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Fish community structure as an indicator of the ecological significance: A study from Ulhas River Estuary, Western coast of India

D.M. Lal[1], G.B. Sreekanth[2], C. Soman[1], K.K. Ramteke[1], R. Kumar[3] and Z.J. Abidi[1]*

[1]Department of Fisheries Resource Management, ICAR- Central Institute of Fisheries Education, Mumbai-400 061, India
[2]Section of Fisheries, ICAR –Central Coastal Agricultural Research Institute, Goa- 403 402, India
[3]Department ofCrustacean Fisheries, ICAR-Central Marine Fisheries Research Institute- Research Centre, Mumbai-400 061, India

***Corresponding Author Email :** zjabidi@cife.edu.in

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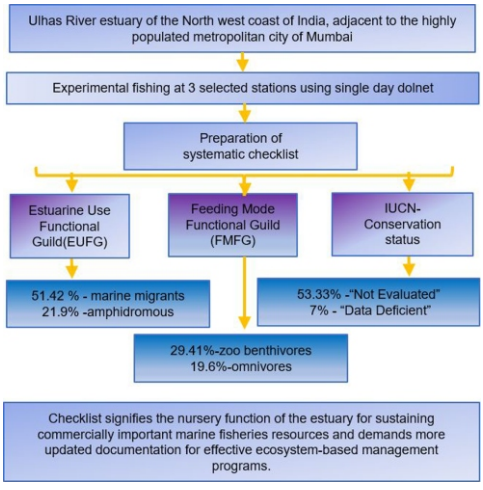
Abstract

Aim: The present study was aimed to analyze the ecological significance of Ulhas River estuary of the western coast of India using the taxonomic, functional and conservation aspects, and also to record an updated data base on the estuarine community structure.

Methodology: Ichthyo faunal diversity was assessed by experimental fishing conducted at 3 selected stations using single day dolnets of code end mesh size of 10mm, from September 2017 to August 2018. The diversity of fish species was recorded considering the most relevant taxonomic classification data and further supplemented by the information pertaining to ecological roles played by the individual species (using guild approach) and the IUCN-conservation status.



Results: There were 105 species, belonging to 4 classes, 19 orders, 44 families and 75 genera, recorded from Ulhas River Estuary. The class: Actinopterygii was the most diverse taxa, (including 12 orders, 32 families and 55 genera) among the total ichthyofauna reported. Order Perciformes was the most representative order of the class (40 species, 31 genera and 17 families), followed by Decapoda (21species, 8 genera and 6 families). Based on the estuarine usefunctional guild categorization, 51.42 % of the species were marine migrants, followed by amphidromous species (21.9%). Zoobenthivores (29.41%) was found to be the most dominant feeding guild followed by omnivores (19.6%). Based on the IUCN Red List, 53.33% of the fish species observed from Ulhas River Estuary were categorized as "Not Evaluated", and 7% were "Data Deficient", signifying the lack of information on biological aspects of the species along Indian waters. *Tenualosa toli* marked its presence under threatened category (Vulnerable) from Ulhas River Estuary.

Interpretation: The abundance of marine migrants as well as the amphidromous species in the estuary signifies the use of this ecosystem for the nursery function of commercially important marine fisheries resources. Increased proportion of "Not Evaluated" and "Data Deficient" categories in the context of high level of anthropogenic stress demands for more updated documentation of the biodiversity and periodic changes in its ecological structure for formulating and implementing effective ecosystem-based management programs for such sensitive estuarine ecosystems.

Key words: Estuary, Fish community, Guild approach, Indian coast

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Introduction

Estuaries along India's western coast are influenced by runoff from numerous rivers and rivulets originating from the Western Ghats on one side and the tidal influx from the Arabian Sea on the other side (Sivadas *et al.,* 2011). Apart from supporting their own resident fish community, the protected environment by the halophyte vegetation like mangrove, organic-rich mud flats and abundant food resources that provide an ideal location for most commercially important fish and shellfish to reproduce, forage and shelter in the estuarine environment (Cabral *et al.,* 2007; McLusky and Elliott, 2004). The ecological significances coupled with the monsoon mediated fluxes makes the tropical estuarine ecosystems highly dynamic in terms of biological community structure than any other ecosystems (Ansari *et al.,* 1995). In general, biological communities were described and classified using one or more of three sets of attributes such as; taxonomic-based entities, summarized by traditional species abundance matrices or by the size and biomass spectra of the individuals present or by the functional attributes of the recorded organisms (Nagelkerken and van der Velde, 2004; Akin *et al.,* 2005). When these are used in combination, a huge amount of information on the community structure and functions can be portrayed.

The concept of ecological guild has been defined and worked out by different authors in a multitude of ways (Wallace, 1975; Elliot *et al.,* 2007). However, the fundamental principle of the guild approach classifies group of species that exploit same class of environmental resources in a similar way. The guild approach increases the understanding of the use of estuaries by fishes and their interactions and connectivity with adjacent areas (Wallace, 1975). At the same time, the information on the guild structure of an ecosystem will enable the identification of the most critical species or groups which are susceptible to get affected as a result of a potential environmental impact on the ecosystem as a function of their estuarine dependence (McLusky and Elliott, 2004). For example, marine migrants are the group of species that use estuaries, especially during their juvenile stages whereas amphidromous species migrate between the sea and fresh water where their migration in neither direction is related to reproduction (McDowall, 1997).

According to Ray (2005), while studying functional attributes of an estuarine ecosystem in a management perspective,it is necessary to determine which fishes 'must' use estuaries obligatory and which therefore will be at risk if estuarine habitats are lost, compared to those which use estuaries facultatively. Therefore, the functional segregation of various species and their relative representation in various guilds yielded from the ecological guild categorization will be a potential tool to illustrate the actual role played by coastal ecosystems in maintaining biodiversity. If studied in a time series scale, It also enable to understand the potential impacts on these critical ecosystems caused by human activities and ultimately aids for the ecosystem-based management of estuaries (McLusky and Elliott, 2004). This study was carried out in Ulhas River Estuary, situated along the western coast of India, adjacent to highly populated metropolitan city of Mumbai in Maharashtra State.

The ecosystem has been stressed by various anthropogenic activities and in this context several studies have been attempted, particularly on heavy metal and pesticide pollution, water quality and hydrological parameters (Singare *et al.,* 2012; Menon and Mahajan, 2011; Singare, 2016), biodegradable waste accumulation (Singare, 2012) and few studies on biodiversity profiles (Lad and Patil, 2012; 2013; 2016). Thus, more studies in Ulhas River estuarine ecosystem are necessary to improve our knowledge of fish communities and their conservation. Hence, this study aims to analyze the ecological significance of Ulhas River estuary of the western coast of India using the taxonomic, functional and conservation aspects and to record the estuarine community structure. The study also attempts to depict the extent of dependency of coastal fisheries resources towards the estuaries for their various ecological functions to emphasize the necessity to protect such tropical estuarine ecosystems.

Materials and Methods

Study area: The Ulhas river estuary is situated adjacent to Mumbai, (Maharashtra) along the western coast of India. The estuary connects the Ulhas river to the Arabian Sea through Vasai creek (Fig. 1). Ulhas river estuary is a macro-tidal and well-mixed estuary, exhibiting seasonal variations in salinity attributed by the monsoon mediated freshwater influx (Rathod *et al.,* 2002). Ulhas river estuary is characterized by semi diurnal tides, rich mangrove vegetation in the bank areas, high salinity gradient from head water to mouth, diurnal temperature variations and the land runoff carrying huge amount of sediments from its catchment area (Nikam *et al.,* 2008).

Sampling and data collection: Ichthyo faunal diversity of the Ulhas river estuary along its true estuarine stretch (average annual Salinity 0.5-30 ppt) was analyzed from September 2017 to August 2018. Monthly sampling was carried out for an entire year to ensure representation of resident and seasonal migrant species in the estuary. Experimental fishing was done at 3 selected stations, care was taken to consider different ecological conditions between the selected stations. Station 1 was sheltered area surrounded by rich mangrove vegetation, where the estuarine area narrows down to a small creak due the presence of small island (Panju Island), while Station 2 was more or less open waters adjacent to the estuarine mouth, where easy transit of the fishes between the marine waters were expected. Station 3 was close to the Vasai-railway bridge, which is comparatively disturbed and characterized by the adjacency of residential area. Experimental fishing was carried out using *dolnets* of cod end mesh size 10 mm and total length of 30 m. For the present study, the dolnets are set against the tidal flow, moored at spikes that are fixed at identified stations and operated for a period of 3 to 4 hrs during daytime according to the tidal pattern in the area. The main

webbing of net consisted of four segments, locally known as Chirate (Mouth), Katra, Mazwala and Khola (cod-end), with large meshes at the mouth and smaller meshes towards the cod-end. At mouth opening, the length and width of the net were 10 m and 4 m, respectively. Finfishes and shellfishes were identified up to species level in the field to the extent as possible. Whereas species with ambiguity were brought to the laboratory for detailed identification. Taxonomic identification was performed based on the relevant taxonomic keys (Fischer and Bianchi, 1984; Bianchi, 1985; Psomadakis *et al.,* 2015).

The taxonomic arrangement (nomenclature and classification) follow WORMS (World Register of Marine Species) data base (2019), while the conservation status was based on the Red List of Threatened Species, International Union for Conservation of Nature (IUCN,2019). The ecological roles played by each individual species were qualitatively identified and listed following a guild approach developed by Elliot *et al.* (2007). By considering the seasonal and spatial occurrence of species and their use of estuarine ecosystem as nursery-feeding or refuge areas and migration routes, species were assigned into 10 broad Estuarine Use Functional Guilds (EUFG) (Elliot *et al.,* 2007), such as: Marine stragglers (MS), Marine migrants (MM), Estuarine species (ES), Anadromous (AN), Semi-anadromous (SA), Catadromous (CA), Semi-catadromous (SC), Amphidromous (AM), Freshwater migrants (FM) and Freshwater stragglers (FS). Likewise, fish species that utilize similar food resources were aggregated and categorized by feeding mode Functional Guilds (FMFG) (Elliott *et al.,* 2007). The feeding niche of each species was identified by direct qualitative estimation of the gut contents to the possible extent and the rest were obtained from the Fish Base (Froese and Pauly, 2019). The Feeding Functional Guilds (FFG) proposed here identifies seven broad categories: Detritivore(DV), Herbivore (HV), Omnivore (OV), Zooplanktivore (ZP), Zoobenthivore (ZB), Piscivore (PV) and miscellaneous/ opportunistfeeders (OP). The assignment criteria of various guilds are listed in supplementary Table1. and 2. The format given by Nelson and Martin (1992) and González *et al.* (2018) was adopted for the tabulation of compiled information.

Results and Discussion

The information on the fish communities and the trophic guild structure in response to environmental factors have been used to make long-term comparisons in variations occurring in estuarine biological communities (Livingston, 1976) and also to assess environmental quality (Bechtel and Copeland, 1970). The systematic list of fish community of Ulhas river estuary including the guild structure and the conservation status are depicted in Table 1. The estuarine Fish community is composed of 105 species, belonging to 4 classes, 19 orders, 44 families and 75 genera. The class: Actinopterygii was the most diverse class representing 73.33% (including 12 orders, 32 families and 55 genera) of the total ichthyo fauna reported. Order Perciformes was the most representative order (40 species, 31 genera 17 families), followed by Decapoda (21species, 8 genera and 6 families) and Clupeiformes (15 species, 7 genera and 3 families) (Fig. 2). The three perciform families such as Sciaenidae (5 genera 8 species), Carangidae (6 genera, 7 species) and Gobiidae (4 genera, 5 species) alone contributed around 25% of the overalll chthyo faunal diversity in the Ulhas river estuary (Fig. 3). The fish diversity reported for Ulhas River Estuarine ecosystem is greater than that reported by the previous studies in the area. According to the available records, the decapod crustacean diversity of the Ulhas river estuary consists of 6 species of crabs and 10 species of shrimps (Lad and Patil, 2012). While the finfish diversity consists of 53 species belonging to 23 families and 6 orders (Lad and Patil, 2013). Thus, the fish community structure described in this study showed an increase in diversity of species from Ulhas river estuary. This represents 5.2 % of the total marine and estuarine fish species known from the country (NBFGR, 2018).

The high fish diversity reported from the estuarine-coastal areas is due to variety of young and adult marine fish species that enter these biotopes, following seasonal patterns in their occurrence and biomass (González-Acosta *et al.,* 2015). Thus, diverse fish species take advantage of the availability of suitable habitats with soft substrates and submerged vegetation (Mangrove biotopes), as well as the area's favorable hydrological conditions (Díaz-Ruiz *et al.,* 2006; González-Acosta *et al.,* 2018). The dominance of class Actinopterygii and predominance of Perciformes over other orders of teleost fishes (e.g., Clupeiformes, Pleuronectiformes, Siluriformes, Anguilliformes and Tetraodontiformes) are in agreement with the community structure of similar coastal lagoons and estuaries in the tropical context (Das *et al.,* 2018; Sreekanth *et al.,* 2018). The limited presence of Elasmobranchs in the estuarine habitat could be due to the absence of suitable soft bottom substrates in the area as well as protective nature of the environment offered by the mangrove patches, restricting entry of such top predators into these ecosystems (Elliott *et al.,* 2007).

Among the total species recorded from the estuary, 51.4% (n=54) were marine migrants (MM), which usually spawn in sea and often enter estuaries in large numbers, particularly as juveniles. The underlying premise of most studies that examine nursery-role concepts is that some nearshore, juvenile habitats contribute disproportionally to the production of individuals that recruit to adult populations (Beck *et al.,* 2001). The Ulhas river estuary is characterized by the presence of considerable mangrove vegetation along its banks (Rathod et al.,2002). Also, the Mumbai coast alone harbours 66 km^2 of mangroves, which accounts 21.7 % of the mangrove cover of the state of Maharashtra (Kantharajan *et al.,* 2018). Therefore, the dominance of marine migrants clearly indicates nursery function of the ecosystem for commercially important marine fisheries resources along the north eastern Arabian Sea. The second major estuarine use guild was that of Amphidromous species (AM) that contributed 21.9% (n=23) to the total species diversity. A total of nine anadromous and one semi anadromous species were also recorded that undergo their greatest growth at sea and migrate to river and estuarine ecosystems, respectively, where spawning

Table 1: Annotated systematic list of fishes of Ulhas River Estuary, including the ecological guild structure and conservation status

Taxon	*EUFG	*FFG	IUCN category
PHYLUM: Chordata			
CLASS: Elasmobranchii			
ORDER: Orectolobiformes			
FAMILY: Hemiscylliidae			
Chiloscyllium griseum Müller & Henle, 1838	MS	ZB	NT
ORDER: Myliobatiformes			
FAMILY: Dasyatidae			
Brevitrygon imbricata (Bloch & Schneider, 1801)	AM	ZB	DD
CLASS: Actinopterygii			
ORDER: Elopiformes			
FAMILY: Megalopidae			
Megalops cyprinoides (Broussonet, 1782)	AM	PV	DD
ORDER: Clupeiformes			
FAMILY: Clupeidae			
Nematalosa nasus (Bloch, 1795)	AN	ZP	LC
Anodontostoma chacunda (Hamilton, 1822)	AN	ZP	NE
Sardinella longiceps Valenciennes, 1847	MM	HV	LC
Sardinella albella (Valenciennes, 1847)	MM	ZP	LC
Sardinella gibbosa (Bleeker, 1849)	MM	ZP	LC
Tenualosa toli (Valenciennes, 1847)	SA	ZP	VU
Escualosa thoracata (Valenciennes, 1847)	MM	ZP	LC
FAMILY: Engraulidae			
Thryssa dussumieri (Valenciennes, 1848)	MM	ZP	LC
Thryssa hamiltonii Gray, 1835	AM	ZP	LC
Coilia dussumieri Valenciennes, 1848	AM	ZP	NE
Thryssa setirostris (Broussonet, 1782)	MM	ZP	LC
Stolephorus indicus (van Hasselt, 1823)	MM	ZP	LC
Thryssa mystax (Bloch & Schneider, 1801)	MM	ZP	LC
FAMILY : Pristigasteridae			
Pellona ditchela Valenciennes, 1847	AN	ZP	LC
Opisthopterus tardoore (Cuvier, 1829)	AM	ZP	LC
Ilisha filigera (Valenciennes, 1847)	AN	ZP	DD
ORDER: Anguilliformes			
FAMILY:Ophichthidae			
Pisodonophis boro (Hamilton, 1822)	AN	PV	LC
ORDER: Siluriformes			
FAMILY: Ariidae			
Arius maculatus (Thunberg, 1792)	AM	ZB	NE
Nemapteryx caelata (Valenciennes, 1840)	AM	ZB	NE
Osteogeneiosus militaris (Linnaeus, 1758)	AM	ZB	NE
FAMILY: Bagridae			
Sperata seenghala (Sykes, 1839)	FM	ZB	LC
Mystus gulio (Hamilton, 1822)	AN	ZB	LC
FAMILY: Plotosidae			
Plotosus lineatus (Thunberg, 1787)	AM	ZB	NE
ORDER: Mugiliformes			
FAMILY: Mugilidae			
Osteomugil cunnesius (Valenciennes, 1836)	CA	DV	NE
Mugil cephalus Linnaeus, 1758	CA	DV	LC
ORDER: Gadiformes			
FAMILY: Bregmacerotidae			
Bregmaceros mcclellandi Thompson, 1840	MM	ZP	NE
ORDER: Perciformes			
FAMILY: Gobiidae			
Boleophthalmus dussumieri Valenciennes, 1837	AM	DV	LC

Table continue

Taxon	*EUFG	*FFG	IUCN category
Boleophthalmus boddarti (Pallas, 1770)	AM	DV	LC
Parachaeturichthys polynema (Bleeker, 1853)	MS	OV	NE
Trypauchen vagina (Bloch & Schneider, 1801)	AM	OV	NE
Odontamblyopus roseus (Valenciennes, 1837)	MM	OV	NE
Butis butis (Hamilton, 1822)	ES	OP	LC
FAMILY: Sillaginidae			
Sillago sihama (Forsskål, 1775)	AM	ZB	LC
FAMILY: Leiognathidae			
Eubleekeria splendens (Cuvier, 1829)	MM	ZB	LC
Secutor insidiator (Bloch, 1787)	AM	ZB	NE
FAMILY: Ambassidae			
Ambassis ambassis (Lacepède, 1802)	ES	OP	LC
FAMILY: Apogonidae			
Ostorhinchus fasciatus (White, 1790)	MS	OP	NE
FAMILY: Scatophagidae			
Scatophagus argus (Linnaeus, 1766)	ES	OV	LC
FAMILY: Scombridae			
Rastrelliger kanagurta (Cuvier, 1816)	MS	ZP	DD
Scomberomorus guttatus (Bloch & Schneider, 1801)	MS	PV	DD
FAMILY: Stromateidae			
Pampus argenteus (Euphrasen, 1788)	MM	ZB	NE
Pampus chinensis (Euphrasen, 1788)	MM	ZB	NE
FAMILY: Gerreidae			
Gerres filamentosus Cuvier, 1829	AM	ZB	NE
FAMILY: Sciaenidae			
Johnius macrorhynus (Lal Mohan, 1976)	MM	ZB	NE
Johnius belangerii (Cuvier, 1830)	AM	ZB	NE
Johnius dussumieri (Cuvier, 1830)	MM	ZB	NE
Johnius glaucus (Day, 1876)	MM	ZB	NE
Johnius borneensis (Bleeker, 1851)	MM	PV	NE
Otolithes cuvieri Trewavas, 1974	MM	PV	NE
Otolithoides biauritus (Cantor, 1849)	AM	ZB	NE
Protonibea diacanthus (Lacepède, 1802)	MM	ZB	NE
FAMILY: Carangidae			
Alepes kleinii (Bloch, 1793)	MM	PV	LC
Alepes djedaba (Forsskål, 1775)	MM	PV	LC
Megalaspis cordyla (Linnaeus, 1758)	MM	PV	LC
Atule mate (Cuvier, 1833)	MM	PV	LC
Decapterus russelli (Rüppell, 1830)	MM	PV	LC
Atropus atropos (Bloch & Schneider, 1801)	MM	ZB	LC
Parastromateus niger (Bloch, 1795)	AM	ZP	LC
Alepes djedaba (Forsskål, 1775)	MM	PV	LC
FAMILY: Terapontidae			
Terapon jarbua (Forsskål, 1775)	CA	OP	LC
Terapon theraps (Cuvier, 1829)	AM	OP	LC
FAMILY: Polynemidae			
Leptomelanosoma indicum (Shaw, 1804)	AM	ZB	NE
Filimanus heptadactyla (Cuvier, 1829)	MM	ZB	NE
Eleutheronema tetradactylum (Shaw, 1804)	AM	ZB	NE
FAMILY: Trichiuridae			
Eupleurogrammus muticus (Gray, 1831)	MM	PV	NE
Lepturacanthus savala (Cuvier, 1829)	MM	PV	NE
Trichiurus lepturus Linnaeus, 1758	MM	PV	LC
FAMILY: Latidae			
Lates calcarifer (Bloch, 1790)	SC	PV	NE
FAMILY: Lactariidae			

Table continue

Taxon	*EUFG	*FFG	IUCN category
Lactarius lactarius (Bloch & Schneider, 1801)	MS	ZB	NE
FAMILY: Lutjanidae			
Lutjanus johni (Bloch, 1792)	MM	PV	LC
FAMILY: Sphyraenidae			
Sphyraena jello Cuvier, 1829	MS	PV	NE
ORDER: Pleuronectiformes			
FAMILY: Cynoglossidae			
Cynoglossus arel (Bloch & Schneider, 1801)	MM	ZB	NE
ORDER: Aulopiformes			
FAMILY: Synodontidae			
Harpadon nehereus (Hamilton, 1822)	MM	OP	NT
ORDER: Scorpaeniformes			
FAMILY: Platycephalidae			
Platycephalus indicus (Linnaeus, 1758)	AM	ZB	DD
ORDER: Batrachoidiformes			
FAMILY: Batrachoididae			
Allenbatrachus grunniens (Linnaeus, 1758)	AM	ZB	NE
ORDER:Tetraodontiformes			
FAMILY: Tetraodontidae			
Takifugu oblongus (Bloch, 1786)	MM	ZB	LC
Lagocephalus lunaris (Bloch & Schneider, 1801)	MM	ZB	LC
PHYLUM: Arthropoda			
CLASS: Malacostraca			
ORDER: Decapoda			
FAMILY: Lysmatidae			
Exhippolysmata ensirostris ensirostris (Kemp, 1914)	MM	OV	NE
FAMILY: Palaemonidae			
Exopalaemon styliferus (H. Milne Edwards, 1840)	MM	OV	NE
Nematopalaemon tenuipes (Henderson, 1893)	MM	OV	NE
Macrobrachium rosenbergii (de Man, 1879)	FM	OV	NE
FAMILY: Penaeidae			
Penaeus indicus H. Milne Edwards, 1837	MM	OV	NE
Metapenaeus brevicornis (H. Milne Edwards, 1837)	MM	OV	NE
Metapenaeus affinis (H. Milne Edwards, 1837)	MM	OV	NE
Parapenaeopsis sculptilis (Heller, 1862)	MM	OV	NE
Metapenaeus monoceros (Fabricius, 1798)	MM	OV	NE
Parapenaeopsis stylifera (H. Milne Edwards, 1837)	MM	OV	NE
FAMILY: Alpheidae			
Alpheus digitalis De Haan, 1844	FM	OV	NE
FAMILY: Sergestidae			
Acetes indicus H. Milne Edwards, 1830	MM	OV	NE
Acetes johni (Nataraj, 1949)	MM	OV	NE
FAMILY: Portunidae			
Charybdis (Charybdis) lucifera (Fabricius, 1798)	MM	OV	NE
Charybdis (Charybdis) orientalis Dana, 1852	MM	OV	NE
Charybdis (Charybdis) callianassa (Herbst, 1789)	MM	OV	NE
Scylla tranquebarica (Fabricius, 1798)	ES	OV	NE
Scylla serrata (Forskål, 1775)	ES	OV	NE
Portunus (Portunus) pelagicus (Linnaeus, 1758)	MM	OV	NE
Portunus (Portunus) sanguinolentus (Herbst, 1783)	MM	OV	NE
ORDER: Stomatopoda			
FAMILY: Squillidae			
Harpiosquilla harpax (de Haan, 1844)	MM	OV	NE
Miyakella nepa (Latreille in Latreille, Le Peletier, Serville & *Guérin,* 1828)	MM	OV	NE
PHYLUM: Mollusca			
CLASS: Cephalopoda			

Table continue

Taxon	*EUFG	*FFG	IUCN category
ORDER: Sepiida			
FAMILY: Sepiidae			
Sepiella inermis (Van Hasselt [in Férussac & d'Orbigny], 1835)	MM	PV	DD
ORDER: Myopsida			
FAMILY: Loliginidae			
Uroteuthis (Photololigo) duvaucelii (d'Orbigny [in Férussac & d'Orbigny], 1835)	MS	PV	DD
ORDER: Octopoda			
FAMILY: Octopodidae			
Cistopus indicus (Rapp, 1835)	MS	PV	LC

*(*EUFG- Estuarine Use Functional Guild; FFG- Feeding Functional Guild; MS- Marine stragglers; MM- Marine migrants; ES- Estuarine species; AN- Anadromous; SA- Semi-anadromous; CA- Catadromous; SC- Semi-catadromous; AM- Amphidromous; FM- Freshwater migrants; FS- Freshwater stragglers; DV- Detritivore; HV- Herbivore; OV- Omnivore; ZP- Zooplanktivore; ZB- Zoobenthivore; PV- Piscivore; OP -miscellaneous/ opportunist feeders; VU- Vulnerable; NT- Near Threatened; LC- Least Concern; DD- Data Deficient; NE- Not Evaluated)*

takes place subsequently. In addition, three catadromous (CA), one semi catadromous (SC) and one freshwater migrant (FM) species were accounted for the guild structure of Ulhas river estuary. Estuarine residents constituted 4.5% of the total species observed in Ulhas river estuary. Amphidromous species are those which migrate between freshwater and the sea, but the movements are not related to breeding migrations (McDowall, 1997). Probably, the abundance of fish food organisms in the estuarine environment might be the reason that attracts the amphidromous as well as marine stragglers (8.5%) in the ecosystem. Estuaries and wetlands have been identified as nurseries in part because they export vast quantities of carbon, nitrogen and phosphorus to coastal food webs (Childers *et al.*, 2005). Export of these nutrients are channelled through direct transfer of animal biomass via movement of individuals, predationor out-welling of dissolved and particulate organic matter (Childers *et al.*, 2005). As per studies, a considerable load of municipal sewage from Thane city mainly attributes for a high degree of organic nutrient loading and supplement to high productivity in the area (Patil and Ingle, 2016).

As far as feeding guild structure is concerned, zoobenthivores (29.41%;n=30) and omnivores (25.49%; n=26) contributed the major proportion of fish species present in Ulhas river estuary. The zoobenthivore consists of fishes that feed on organisms associated with the substratum including animals that

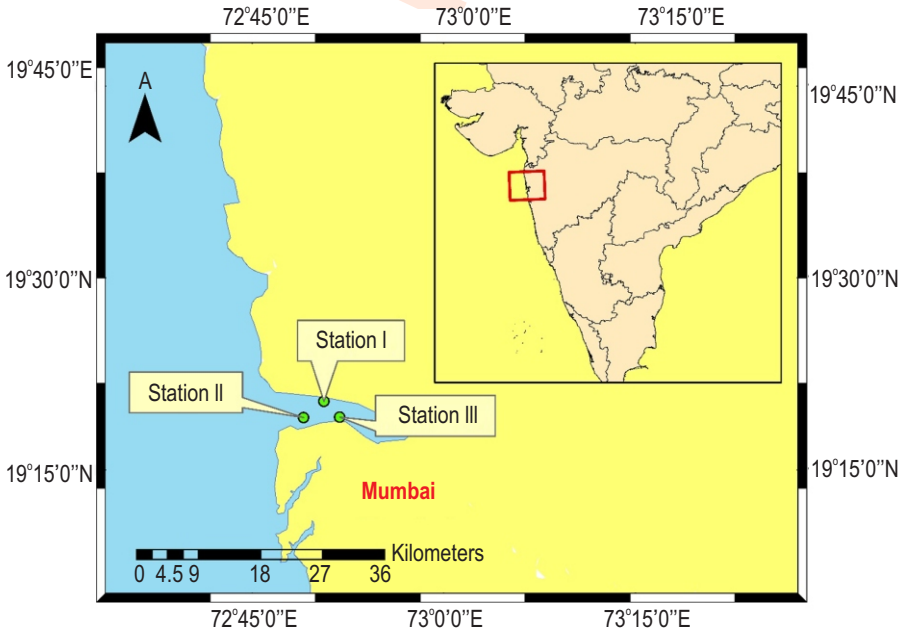

Fig. 1: Study area in Ulhas River Estuary located along the N- West coast of India.

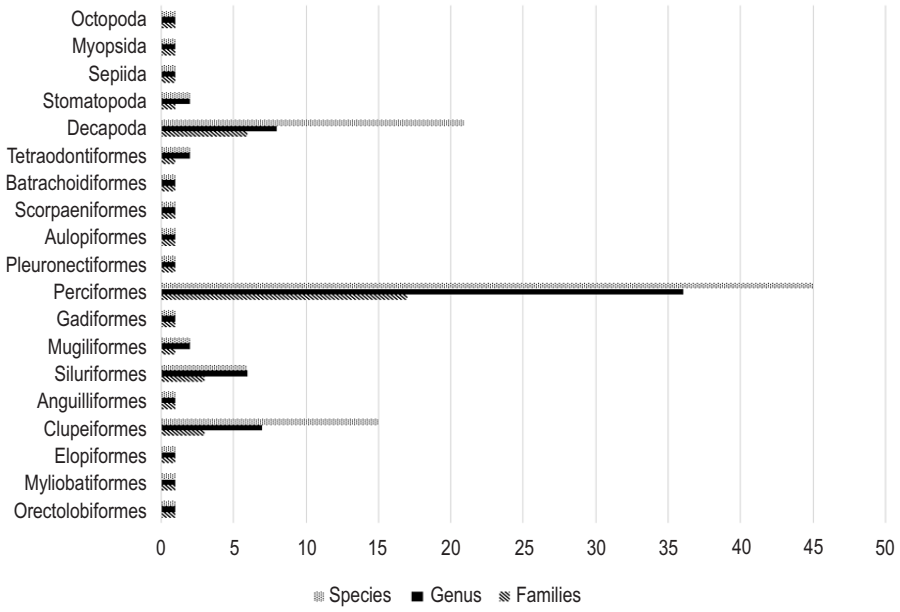

Fig. 2: Families, genera and species by order of Ulhas River Estuary.

live in the sediment (infauna), on the sediment (epifauna) or immediately above the sediment (Elliot *et al.,* 2007). Deshmukh (2002) has reported the existence of good amount of detritus in the shallow coastal waters, several times than that along the off Mumbai waters in the north west coast of India, which supports the abundance of benthos and benthic invertebrates in the region. This includes species like *Acetes indicus* (paste shrimp), one of the highly significant food item of most of the commercial fin fish species (belonging to the dominant groups like Sciaenids, Carangids, Bombay duck, etc.) in the north western coast of India (Jaiswar and Chakraborty, 2005). Hence, the abundance of zoobenthivores is a clear indication of foraging aggregation of these

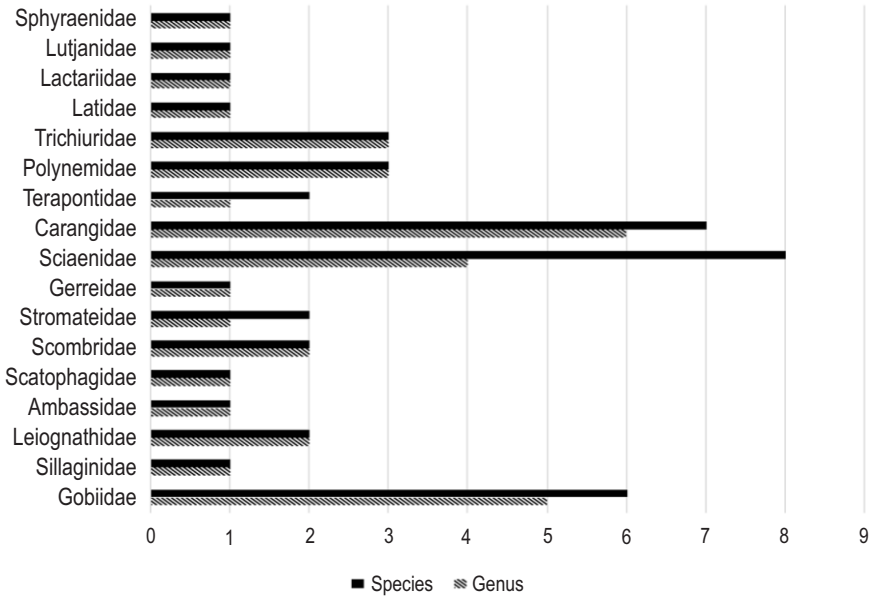

Fig. 3: Genera and species representative of the order Perciformes Ulhas River Estuary.

species in the ecosystem. Piscivores (19%) and zooplanktivores (17%) have also contributed a notable proportion of feeding guilds in Ulhas river estuary. This shows the abundance of secondary and territory consumer groups over herbivores and detritivores, which together accounts merely about 4% of the total species recorded.

Since there is lack of corresponding information on biological aspects, 53.3% of fish species observed from Ulhas River Estuary were categorized based on the IUCN Red List of Threatened Species as "Not Evaluated", and 7% were "Data Deficient". On the other hand, 36.1% of the species were listed as "Least Concern". *Tenualosa toli* was the single species reported under the threatened category (Vulnerable-VU). The bamboo shark, *Chiloscyllium griseum* and the Bombay duck, *Harpadon nehereus* were the near-threatened species among the recorded species. The presence of threatened and near-threatened groups in the estuary points towards a big concern for the near future when the present fishing scenario in the estuary is considered. In Ulhas river estuary, the major fishing gear in operation is single day dolnet (Locally known as bokshi jal/ Ghana khola), with a codend mesh of 5 mm to 10 mm. Hence the non-selective fishing activities along with the pollution load have a great potential to cause apparent damage to the biodiversity and community structure with a major threat to the juveniles as well as the threatened species (Singare *et al.,* 2012; Menon and Mahajan, 2011; Singhare, 2016). As a whole, this study quotes a caution for managing this valuable ecosystem and its biodiversity in the context of its remarkable functions as nursery, refuge habitat and migratory pathway as indicated by representing of 51.4% of marine migrant species and 21.9% of amphidromous species that visit the estuary annually.

In conclusion, the present study emphasizes high magnitude of dependency on coastal fisheries resources towards the estuarine habitat. Further, detailed information on the community structure of Ulhas River Estuary depicted in this study, based on the guild approach, will potentially advance our understanding of functional community segregation in estuaries of the Indian context. We encourage more studies that quantify the fish assemblage structure of the estuaries in wide regional scales that will facilitate rigorous comparisons between the characteristics of estuarine communities that enable the formulation of more reliable ecosystem-based management plans for this sensitive transitional ecosystem with high fisheries potential.

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