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Low-value bycatch diversity in coastal fisheries of Purba Medinipur, West Bengal, India

¹Dipan Adhikary, ²Rakhi Das, ³Pijush Payra and ⁴Shriparna Saxena

¹PG Scholar, Department of Aquaculture, Sanjeev Agrawal Global Educational University, Bhopal, Madhya Pradesh, India

²Assistant Professor, Department of Aquaculture, Sanjeev Agrawal Global Educational University, Bhopal, Madhya Pradesh, India

³Faculty, Department of Fisheries Science, Ramnagar College, Purba Medinipur, West Bengal, India

⁴HOD, Department of Aquaculture, Sanjeev Agrawal Global Educational University, Bhopal, Madhya Pradesh, India

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Corresponding Author: Rakhi Das

Abstract

This effective study provides a comprehensive assessment of finfish and shellfish species occurring as low-value by catch along the coastal waters of Purba Medinipur, from August, 2025 to January, 2026; highlighting considerable taxonomic diversity across multiple orders and families. The results indicate that a wide range of species, spanning different ecological niches and trophic levels, are nonintentionally captured in marine fisheries. Although the majority of recorded species fall under the least concern category, while the occurrence of Vulnerable and Endangered species underscores potential conservation concerns associated with bycatch. Most species were found to be non-threatening to humans. Large-scale fishing operations that remove them could upset the balance of the ecosystem, change the species makeup, and have an impact on total marine productivity. Bycatch quantity and composition variations are also significant markers of ecosystem health, fishing pressure, and environmental circumstances. Despite being classified as “low-value”, these species helped in food security and coastal livelihoods by being used in the manufacturing of fishmeal, animal feed, dried fish products, and subsistence consumption.

Keywords: Low-value bycatch, finfish and shellfishes, environmental impact

Introduction

Fisheries is a major sector in the economics of many countries. Fisheries have played an important role in food and nutritional security of people, especially in rural India. The affordability of the fish, which has been shown to be the most nutritious health food, has contributed to a better nutritional status of the people (Ghufoorunissa, 2001) ^[17]. Fisheries and aquaculture production has grown significantly over the last 50 years - particularly in the last 20 years - resulting in an increase in the world's capacity to eat diverse and nutritious food. Fish is a rich source of nutrients such as calcium, iron zinc and vitamin A, and protects against some diseases. For example, a serving of 150 gm of fish contains around 50-60% of the protein needed by an adult, making fish and fisheries products an excellent source of animal protein (FAO, 2014) ^[14]. The continuous production of fish in aquaculture is important to increasing global fisheries production (Harris, 2004) ^[19]. More than 60% of the world's 128.8 million tonnes of fish production are destined for human consumption and more than 40% remain unused. 'Bycatch' is the name given to species captured along with the target fish species. Lizardfish, pufferfish, silverbelly and more are examples of bycatch. There are 20 million tons of wastage bycatch and 30 million tons of small pelagic fish are converted to fishmeal (Chandrapal 2005 and Chavan *et al.*, 2008).

Bycatch of non-useful species is a threat to the world's oceans (Kelleher, 2005). The ecological consequences of long-lived marine mega fauna bycatch include direct and indirect effects of reduced mega fauna populations (Heppell *et al.*, 2000) and indirect effects on the structures of oceans (Estes *et al.*, 2011; McCauley *et al.*, 2015) ^[8, 9, 13, 21, 29, 31].

Many of these species are threatened because of declines due to increased incidental mortality from fisheries (Jaramillo-Legorreta *et al.*, 2007). This is a multifaceted environmental issue with sociocultural, scientific and socioeconomic implications in understanding the issues and finding more effective ways to reduce bycatch. In recent years, bycatch studies have grown considerably, giving us more knowledge of which species are affected, the quantities are involved, and the spatial extent of bycatch. Progress has also been made in the development of mitigation strategies. This kind of research identifies the vulnerability of bycatch, mitigates bycatch directly through changes in fishing operations or gear, and mitigates bycatch indirectly through a better understanding of the distribution of bycatch in both time and space (Soykanet *et al.*, 2008). Bycatch plays a role in the overfishing of some target species because they are discarded or used as bait before they reach their first maturity. According to (Funge-Smith *et al.*, 2005) and (Nunoo *et al.*, 2009) ^[16], one of the reasons for an increase in the landing of previously discarded

bycatch is that it is used as livestock and aquaculture feed, as farm manure and as human product. Efforts have been made to develop products from fish waste that are valuable (Nilsang *et al.*, 2005) and (Bhaskar *et al.*, 2008). Fish wastes are a valuable source of high biological value proteins, lipids and minerals (Toppe *et al.*, 2007) and (Kacem *et al.*, 2011) [4, 23, 27, 34, 35, 40, 43].

Trawling is one of the most effective technological innovations in history of fisheries. It has been widely adopted around the globe and is responsible for enhancing marine fish production. But, primarily because of non-selective practices, bottom trawling has resulted in damage to the sea's bottom and biota (Jennings and Kaiser, 1998). In India, the trawl fleet accounted for 51% of the marine fish landings in 2008-2012 (CMFRI, 2012). Through intensive dragging of the sea bottom and use of very fine mesh size (15-20 mm knot-to-knot) in cod-end, huge marine damage to marine life including fish was observed a decade and half ago in the Indian coast (Devaraj and Vivekanandan, 1999). Along with trawl bycatch seine, other gears such as gillnets, cast nets, traps and traditional fishing gears are also very important in bycatch and LVB. Purba Medinipur coastal zone is priceless and has a rich flora and fauna (Mandal *et al.*, 2015; Yennawaret *et al.*, 2017; Das and Das, 2019c; Bhanja *et al.*, 2023; Bhunia *et al.*, 2024). Coastal Purba Medinipur consists of Haldia and Contai sub-divisions in Purba Medinipur district of West Bengal which is a long stretch of coastline from Digha (close to Odisha) to Nandigram, Haldia. It includes Digha-Mohana, Ramnagar, Chalti-Basantia, Dadanpatrabar, Petuaghat, Rasulpur, Khejuri and Nandigram site. The major traditional fishing gear used in coastal areas of Purba Medinipur as well as West Bengal are trawls, shore seines, gill nets, encircling nets, fixed bag nets, hooks and lines etc. In addition, scoop nets and traps are also being used (Payra *et al.*, 2014; Bhanja *et al.*, 2024). In this study, the variety of LVBs from marine fishing of the coastal areas of Purba Medinipur, West Bengal was chosen [1, 2, 5, 10, 11, 12, 25, 32, 46].

Materials and methods

Study area and duration: The present study area is located in the coastal area of Purba Medinipur, West Bengal. The selected sampling sites are - Digha (21°38'18"N 87°30'35"E); Sankarpur (21.6491° N, 87.5699° E); Tajpur (21.652882°N, 87.629272°E); Mandarmoni (21.6681° N, 87.7025° E); Junput Sea Beach (21.7129° N, 87.8208° E) and Patuaghat (21.79472°N, 87.88333°E). Field surveys were carried out over a six-month period from August, 2025 to January, 2026. Data collection occurred at weekly intervals during peak fishing hours (06:00-10:00 and 15:00-17:00) to ensure representative sampling of the local landings.

Sample Collection and Identification

All specimens were photographed (Realme RMX3392) and identified based on morphological features such as shell colour, claw shape, body colour and size. Taxonomic identification was performed using standard keys and literature (Talwar and Jhingran, 1991; Jayaram, 1999;

Jeyabaskaran and Wafar, 2002; Viswanath, 2002; Motoh and Kuronuma, 2015; Harshith *et al.*, 2016) and cross referenced with global databases including [Fishbase] and [WoRMS] [15, 20, 24, 26, 33, 42, 45].

Biodiversity indices

Species diversity and community structure were evaluated using the following ecological indices:

Simpson index (λ): To calculate the probability of interspecific encounter:

$$\lambda = \frac{\sum_{i=1}^S n_i(n_i - 1)}{N(N - 1)}$$

Shannon-Wiener index (H'): To determine species diversity and relative abundance:

$$H' = - \sum p_i \ln p_i$$

Pielou's Evenness Index (J'): To assess the distribution of individuals among species:

$$J' = H' / \ln S$$

Margalef Richness Index (R): To evaluate species richness per unit area:

$$R = S - 1 / \ln(N)$$

Here, n_i is the number of individuals of species i , N is the total number of individuals, and S is the total species richness.

Statistical analysis: The statistical analysis was done through Ms-Excel and Past Software.

Results and Discussions

Taxonomic Composition of Low value bycatch

The recorded total 27 finfish species (Table-1) belongs to 12 orders, 17 families and 8 shellfish species (Table-2) belonging to 1 order, 4 families during the study period. Out of finfishes, the species under Clupeiformes were dominant (22%), followed by Carangiformes (15%), Acanthuriformes (15%) and Anguilliformes (7%), Centrarchiformes (7%), Mugiliformes (7%); while orders like Aulopiformes, Beloniformes, Carcharhiniformes, Gobiiformes, and Myliobatiformes recorded at 4% availability (Figure-2). On other side, shellfish species under, Portunidae (45%) constitutes the largest share followed by Matutidae and Oregoniidae each account for 22%, while Grapsidae contributes the least, comprising only 11% of the recorded shellfish species (Figure-3). Similarly, (Rajkumar *et al.* 2025) found that in the Palk Bay, fishing is done throughout the year, with the peak seasons being June-July and January-February. During our study period we also recorded that peak commercial landings were observed in January with a huge amount of LVB with it [38].

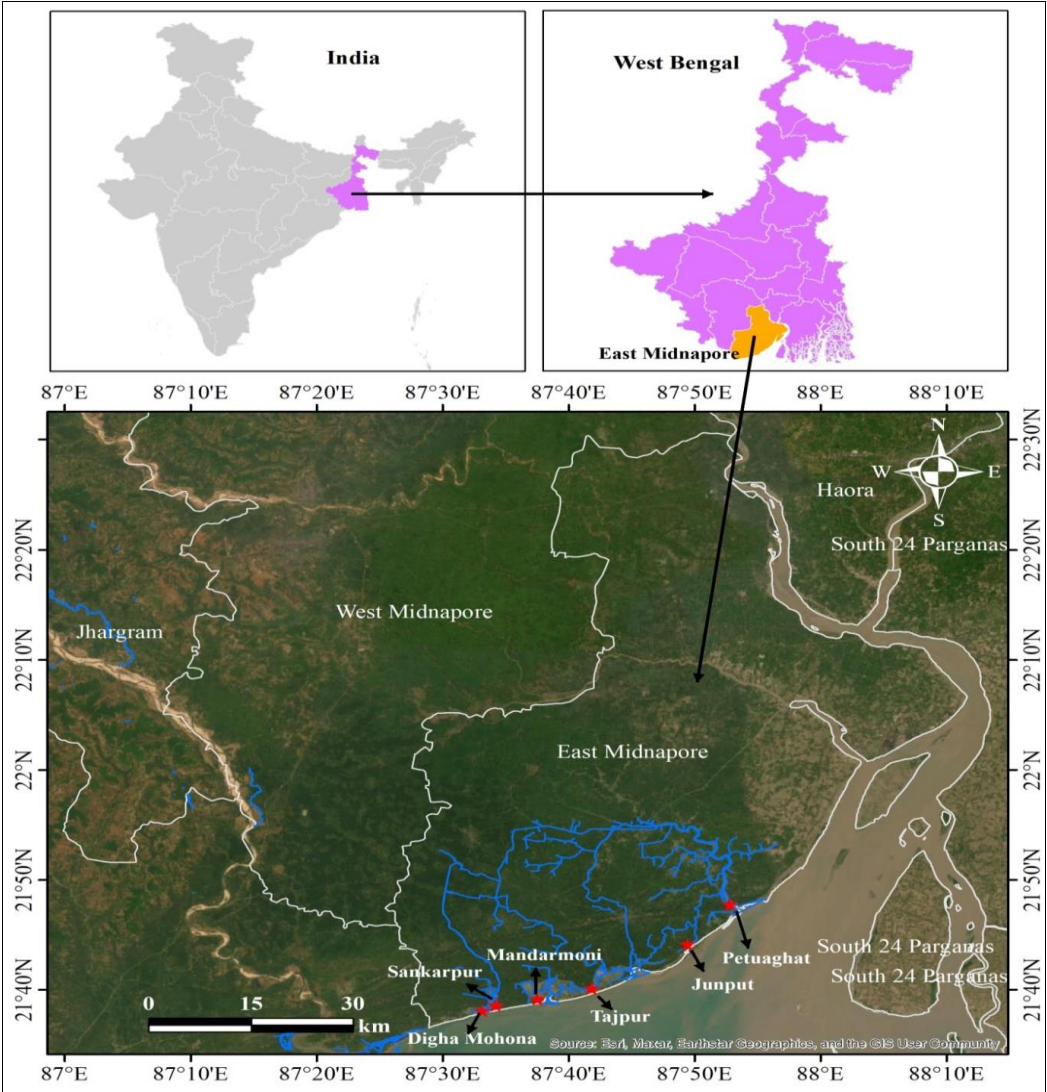


Fig 1: Location map of the study area

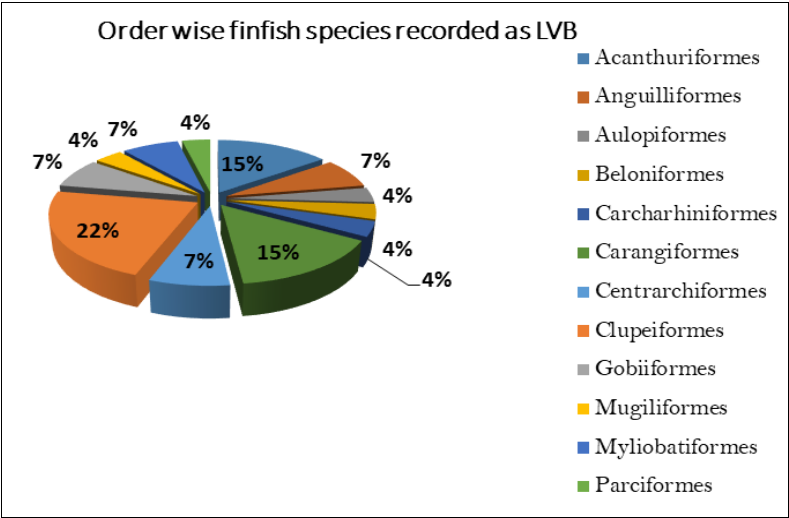


Fig 2: Order wise finfish species recorded as LVB in Coastal Purba Medinipur

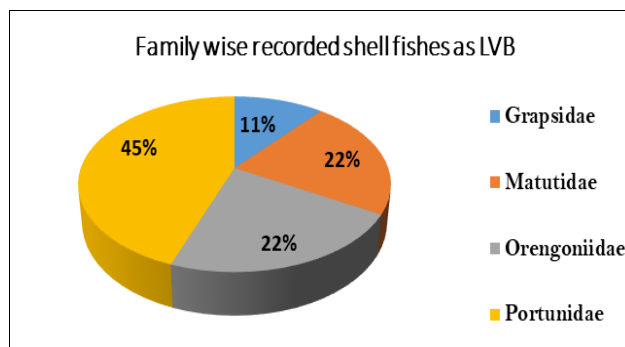


Fig 3: Order wise finfish species recorded as LVB in Coastal Purba Medinipur



Fig 4: Photographic documentation of *Drepane punctate*; 2. *Secutor insidiator*; 3. *Nibea maculate*; 4. *Johnius belangerii*; 5. *Gymnothorax tile*; 6. *Moringua macrochir*; 7. *Harpodon nehereus*; 8. *Strongylura strongylura*; 9. *Carcharhinus dussumieri*; 10. *Cynoglossus macrolepidotus*; 11. *Cynoglossus arel*; 12. *Polynemus paradiseus*; 13.

Zebrias quagga; 14. *Terapon jarbua*; 15. *Terapon theraps*; 16. *Escualosa thoracata*; 17. *Anchoa mitchilli*; 18. *Coilia dussumieri*; 19. *Coilia ramcarati*; 20. *Encrasicholina devisi*; 21. *Setipinna taty*; 22. *Gobioides peruanus*; 23. *Trypauchen vagina*; 24. *Chanda nama*; 25. *Dasyatis zugei*; 26. *Pateobatis bleekeri*; 27. *Platycephalus indicus*.



Fig 5: Photographic documentation of *Pachygrapsus marmoratus*; 2. *Matuta planipes*; 3. *Matuta victor*; 4. *Conchoecetes artificiosus*; 5. *Portunus sanguinolentus*; 6. *Charybdis feriata*; 7. *Metapenaeus brevicornis*; 8. *Mierspenaeopsis sculptilis*.

Conservation status and Human Interaction

In terms of IUCN conservation status, most species are classified as Least Concern (LC), including relatively stable populations. However, several species fall under Data Deficient (DD) and Not Evaluated (NE) categories, suggesting a lack of sufficient information of proper assessment. Notably a few species such as *Carcharhinus dussumieri* and *Pateobatis bleekeri* are categorized as Endangered (EN), while *Dasyatis zugei* is listed as Vulnerable (VU), highlighting potential conservation within bycatch. The table also provides insight into human

interaction, showing that the majority of species are harmless with very few exceptions such as *Pateobatis bleekeri*, which is noted as venomous. On the other hand, the conservation status of all listed shellfish species is marked as Not Evaluated (NE), indicating that they have not yet been assessed under standard conservation frameworks such as the IUCN Red List and all recorded shellfish are harmless and do not pose any direct threat. Species under IUCN-DD are frequently overlooked in conservation programs (Bland *et al.*, 2015). In Digha and Kakdwip, there is an analysis by (Kar *et al.*, 2017) on the marine fish standards, 4.46% of species has certain information, population in the northern Bay of Bengal, found that 18.47% species were under LC category, 6.37% NT, 66.56% species were unknown according to IUCN 2.23% VU, 0.95% EN and 0.95% CR [6, 28].

Table 1: Fin fishes recorded as Low value bycatch from Marine Fisheries along the coastal region of Purba Medinipur

Order Name	Family	Scientific Name	Local Name/ Vernacular Name	IUCN Status	Threats to Human
Acanthuriformes	Drepaneidae	<i>Drepane punctata</i> (Linnaeus, 1758)	Spotted sicklefish	Least Concern	Harmless
	Leiognathidae	<i>Secutor insidiator</i> (Bloch, 1787)	Pugnoseponyfish	Data Deficient	Harmless
	Scaenidae	<i>Nibea maculata</i> (Bloch & Schneider, 1801)	Blotched croaker	Least Concern	Harmless
		<i>Johnius belangerii</i> (Cuvier, 1830)	Belanger's croaker	Least Concern	Harmless
Anguilliformes	Muraenidae	<i>Gymnothorax tile</i> (Hamilton, 1822)	Indian mud moray	Least Concern	Harmless

		<i>Moringua macrochir</i> (Bleeker, 1853)	Longfin spaghetti eel	Data Deficient	Harmless
Aulopiformes	Synodontidae	<i>Harpodon nehereus</i> (Hamilton, 1822)	Bombay duck	Near Threatened	Harmless
Beloniformes	Belonidae	<i>Strongylura strongylura</i> (Van Hasselt, 1823)	Spottail needlefish	Not Evaluated	Harmless
Carcharhiniformes	Carcharhinidae	<i>Carcharhinus dussumieri</i> (Valenciennes, 1839)	Whitecheek shark	Endangered	Harmless
Carangiformes	Cynoglossidae	<i>Cynoglossus macrolepidotus</i> (Bleeker, 1851)	Largescaledtonguesole	Data Deficient	Harmless
		<i>Cynoglossus arel</i> (Bloch & Schneider, 1801)	Largescale tonguesole	Data Deficient	Harmless
	Polynemidae	<i>Polynemus paradiseus</i> (Linnaeus, 1758)	Paradise threadfish	Least Concern	Harmless
	Soleidae	<i>Zebrias quagga</i> (Kaup, 1858)	Fringefin zebra sole	Least Concern	Harmless
Centrarchiformes	Terapontidae	<i>Terapon jarbua</i> (Fabricius, 1775)	Jarbuaterapon	Least Concern	Harmless
		<i>Terapon theraps</i> (Cuvier, 1829)	Largescaledterapon	Least Concern	Harmless
Clupeiformes	Dorosomatidae	<i>Escualosa thoracata</i> (Valenciennes, 1847)	White sardine	Least Concern	Harmless
	Engraulidae	<i>Anchoa mitchilli</i> (Valenciennes, 1848)	Bay anchovy	Least Concern	Harmless
		<i>Coilia dussumieri</i> (Valenciennes, 1848)	Goldspotted grenadier anchovy	Least Concern	Harmless
		<i>Coilia ramcarati</i> (Hamilton, 1822)	Ramcarat grenadier anchovy	Data Deficient	Harmless
		<i>Encrasicholina devisi</i> (Whitley, 1940)	Devis' anchovy	Not Evaluated	Harmless
		<i>Setipinnataty</i> (Valenciennes, 1848)	Scaly hairfin anchovy	Least Concern	Harmless
Gobiiformes	Oxudercidae	<i>Gobioides peruanus</i> (Steindachner, 1880)	Peruvian eelgoby	Least Concern	Harmless
		<i>Trypauchen vagina</i> (Bloch & Schneider, 1801)	Burrowing goby	Least Concern	Harmless
Mugiliformes	Ambassidae	<i>Chanda nama</i> (Hamilton, 1822)	Elongate glass-perchlet	Least Concern	Harmless
Myliobatiformes	Dasyatidae	<i>Dasyatis zugei</i> (Muller & Henle, 1841)	Pale-edged stingray	Vulnerable	Harmless
		<i>Pateobatis bleekeri</i> (Blyth, 1860)	Bleeker's whiplay	Endangered	Venomous
Parciformes	Platycephalidae	<i>Platycephalus indicus</i> (Linnaeus, 1758)	Bartail flathead	Data Deficient	Harmless

Table 2: Shell fishes recorded as LVB from Marine Fisheries along the coastal region of Purba Medinipur

Order Name	Family	Scientific Name	Local Name/ Vernacular Name	IUCN Status	Threats to Human
Decapoda	Grapsidae	<i>Pachygrapsus marmoratus</i> (Fabricius, 1787)	Marbled shore crab	Not Evaluated	Harmless
	Matutidae	<i>Matuta planipes</i> (Fabricius, 1798)	Flower moon crab	Not Evaluated	Harmless
		<i>Matuta victor</i> (Fabricius, 1781)	Common moon crab	Not Evaluated	Harmless
	Orengoniidae	<i>Conchoecetes artificiosus</i> (Fabricius, 1798)	Sponge crab	Not Evaluated	Harmless
	Portunidae	<i>Portunus sanguinolentus</i> (Herbst, 1783)	Threespot swimming crab	Not Evaluated	Harmless
		<i>Charybdis feriata</i> (Linnaeus, 1758)	Crucifix crab	Not Evaluated	Harmless
		<i>Metapenaeus brevicornis</i> (Milne Edwards, 1837)	Yellow shrimp	Not Evaluated	Harmless
		<i>Mierspenaeopsis sculptilis</i> (Heller, 1862)	Rainbow shrimp	Not Evaluated	Harmless

3.3 Spatial Variation and Diversity Indices

Table-3 and Table-4 present the spatial variation in diversity indices of finfish and shellfish species recorded as LVB across six sampling stations along the coastal region of

Purba Medinipur. The observed patterns reveal notable differences in species composition, abundance, and distribution among the stations.

Table 3: Diversity profiles of fin fishes recorded as LVB from Marine Fisheries along the coastal region of Purba Medinipur

Diversity indices	S1	S2	S3	S4	S5	S6
Taxa_S	25	25	18	21	23	26
Individuals	8662	6446	2326	3521	10446	9751
Dominance_D	0.0605	0.07168	0.1506	0.1231	0.06829	0.06006
Simpson_1-D	0.9395	0.9283	0.8494	0.8769	0.9317	0.9399
Shannon_H	2.946	2.811	2.258	2.501	2.826	2.942
Evenness_e^H/S	0.7609	0.6652	0.5316	0.5806	0.7339	0.7293
Brillouin	2.936	2.799	2.237	2.483	2.818	2.933
Menhinick	0.2686	0.3114	0.3732	0.3539	0.225	0.2633
Margalef	2.647	2.736	2.193	2.449	2.377	2.722
Equitability_J	0.9151	0.8734	0.7814	0.8214	0.9013	0.9031
Fisher_alpha	3.158	3.299	2.656	2.966	2.796	3.247
Berger-Parker	0.08693	0.1131	0.2941	0.2817	0.1342	0.08502
Chao-1	25	25	18	21	23	26

Table 4: Diversity profiles of shell fishes recorded as LVB from Marine Fisheries along the coastal region of Purba Medinipur

Diversity indices	S1	S2	S3	S4	S5	S6
Taxa_S	8	5	5	6	6	8
Individuals	2088	1444	161	593	2964	1834
Dominance_D	0.2112	0.3245	0.2311	0.2306	0.1891	0.2509
Simpson_1-D	0.7888	0.6755	0.7689	0.7694	0.8109	0.7491
Shannon_H	1.767	1.297	1.541	1.592	1.716	1.633
Evenness_e^H/S	0.7318	0.7314	0.9336	0.8188	0.9273	0.6402
Brillouin	1.756	1.287	1.481	1.567	1.71	1.621
Menhinick	0.1751	0.1316	0.3941	0.2464	0.1102	0.1868
Margalef	0.9158	0.5498	0.7872	0.7831	0.6254	0.9316
Equitability_J	0.8499	0.8056	0.9573	0.8884	0.9579	0.7855
Fisher_alpha	1.054	0.6486	0.9786	0.9287	0.721	1.075
Berger-Parker	0.3606	0.4515	0.354	0.339	0.2274	0.3926
Chao-1	8	5	5	6	6	8

Here, S1= Digha; S2= Sankarpur; S3= Tajpur; S4= Mandarmoni; S5= Junput Sea Beach; S6= Petuaghat

Ecological and Environmental Implications

The findings confirm that the bycatch in the region remains a high-stakes ecological issue, with bottom trawling contributing significantly to the capture of non-targeted juveniles threatened species. (Gibinkumar *et al.*, 2012) also found that amongst the fishing gears, trawling is responsible for a higher bycatch rate, because of low selectivity of gear. The high abundance of LVB at Junput (S5) and Petuaghat (S6), followed by Digha (S1) suggests these are high-intensity fishing zones where the loss of trophic balance and diversity is most acute. The presence of endangered species in the Low-Value Bycatch (LVB) necessitates the immediate implications of Bycatch Reduction Devices (BRDs) and stricter monitoring of trawl selectivity to ensure long-term fishery sustainability and the protection of Bengal's marine biodiversity. (Stobutzki *et al.* 2001) also suggested that technological interventions such as, Turtle Excluder Devices (TEDs) and Bycatch Reduction Devices (BRDs) help to reduce mortality and prevent the removal of juveniles [18, 41].

Conclusion

The present study showed a comprehensive overview of finfish and shellfish species occurring as low-value bycatch (LVB) along the coastal waters of Purba Medinipur,

revealing a high level of taxonomic diversity across multiple orders and families. This diversity reflects the wide ecological range of species unintentionally captured in marine fisheries. Although the majority of species are classified as Least Concern, the presence of Data Deficient and Not Evaluated species indicates significant gaps in scientific knowledge, while the occurrence of Endangered and Vulnerable species highlights potential conservation risks associated with bycatch. Most species pose little threat to humans, with only a few exceptions. Overall, the findings emphasize the ecological importance of bycatch species and the urgent need for improved monitoring, assessment, and management practices to ensure sustainable fisheries and the protection of threatened marine biodiversity.

LVB consists of a wide variety of species occupying different trophic levels - ranging from small forage fish to juveniles of larger predators. These species are integral to marine food webs, acting as prey for commercially important fish, seabirds, and marine mammals. Removing them in large quantities can disrupt ecosystem balance, alter species composition, and affect overall marine productivity. Changes in the composition and quantity of bycatch can reflect shifts in biodiversity, habitat conditions, and fishing pressure. A high proportion of juveniles or sensitive species in LVB may indicate overfishing or habitat degradation,

making bycatch data a useful tool for monitoring ecosystem health. Even though labelled 'low-value' these species are frequently used for fishmeal, animal feed, dried fish products, and local consumption, especially in coastal communities. Thus, they contribute indirectly to food security and rural livelihoods. Understanding LVB consumption helps in designing sustainable fishing practices, such as gear modifications, seasonal restrictions, and bycatch reduction technologies. It also supports ecosystem-based fisheries management approaches. Low-value bycatch is not 'low importance'. It is critical component of marine ecosystems and fisheries systems, and its proper monitoring and management are essential for maintaining biodiversity, ecosystem stability, and sustainable fisheries.

Present investigation can be serves as a useful baseline dataset for understanding the diversity and consumption of low-value bycatch in the region. It also contributes to ecological knowledge, fisheries management, and future biodiversity and conservation studies in the coastal waters of Purba Medinipur.

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