Structure and Functional Guild Composition of Fish Assemblages in the Matla Estuary, Indian Sundarbans

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Abstract: Fish assemblage structure is a complex and multifaceted concept that is critical for understanding the ecology and conservation of fish populations. By examining the components of fish assemblage structure, the factors that influence it, and the methods used to study it, researchers and managers can gain a deeper understanding of fish assemblage structure and its applications in fisheries management, conservation biology, and ecosystem-based management. The Matla Estuary, located in the Indian Sundarbans, is a critical habitat for diverse fish assemblages. This study aimed to investigate the structure and functional guild composition of fish assemblages in the Matla Estuary. During the study period, a total of 120 fish species from 34 families were identified. Fish assemblage structure varied significantly over time and space, according to multivariate analysis. Five different guilds—herbivores, omnivores, carnivores, planktivores, and detritivores—were found by functional guild analysis. The Matla Estuary serves as a nursery for numerous commercially significant fish species, which is why the study emphasizes its significance. The study's conclusions offer important new information about the ecology and preservation of fish assemblages in the Indian Sundarbans.

Keywords: Fish Assemblage; Indian Fishes; Freshwater; Ecology.

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I. Introduction

The composition and arrangement of fish species within a specific ecosystem or habitat is referred to as the "fish assemblage structure." It includes fish species' distribution, variety, and abundance as well as how they interact with one another and their surroundings. To manage and conserve fish populations and their habitats, it is essential to comprehend the structure of fish assemblages (Eick & Thiel, 2014). It sheds light on the trophic linkages, ecological responsibilities, and reactions to environmental changes of many fish species (Hoeinghaus et al., 2007). A water body's nutrient level, which ultimately dictates productivity, affects the distribution and richness of its flora and fauna. Many people are supported by the water's nutrient abundance. Investigating the seasonal change, distribution, and consumption of nutrients is therefore crucial. In nature, primary productivity is a significant biological process that directly or indirectly supports a wide variety of life. One way to assess a lake's trophic condition is to look at its annual primary production. The trophic state index would ultimately be impacted by any factor that affects productivity. Therefore, a good assessment of the ecosystem requires continuous monitoring of several environmental factors. With around 35,000 species that live in different kinds of aquatic bodies, fishes are the most prevalent group of lower vertebrates. One of the least popular areas of natural science is the study of fish (Franco et al., 2008). History, most likely because the environment in which fishes live keeps their quirks and behaviors from becoming as widely known to us as those of animals that live on dry land. Furthermore, fish do not try to attract our attention or exhibit any signs of advantage when removed from the water; in fact, to the untrained eye, there does not appear to be much of a difference between different species. There haven't been many attempts to make the topic more well known yet, and the main goal has been to gather information, identify new species, compare them, and organize them into natural groups based on their affinities—in other words, to classify them. Since the time of ancient biologists, there has been curiosity in the connection between fish morphology and life patterns (Ferreira et al., 2019). A thorough catalog of the fish fauna in the Matla Estuary, Indian Sundarbans, has not yet been seriously attempted, despite the fact that a great deal of work has been done recently in the field of taxonomy of Indian fishes. This study aims to give a comprehensive list of fish species found in the Indian Sundarbans' Matla Estuary, together with information on their morphometric and meristic characteristics. Fish Assemblage Structure shown in Figure 1.

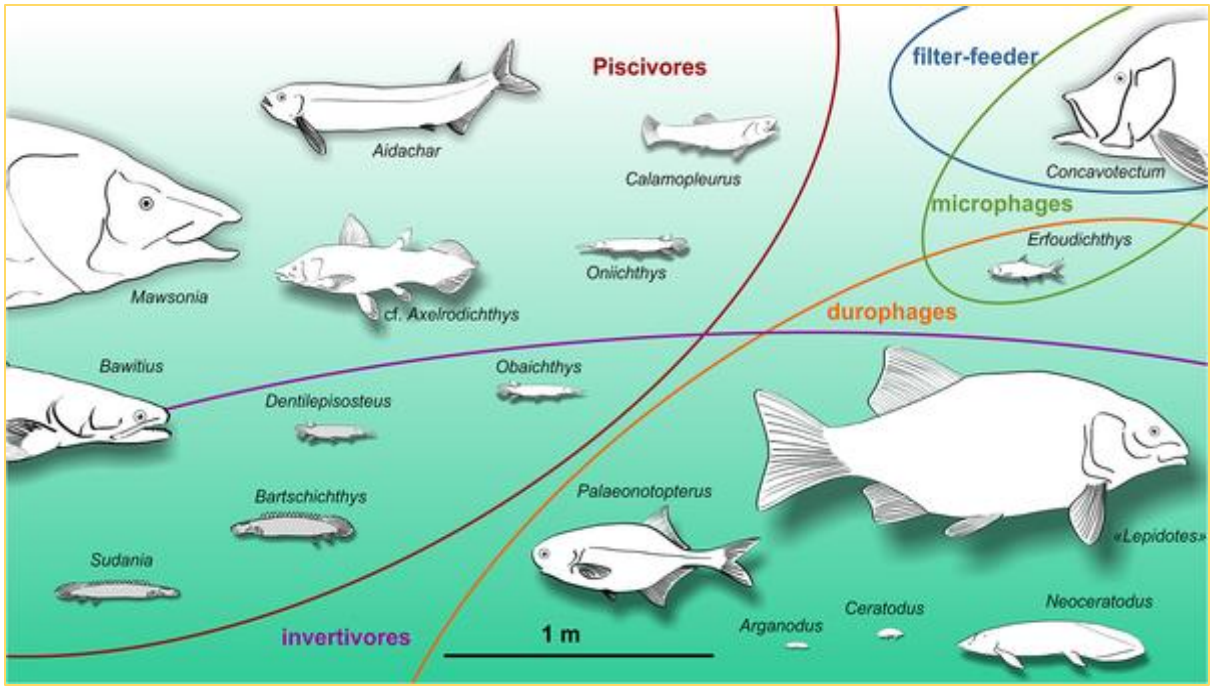

Figure 1: Fish Assemblage Structure

II. Related Works

In these changes, freshwater ecology has not exactly followed other ecological disciplines. About ten years separated the general interest in freshwater community structure from the theoretical developments in this area. Additionally, after the technical advancements related to the use of carbon-14, there was a dramatic resurgence of interest in energy flow at the first trophic level in the late 1950s and early 1960s. However, interest in the structure and adaptive features of freshwater ecosystems has not largely replaced interest in energy flow, especially in herbivores and higher trophic levels. Energy flow has received less attention than studies of community structure and adaptive strategy, in part because these fields have frequently shown themselves to be rich sources of mechanical information that are particularly rewarding to those who want to comprehend the interspecific interactions that shape communities. Since energy offers a potent tool for comparing species both within and between trophic levels, information on energy flow is crucial for a thorough assessment of community structure and species adaptability. Furthermore, predation and competition—two processes that shape community structure—are mostly evolutionary exercises in energy allocation carried out through adaptation. To properly understand the ecosystem and make better use of energy sources, one must have a thorough understanding of the relationships between organisms, the flow of nutrients and energy from one level to another, and the role of environmental factors in the energy transformation process. Information on the fate of energy beyond the producer level in the autochthonous and allochthonous systems of tropical fish ponds is incredibly limited, despite India's enormous potential resources for fish culture (Favero et al., 2019). Furthermore, because tropical systems and temperate water bodies differ greatly in terms of environmental variations, biotic quality, and biotic abundance, a wealth of information about the former cannot be extrapolated to the latter. The objective of the present study was to fish assemblage structure and functional guild composition of Matla estuary, Indian Sundarbans (Mathieson et al., 2000).

III. Materials And Methods

The Matla estuary flows through mangrove trees and is situated in the center of the Indian Sundarbans. Its estuary qualities are preserved in part by tidal activity and monsoon runoff. The Hooghly and Matla

estuaries both experience semidiurnal tides and are meso-macro tidal. A number of rivers, including the Mooriganga, Saptamukhi, Thakuran, and Bidya, flow through the Indian Sundarbans mangrove system from west to east in addition to the Hooghly and Matla. The Matla River is home to a variety of fish species due to its nearly constant opening to the sea (Whitfield et al., 2022). There is typically more biological variety in open estuaries. The Matla River is dominated by euryhaline teleost species, with the exception of a few freshwater species like Pangasius pangasius, Gudusia chapra, and Anguilla bengalensis. Overall, there was 30% commonality in the fish assemblage pattern across all sites. Fish diversity in the canal system is modest, as indicated by the computed Margalef richness (d′) and Shannon diversity (H′) indices, which are 4.42 ± 0.84 and 2.62 ± 0.18, respectively. Distance-based redundancy analysis (db-RDA) and the BIO-ENV module reveal that water variables—such as temperature, dissolved oxygen, pH, salinity, specific conductivity, transparency, depth, and water flow—play a crucial role in structuring the fish assemblages in the studied canals (Elliott et al., 2007). Notably, fish populations exhibit minimal seasonal change, likely due to species-specific adaptations to the prevailing ecological conditions. The Indian Sundarbans Mangrove Ecosystem shown in Figure 2.

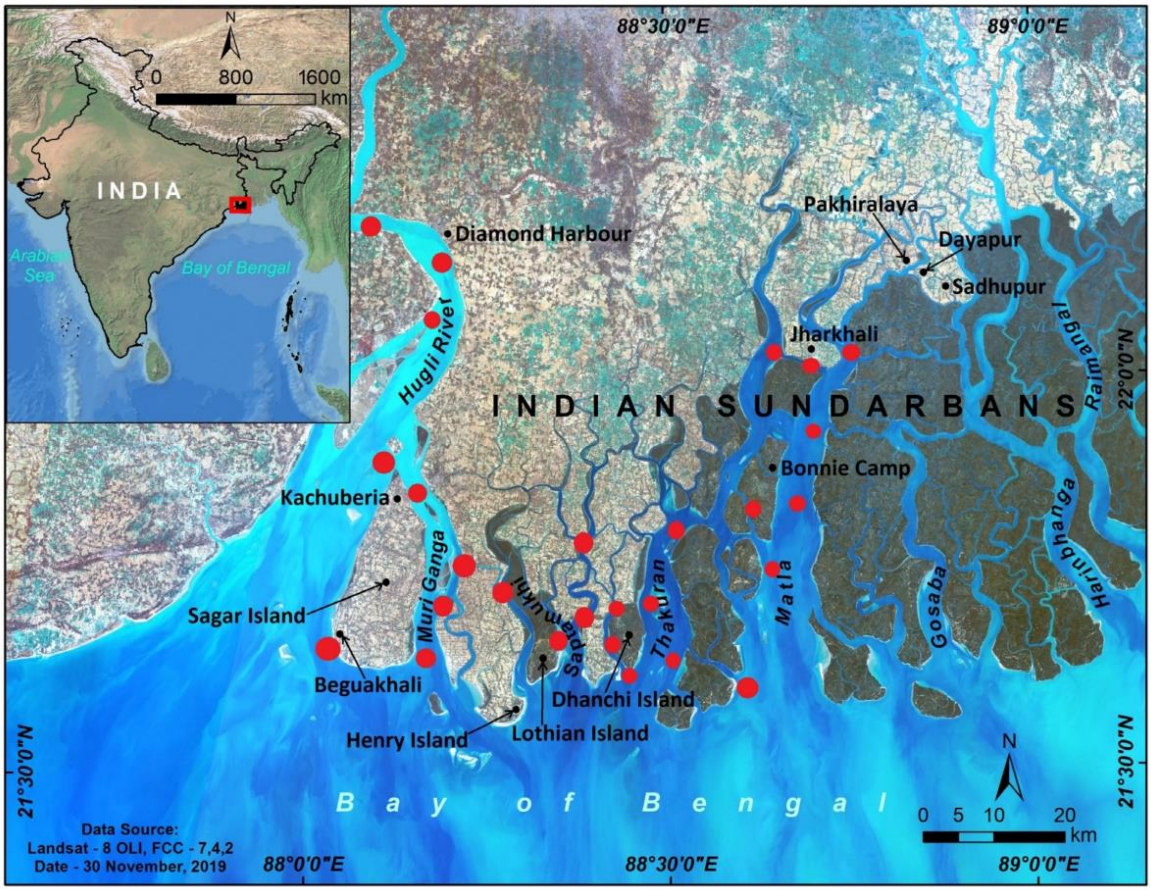

Figure 2: The Indian Sundarbans Mangrove Ecosystem

IV. Results

Total abundance, biomass, and species richness were marginally higher in the artificial habitat than in the natural habitat with respect to regional changes in fish assemblages. There were notable differences in the total abundance in the natural habitat (60 ind./m^2) and the artificial habitat (100 ind./m^2). Boxplot of Total Abundance of Fishes shown in Figure 3.

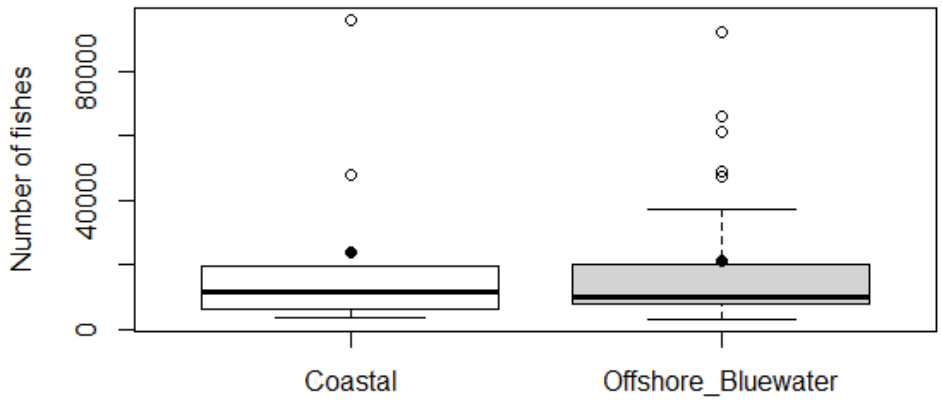

Figure 3: Boxplot of Total Abundance of Fishes

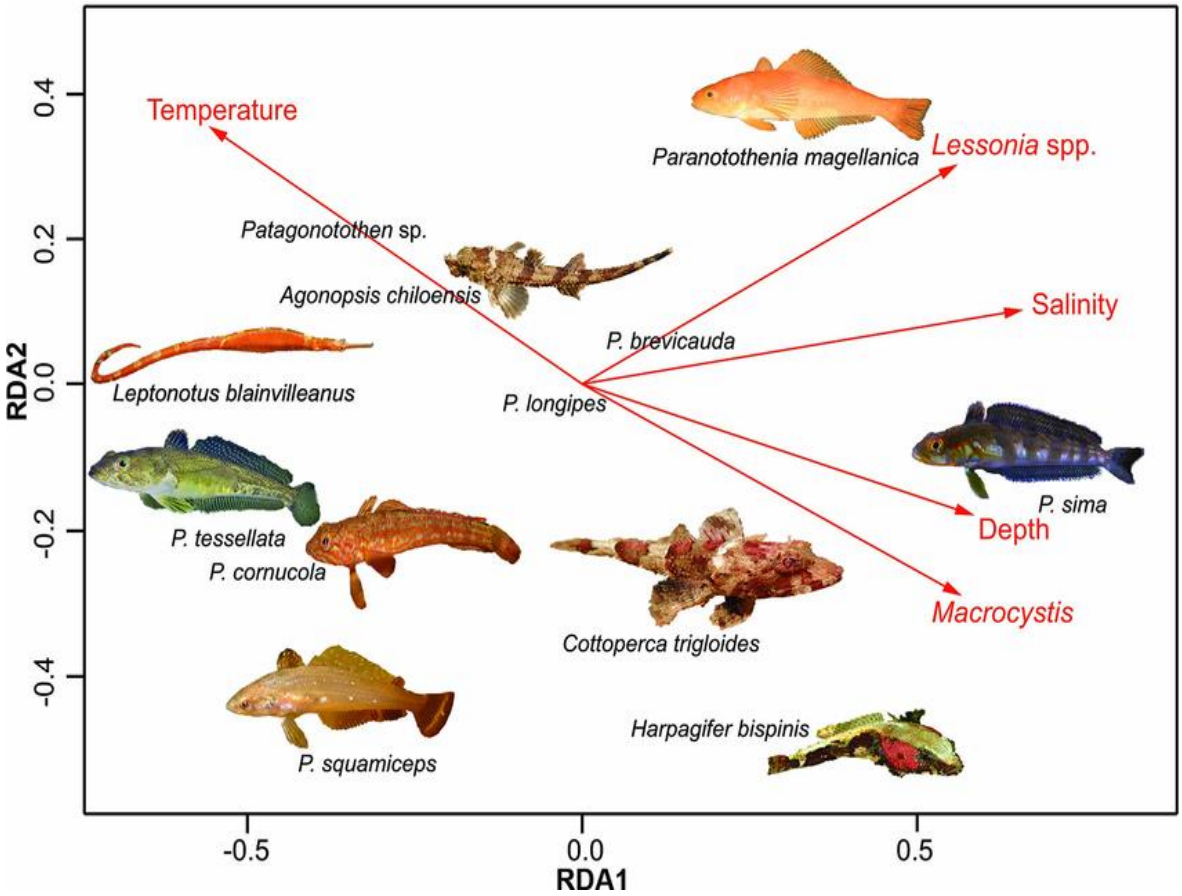

Figure 4: Various Treatments in the RDA

The distribution of samples from various treatments in the RDA revealed a considerable degree of overlap with regard to habitat heterogeneity shown in Figure 4. From January to December 2006, water and sediment samples from the three sites were examined for environmental factors such temperature, salinity, pH, dissolved oxygen, nutrients (ammonia, nitrate, nitrite, total nitrogen, inorganic phosphate, total phosphate, silicate), and soil texture. In the current study, summertime recorded the highest salinity and temperature in the atmosphere, while monsoon season recorded the lowest. The temperature of the surface water did not show any significant fluctuation. The monsoon season has a comparatively higher concentration of nutrients and dissolved oxygen.

V. Conclusion

Rivers are currently dealing with a number of issues, such as indiscriminate deforestation in the catchment areas, encroachment of the river bed, water abstraction for irrigation, dam and barrage development that may limit the river's interaction with the associated ecosystems, etc. In India, many fish species travel short or great distances to reproduce. Recruitment is impacted by any restriction to the spawning paths. In addition to irresponsible fishing, fishes in riverine areas face significant risks from deforestation, poor land use, increased alien species proliferation, fragmentation, and changes in river hydrology. The fish's ecological services have not been acknowledged by the state. Fishermen that depend on river productivity confront significant difficulties in maintaining their livelihoods as a result of declining natural populations of riverine fish. The reduction in riverine production has a significant impact on the livelihood of fishermen. In this regard, careful preparation of conservation and management plans is necessary to guarantee the sustainable use of native fish. It is necessary to investigate the aquatic ecology and fish assemblage structure of this ecoregion's lower order streams.

References

[1] Eick, D., & Thiel, R. (2014). Fish assemblage patterns in the Elbe estuary: guild composition, spatial and temporal structure, and influence of environmental factors. *Marine Biodiversity*, *44*, 559-580. https://doi.org/10.1007/s12526-014-0225-4

[2] Hoeinghaus, D. J., Winemiller, K. O., & Birnbaum, J. S. (2007). Local and regional determinants of stream fish assemblage structure: inferences based on taxonomic vs. functional groups. *Journal of Biogeography*, *34*(2), 324-338. https://doi.org/10.1111/j.1365-2699.2006.01587.x

[3] Franco, A., Elliott, M., Franzoi, P., & Torricelli, P. (2008). Life strategies of fishes in European estuaries: the functional guild approach. *Marine Ecology Progress Series*, *354*, 219-228. https://doi.org/10.3354/meps07203

[4] Ferreira, V., Le Loc'h, F., Ménard, F., Frédou, T., & Frédou, F. (2019). Composition of the fish fauna in a tropical estuary: the ecological guild approach. *Scientia Marina*, *83*(2), 133-142. https://doi.org/10.3989/scimar.04855.25A

[5] Favero, F. D. L. T., Da Silva Araujo, I. M., & Severi, W. (2019). Structure of the fish assemblage and functional guilds in the estuary of Maracaípe, northeast coast of Brazil. *Boletim do Instituto de Pesca*, *45*(1), e.417. https://doi.org/10.20950/1678-2305.2019.45.1.417

[6] Mathieson, S., Cattrijsse, A., Costa, M. J., Drake, P., Elliott, M., Gardner, J., & Marchand, J. (2000). Fish assemblages of European tidal marshes: a comparison based on species, families and functional guilds. *Marine Ecology Progress Series*, *204*, 225-242. https://doi.org/10.3354/meps204225

[7] Whitfield, A. K., Able, K. W., Blaber, S. J., Elliott, M., Franco, A., Harrison, T. D., ... & Tweedley, J. R. (2022). Fish assemblages and functional groups. *Fish and fisheries in estuaries: a global perspective*, *1*, 16-59. https://doi.org/10.1002/9781119705345.ch2

[8] Elliott, M., Whitfield, A. K., Potter, I. C., Blaber, S. J., Cyrus, D. P., Nordlie, F. G., & Harrison, T. D. (2007). The guild approach to categorizing estuarine fish assemblages: a global review. *Fish and fisheries*, *8*(3), 241-268. https://doi.org/10.1111/j.1467-2679.2007.00253.x