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Seasonal Fish Diversity And Distribution In The Manapadu Coastal Zone Of The Gulf Of Mannar, India

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ABSTRACT

This study assessed the diversity and distribution of fish fauna in the Manapadu coastal zone of the Gulf of Mannar, Tamil Nadu, India. A total of 110 species representing 31 families and 22 orders were documented through systematic surveys conducted during the study period.. Dominant families included Carangidae, Lutjanidae, Serranidae, Dasyatidae, and Scaridae. Biodiversity indices such as Fisher's Alpha and Margalef richness peaked during April and November, indicating clear seasonal richness patterns, while evenness remained low due to dominance by a few species. These temporal trends likely reflect ecological processes such as breeding migrations and environmental variability affecting species assemblages. The findings highlight high species richness but skewed community structure in this biologically significant marine region. Understanding these patterns can inform local fisheries management, conservation planning, and policy decisions regarding sustainable harvest and trade. The results provide a robust baseline for future monitoring, ecological assessments, and ecosystem-based management in the Gulf of Mannar coastal ecosystem..

Keywords: biodiversity, species richness, Gulf of Mannar, seasonal variation, conservation, Fisheries management

1. INTRODUCTION

Fishes are economically and ecologically important components of aquatic ecosystems. In addition to supporting valuable aquaculture and wild-harvest industries, their populations determine the structure of benthic communities. Fish are an incredibly diverse group of aquatic vertebrates that play a crucial role in aquatic ecosystems and human livelihoods.. Fish contribute significantly to ecological balance by maintaining food webs, nutrient cycling, and supporting aquatic biodiversity. Predatory fish control the population of prey species, while herbivorous fish influence algal growth and aquatic vegetation. Economically, fish are a crucial source of protein for billions of people worldwide, particularly in developing countries. The global fisheries and aquaculture sector produced around 214 million tonnes of fish in 2020, supporting food security and employment (FAO, 2022).

Globally, there are more than 34,000 recognized fish species, making them the most diverse group of vertebrates (Nelson et al., 2016). While about 58% of fish species inhabit marine waters, the remaining 42% are found in freshwater, which covers less than 1% of Earth's surface highlighting the extraordinary richness of freshwater ecosystems (Reid et al., 2019). Understanding fish diversity is vital for biodiversity conservation, sustainable fisheries, and ecosystem health. Manapadu lies on the Gulf of Mannar coast, a biologically rich zone forming part of the marine biosphere. The coastal stretch from Thoothukudi, including Manapadu, features coral reefs, sea grass beds, and rocky shores, creating ideal habitats for diverse reef and demersal fish species (Yogesh et al., 2013)

In the present study an attempt has been made to investigate the diversity and distribution of fishes in and around Manapadu coastal area. It includes 110 fish species representatives from 31 families and 22 orders, with dominant families such as Carangidae, Lutjanidae, Serranidae, Dasyatidae, and Scaridae. The analysis indicates overall high biodiversity throughout the year, with Fisher's Alpha and Margalef indices peaking in April and November, suggesting seasonal richness variations. Even though species richness is high, evenness remains low, implying that certain species are more dominant. This pattern might reflect seasonal ecological dynamics such as migration, breeding seasons, or environmental changes influencing species composition. This review of current knowledge about the distribution of fish species will be used for conservation,.

management, future political plans on imports and exports and it is of economical importance both for the fishermen and for the growth of the country

2. MATERIALS AND METHODS:

The present study was conducted over a 12-month period from March to February to assess the biodiversity of the selected aquatic ecosystem. Monthly sampling was carried out to collect species data'

Fish Survey

In order to unfold and precisely record the fish diversity in the study area, periodic surveys were carried out in the study stations by adapting systematic field level procedures. Observations were done in the morning between 06.00 AM and 10.00 AM and sometime in the evening 05.00 PM to 06.00 PM. This was found to be the best time for the observation of fishes in the selected localities. Besides this scheduled observation, several randomized visits were also made during different hours of the day in the selected sea. Days with unfavorable climatic conditions such as heavy rainy days were avoided for data collections.

Description and Identification of fishes

Fishes were collected every month from the station located along Manapadu after a preliminary survey. The preliminary survey was conducted to fix commercially important fishes in the local market of Manapadu. The commonly used gears for fishing at Manapadu includes: hook & line, gillnet, sardine gillnet, bottom set gillnet, seine net. The type of gears operating in the study area was undertaken during the first week of the study period by visiting the landing site and by questioning the fisher folks on the operating, usage and the composition of catches of these gears.

Description of a fish includes its scientific name, common name used in Tamil Nadu wherever available, size, field characters, general habits and habitat along with known distribution in the study area. Identification of species was done using standard literature [WCMC, 1998]. Biodiversity indices were calculated.

Statistical Analysis, Biodiversity Indices Ludwig, J. A., & Reynolds, J. F. (1988).

To assess the biodiversity of the fish community, a range of diversity indices was calculated using PAST (Paleontological Statistics) software version [X] or Microsoft Excel. The indices used in this study are described below:

Dominance Index (D): Measures the dominance of the most abundant species in the community. A higher value indicates lower diversity.

Simpson's Diversity Index (1-D): Represents the probability that two individuals randomly selected from a sample belong to different species. Values range from 0 to 1, where higher values indicate greater diversity.

Shannon-Wiener Index (H'): Accounts for both abundance and evenness of species present. A higher value indicates higher diversity.

Evenness (e^H/S): This index provides the equitability of species distribution in the community. Values close to 1 indicate equal distribution.

Brillouin Index: Used when the community is completely censused; considers both species richness and total abundance.

Menhinick Index: A species richness index that standardizes the number of species by the square root of the total number of individuals.

Margalef Index: Another richness index that adjusts for sample size.

Equitability Index (J): Measures the evenness component of diversity based on the Shannon index. Values closer to 1 indicate a more even distribution of species.

Fisher's Alpha Index: Assumes a logarithmic distribution of species abundance and is used as a diversity index independent of sample size.

Berger-Parker Index: Represents the proportional abundance of the most common species. A lower value suggests higher diversity

Status of fishes

The following biological attributes of the fish such as Residential status and conservation status under IUCN were explored in the present study.

Based on the frequency of sightings during the field visits, fishes were classified as 'Common' or 'C'. The meaning of those fishes was found in all suitable habitats, during most of the visits. Uncommon or UC – which indicates that the species which occur in an irregular basis on a few visits and 'Rare' or 'R' which denotes that the specific set of fishes sighted only once in one sea.

Results: Distribution of Marine fishes were recorded (Table 1). Diversity index of fishes were calculated (Figure 1) .

Table 1: Distribution of Marine Fishes at Manapadu Coastal area

S. No	Order	Family	Common Name	Scientific Name	IUCN Status	Abundance Status
1	Anguilliformes	Muraenidae	Eel	Enchelycore schimatorhynches	TR	R
2	Aulopiformes	Synodontidae	Greater lazzard fish	Saurida tumbil	LC	C
3			Lizzard fish	Saurida sp	LC	R
4	Beloniformes	Belonidae	crocodile needlefish	Tylosurus crocodilus	LC	UC
5			Spotted long tom	Tylosurus punctutatus	NE	UC
6		Hemiramphidae	Black barred or spotted halfbeak	Hemiramphus far	NE	C
7			Halfbeak	Hemiramphus georgii	NE	C
8	Carangiformes	Carangidae	Pennanfish	Alectis cilaris(juv)	LC	C
9			Pennanfish	Alectis cilaris	LC	C
10			Razorbellyscad	Alepes klainii	LC	C
11			Malabar travelly	Carangoides malabaricus	LC	C
12			Barcheektravelly	Carangoides plagiotaenia	LC	C
13			Yellow-spotted Trevally	Carangoides ferdau	LC	C
14			Bigeye Trevally	Caranx sexfasciatus	LC	UC
15			Trevally	Caranx sp	LC	C
16			Needleskin	Scomberoides tol	LC	C
17			Giant travelly	Caranx ignobil	LC	C
18		Rachycentidae	Gobia	Rachycentron canadum	LC	C
19	Carcharhiniformes	Carcharhinidae	Milky shark	Carcharinus sorrah	NT	UC
20	Clupeiformes	Chirocentridae	Wolf herring	Chirocentrus nudes	LC	UC
21		Engraulididae	Indian anchovy	Stolephorus indicus	NE	C
22			Short silverbelly	Gerres erythrorus	LC	C
23		Clupidae	Indian oil sardine	Saridinella longiceps	LC	C
24			sardinella	Saridinella melauna	LC	C
25			sardine	Sardinella quadrimaculates	LC	C
26	Elopiformes	Megalopidae	Indo-pacific tarpon	Megalops cyprinoides	DD	UC

27	Labriformes	Labridae	angelfish	Choerodon oligacanthus	LC	UC
28		Scaridae	Three color parrotfish	Scarus tricolor	LC	C
29			parrotfish	Scarussordicus	LC	C
30			parrotfish	Colotomus sp	LC	C
31			parrotfish	Scarus sp	LC	C
32	Myliobatiformes	Dasyatidae	Short tail stingray	Dasyatis brevicaudata	LC	UC
33			southern stingray	Hypnos americanus	LC	UC
34			Common stingray	Dasyatis sephen	DD	UC
35			Blue spotted singray	Dasyatis kuhlii	DD	UC
36			Honeycomb Stingray	Himantura uarnak	VU	R
37	Myopsida	Loliginidae	squid	Loligo formosa	TR	R
38			European squid	Loligo vulgaris	DD	R
39	Orectolobiformes	Hemiscyllidae	grey bamboo gris	Clylosyllium griseus	NT	UC
40	Perciformes	Acanthuridae	Epaulette surgeonfish-spaw in paris	Acanthus nigricauda	LC	C
41			Striped surgeonfish	Acanthurus bleekeri	LC	C
42			Surgeonfish	Acanthurus mata	LC	C
43		Ariidae	Sea catfish	Arius maculates	LC	C
44		Caesionidae	Yellow tail fusilier	Casio aerulaures	LC	C
45			Yellow and blueback fusilier	Caesioteres	LC	C
46			Goldstripponyfish	Karaladaura sp	LC	C
47		Coryphaenidae	Dolphin fish	Coryphaena hippurus	LC	C
48		Ephippidae	Teira batfish	Platax pinnatus	LC	C
49		Haemulidae	Lined Sweet lips	Plectorhinchus lessoni	NE	R
50		Labridae	White-patch tuskfish	Choerodon oligacanthus	LC	C
51				Choerodon schoenleinii	NT	UC
52			Cigar Wrasse	Cheilio linermis	LC	UC
53		Lujnanidae	Red snapper	Lutjanus argentimaculatus	LC	C
54			Crimson snapper	Lutjanus crythroptorousbloch	NE	C
55			Block spot snapper	Lutjanus fulviflamma	LC	C

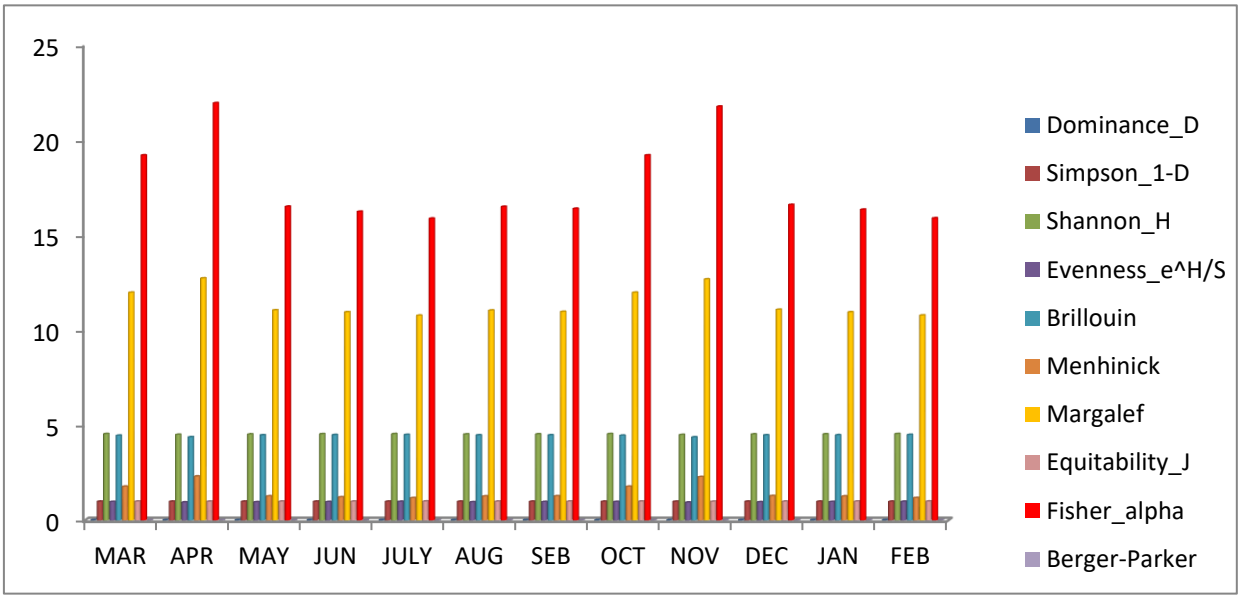
56			Black tail snapper	Lutjanus fulvus	NE	C
57			Brown stripe red snapper	Lutjanus vitta	LC	C
58			Five lined snapper	Lutjanus quinquilineatus	LC	C
59			Red snapper	Lutjanus rivulatus	LC	C
60			Gold Banded Snapper	Lutjanus carponotatus	LC	UC
61		Leiognathidae	Common ponyfish	Leiognathus equulus	LC	C
62		Lenthrinidae	Thumbprint emperror	Lethrinus harak	LC	C
63			Emperor fish	Lenthrinus lentjan	LC	C
64			Trumpet emperror	Lenthrinus miniatus	LC	C
65			Spangled emperror	Lenthrinus nebulasus	LC	C
66			Long face emperror	Lenthrinus olivaceus	LC	C
67			Emperror	Lenthrinus	LC	C
68			emperror	Lenthrinus	LC	C
69			Ornate emperror	Lenthrinus ornatus	LC	C
70		Mullidae	Yellowstripe goatfish	Mulloidichthys flavolineatus	LC	UC
71		Nemipteridae	Japanese threadfin bream	Nempterus japonius	NE	C
72		Opistognathidae	Dendtric jaw fish	Optistonathus dentricus	LC	C
73		Polynemidae	Striped threadfin	Polydoctylus plebius	NE	UC
74		Pomacanthridae	Emperror angelfish	Pomacanthus imperator	LC	C
75			Lagoon damselfish	Hemiglyphidodon plagiometopon	NE	UC
76		Pracanthidae	Lunar-tailed bigeye	Priacanthus hamrur	LC	C
77		Serranidae	Grouper	Epinephelus sp	LC	C
78			Tomato hind	Cephalopholis sonnorati	LC	C
79			Grouper	Cephalopholis conneati	LC	C
80			Yellow-edged iyertail	Variola louti	LC	C
81			grouper	Epinephelus radiatus	LC	C
82			Malabar groper	Epinephelus malabricus	LC	C
83			Ray fined fish or grouper	Epinephelus suilius	LC	C

84			Wavy-lined grouper	Epinephelus undulosus	LC	C
85			Grouper	Epinephelus	LC	C
86			Comet grouper	Epinephelus morrhua	LC	C
87		Terapontidae	Eastern striped grunter	Helotes sexlineatus	LC	C
88		Trichiuridae	Ribbon fish	Lepturacanthus shark	LC	C
89		Scatophagidae	Spotted scat fish	Scatophagus argus	LC	C
90		Sphyroenidae	Pickhandle barracuda	Sphyraena jello	NE	UC
91			Obtusta barracuda	Sphyraena obtusta	NE	UC
92			Pacific barracuda	Sphyraena qenie	NE	C
93		sciaenidae	Tigertoothcroaker	Otolithes ruber	NE	C
94			Jaw fish	Argyrosomus sp	LC	C
95			Bleeker	Pennahia macropthalmus	NE	C
96			Reeve's croaker	Chrysochir aureus	NE	C
97		Siganidae	Trumpeter 60whiting	Sillago maculata	NE	C
98			Rabbit fish	Siganus javus	LC	C
99	Pleuronectiformes	pesettodidae	Indian halibut	Psettodes erumei	NE	C
100		cynoglossidae	Tonguefish	Paraplagusia albilaris	LC	C
101			Largescaletonguesole	Cynoglossus arel	NE	UC
102			Tonguefish	Paraplagusia bilineata	NE	UC
103			Dog tooth tuna	Gymnosorda unicolor	LC	UC
104	Rhinopristiformes	Glaucostegidae	Ray	Glaucosegus granulatus	CR	R
105	Scombriformes	Scombridae	Bullet tuna	Auxis rochei	LC	C
106			Tuna	Thunnus tonggol	DD	C
107			Dog tooth tuna	Gymnosorda unicolor	LC	UC
108	scorpaeniformes	platycephalidae	Bartail flathead	Pllatycephalus indicus	LC	C
109			Flathead	Platycephalus	LC	C
110	Sepiidae	sepiida	Common cuttlefish	Sepia officinalls	LC	UC
111	Siluriformes	Plotosidae	Whitelipped eel catfish	Paraplotosus albilabris	NE	UC
112	Tetraodontiformes	Balistidae	Bluefin filefish	Balistoidsviridescons	NE	C
113			Masked triggerfish	Sufflamen fraenatus	LC	C

114		Tetradontidae	Half smmoth golden pufferfish	Lagocephalus spadiceus	LC	C
115			Pufferfish	Diodon holocanthus	LC	C
116		Triacanthridae	Short nosed tripodfish	Tricanthus nieuhofii bleeker	NE	UC
117		Ostraciidae	Hoorn-nosed boxfish	Rhinorhynchos sp	NE	
118	Torpendiniformes	Torpendinidae	Marble electric ray	Torpedo marmorata	DD	R

Abbreviations: DD-Data deficient,NE- Not evaluated, CR- Critically endangered, TR-Threatened, NT - Near Threatened:.,LC - Least Concern: Lowest Risk., VU-Vulnerable

Figure :1 Diversity index of fishes in Manapadu during March2023-february 2024



3. DISCUSSION

The dataset includes representatives from 31 families and 22 orders, with dominant families such as Carangidae, Lutjanidae, Serranidae, Dasyatidae, and Scaridae. The order Perciformes is particularly well-represented, consistent with global trends in tropical marine biodiversity (Nelson *et al*., 2016). The dataset includes over 110 fish species spread across multiple orders such as Perciformes, Carangiformes, Siluriformes, Elopiformes, and Scombriformes, indicating high taxonomic diversity. This richness is consistent with the high values of Fisher's Alpha and Margalef Index shown in the study, particularly in April and November, possibly corresponding to peak breeding or recruitment seasons (Kumar *et al*., 2018). A majority of species are classified as **Least Concern (LC)**, Several are Not Evaluated (NE) or Data Deficient (DD),Threatened categories include Himantura uarnak (Honeycomb Stingray – VU), Glaucosegus granulatus (Ray – CR), Carcharhinus sorrah (Milky Shark – NT), Choerodon schoenleinii (Tuskfish – NT), Torpedo marmorata (Electric Ray – DD), Loligo species (Squid – TR), Enchelycore schismatorhynchos (Eel – TR).This mixture highlights the urgent need for monitoring and conservation, particularly for elasmobranchs (rays and sharks) and rare cephalopods, which are typically more vulnerable due to low reproductive rates (Dulvy *et al.,* 2014).

In the present study the fish diversity reveals a **rich and varied community** with ecological balance maintained by the presence of multiple trophic levels. However, the occurrence of **threatened and rare species,** along with numerous **data-deficient taxa**, underscores the need for **targeted conservation strategies,** especially in the face of **climate change, habitat degradation,** and **fishing pressures**. Strategic and science-based management plans can ensure the long-term sustainability of this valuable marine biodiversity. The monthly variation in fish diversity using a suite of biodiversity indices, including richness, evenness, dominance, and diversity measures. These indices provide insight into the structure, stability, and health

of the aquatic ecosystem over the year.

The Fisher's alpha index displays prominent peaks in April and November, suggesting increased species richness during these months. These peaks could be attributed to breeding seasons, migration patterns, or favourable environmental conditions such as optimal temperature and food availability, which are known to influence fish population dynamics (Magurran, 2004). Similarly, the Margalef index, which is sensitive to species richness and total number of individuals, follows a comparable trend, indicating higher fish diversity during these periods.

The Shannon-Wiener index (H') and Simpson's index (1-D) values remain relatively stable across all months, suggesting consistent fish diversity. Shannon_H values ranging between 1.5 to 2.5 and Simpson values nearing 0.9 indicate a highly diverse fish community with a balanced representation of multiple species (Ludwig & Reynolds, 1988).

Shannon values ranging from ~1.5 to 2.5 and Simpson values near 0.9 suggest that despite minor fluctuations in richness, the **overall community structure remains diverse** throughout the year.This trend supports studies by **Odum (1971)** and **Pielou (1975),** which state that high Simpson and Shannon values are indicative of complex, stable aquatic ecosystems with reduced dominance by any single species.

Despite the high richness, evenness indices such as Equitability_J and Evenness_e^H/S are relatively low and consistent throughout the year. This suggests that a few dominant fish species may be more abundant, while many others are present in smaller numbers—a common phenomenon in aquatic ecosystems where environmental stressors and competition influence dominance (Pielou, 1975).

The Dominance (D) and Berger-Parker indices, which reflect dominance by the most abundant species, remain low throughout the year. This suggests no single species overwhelmingly dominates the ecosystem, supporting a healthy diversity and balance.

The **seasonal peaks** in richness during **April and November** could be associated with **pre-monsoon and post-monsoon transitions**, which are critical periods in fish reproductive cycles and recruitment. Increased food supply and optimal hydrological conditions may attract a wider range of species during these months (Welcomme, 2001). Moreover, the relative stability in diversity and dominance throughout the year reflects **a well-functioning and resilient aquatic ecosystem**, likely with a mix of **resident and migratory fish species** maintaining the ecological balance.

4. CONCLUSION

This study provides important baseline information on the structure of fish communities in the Manapadu coastal area. The overall analysis reveals that the fish diversity in the studied aquatic system is **consistently high**, with **distinct seasonal peaks in species richness.** The stability in diversity indices alongside fluctuations in richness highlights the **dynamic yet balanced nature** of the fish community. This underscores the importance of **seasonal monitoring** and **conservation efforts** to protect biodiversity, especially during ecologically sensitive periods. Higher diversity value observed in the present investigation clearly showed the healthy nature of the fish ecosystems along Manapadu coastal waters. The data generated through the present research report can provide baseline information for commercial exploitation of fish resources along Manapadu coastal waters..

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