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Checklist of commercially important fishes of Puducherry coastal waters, east coast of India

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Abstract
The aim of this study is to update the list of fish species in order to increase the knowledge about biodiversity of commercially important fishes of Puducherry coastal waters. This study also concentrated on the availability and threatened status of commercially important fish species. A total of 88 fish species under 36 families and 11 orders has been collected during the study. Order Perciformes were made up to 65% with 23 families and 58 species followed by Clupeidae 15% with 3 families and 13 species. Clupeiformes stand on top in the catch followed by perches and mackerel's. The study revealed that there were noteworthy variations found in the ichthyofaunal diversity. Among the 36 families, only 27 families were seen in the caught without any depletion. Order Beloniformes and Gadiformes showed sudden appearance in the catch which were not seen for the past 7 years. IUCN status of 88species were studied, about 63% of species were under least concern and 8% near threatened, 3% vulnerable category, 7% data deficient, 19% not evaluated. Anthropogenic activities affect aquatic habitats leading to loss of many species as well as bring changes in the species composition. Therefore, ichthyofaunal diversity studies on regular basis are essential for sustainable management.

Keywords: Ichthyofaunal diversity, fishery production, iucn status, conservation, Puducherry

1. Introduction
Every realm of the sea is a warehouse of biodiversity which is a residence for multifarious of life. Having a deep understanding of biodiversity is an essential element for survival for most of the human past. The description of new species and mapping of their distribution is an important activity in post-enlightenment science (Costello *et al.* 2013) [1]. Among various living organisms, fishes are most diverse vertebrate occupying various habitats in different types of ecosystem. In terms of biodiversity fishes overtake all other group of organisms (Mustafa S.1999) [2]. Fish are immensely important to human beings as they have long been a staple food item for a longer period. The Indian fisheries sector plays a valuable role in the global fish production and it is the second largest producer of fish in the world. The importance of the fisheries sector in India is revealed by the fact that it employs more than five million people (Anon, 2000) [3], contributes to food and nutritional security and employment, supports livelihoods and raises the socioeconomic status of poor fishing communities. Fishes are involved in the environmental policies as biodiversity and ecological quality indicators (Kestemont et.al.,2000,Schmutz *et al.*,2007) [4, 5] and they have been used successfully in biogeographical studies, ecoregion delineations (Abell *et al.*,2008) [6], conservation evaluations(Moyle and Randall.,1998) [7] and assessments of ecologically acceptable water regime management(Jowett.,1997) [8]. The marine fish diversity of India is in ever-increasing danger due to overfishing of commercially important species. Further, fish may be considered as apt indicators of aquatic biodiversity, since their rich diversity is reflective of a wide range of environmental conditions (Moyle PB, Leidy RA.1992) [9]. It is well known that biodiversity is in world-wide decline (Butchart *et al.* 2010) [10]. Knowledge of fish diversity of the particular region is considered to be essential not only for their rational management but also for the conservational strategies for the ichthyo-fauna of that region. Considering the above, the present study has been made to provide a well-documented checklist about species composition and IUCN status of commercially important ichthyofaunal diversity of Puducherry coastal waters.

2. Materials and method

2.1 Study area

Puducherry has a coastline of 45 km, with a continental shelf area of about 1000 sq. km and it lies between North Latitudes 11° 46' and 120 03' and East Latitudes 79° 52' bounded by Bay of Bengal on the East. The diversity study was conducted in the 14 fish landing centres of Puducherry *viz*. Kanagachettikulam, Periyakalapet, Chinnakalapet, Pillaichavadi, Solainagar, Vaithikuppam, Kuruchikuppam, Thengaithittu, Veerampattinam, Pudukuppam, Nallavadu, Narambai, Pannithitu and Moorthikuppam from 2016 to 2017.

2.2 Fish collection methods

The collections was done almost on daily basis during morning and evening hours. The major objective of the bio inventory is to identify all the available species in the habitat using all gear combinations. Information regarding the seasonal availability, fish catch, size, quality, value of fish, common name, crafts and gears used etc., has been collected from traditional fishermen of all the coastal villages and recorded. Collected fish samples were brought to the laboratory and preserved in 10% formaldehyde and identification of the species was established by using FAO identification sheets (Fischer and Bianchi, 1984) [11].

2.3 Gear combinations

Various types of fishing gears are used by the fishermen of Puducherry region for exploiting different types of fishes. The major part of marine fish landings in Puducherry was from mechanised sector (86.7%). Motorised and non-motorised sectors contributed 13.3% and 0.04% respectively (Grinson George *et al*. 2016) [12]. The motorized sector includes gillnets, seine nets, hooks & lines and bagnets. All small boats and catamarans with low sea worthiness take on single day fishing with unfixed voyage times based on the season and the fishery resource which they target. Multiday and single day trawlers together contributed 82% of the total catch (FRAD, CMFRI, 2017) [13].

3. Results

A total of 88 commercially important fish species belonging to 36 families and 11 orders were reported from all landing centres of Puducherry. Out of 88 species, 84 species were teleost and the remaining were cartilaginous (Table: 1). In general, the fishes belong to the class Actinopterygii were found to be dominant. The best represented order was Perciformes (65%) with 23 families and 58 species followed by Clupeidae (15%) with 3 families and 13 species. Other families were each represented by 1 to 3 species (Fig: 1).Among 88 species, 40 species were caught regularly (45%), 33 species were less available (38%), 9 species shows rare occurrence (10%) and 6 species (Hilsha ilisha, Hilsha other, Harpodon nehereus, Eel, Bregmaceros, Elagatis) were very rare (7%) (Fig.2). In present study, as per IUCN 2016 red list status, out of 88 species, about 63% of species were under the status of least concern and 8% near threatened, 3% vulnerable category, 7% data deficient, 19% not evaluated categories (Fig. 3).

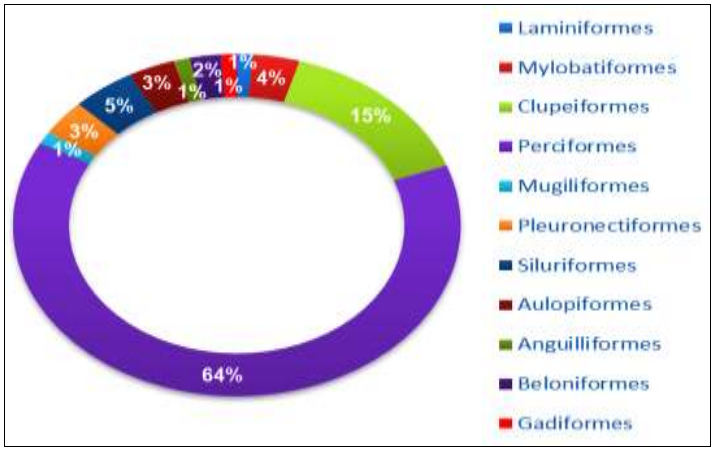

Fig 1: Order wise representation of fish in the study area

4. Discussion

The focus of the present study is to establish the list of commercially important fish species with its IUCN status. In this study visual illustrations and descriptive statistics were used to study the fish diversity in Puducherry. Among fin fishes, the pelagic group was dominant which contributed about 70.3% of the total catch followed by demersal fin fish (29.6%). The major fish species representing the fish landings along Puducherry coast were sardines including oil sardines, Indian mackerel, seer fish, pomfrets, carangids, perches (sea bass and Leiognathus), flat fishes, mullets, crockers, etc. Many researchers have tried to foretell the more availability of pelagic resources, particularly oil sardine, from the relationship between catches and climatic as well as oceanographic features such as seawater temperature, salinity, rainfall, upwelling and chlorophyll concentration (Banse, 1959; Longhurstand Wooster, 1990; Madhupratap *et al*., 1994; Yohannan and Abdulrahiman, 1998; Jayaprakash, 2002; Xu and Boyce, 2009) [14, 15, 16, 17, 18, 19]. Order Perciformes and Clupeiformes held most of the families and species (Table: 1). A total of 23 families falls under Perciformes in which the Carangidae family was dominated by holding 11 species followed by Scombridae with 9 species. Family Sciaenidae and Polynemidae were also contributed with a reasonable of 5 species each. 13 species were recorded in order Clupeiformes under three families. Out of this, Clupeidae family was represented by 7 species. These observation were common in most of marine environment. The presence of large number of species in these two orders could also be explained by the fact that they found favourable condition which allows them to develop and grow (Leveque *et al.*, 1991) [20]. The present finding was supported by Kumaran *et al.*, (2012) [21] in Griyampeta estuary, Yanam and Kuppan *et al.*, (2016) [22] from east coastal region, Chennai. Among the 36 families, only 27 families were seen in the caught without any depletion (Puducherry Fisheries Statistics, 2010) [23]. It is made known that, six fish groups (*Hilsha ilisha, Hilsha other, Harpodon nehereus*, Eel, Bregmaceros,

Elagatis) were in downfall status owing to human activities such as over fishing, modification of water quality etc.(Konan Gervias *et al.*, 2014) [24]. It has been came to know that 2 groups *viz*, Belone & Hemiramphus and Lactarius were resurface again in the catch during 2015 to 2017 which were not seen before 2015 (Puducherry Fisheries Statistics, 2017) [25].

Among the total 88 species reported during the study, 40 species were available (45%), 33 species were less available (38%), 9 species were rare (10%) and 6 species were very rare (7%) (Fig.2) based on the availability status recorded by Department of Fisheries and Fishermen Welfare, Puducherry. From the various detailed studies on fishery resources reported by the scientists of CMFRI (2006) [26], it is understood that 65% of the commercially important fish varieties in marine waters are overfished. Over exploitation indicates that fisheries prompted changes in the ecosystem owing to low productivity of the coastal waters and high density of fishing craft. The number of mechanised and motorised vessels went amassed due to ultimate demand for seafood and subsequent price escalation. Various developmental programmes of Central and State Governments such as subsidies for diesel engines, new gears and gear materials, vessels and financial assistance to fishermen and cooperative societies (Srivastava *et al.*, 1991) [27] zipped up the modernization in fishing process. Present estimated number of fishing vessels of almost all the types seem to be far excess than the actual number required to produce the sustainable yield (Mohammed Kasim and Vivekanandan, CMFRI, 2011) [28].In simple words, coastal biodiversity is at risk and marine environments are threatened (Imtiyaz *et al.*, 2011) [29] due to intensified human activities (Dulvy *et al.* 2014) [30].

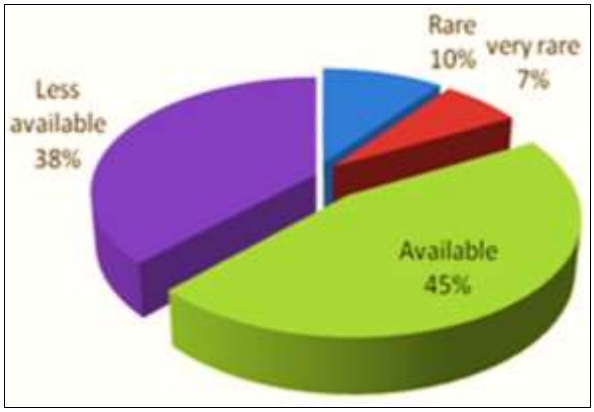

Fig 2: Availability of recorded fish species in the study area

4.1 Threatened Status

While evaluating the threat status of 88 fish species, 6 species comes under near threatened (NT), 3 species are vulnerable, 53 least concern,5 species have deficient data and data about 17 species did not drop under any threat category so it was placed in not evaluated group (Table 1). In present study, as per IUCN 2016 (31) red list status out of 88 species, about 63% of species were under least concern and 8% near threatened, 3% vulnerable category, 7% data deficient, 19% not evaluated categories (Fig. 3).

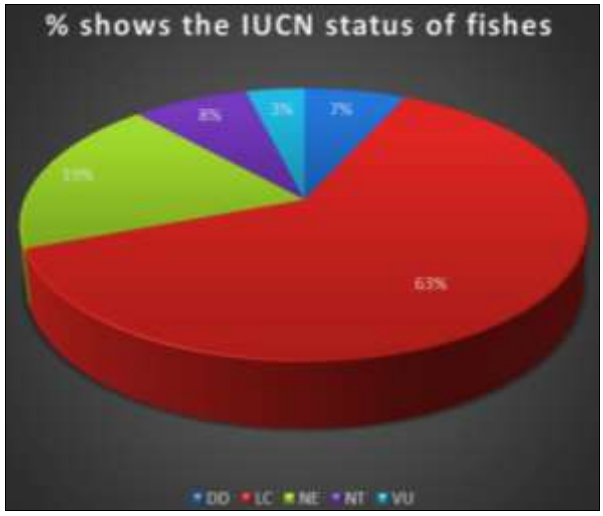

Fig: 3: IUCN stat us of fishes

The coastal waters of Puducherry receive discharges from 4 major industrial complexes including untreated municipal sewage from urban settlements and tourist resorts (Ramachandran, 2001) [32]. The other source of marine pollution includes tourism activities which lead to dumping of plastic and other solid wastes by tourists on the beaches. Recreational activities like tourism lead to loss of habitats, habitat degradation, the spread of disease, pollution, and unsustainable fishing practices are directly related to the actions of humans and recovery from these problems is rarely straightforward.

Table: 1: Systematic position of the fishes collected in the study with threat status

Super class: pisces						
Class:1: chondrichthyes						
Subclass:1:elasmobranchii						
Super order: Gnathostomata						
Order and suborder	**Family & subfamily**		**Name of species**	**Common Name**	**Vernacular name**	**IUCN/status**
Order 1: Lamniformes	Family 1: Carcharhinidae	1	*Rhizoprionodon acutus*, Rüppell, 1837	Milk shark	Pall surra	LC/AV
suborder: Scyliorhinoidei						
Order 2: Myliobatiformes	Family 2: Dasyatidae	2	*Dasyatis zugei*, Müller & Henle, 1841	Pale-edged stingray	Chambara-kah	NT/AV
Suborder: Squloidae	Subfamily: Dasyatinae	3	*Himantura uarnak*, Gmelin, 1789	Honey combed stingray	Pulli- thirukkai	VU/AV
		4	*Dasyatis jenkinsii, Annandale, 1909*	Sharpnose stingray	Sen-thirukkai	VU/AV
Class 2: Osteichthyes						
Subclass 2: actinopterygii						
Super order: Teloestei						
Order 3: Clupeiformes	Family 3: Clupeidae	5	*Sardinella longiceps* Valenciennes, 1847	Indian oil sardine	Mathi	LC/AV
Suborder: Clupeoidae	Subfamily: Clupeinae	6	*Escualosa thoracata*, Valenciennes, 1847	White sardine	Therakuthuva	LC/AV
		7	*Sardinella albella*, Valenciennes, 1847	White Sardinella	Thattakavalai	LC/AV
	Subfamily: Alosinae	8	*Hilsha ilisha*, Hamilton& Buch., 1822	Hilsa shad	Karuvaullam	LC/VR
		9	*Hilsa toli*, Valenciennes, 1847	Toli shad	Chudai	LC/VR
	Subfamily: Dorosomatinae	10	*Anodontostoma chacunda*, Hamilton, 1822	Chacunda gizzard	Poikendai	LC/AV
	Subfamily: Pristigasterinae	11	*Ophisthopterus tardoore*, Cuvier, 1829	Shad Tardoore	Thalporuva	LC/AV
	Family 4: Engraulidae					
	Subfamily: Collinae	12	*Colia dussumieri*, Valenciennes, 1848	Golden anchovy	Thova	LC/LA
	Subfamily: Engraulinae	13	*Stolephorus commersonii*, Lacepède, 1803	Commerson's anchovy	Therangunni	LC/LA
		14	*Thryssa mystax*, Schneider, 1801	Moustached thryssa	Poruva	LC/LA
		15	*Thryssa vitrirostris*, Gilchrist & Thompson, 1908	Orange mouth thryssa	Nedunporuva	LC/LA
	Family 5: Chirocentridae	16	*Chirocentrus nudus*, Swainson, 1839	White fin wolf herring	Mullvalai	LC/R
		17	*Chirocentrus dorab*, Forsskål, 1775	Dorab wolf herring	Karivalai	LC/R
Order 4: Perciformes						
Suborder: Percoidei	Family 6: Centropomidae	18	*Lates calcarifer*, Bloch, 1790	Sea bass	Koduva	NE/AV
	Family 7: Serranidae					
	Subfamily: Epinephelinae	19	*Epinephelus diacanthus*, Valenciennes, 1828	Thorny cheek groupers	Kadisan	NT/AV
	Family 8: Terapontidae	20	*Terapon jarbua* Forsskal, 1775	Jarbua Terapon	Katta keetchan	LC/AV
		21	*Terapon theraps*, Cuvier, 1829	Large scaled terapon	Thova keetchan	LC/AV
	Family 9: Lutjanidae	22	*Lutjanus argentimaculatus*, Forsskal, 1775	Mangrove red snapper	Ertha	LC/AV
	Family 10: Gerreidae	23	*Gerres filamentosus*, Cuvier, 1829	Whip fin silver biddy	Oodan	LC/AV
	Family 11: Lethrinidae	24	*Lethrinus nebulosus*, Forsskål, 1775	Spangled emperor	Kal	LC/AV
	Family 12: Nemipteridae	25	*Nemipterus japonicus*, Bloch, 1791	Japanese threadfin bream	Sankara	NE/AV
	Family:13 Priacanthidae	26	*Priacanthus hamrur*,Forsskal, 1775	Moontail bulls eye	Seruppu	LC/AV
	Family:14 Rachycentridae	27	*Rachicentron canadum*, Linnaeus, 1766	Cobia	Kadaveerang	LC/AV
	Family 15: Siganidae	28	*Siganus javus*, Linnaeus, 1766	Streaked spine foot	Oora	LC/AV
	Family 16: Sillaginidae	29	*Sillago sihama*, Forsskal, 1775	Silver sillago	Vella kezhangan	LC/AV
		30	*Sillago maculate*, Quoy & Gaimard, 1824	Trumpeter sillago	Karupu kezhangan	LC/AV
	Family 17: Lactariidae	31	*Lactarius lactarius*, Bloch & Schneider, 1801	False travelly	Sudumbu	NE/R
	Family 18: Carangidae	32	*Caranx para*, Cuvier, 1833	Banded scad	Ottampaara	LC/AV

		33	*Chorinemus lysan*, Forsskål, 1775	Double spotted queen fish		DD/R
		34	*Elagatis bipinnulata*, Quoy & Gaimard, 1825	Rainbow runner	Kulkul	LC/VR
		35	*Alepes djedaba*, Forsskål, 1775	Shrimp scad	Valam paarai	LC/LA
		36	*Atropus atropos* Bloch & Schneider, 1801	leftbally travelly	Thallam paarai	NE/LA
		37	*Atule mate*, Cuvier, 1833	Yellow tail scad	Manja paarai	LC/LA
		38	*Carangoides chrysophrys*, Valenciennes, 1833	Large nose travelly	Vezhum paarai	LC/LA
		39	*Gnathanodon speciosus*, Forsskål, 1775	Golden travelly	Eera paarai	LC/LA
		40	*Decapterus russelli*, Ruppell, 1830	Indian scad	Kilitchai	LC/LA
		41	*Megalaspis cordyla*, Linnaeus, 1758	Torpedo scad	Valangadai	LC/LA
		42	*Trachinotus mookalee*, Cuvier, 1832	Indian pompano	Perum paarai	LC/LA
	Family:19 Leiognathidae	43	*Leiognathus bindus*, Valenciennes, 1835	Orange fin pony fish	Thattana kaarai	LC/AV
		44	*Leiognathus brevirostris*, Valenciennes, 1835	Short nose pony fish	Oola kaarai	NE/AV
		45	*Gazza minuta*, Bloch, 1795	Toothed pony fish	Sudupana kaarai	LC/AV
	Family 20: Scianidae	46	*Dendrophysa russelli*, Cuvier, 1830	Goat croaker	Paruva thaalai	LC/LA
		47	*Johnius belangerii*, Cuvier, 1830	Belangers croaker	Thur kathalai	NE/LA
		48	*Nibea maculata*, Schneider, 1801	Blotched croaker	Kaarimunch kathalai	NE/LA
		49	*Protonibea diacanthus*,Lacepède, 1802	Spotted croaker	Panna	NE/LA
		50	*Otolithoides biauritus*, Cantor, 1849	Bronze croaker	Kaasai kathalai	NE/LA
	Family 21: Mullidae	51	*Upeneus moluccensis*, Bleeker, 1855	Gold banned goatfish	Kuliri	LC/AV
		52	*Upeneus vittatus*, Lacepède, 1801	Striped goatfish	Varina varai	LC/AV
Suborder: Sphyraenoidei	Family 23: Sphyraenidae	53	*Sphyraena jello*, Cuvier, 1829	Pick handle barracuda	Seela	NE/LA
		54	*Sphyraena obtusata*, Cuvier, 1829	Obtuse barracuda	Arakola	NE/LA
Suborder: Polynemoidei	Family 24: Polynemidae	55	*Eleutheronema tetradactylum*, Shaw, 1804	Four finger thread fin	Kittikaala	DD/R
		56	*Polynemus heptadactylus*, Cuvier, 1829	Seven finger thread fin	Erakaala	NE/R
		57	*Polynemus indicus*, Shaw, 1804	Indian thread fin	Vaalangkaala	LC/R
		58	*Polynemus paradiseus*, Linnaeus, 1758	Paradise thread fin	Thadikaala	LC/R
		59	*Polynemus sextarius*, Bloch & Schneider, 1801	Black spot thread fin	Pazhaikaala	NE/R
Suborder: Scombridei	Family 25: Trichiuridae	60	*Trichiurus lepturus*, Linnaeus, 1758	Large head hair tail	Chunnambu vaalai	LC/LA
	Family 26: Scombridae	61	*Scomberomorus commerson*, Lacepède, 1802)	Spanish mackerel	Maavalasi	NT/AV
		62	*Euthynnus affinis*, Cantor, 1850	Kawa kawa	Kakka churai	LC/AV
		63	*Rastrelliger kanagurta*, Cuvier, 1816	Indian mackerel	Kanangeluthi	DD/AV
		64	*Scomberomorus guttatus*, Bloch & Schneider, 1801	Indopacific king mackerel	Pulli vanjeeram	DD/AV
		65	*Auxis thazard*, Lacepède, 1803	Frigate tuna	Veldra churai	LC/AV
		66	*Katsuwonus pelamis*, Linnaeus, 1758	Skipjack tuna	Vari churai	LC/AV
		67	*Thunnus albacares*, Bonnaterre, 1788	Yellow fin tuna	Manja churai	NT/AV
		68	*Thunnus obesus*, Lowe, 1839	Big eye tuna	Sundam	VU/AV
		69	*Thunnus tonggol*, Bleeker, 1851	Long tail tuna	Sundam	DD/AV
	Family 27: Stromateidae	70	*Pampus argenteus*, Euphrasen, 1788	Silver pomfrets	Vella vauva	LC/LA
		71	*Pampus chinensis*, Euphrasen, 1788	Chinese silver pomfret	Tharattai	NE/LA
Suborder: XiPhioidei	Family 28: Istiophoridae	72	*Istiophorus platypterus*, Shaw, 1792	Indo-Pacific sail fish	Myilkola	LC/AV
		73	*Makaira indica*, Cuvier, 1832	Black Marlin	Tharattai	NE/LA
Order Order:5 Mugiliformes						
Suborder: Mugiloidei	Family 22: Mugilidae	74	*Mugil cephalus*, Linnaeus, 1758	Flat head mullet	Madavai	LC/LA
Order 6: Pleuronectiformes	Family 29: Cynoglossidae	75	*Cynoglossus macrostomus*, Norman, 1928	Malabar tongue sole	Mukuthi athil	NE/LA

		76	*Cynoglossus puncticeps*, Richardson, 1846	Speckled tongue sole	Athil	NE/LA
	Family 30: Soleidae	77	*Euryglossa orientalis*, Bloch & Schneider, 1801	Oriental tongue sole	Naaku meen	NE/LA
Order 7: Siluriformes	Family 31: Ariidae	78	*Arius caelatus*, Valenciennes, 1840	Engraved catfish	Venkeluthi	NT/LA
		79	*Arius tenuispinis*, Day, 1877	Thin spine sea catfish	Kummakeluthi	NT/LA
		80	*Arius thalassinus*, Rüppell, 1837	Giant catfish	Kattakeluthi	NT/LA
		81	*Osteogeneiosus militaris*, Linnaeus, 1758	Soldier catfish	Porikeluthi	NE/LA
Order 8: Aulopiformes	Family 32: Synodontidae	82	*Saurida tumbil*, Bloch, 1795	Greater lizard fish	Thumbili	LC/LA
		83	*Saurida undosquamis*, Richardson, 1848	Brush tooth lizardfish	Vettanthumbili	LC/LA
		84	*Harpadon nehereus*, Hamillton, 1822	Bombay duck	Vangaravaasi	NE/VR
Order 9: Anguilliformes	Family 33: Muraenesocidae	85	*Congresox talabonoides*, Bleeker, 1853	Indian pike-conger	Kuliri	NE/VR
Suborder: Anguilloidae						
Order10: Beloniformes	Family 34: Exocoetidae					
Suborder: Exocoetoidei	Subfamily: Exocoetinae	86	*Cheilopogon nigricans*, Bennett, 1840	African flying fish	Paravaikola	LC/LA
	Subfamily: Hemiramphinae	86	*Cheilopogon nigricans*, Bennett, 1840	African flying fish	Paravaikola	LC/LA
	Family 35: Hemiramphidae	87	*Hemiramphus far*, Forsskål 1775	Niparus half beak	Oosikola	LC/R
Order 11: Gadiformes	Family 36: Bregmacerotidae	88	*Bregmaceros bathymaster*, Jordan & Bollman, 1890	Codlet		LC/VR

LC- least concern, NT- Near Threatened, VU- Vulnerable, DD- Data Deficient, NE- Not Evaluated, AV-Available, VR- Very Rare, R- Rare, LA- Less Available

5. Conclusion

Biodiversity, the variation of life on Earth, is a major factor in its resilience. It is regularly to be overlooked species that are the most important to healthy ecosystems. There are promising fisheries technologies which have been developed and are being practised for improving fish biodiversity and nutrition. Loss of habitat threatens habitat specialists with extinction risk. The stress on major ecosystems has resulted in erosion of biodiversity due to various anthropogenic activities. This study attempted to record the diversity of commercially important fishes and fishery status of Puducherry coastal waters and also to open up arguments and considerations on the importance of conservation management, and further points to new directions on this frontier

6. Acknowledgement

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