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A Study on the Availability of Marine Fishes in Digha Mohana Fish Landing Centre, Purba Medinipur, West Bengal, India

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ABSTRACT: The present study was conducted at Digha Mohana fish landing centre, West Bengal & attempts this study to investigate the availability of marine finfish and shellfishes in the centre. The present survey was of 9 months duration. Major concerns of this study were based on a suitable scientific sampling process, because it was too hectic to collect the fish sample in the morning hours, due to extreme crowding conditions for trading. Beside this, in most cases tons of fishes unloaded in this fish landing centre and from there bulk quantity of fishes are distributed immediately. Among this large amount of fish, it was difficult to obtain samples of small-sized fishes. A total of 148 finfish and 15 shellfish species were recorded. The study reveals order Perciformes (25%) and order Decapoda (79%) were dominant for finfish and shellfish respectively. While in the finfish family Engraulidae (6%), Carangidae (6%) and in the shellfish family Penaeidae (43%) were dominant. Six types of marketing supply chains are available for the distribution of marine fish landings. About 2100 fishing crafts are used to depot their capture in the landing centre. Almost 85,000 fishermen are directly or indirectly involved in the operation of the landing centre.

Keywords: Mohana fish landing centre, Fish availability, Marketing supply chain, Crafts operating, Digha.

INTRODUCTION

Fishes are one of the most commercially important groups among animals (Solanki *et al.,* 2011). According to context and scale, ichthyofaunal diversity refers to the variety of fish species. It may also refer to alleles or genotypes within fish populations, species of life within fish communities, and species of life throughout aqua-regimes (Burton *et al.,* 1992). Moreover, biodiversity is crucial for maintaining ecosystems, safeguarding the quality of the environment as a whole, and comprehending the intrinsic value of every species on the planet (Ehrlich and Wilson 1991). India is one of the mega biodiversity countries in the world. The country occupies the 9th position in terms of freshwater mega biodiversity (Mittermeier and Mittermeier 1997). In India, there are 2,500 species of fishes; of which, 930 live in freshwater and 1570 are marine fish species (Kar, 2003). Most of the fish production and capture are sold in the local markets of India. From the last few decades the harvest and post-harvest scenario of Indian capture fisheries transformed into a market-oriented multi-crore industry (Pillai and Nair 2010). But still this present time most of the Indian fish markets are in the development stages. Major problems faced by the Indian markets are harvesting of large quantities of fishes, poor transportation channels, lack of modern storage facilities, high variability in market demand and supply ecosystem.

Almost 60% of people live in the coastal zone, which makes up 18% of the surface of the planet. It has a strong biological potential since it supports a wide range of marine forms with feeding, nursery, and spawning habitats (Saxena, 2012). Digha is a coastal semi-urban area in the Purba Medinipur district of Indian state West Bengal and on the northern edge of the Bay of Bengal. Fish landing centre plays a vital role in making fresh fish available for customer consumption through different marketing channels (Ahsan *et al.*, 2014). Digha Mohana is the largest fish landing centre in West Bengal. Marine fish species catches form the sea point-area completing demands around the state, especially Howrah and Kolkata. The abundance of fish resources in the Coastal and EEZ area of Digha is valuable in terms of their utility as food and as materials for scientific biodiversity study. Manna and Goswami (1985) were first published and listed 168 marine and estuarine fish species from Digha. Later Goswami (1992) published an elaborated fish faunal list with 239 fish species from Digha including the

freshwater fish species. There are 402 species inhabiting the marine and estuarine zones of West Bengal state (Talwar *et al.,* 1992). Total of 37 fish species and 9 shellfish species were recorded from Negua Diversion Canal, Purba Medinipur (Payra *et al.,* 2018). Baliarsingh *et al.* (2020) identified 7 marine fish species from the Kendrapara district of Odisha. Many of the species found in the canal are similar to the species found in the Mohana fish landing centre. Besides those studies made by Yennawar and Tudu (2010); Mohapatra *et al*. (2012a, 2012b, 2013a, 2013b, 2013c, 2015, 2016); Ray *et al*. (2012a, 2012b, 2013, 2014, 2015a, 2015b, 2015c, 2015d, 2016); Ray and Mohapatra (2013, 2015a, 2015b, 2016a, 2016b, 2016c) added many more fishes to the list of Digha coast. Yennawar *et al.* (2017) reported 340 species from 210 genera, 107 families and 19 orders from the region. Yennawar and Tudu (2014) reported 57 macro-benthic faunal species from Digha Mohana. One of the difficulties is that report also accounts for the species from the Hugli estuary and Sand heads, without specifying the places of occurrence in most of the species. So, it is so difficult for a common reader to understand the availability of marine species in the Digha coast. The morphometric and meristic features are the two most important criteria for the classification and identification of species (Jayaram, 1999; Hossen *et al*., 2020; Das *et al.,* 2023). So, identifying of species available in the Mohana market is the prime necessity for this present study. Furthermore, knowing the availability of fish is crucial for planning any programme of proper utilisation. Therefore, the current study was undertaken to document the status of species that are landed and marketed at Digha Mohana Fish Landing Centre.

MATERIALS AND METHODS

Study Area. The study was carried out in the Digha Mohana fish landing centre, Purba Medinipur, West Bengal, India (Fig. 1). The study area (Digha Mohana fish market) lies between Latitude-21º63″ North and Longitude-87º54″ East. The study was conducted for a period of 9 months from February 2022 to October 2022.

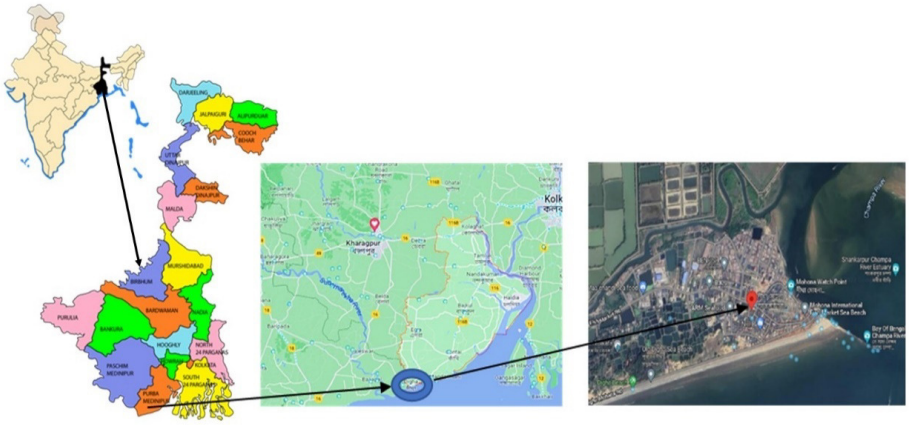

Fig. 1. (a) Showing map of West Bengal, (b) Purba Medinipur (c) Digha Mohana Fish landing centre.

Data Collection and Identification of Fishes. The fish samples and data were collected from the Digha Mohana fish landing centre. The sampling of fishes was carried out by direct sampling method. After collection of the samples, fishes were immediately preserved with 10% formalin (HCHO) solution in a labelling container. After that, a detailing of identifying characteristics of the fishes was studied. The morpho-meristic identifying system was followed by Talwar and Jhingran (1991); Jayaram (1999) and also the www. Fishbase.org. Illustrations of marine fishes by Talwar and Kacker (1994); Talwar *et al.* (1992); Jhingran (1991) helped in the identification of the collected fishes. Conservation status of the identified species presented in this study as per the IUCN-Red Data List (IUCN, 2022).

RESULTS AND DISCUSSION

We have recorded a total number of 148 finfish species (Plate-I) belonging to 21 orders, 64 families and 15 shellfish species (Plate-II) belonging to 3 orders, 6 families during the study period (Table 1 & 2). Yennawar *et al.* (2017) identified total of 340 species from five different sides including Mohana along the Digha coast. Out of finfishes, the species under perciformes were dominant (25%), followed by Clupeiformes (14%), Carangiformes (8%), Scombriformes & Acanthuriformes (7%), while orders like Beloniformes, Carcharhiniformes, Rajiformes, Rhinobatiformes, Scorpeniformes, Mugiliformes, Pleuronectiformes, Angulliformes and others were recorded under 5% availability (Fig. 2). On the other side, shellfish species under decapoda (79%), Sepiida (14%), Myopsida (7%) were recorded during the study (Fig. 3). Pelagic species constitute approximately 71% of the total marine fish caught from the coast of Kerala. Out of the total pelagic catch, oil sardine, tunas, carangids, anchovies, etc. occupied about 65%, which is about 35% of the total marine fish captured in India (Pillai and Nair 2010). Major pelagic fishes include mackerel, tuna, sardine, anchovies, ribbon, carangids etc and major demersal fishes includes sharks, breams, rays, soles, breams, groupers, snapper lands in the Digha fish landing centre. Penaeid and Plinurid shrimp, crabs, lobster, squid, and cuttlefishes are available enough in the land centre.

Table 1: Finfish species enlisted in the Digha Mohana fish landing centre, West Bengal, India.

Order Name	Family	Scientific Name	Local Name/Vernacular Name	IUCN Status	Availability Status
Perciformes	Sciaenidae	*Nibea maculata* (Bloch & Schneider, 1801)	Blotched croaker	LC	_
	Priacanthidae	*Priacanthus hamrur* (Forsskal, 1775)	Goggle eye	LC	_
	Serranidae	*Epinephelus malabaricus* (Bloch & Schneider, 1801)	Speckeled grouper	LC	++
		Epinephelus tauvina (Forsskal, 1775)	Greasy rockcod	DD	_
		Epinephelus coioides (Hamilton, 1822)	Brown-spotted rock-cod	LC	_
		Epinephelus areolatus (Forsskal, 1775)	Aerolate rockcod	LC	_
		Epinephelus latifasciatus (Temminck & Schlegel, 1842)	Spotfin rockcod	LC	_
	Lutjanidae	*Lutjanus johnii* (Bloch, 1792)	Golden Snapper	LC	+
		Lutjanus argentimaculatus (Forsskal, 1775)	Mangrove Red Snapper	LC	_
		Lutjanus lutjanus (Bloch, 1790)	Big eye snapper	LC	_
	Gerreidae	*Pentaprion longimanus* (Cantor, 1849)	Longfin mojarra	LC	_
		Gerres filamentosus (Cuvier, 1829)	Flagfin mojarra	LC	++
		Gerres longirostris (Lacepede, 1801)	Strongspine silver-biddy	NE	_
		Gerres setifer (Hamilton, 1822)	Small Bengal silver-biddy	NE	+
	Lactariidae	*Lactarius lactarius (Bloch & J. G. Schneider, 1801)*	False trevally	NE	_
	Latidae	*Lates calcarifer* (Bloch, 1790)	Barramundi/ Asian sea bass/ Bhetki	LC	+
	Haemulidae	*Diagramma pictum* (Thunberg, 1792)	Painted sweetlips	NE	_
		Pomadasys maculatus (Bloch, 1793)	Saddle grunt	LC	++
	Polynemidae	*Polynemus paradiseus* (Linnaeus, 1758)	Paradise threadfin/ Topse	LC	++
		Leptomelanosoma indicum (Shaw, 1804)	Indian threadfin	NE	+
		Eleutheronema tetradactylum (Shaw, 1804)	Fourfinger threadfin	NE	++
	Sciaenidae	*Otolithes ruber* (Bloch & Schneider, 1801)	Tigertooth croacker	LC	+
		Johnius belangerii (Cuvier, 1830)	Belanger's croaker	LC	+
		Johnius dussumieri (Cuvier, 1830)	Sin croaker	LC	++
		Johnius borneensis (Bleeker, 1851)	Sharpnose hammer croaker	LC	_
		Protonibea diacanthus (Lacepede, 1802)	Blackspotted croaker	NT	_
	Scatophagidae	*Scatophagus argus* (Linnaeus, 1766)	Spotted scat	LC	++
	Terapontidae	*Terapon jarbua* (Forsskal, 1775)	Tiger perch/ Kunkuni	LC	++
	Sillaginidae	*Sillago sihama* (Forsskal, 1775)	Sand smelt/ Talkorhma	LC	++
		Sillaginopsis panijus (Hamilton, 1822)	Flatehead sillago	NE	+
	Nemipteridae	*Nemipterus japonicus* (Bloch, 1791)	Japanese threadfin bream	LC	_
		Nemipterus bipunctatus (Valenciennes,1830)	Belagoa threadfin bream	LC	+
		Nemipterus nematophorus (Bleeker, 1854)	Doublewhip threadfin bream	LC	_
	Lobotidae	*Lobotes surinamensis* (Bloch, 1790)	Tripletails	LC	_
	Siganidae	*Siganus canaliculatus* (Park, 1797)	Seagrass rabbitfish	LC	_
	Sparidae	*Acanthopagrus berda*	Goldsilk seabream	LC	+

		(Forsskal, 1775)			
		Argyrops spinifer (Forsskal, 1775)	King soldierbream	LC	_
		Rhabdosargus sarba (Forsskal, 1775)	Goldlined seabream	LC	_
Clupeiformes	Clupeidae	*Tenualosa ilisha* (Hamilton, 1822)	Hilsa shad/ Ilish	LC	+
		Sardinella longiceps (Valenciennes,1847)	Indian oil sardine/ Teltapra	LC	++
		Sardinella fimbriata (Valenciennes,1847)	Fringescale sardinella	LC	++
		Sardinella gibbosa (Bleeker, 1849)	Goldstripe sardinella	LC	+
		Hilsa kelee (Cuvier, 1829)	Kelee shad	LC	+
		Escualosa thoracata (Valenciennes,1847)	White sardine/ Kagja	LC	++
		Anodontostoma chacunda (Hamilton, 1822)	Chacunda gizzard shad	LC	+
	Engraulidae	*Anchoa mitchilli* (Valenciennes,1848)	Bay anchovy	LC	++
		Stolephorus indicus (Van Hasselt, 1823)	Indian anchovy	LC	++
		Setipinna phasa (Hamilton, 1822)	Gangetic hairfin anchovy	LC	++
		Setipinna taty (Valenciennes,1848)	Scaly hairfin anchovy/ Tapra	LC	++
		Coilia dussumieri (Valenciennes, 1848)	Goldspotted grenadier anchovy/ Ruli	LC	++
		Coilia neglecta (Whitehead, 1968)	Neglected grenadier anchovy	LC	+
		Thryssa dussumieri (Valenciennes,1848)	Dussmier's thryssa	LC	+
		Encrasicholina devisi (Whitley, 1940)	Devis' anchovy	NE	+
		Stolephorus commersonnii (Lacepède, 1803)	Commerson's anchovy	LC	+
	Chirocentridae	*Chirocentrus nudus* (Swainson, 1839)	Whitefin wolf- herring/ Khanra	LC	++
	Pristigasteridae	*Ilisha megaloptera* (Swainson, 1838)	Bigeye ilisha	LC	++
		Ilisha melastoma (Bloch & Schneider, 1801)	Indian ilisha	LC	+
		Pellona ditchela (Valenciennes,1847)	Indian pellona	LC	+
Carcharhiniformes	Carcharhinidae	*Carcharhinus dussumieri* (Valenciennes,1839)	White-cheek shark	EN	_
		Rhizoprionodon acutus (Rüppell, 1837)	Milk shark	VU	+
		Scoliodon sorrakowah (Bleeker, 1853)	Spadenose shark	NT	+
		Galeocerdo cuvier (Péron & Lesueur, 1822)	Tiger shark	NT	_
	Sphyrnidae	*Sphyrna zygaena* (Linnaeus, 1758)	Smooth hammerhead	VU	_
	Proscyllidae	*Eridancis radcliffei* (Smith, 1913)	Finback shark	LC	_
Rajiformes	Pristidae	*Anoxypristis cuspidata* (Latham, 1794)	Pointed sawfish	EN	_
		Pristis microdon (Latham, 1794)	Largetooth sawfish	NE	_
Rhinopristiformes	Rhinidae	*Rhynchobatus djiddensis* (Forsskal, 1775)	Giant guitarfish	CR	_
	Rhinobatidae	*Rhinobatos annandalei* (Norman, 1926)	Annandale's guiterfish	CR	_
		Rhinobatos lionotus (Norman, 1926)	Smoothback guitarfish	NT	+
Myliobatiformes	Dasyatidae	*Pateobatis bleekeri* (Blyth, 1860)	Bleeker's whipray	EN	+
		Dasyatis zugei (Muller & Henle, 1841)	Sharpnose stingray	VU	_
	Gymnuridae	*Gymnura micrura* (Bloch & Schneider 1801)	Smooth butterfly ray	NT	_
	Mobulidae	*Mobula mobular* (Bonnaterre, 1788)	Devil fish	EN	_
Mugiliformes	Mugilidae	*Planiliza parsia*	Parse/ Mullet	LC	++

		(Hamilton, 1822)			
		Mugil cephalus (Linnaeus, 1758)	Flathead grey mullet	LC	+
		Planiliza tade (Fabricius, 1775)	Tade grey mullet	DD	+
Pleuronectiformes	Cynoglossidae	*Cynoglossus cynoglossus* (Hamilton, 1822)	Bengal tongue sole	NE	++
		Cynoglossus semifasciatus (Day, 1877)	Bengal tonguesole	DD	++
		Cynoglossus lingua (Hamilton, 1822)	Long tongue sole	LC	_
		Paraplagusia bilineata (Bloch, 1787)	Doublelined tonguesole	LC	+
	Psettoodidae	*Psettodes erumei* (Bloch & Schneider, 1801)	Indian Halibut	DD	_
Aulopiformes	Synodontidae	*Harpodon nehereus* (Hamilton, 1822)	Bombay-duck	NT	++
Anguilliformes	Congridae	*Conger myriaster* (Brevoort, 1856)	Whitespotted conger	LC	+
	Anguillidae	*Anguilla bicolor bicolor* (McClelland, 1844)	Indonesian shortfin eel	NT	_
		Anguilla bengalensis bengalensis (Gray, 1831)	Indian mottled eel	NT	_
Beloniformes	Belonidae	*Strongylura strongylura* (Van Hasselt, 1823)	Spottail needlefish	LC	_
		Strongylura leiura (Bleeker, 1850)	Banded needlefish	NE	+
		Tylosurus crocodilus (Peron & Lesueur, 1821)	Hound needlefish	LC	_
	Exocoetidae	*Exocoetus volitans* (Linnaeus, 1758)	Two-wing flying fish/ Urukku mach	LC	_
	Hemiramphidae	*Hemiramphus far* (Forsskal, 1775)	Black-barred halfbeak	NE	+
		Hyporhamphus limbatus (Valenciennes,1847)	Congaturi halfbeak	LC	_
		Rhynchorhamphus georgii (Valenciennes,1847)	Long billed half beak	NE	+
Orectolobiformes	Rhincodontidae	*Rhincodon typus* (Smith, 1828)	Whale shark	EN	_
	Hemiscylliidae	*Chiloscyllium indicum* (Gmelin, 1789)	Slender bamboo-shark	NT	_
Scorpaeniformes	Scorpaenidae	*Pterois russelii* (Bennett, 1831)	Plaintail turkey fish	LC	_
	Platycephalidae	*Platycephalus indicus* (Linnaeus, 1758)	Bartail flathead	DD	++
		Grammoplites scaber (Linnaeus, 1758)	Rough flathead	NE	_
Siluriformes	Bagridae	*Mystus gulio* (Hamilton, 1822)	Nona Tangra	LC	+
	Plotosidae	*Plotosus canius* (Hamilton, 1822)	Gray eel-catfish	NE	_
	Ariidae	*Arius maculatus* (Thunberg, 1792)	Spotted sea catfish	NE	+
		Sciades sona (Hamilton, 1822)	Sona sea catfish	NE	_
		Arius gagora (Hamilton, 1822)	Gagora catfish	NT	+
		Hexanematichthys sagor (Hamilton, 1822)	Sagor catfish	NE	_
Torpediniformes	Narcinidae	*Narcine brunnea* (Annandale, 1909)	Brown numbfish	NE	+
		Narcine prodorsalis (Bessednov, 1966)	Tonkin numbfish	NT	_
	Narkidae	*Narke dipterygia* (Bloch & Schneider, 1801)	Numbray	VU	_
Tetraodontiformes	Tetraodontidae	*Lagocephalus inermis* (Temminck & Schlegel 1850)	Smooth blaasop	LC	_
		Arothron immaculatus (Bloch & Schneider 1801)	yellow-eyed puffer	LC	_
		Takifugu oblongus (Bloch, 1786)	Lattice blaasop	LC	+
		Tetraodon fluviatilis (Hamilton, 1822)	Green Puffer	LC	_
		Lagocephalus lunaris (Bloch & Schneider 1801)	Lunartail puffer	LC	++

	Triacanthidae	*Triacanthus biaculeatus* (Bloch, 1786)	Short-nosed tripodfish	NE	_
Scombriformes	Scombridae	*Rastrelliger brachysoma* (Bleeker, 1851)	Short Mackerel	DD	+
		Rastrelliger kanagurta (Cuvier, 1816)	Indian mackerel	DD	++
		Scomberomorus guttatus (Bloch & Schneider 1801)	Indo-Pacific king mackerel	DD	++
		Scomberomorus maculatus (Mitchill, 1815)	Atlantic Spanish mackerel	LC	+
		Katsuwonus pelamis (Linnaeus, 1758)	Skipjack tuna	LC	_
	Stromateidae	*Pampus argenteus* (Euphrasen, 1788)	Silver pomfret	VU	++
		Pampus chinensis (Euphrasen, 1788)	Chinese silver pomfret	NE	+
	Trichiuridae	*Lepturacanthus savala* (Cuvier, 1829)	Small head ribbon	NE	++
		Trichiurus lepturus (Linnaeus, 1758)	Grey ribbon/ Large head ribbon	LC	+
		Trichiurus gangeticus (Gupta, 1966)	Ganges-hairtail	NE	+
Acanthuriformes	Zanclidae	*Zanclus cornutus* (Linnaeus, 1758)	Moorish idol	NE	+
	Chaetodontidae	*Heniochus acuminatus* (Linnaeus, 1758)	Pennant coralfish	NE	_
	Ephippidae	*Ephippus orbis* (Bloch, 1787)	Spade fish	NE	++
		Platax teira (Forsskal, 1775)	Longfin batfish	LC	_
	Drepaneidae	*Drepane longimana* (Bloch & Schneider, 1801)	Concertina fish	NE	+
		Drepane punctata (Linnaeus, 1758)	Spotted sicklefish	NE	+
	Leiognathidae	*Photopectoralis bindus* (Valenciennes,1835)	Orange fin ponyfish	NE	++
		Karalla daura (Cuvier, 1829)	Gold stripe ponyfish	NE	_
		Aurigequula fasciata (Lacepede, 1803)	Striped ponyfish	LC	_
		Eubleekeria jonesi (James, 1971)	Jones' pony fish	NE	++
Istiophoriformes	Sphyraenidae	*Sphyraena jello* (Cuvier and Valenciennes, 1829)	Pickhandle barracuda	NE	+
	Istiophoridae	*Istiophorus platypterus* (Shaw, 1792)	Sailfish	VU	_
Mulliformes	Mullidae	*Upeneus moluccensis* (Bleeker, 1855)	Gold band goatfish	LC	_
		Upeneus vittatus (Forsskal, 1775)	Yellow striped goatfish	LC	+
		Parupeneus indicus (Shaw 1803)	Indian goatfish	LC	_
Carangiformes	Echeneidae	*Echeneis naucrates* (Linnaeus, 1758)	Remora/ Live sucker	LC	_
	Carangidae	*Scomberoides tala* (Cuvier, 1832)	Barred queen fish	LC	+
		Scomberoides tol (Cuvier, 1832)	Needle-scaled queenfish	LC	+
		Scomberoides pelagicus (Abdussamad,2022)	Queen fish	NE	_
		Parastromateus niger (Bloch, 1795)	Black pomfret	LC	+
		Selene vomer (Linnaeus, 1758)	Lookdown (Game fish)	LC	_
		Caranx ignobilis (Forsskal, 1775)	Ulua/ Giant kingfish	LC	_
		Alepes kleinii (Bloch, 1793)	Golden scad	LC	+
		Megalaspis cordyla (Linnaeus, 1758)	Hardtail scad	LC	++
		Alepes djedaba (Forsskal, 1775)	Shrimp scad/ Slender yellow- tail kingfish	LC	+
	Rachycentridae	*Rachycentron canadum* (Linnaeus, 1766)	Black king fish/ Lemon fish	LC	_
	Menidae	*Mene maculata* (Bloch & Schneider 1801)	Moonfish	NE	_

Table 2: Shellfish species enlisted in the Digha Mohana fish landing centre, West Bengal, India.

Order Name	Family	Scientific Name	Local Name/Vernacular Name	IUCN Status	Availability Status
	Portunidae	*Portunus sanguinolentus* (Herbst, 1783)	Red sea crab	NE	+
		Portunus pelagicus (Linnaeus, 1758)	Indian Ocean blueswimmer crab/ flower crab	NE	++
		Portunus armatus (Milne-Edwards, 1861)	Blue swimmer crab	NE	_
		Charybdis feriata (Linnaeus, 1758)	Crucifix crab	NE	++
	Penaeidae	*Penaeus monodon* (Fabricius, 1798)	Giant tiger prawn/ Bagda	NE	++
		Metapenaeus monoceros (Fabricius, 1798)	Speckled Shrimp	NE	+
		Fenneropenaeus indicus (H. Milne-Edwards, 1837)	Indian whiteshrimp	NE	++
		Metapenaeus dobsoni (Miers, 1878)	Kadal shrimp	NE	++
		Metapenaeus brevicornis (H. Milne-Edwards, 1837)	Yellow shrimp	NE	_
		Metapenaeus affinis (H. Milne-Edwards, 1837)	Jinga Shrimp	NE	+
	Pandalidae	*Plesionika edwardsii* (Brandt, 1851)	Golden Shrimp	NE	+
	Plinuridae	*Panulirus versicolor* (Latreille, 1804)	Painted spiny-lobster	LC	++
Sepiida	Sepiidae	*Sepia pharaonic* (Ehrenberg, 1831)	Pharaoh cuttlefish	DD	+
		Sepia aculeata (Van Hasselt, 1835)	Needle cuttlefish	DD	++
Myopsida	Loliginidae	*Uroteuthis duvaucelii* (d'Orbigny, 1835)	Squid	DD	++

EN= Endangered; CR= Critically Endangered; NT = Near Threaten, LC = Least Concern; VU= Vulnerable; DD = Data Deficient; NE = Not Evaluate

'++' Abundantly available; '+' Commonly available, '_' Rarely available

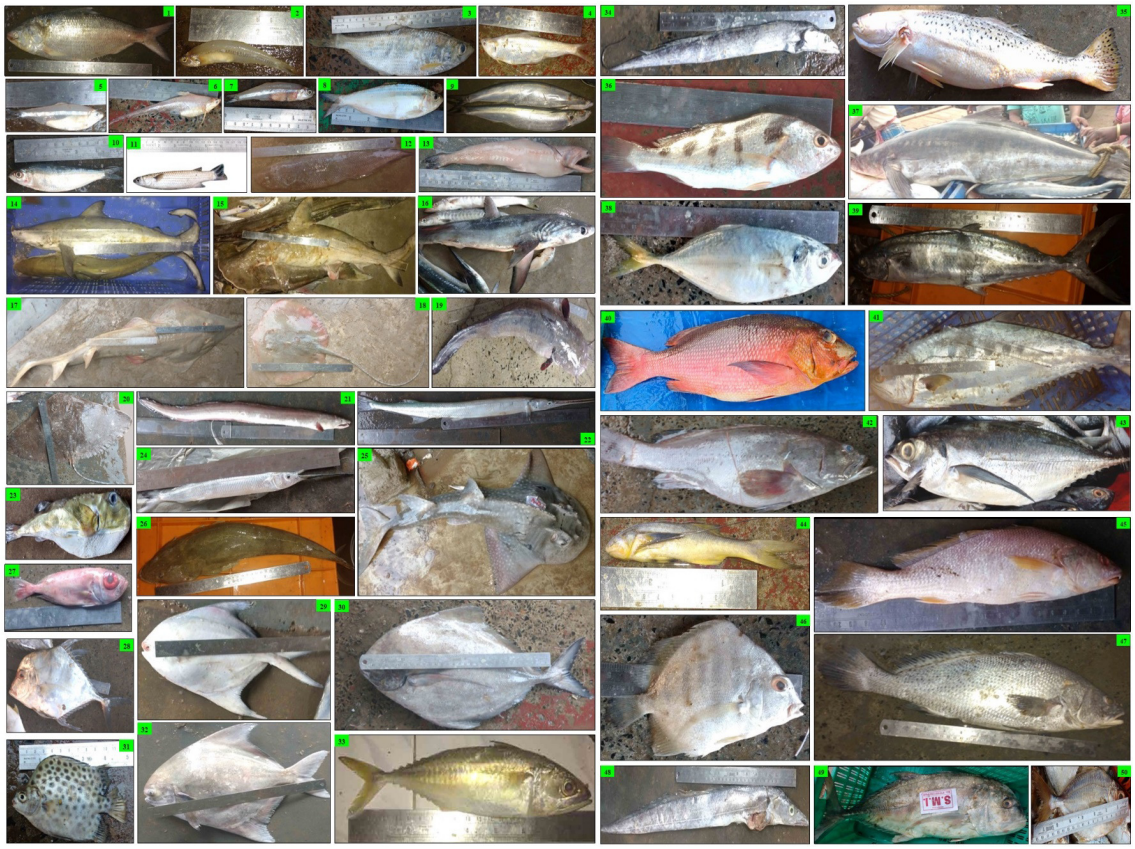

Plate I. 1. *Tenualosa ilisha* (Hamilton, 1822), **2.** *Anchoa mitchilli* (Valenciennes,1848), **3.** *Ilisha megaloptera* (Swainson, 1838), **4.** *Setipinna taty (Valenciennes,1848)*, **5.** *Escualosa thoracata* (Valenciennes,1847), **6.** *Coilia dussumieri* (Valenciennes, 1848), **7.** *Encrasicholina devisi* (Whitley, 1940), **8.** *Sardinella longiceps* (Valenciennes,1847), **9.** *Chirocentrus nudus* (Swainson, 1839), **10.** *Sardinella gibbosa* (Bleeker, 1849). **11.** *Planiliza parsia* (Hamilton, 1822), **12.** *Paraplagusia bilineata* (Bloch, 1787), **13.** *Harpodon nehereus* (Hamilton, 1822), **14.** *Carcharhinus dussumieri* (Valenciennes,1839), **15.** *Sphyrna zygaena* (Linnaeus, 1758), **16.** *Scoliodon sorrakowah* (Bleeker, 1853), **17.** *Rhynchobatus djiddensis* (Forsskal, 1775), **18.** *Pateobatis bleekeri* (Blyth, 1860), **19.** *Plotosus canius* (Hamilton, 1822), **20.** *Gymnura micrura* (Bloch & Schneider, 1801), **21.** *Conger myriaster* (Brevoort, 1856), **22.** *Strongylura strongylura* (Van Hasselt, 1823), **23.** *Lagocephalus inermis* (Temminck & Schlegel, 1850), **24.** *Hyporhamphus limbatus* (Valenciennes,1847), **25.** *Rhincodon typus* (Smith, 1828), **26.** *Platycephalus indicus* (Linnaeus, 1758), **27.** *Priacanthus hamrur* (Forsskal, 1775), **28.** *Selene vomer* (Linnaeus, 1758), **29.** *Pampus argenteus* (Euphrasen, 1788), **30.** *Parastromateus niger* (Bloch, 1795), **31.** *Scatophagus argus* (Linnaeus, 1766), **32.** *Pampus chinensis* (Euphrasen, 1788), **33.** *Rastrelliger kanagurta* (Cuvier, 1816), **34.** *Lepturacanthus savala* (Cuvier, 1829), **35.** *Epinephelus malabaricus* (Bloch & Schneider, 1801), **36.** *Nibea maculata* (Bloch & Schneider, 1801), **37.** *Rachycentron canadum* (Linnaeus, 1766), **38.** *Alepes djedaba* (Forsskal, 1775), **39.** *Scomberomorus maculatus* (Mitchill, 1815), **40.** *Lutjanus argentimaculatus* (Forsskal, 1775), **41.** *Scomberoides tol* (Cuvier, 1832), **42.** *Epinephelus latifasciatus* (Temminck & Schlegel, 1842), **43.** *Megalaspis cordyla* (Linnaeus, 1758), **44.** *Polynemus paradiseus* (Linnaeus, 1758), **45.** *Otolithes ruber* (Bloch & Schneider, 1801), **46.** *Ephippus orbis* (Bloch, 1787), **47.** *Lates calcarifer* (Bloch, 1790), **48.** *Trichiurus lepturus* (Linnaeus, 1758), **49.** *Caranx ignobilis* (Forsskal, 1775), **50.** *Eubleekeria jonesi* (James, 1971), **51.** *Lutjanus johnii* (Bloch, 1792), **52.** *Johnius belangerii* (Cuvier, 1830), **53.** *Terapon jarbua* (Forsskal, 1775), **54.** *Alepes kleinii* (Bloch, 1793), **55.** *Istiophorus platypterus* (Shaw, 1792), **56.** *Katsuwonus pelamis* (Linnaeus, 1758), **57.** *Eleutheronema tetradactylum* (Shaw, 1804), **58.** *Mene maculata* (Bloch & Schneider, 1801), **59.** *Upeneus moluccensis* (Bleeker, 1855), **60.** *Upeneus vittatus* (Forsskal, 1775), **61.** *Sillago sihama* (Forsskal, 1775), **62.** *Gerres filamentosus* (Cuvier, 1829), **63.** *Nemipterus japonicus* (Bloch, 1791), **64.** *Siganus canaliculatus* (Park, 1797), **65.** *Photopectoralis bindus* (Valenciennes,1835), 66. *Mugil cephalus* (Linnaeus, 1758), **67.** *Zanclus cornutus* (Linnaeus, 1758), **68.** *Planiliza tade* (Fabricius, 1775), **69.** *Argyrops spinifer* (Forsskal, 1775), **70.** *Mystus gulio* (Hamilton, 1822), **71.** *Mobula mobular* (Bonnaterre, 1788), **72.** *Lactarius lactarius* (Bloch & J. G. Schneider, 1801), **73.** *Protonibea diacanthus* (Lacepede, 1802).

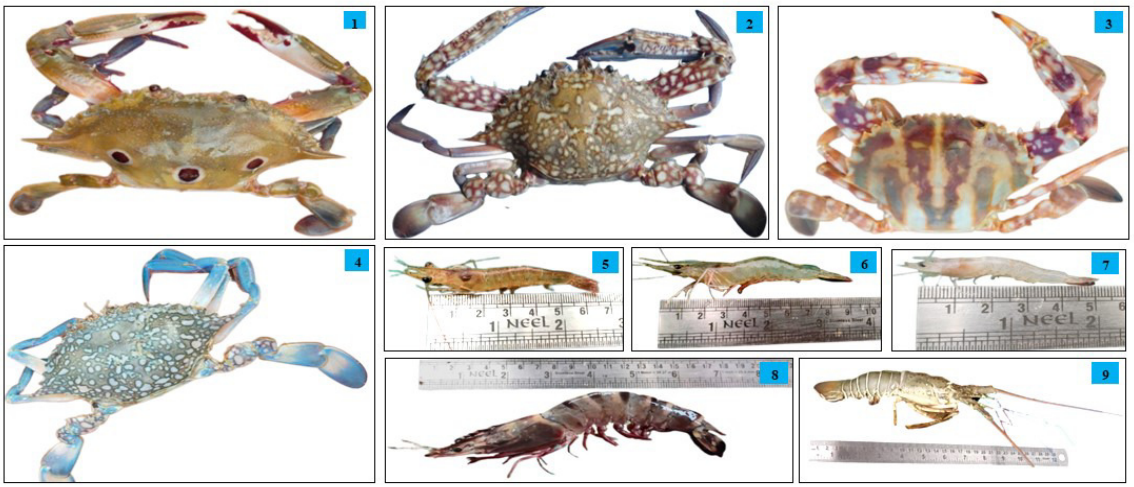

Plate II. 1. *Portunus sanguinolentus* (Herbst, 1783), **2.** *Portunus pelagicus* (Linnaeus, 1758), **3.** *Charybdis feriata* (Linnaeus, 1758), **4.** *Portunus armatus* (Milne-Edwards, 1861), **5.** *Metapenaeus monoceros* (Fabricius, 1798), **6.** *Metapenaeus affinis* (H. Milne-Edwards, 1837), **7.** *Fenneropenaeus indicus* (H. Milne-Edwards, 1837), **8.** *Penaeus monodon* (Fabricius, 1798), **9.** *Panulirus versicolor* (Latreille, 1804).

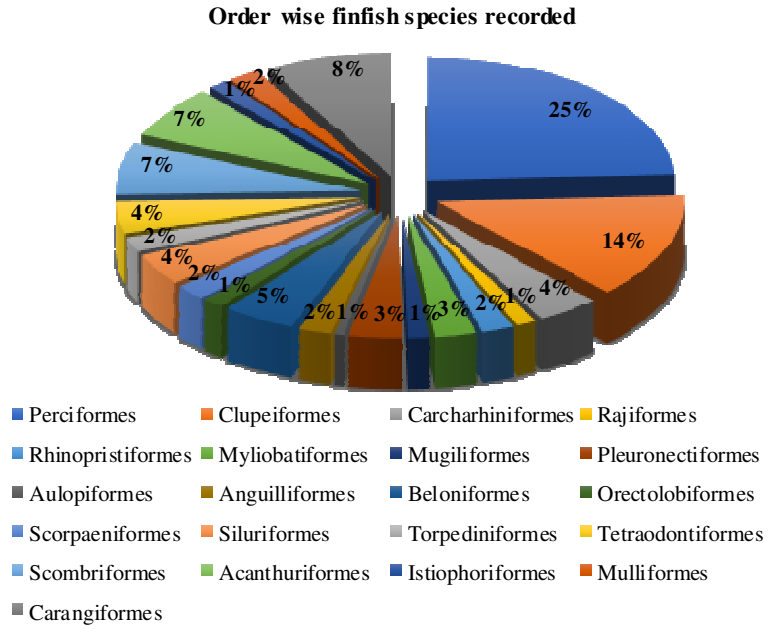

Fig. 2. Order-wise finfish species recorded at Digha Mohana fish landing centre.

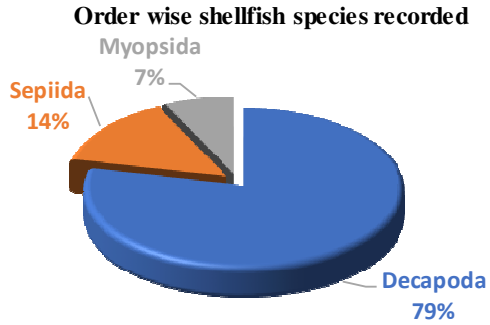

Fig. 3. Order wise Shellfish species recorded at Digha Mohana fish landing centre.

Dominant finfish families recorded during the study are Engraulidae & Carangidae (6%). While clupeidae contributes 5%, families like Gerreidae, Carcharhinidae, Cynoglossidae, Leiognathidae, Ariidae, Serranidae etc. contributes 3% each. Belonidae, Hemiramphidae, Trichiuridae, Mullidae & some other families were found in each of 2% availability in the fish landing centre. The rest families were recorded each of only 1% during the study (Fig. 4). Shellfish family Penaeidae (43%) was the highest recorded, following Portunidae (22%), Sepiidae (14%), and others at 7% each (Fig. 5).

Table 3: Fishing crafts operating in the Digha Coastal region (Data resource; Annual report DFFTA, 2020-21)

Craft Name	Number of Crafts Operating
Large Trawler	1130
Mechanised boat (Operating Gill net)	150
Small mechanised boat or Bhutbhuti	100
Indigenous Craft or Nauka	25
Hand Trawler	15
Temporary Vessel	650

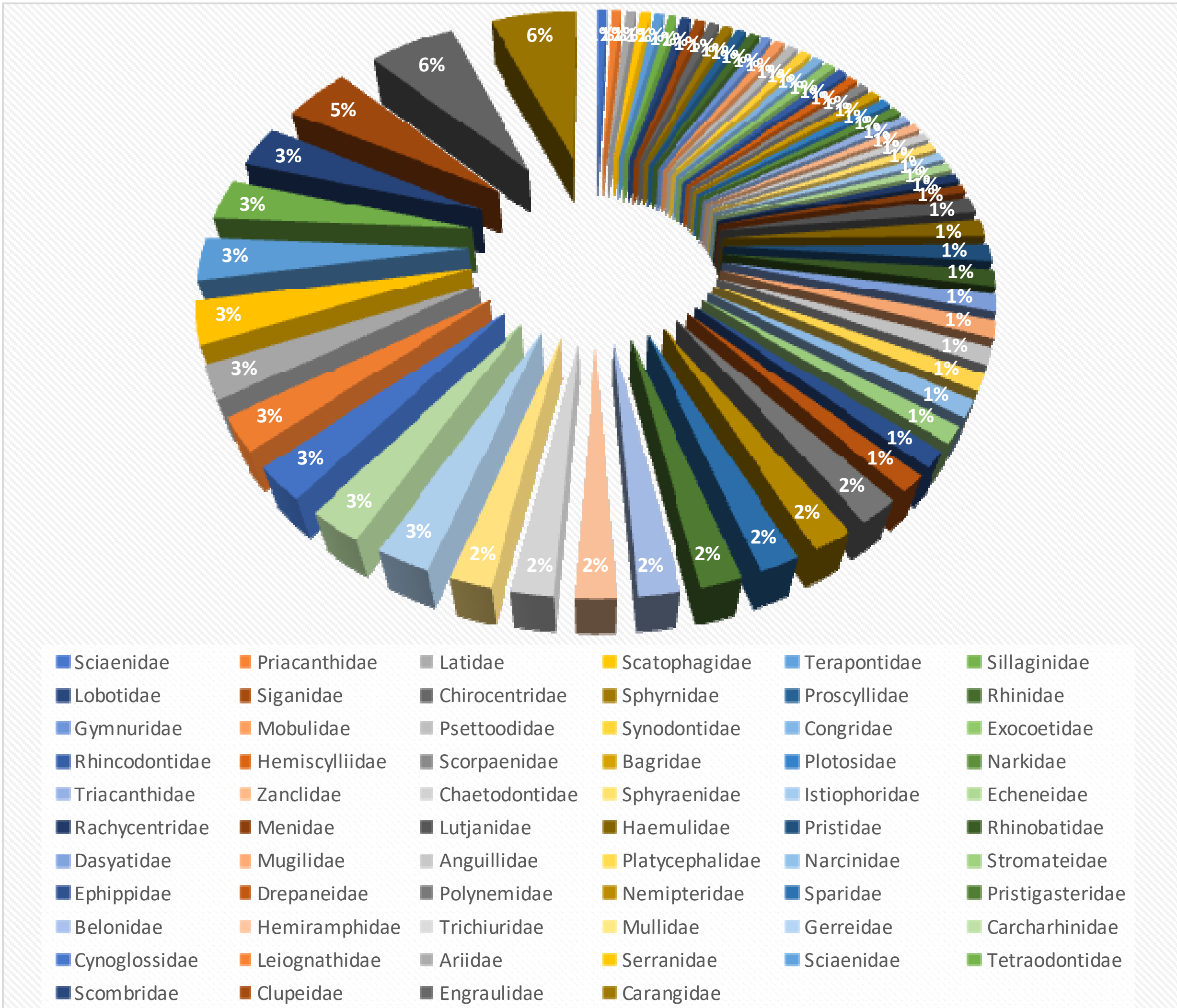

Fig. 4. Family wise finfish species recorded at Digha Mohana fish landing centre.

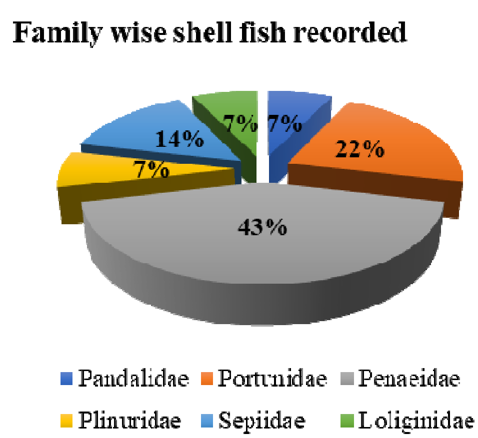

Fig. 5. Family-wise Shellfish species recorded at Digha Mohana fish landing centre.

If we see the IUCN conservational status (as per IUCN, 2022) of the recorded species, then most of the species belong to LC (Least Concern) category (57%), 22% of recorded finfishes belong to NE (Not Evaluated) category, 8% NT (Near Threatened), 5% DD (Data Deficient), 4% VU (Vulnerable), 3% EN (Endangered) & 1% belong to CR (Critically Endangered) category (Fig. 6). While 72% of recorded shellfishes belong to NE (Not Evaluated), 21% DD (Data Deficient) & 7% belong to LC (Least Concern) category (Fig. 7). Species under IUCN-DD status are frequently overlooked in conservation programmes (Bland *et al.,* 2015). An

analysis by Kar *et al*. (2017) on the marine fish population in the northern Bay of Bengal, found that 66.56% species were unknown according to IUCN standards, 4.46% of species has certain information, 18.47% species were under LC category, 6.37% NT, 2.23% VU, 0.95% EN and 0.95% CR.

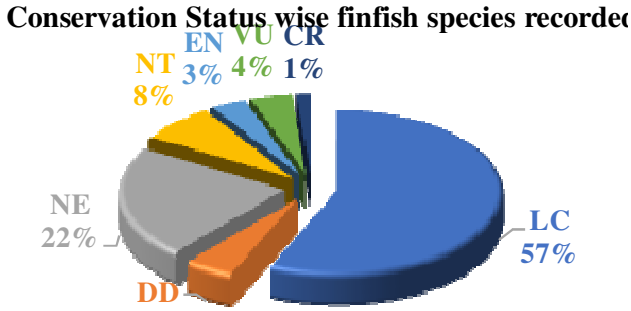

Fig. 6. Conservation status wise finfish species recorded at Digha Mohana fish landing centre.

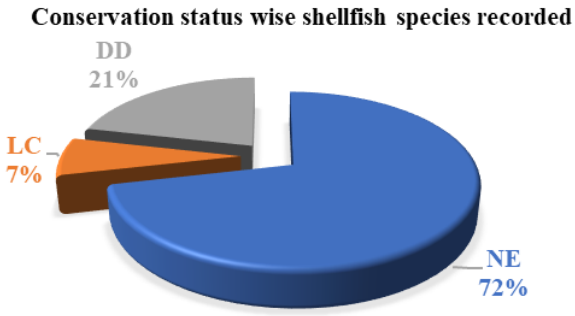

Fig. 7. Conservation status wise Shellfish species recorded at Digha Mohana fish landing centre.

We have found a total number of 148 fin fish and 15 shellfish species from the overall study. Out of which, approx. 15 fin fishes and 2 shellfishes are not edible by humans, but used as different by-products. Anchovy, groupers, Mackerel, Tuna, Pomfret, Ribbon, Sardine, Bombay duck, Eel, Scad, *Mystus*, Giant tiger prawn, Golden shrimp, Indian white shrimp, red sea crab, Spiny-lobster, Squid are the most common fishes recorded during the survey and the above species have wide consumer acceptancy especially the local people. Various elasmobranchs species landed at the Mohana fish landing centre. In Digha and Kakdwip, there is a well-export market for shark and ray meat and fins (Sen *et al.,* 2018). From the current investigation 15 different species of sharks and rays were identified at the landing centre.

From the Digha fish landing centre to the market, where fish are sold to the consumers, the supply chain involves auctioneers, local fish traders, Wholesalers, retailers, fish feed manufacturers, seafood processing plants, and traditional fish preservers. The traditional fish preservers keep the fish in 'Khuties' for sun-drying after buying from Mohana Market. Digha Mohana contains major "Khuties" along the Coastal belt of West Bengal due to its nearby landing centre (Payra *et al.,* 2016; Sahu *et al.,* 2018). In order to allow the fish stocks to repopulate, fishing is essentially restricted for two months during the closed season, which typically lasts from the middle of April until the end of June (Banerjee *et al.,* 2016). In general, the number of intermediaries determines the length of a marketing channel (Nadia *et al.,* 2022). Six types of marketing supply chains were found in the Digha fish landing centre. Chourey *et al.* (2014) surveyed 4 types of marketing supply chain systems in Bhopal of Madhya Pradesh. Leela *et al*. (2018) described five types of marketing supply chains in Noakhali district of Bangladesh. Two types of marketing supply channels were found in the Navsari district of Gujarat (Parmar *et al.,* 2018). Das *et al*. (2013) stated five types of marketing channel in some selected markets of Tripura state. Fluctuations in fish prices are more than any other agricultural and allied products does (Chourey *et al*., 2014). So, in Digha Mohana fish landing centre faced a great price change of fish due to variations in supply because all fishing crafts don't capture the same amount or same species of fish every day and the variety of fish varies in different seasons in the Bay of Bengal. Digha Mohana fish landing centre was virtually closed during the COVID-19 pandemic because of different restrictions on fishing and marketing (Mandal and Mandal 2021). Most of the landing centre was submerged due to the effect of the Yaas cyclone and fishermen were restricted to go to sea for fishing. Because of those reasons, such a large marketing channel of the Mohana fish landing centre was paralyzed at those times. Mechanized trawlers (60%), mechanized gill netters (10%), mechanized bag netters (9%) and others like hook and liners, bag netters, shore seiners etc. are the key mechanized fishing crafts, used to catch fish for West Bengal (CMFRI, 2019). According to Digha Fishermen and Fish Traders

Association (2021), a total number of 1,420 enlisted mechanised boats including indigenous vessels (Nauka) were used for fishing in the Digha Coastal region. The DFFTA (2021) stated that approximately 650 temporal mechanised boats from Namkhana, Kakdwip block and Odisha state are used to unload fish in the Digha Mohana fish landing centre. Overall, an approximate number of 2,100 fishing crafts were used to depot their harvesting in this landing centre (Table 3). Almost 35,000 fishermen were involved directly in fishing and its ancillary works. While about 50,000 fishermen were involved indirectly in the landing centre for their livelihood (DFFTA, 2021). Mohapatra and Patra (2012) reported that marine fish landings at the seashore of Puri district in Odisha were about 6619.35 MT during 2009-10. The highest amount of fish was landed in the Vizhinijam landing centre of Kerala during the monsoon (Jun to September 2021), post-monsoon seasons, and pre-monsoon (February to May 2022), which were about 8594.1 MT, 2128.3 MT, and 2474 MT respectively (CMFRI, 2022). According to the association approx. 1.3-1.5 lakh MT fish transported to Domestic and International markets. By exporting that amount of fish from the landing centre, 400-450 crores (approx.) from the domestic market and 75 million US dollar (approx.) from the International market is earned annually (DFFTA, 2021).

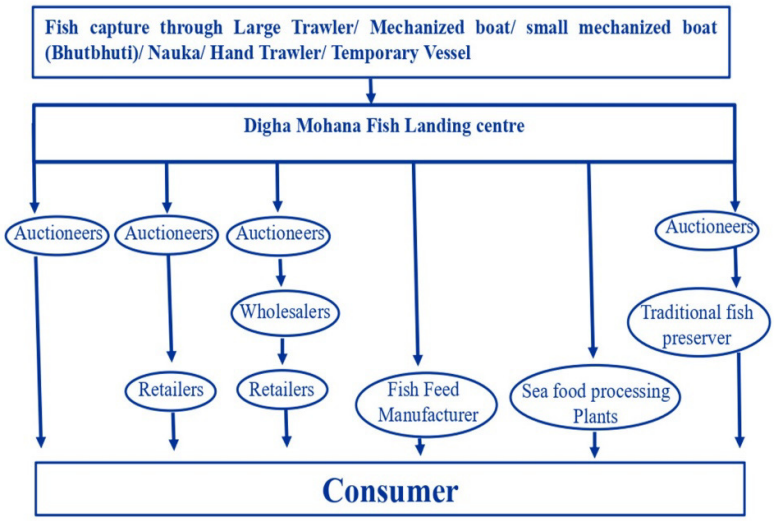

Fig. 8. Fish marketing supply chain from Digha Mohana fish landing centre to consumers.

CONCLUSIONS

Digha Mohana plays a vital role, not only in West Bengal's economy but also in India's economy. Out of the recorded species, different species are occasionally found during Monsoon or Winter season, because during that season, many species like hilsha, sardines etc. are migrated near the coastal area for breeding purposes. That peak seasons are important for available wide varieties of fish in the Digha fish landing centre. According to our survey, 5 species belong to the Endangered category, 2 species belong to the Critically Endangered category and 11 species belong to the Near Threatened category. So, there is a critical need for attention on a proper conservation strategy by the Govt. The Fishermen awareness programme is one of the good strategies for controlling the harvest of critical species.

FUTURE SCOPE

After reading this research article one can get a decorated idea about the fish found in the Digha Mohana fish landing centre. Since there are no previous elaborate studies on fish availability at this important fish landing centre on the East-Coast of India, other researchers can collect a lot of information based on the study of that place later on. And this research will serve as a point of observation to examine the availability of fish and the status of the fish population in Bay of Bengal.

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Conflict of Interest. None.

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