling, pollution breakdown and absorption, contribution to climate stability, maintenance of ecosystems and recovery from unpredictable events. In the present communication, pattern of biodiversity of coastal and estuarine fishes have been discussed and synthesized based on the available literatures with reference to documentation and database, pattern in distribution, potential threats, important issues and challenges.

### NBFG's Fish Database

Knowledge of species and communities can reveal crucial facts necessary to the management of ecosystems and habitats as well as to the identification of important genomes and genes. Identification, listing and prioritization of species are one of the important tasks in conservation. NBFG, Lucknow has developed database on Indian fish diversity comprising information on 2799 fin fishes (Table 1) which provides ready information on classification, valid scientific

Table 1: Fish diversity of India

Category	Ecosystem	Fish Species (No.)
Native fishes	Fresh water	877
	Brackish water	113
	Marine water	1518
		2508
Exotic fishes		291
<b>Total</b>		<b>2799</b>

names, synonyms, local names, and common names, distribution: in India and global, habitat: coldwater, commercial importance, reported size, morphological features including key identification features like fin formula, status, images: studio photographs, diagrams

and digital images and references. The information can be retrieved by selecting a query or by setting set of queries selected from the menu and radio buttons on the main menu. Additionally, several user friendly databases are also available like Database on Cat fishes of India, Image library of Marine Ornamental Fishes, Image library of Freshwater Ornamental Fishes and Fish Barcode Database.

### Biodiversity

Fish as a group, apart from its economic value, from a biodiversity viewpoint, has the highest species diversity among all vertebrate taxa. It is believed that out of 61,259 species of vertebrates recognized world over, 32,300 are fish species; of which 15,170 are fresh water while 16,764 are marine (William *et al.* 2010). Global surveys emphasized that there could well be at least 5,000 species more to be discovered. Review of the available literature on Coastal and Marine Biodiversity showed that only fish has been well catalogued across the countries of the Indian Ocean as compared to other biota (Wafar *et al.* 2011). In a recent study, Kathiresan and Rajendran (2005) provided a comprehensive account of 546 fish species from Indian mangroves.

The brakish water habitats are considered as the transition zone between freshwater of the rivers and the saline water of seas. The salinity of brakish water ranges from 0.5 to 30 ppt. the major estuarine systems are Hooghly-Matlah, Mahanadi, Godavari, Krishna, Cauvery, Narmada, Tapti and other estuaries of east and west coasts including large brakish water lakes such as Chilka, Pulicat and Vembanad. The brakish water harbours 113 taxa including commercially important species like *Elops saurus*, *E. machnata*, *Mystus gulio*, *Nematolosa nasus*, *Pseudosciaena coibor*, *Gerres setifer*, *G. oyena*, *Sillago sihama*, *Megalops cyprinoides*, *Polynemus tetradactylus*, *P. paradiseus*, *Eleutheronema tetradactyla*, *Mugil cephalus*, *M. seheli*, *M. waigiensis*, *M. cunnesius*, *Liza macrolepis*, *L. tade*, *L. parsia*, *Ephinephelus tauvina*, *Rhinomugil corsula*, *Tenualosa ilisha*, *Chanos chanos*, *Etroplus suratensis*, *E. maculatus*, *Lutianus argenti-maculatus*, *Lates calcarifer* and *Tachysurus* spp. The brakish waters also harbour lucrative shellfish species like *Penaeus monodon*, *Fenneropenaeus (Penaeus) indicus*, *P. semisulcatus*, *Metapenaeus monoceros*, *M.*



*dobsoni*, *M. affinis*, *M. brevicornis*, *Palaemon styliferus*, *Macrobrachium rosenbergii*, *M. malcolmsonii*, *M. rude*, *M. mirabilis*, *M. lamarrei*, *M. scarbiculum* and *Acetes indicus*.

The Sunderbans, with a total extent of dense tidal forest extending nearly 6,050 sq. km. shared between India (2,000 sq.km.) and Bangladesh (4,050 sq. km.), has the unique distinction of being one of the world's largest contiguous stretches of mangrove forests. This region is crisscrossed with many rivers, rivulets, creeks and canals with an agro-climate typical of a coastal region. The fish biodiversity includes about 250 species of fresh water and brackish water sector. Fishes such as *Harpodon nehereus*, *Trichiurus savala*, *Setipinna* sp., *Pampus* sp., *Sardinella* sp. and *Salar* sp. occur in areas with salinity, whereas *Pangasius pangasius* and *Lates calcarifer* occur in fresh water areas or those with very low salinity. The dominant fishes in brackish water zones (moderate salinity) are *Hilsa* (*Tenualosa*) *ilisha*, *Pomadasys hasta*, *Polynemus* sp. and *Coilia* sp.

Andaman and Nicobar Islands represents one of the richest repositories of biodiversity in the whole of south and south East Asia. These islands are a virtual bio reserve, which is unique both in terms of biodiversity and abundance. Situated between two major biodiversity hot spots, namely the Indian sub continent and the Malaysia- Indonesia region, it is hardly surprising that the islands manifest biodiversity of extraordinary range with in a limited geographical area. The fish fauna consists of more than 1200 species of which over 250 are food fishes while another 250 are of ornamental nature.

The Gulf of Mannar is endowed with three marine ecosystems, the corals, sea grass beds and mangroves. It covers an area of 10,500 sq.km along 8° 35'N-9° 25' N latitude and 78° 08'E- 79° 30'E longitude. There are 21 islands covering an area of 623 ha. Most of the islands have luxuriant growth of mangroves on their shorelines and swampy regions and are surrounded by highly productive fringing and patch coral reefs. The total area of Gulf of Mannar under the Indian Exclusive Zone is about 5,500 Sq.km within 50 m depth. As far as fish species are concerned, 538 species have been reported.

The Lakshadweep group of islands forms the smallest Union Territory of India. It lies in the Arabian Sea between 8° and 12° 30' N latitude and 71° and 74° E

longitude, scattered at a distance of 220-440 km from the mainland coast. Among the 36 islands, 10 are inhabited while others are seasonally habited or uninhabited. The fishes that occur in the coralline niches of the lagoon exhibit the characteristic variety of colours and mainly consist of perches, gar-fishes, half-beaks, scarids, goat-fishes, carangids, grey mullets, spyraenids, polynemids, balistids, blennids and globe-fishes (Balan, 1958). Jones and Kumaran (1980) recorded 603 species of fish from the Laccadive archipelago. Of the 603 species of marine fishes belonging to 126 families that are reported from the islands, at least 300 species belong to the ornamental fish category.

## Estuaries a vital source of coastal biodiversity

Estuaries perform a crucial role in the life cycles of many fish species. They act as important nurseries for certain fishes by providing rich main food sources and protection from predation. (Cronin & Mansueti, 1971). Some estuaries along the east and west coast have been partially studied for their fishery biology, such as Kali in Uttara Kannada (Surendra Babu *et al.* 1983). It is reported that among the 200 or so estuaries on the two coasts of India, only few major ones have been surveyed for biodiversity (Wafar *et al.* 2011). The pattern of major fisheries in the estuaries of India has been presented in Table 2. Therefore, an integrated approach in understanding estuarine fish diversity and fisheries related livelihoods are required immediately. Review of literature shows that a large bulk of published literature exists on the fisheries of the major estuaries (Jha *et al.* 2008, Day 1989, Kathiresan 2005, Wafar 2011) covering many aspects, however very little is known about the current functional aspects (Gopal and Chauhan 2006). The Hooghly, the largest estuarine systems in the country with a width of 02 km to 12 km, is a live estuary supporting rich biodiversity. The Godavari estuary in Andhra Pradesh has two distinct distributaries, immediately below the Dowalisawaram barrage viz. the east flowing Gautami-Godavari estuary and south flowing Gautami-Godavan estuary and creeks supporting lucrative prawn fishery. In general however, Godavari estuary supports 23 prawn species among which *M.monoceros*, *M.dobsonii*, *M.brevicornis*, *P.indicus*,



Table 2. Composition of major Fishes in the Estuaries of India (Source: Jha et al 2008).

Estuarine system	Major fisheries
Hoogly Matlah (Pre Farakka)	<i>Harpodon nehereus, Tenulosa ilisha, Pama pama.</i>
Hoogly Matlah (Post Farakka)	<i>Trichiurus spp, Lates calcarifer, Setipina spp.</i>
Godavri	Mullet ( <i>L. persia, M. cephalus</i> ), Prawn ( <i>P.monodon</i> and <i>P. indicus</i> )
Krishna	Mulletts ( <i>L.persia, M.cephalus</i> ), Clupeids ( <i>T. ilisha, T. kelee</i> ), Perches, Sciaenids Catfish, Penaeid Prawn ( <i>P. indicus</i> ), crabs ( <i>Scylla serrata</i> )
Mahanadi	Mulletts, Lates, Sciaenids, Prawns
Narmada	<i>T. ilisha</i> , Mulletts, Prawn
Peninsular estuarne system	Mulletts, Prawn, Clupeids, Crabs.
Chilika lagoon	<i>P. monodon, P. indicus</i> , Mulletts, Catfish, Clupeids, Perches, Sciaenids, Eutroplus, Crabs ( <i>Scylla seratta</i> )
Pulicat	<i>P. indicus, P. monodon</i> , Mulletts
Vembanad backwaters	Prawn, Mulletts, Lates, Eutroplus, Chanos.

*P.monodon, P.semisulcatus, P.merguensis* and *P.japonicus* are important from fishery point of view. Mahanadi estuarine system comprises of two estuaries of Orissa viz. Mahanadi and Devi. The fishery system indicated the dominance of scianeids followed by mullets, prawn, threat fins, perches and others, contributed by 96 species of fin fish and 10 species of shell fish. The pear-shaped Chllika lagoon is the largest lagoon in the east coast of India, situated between latitude 19° 28' and 19° 54' N and Iongitude 85° 05' and 85° 38' E. The lagoon has distinct marine, brackish and freshwater stands, but it is primarily an estuarine ecosystem. The Pulicat Lake is the second largest brackish water lake in India (13° 26' and 13° 43' N latitude and 80° 03' and 80° 18'E) running almost parallel to the Bay of Bengal. It extends between Ponueri and Gumidi Pundi Taluk of Thiruvallum district in Tamil Nadu and Sulturpet and Tada Taluk of Nellore district in Andhra Pradesh, covering an area of about 461 km<sup>2</sup>. Presently, the fisheries of Pulicat lake are largely depend on the catch of *P. indicus*, mullets (*M.cephalus >M.tade> M.canneaius> M.macrolapeius> Liza persia*) and *Chanos chanos*. However, the dominant fishery of *Chanos chanos* in 1970's and 1980's has become almost rare. The

fisheries of *Plotus canius, Sardinella sp* and *Hilsa keele* which were sizeable till 1980's have also declined significantly (Jha et al., 2008).

### Climate change and biodiversity

Global climate change is impacting and will continue to impact marine and estuarine fish and fisheries. Changing fish distributions and abundances will undoubtedly affect communities of humans who harvest these stocks. Coastal-based harvesters (subsistence, commercial, recreational) may also be impacted (negatively or positively) by changes in fish stocks due to climate change. Furthermore, marine protected area boundaries, low-lying island countries dependent on coastal economies, and disease incidence (in aquatic organisms and humans) are also affected by a relatively small increase in temperature and sea level (Roessig et al., 2004). Estuarine and coastal regions are extremely productive because they receive inputs from several primary production sources and detritus food webs. Yet, these systems present the biota with a harsh environment, forcing organisms to evolve physiological or behavioral adaptations to cope with wide ranging physical and chemical variables. Due to water circulation



and oceanic volume changes, estuarine and coastal systems are predicted to experience a loss of marsh and intertidal habitat, a greater marine intrusion or fresh water plumes, and increased eutrophication, hypoxia, and anoxia (Kennedy, 1990). Because many native organisms currently live near their tolerance limits, estuarine and coastal ecosystems will likely exhibit responses earlier to regional changes, including native species loss and exotic species increases (Kennedy, 1990 and Carlton, 1996). Therefore, there is a need to research the physiology and ecology of marine and estuarine fishes, particularly in the tropics where comparatively little research has been conducted.

Many studies of species abundance and distribution corroborate predicted systematic shifts related to changes in climatic regimes, often via species specific physiological thresholds of temperature and precipitation tolerance. Therefore, focused research is required to link available biological and ecological information on the impacts of climate change to water resource and the immediate priority should be to conduct studies of closely linked species, ecosystems and fisheries that have data and information rich Climate Variation and Changes (CVS) response in cold water ecosystem. ICAR has already established a network project with the involvement of 15 institutions and SAU's for critical research on crops, livestock and fisheries. NAIP (National Agricultural Innovative Project) has also identified climate change as a thrust area.

## Other Threats

India's coastal biodiversity is under threat by several factors. The multiple uses of coastal zones pose excessive and competing demands on the limited resources. The coastal area faces many problems including poorly planned land use, pollution, over-fishing and other forms of resource extraction. The adverse impacts of industries on the coastal ecosystems cannot be neglected. Adequate legal structure for coastal zones and strict implementation of the existing laws are required to collect the benefits without compromising ecology. The coastal zone and its resources bring about multidimensional problems for the management of the various systems and subsystems in a citation. Understanding these complexities requires

a thorough understanding of the issues and constrains involved - human, sociological, environmental, physical and economic, as well as local needs and aims. Planning and policy -making for coastal areas is difficult due to the conditions of uncertainty, complexity and scale of ecosystems.

Overexploitation occurs when a resource is consumed at an unsustainable rate. A number of coastal areas and ecosystems in India are under stress due to growing aquaculture and agriculture activities. Industries remain one of the major competitors for the use of coastal areas. For industries, the major advantages of the location on the coast are transportation, water use and waste disposal. Gulf of Kutch is also home to petrochemicals, SEZs, chemical industries, including ports and jetties, all posing danger to the marine park, states a recent scientific study funded by the Gujarat Ecology Commission. There have been too few studies so far, especially on impacts and how they can be thwarted. The biggest threat to the biodiversity of marine park is industries like Reliance and Essar have been allowed to lay oil pipelines right through the Marine National Park and Sanctuary and seven Single Buoy Moorings needed to unload petrochemicals from large ships are planned in the area. Half of the planned development is in this sector.

Natural causes affecting coastal biodiversity have also been of concern in recent years. These effects occur mainly in the form of shoreline changes due to rising sea level and physiological impairments, such as bleaching in corals, related to high sea surface temperature. The extent of loss of species diversity resulting from these causes, however is not known (Wafar *et al.*, 2011).

Invasive alien fish species has been emerging as a growing environmental and economic threat to coastal aquaculture and fish biodiversity (Singh and Lakra 2011). Conservation biologists have globally ranked invasive alien species (or "exotics") as the second most serious threat to species at risk after habitat destruction. Invasive alien species have had extensive effects on the habitats they have invaded, altering forest fire cycles, nutrient cycling, hydrology and energy budgets in native ecosystems. They can also compete with, prey on, and carry and cause diseases in native species. Alien species



introductions are one of the most important threats to "Red Listed" (endangered or threatened) plants and animals in BC. About a quarter of Canada's species at risk are adversely affected in some way because of alien species. During the last two decades rates of invasions of coastal waters by alien species has increased significantly. The development of an internet based information resources database on aquatic invasive species is considered one of the most important mechanisms of information exchange within the scientific community. These information may provide comprehensive information on management of aquatic invasive species for scientific and educational purposes.

## Future Issues

The foremost issue in improving the state of knowledge of coastal and marine biodiversity is strengthening the taxonomic capacity base. In light of the dwindling population of taxonomists, however, the magnitude of the task ahead is obvious. Therefore, the first is to make taxonomy an easier subject to master through the use of tools such as computer-aided taxonomy, pattern recognition, image analysis, and DNA fingerprinting/barcoding. The second is value addition to taxonomic research, such as the need to have a correct taxonomic identity established in dealing with extraction of bioproducts, genetic manipulation to enhance product yield, and biosafety. One other area where taxonomy can be made attractive is sustained monitoring of coastal ecosystems for natural and manmade changes. This requires, besides measurements of routine water quality parameters, also data on

biological diversity, which often is a harbinger of changes to come. Contrasted with descriptive taxonomy, these approaches come with incentives of job security and future prospects that could make taxonomy more attractive as a career (*Wafar et al., 2011*).

## Conclusion

India, being a signatory of the Convention on Biological Diversity (CBD) is required to inventory and monitor their own biodiversity and biological resources. In recent years, International community has also become sensitive for the conservation of natural resources and number of different initiatives in progress at present, all approaching the need to inventory, documentation and monitor coastal and marine fish diversity from different points of view. Such an online information systems like Fish base, [www.fishbase.org](http://www.fishbase.org), California Academy of Sciences and IUCN, [www.iucnredlist.org](http://www.iucnredlist.org) developed by the collective effort of international community are well known for its proper effectiveness and utility worldwide. There is need for more exploration and documentation of biodiversity at different spatial scale, developing comprehensive database having information on biology, life history traits, taxonomy, molecular, ecological at different scale. There is also need to create more public awareness on the importance of biodiversity. Therefore, a collective effort to determine the priorities and to concentrate the available genetic resources on these is highly essential for the better sustainable management of the coastal ecosystem.

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