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ARTICLE

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SEASONAL CATCH DYNAMICS AND TRENDS OF HILSA (*TENUALOSA ILISHA*) IN THE DOWNSTREAM REGION OF THE FARAKKA BARRAGE

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This three-year study observes the catch pattern of Tenualosa ilisha during 2022-2024, downstream of the Farakka Barrage with special emphasis on seasonal and quarterly variations. The catches of Q1 (January-March) and Q4 (October-December) peaks related to Hilsa's migration. The largest catch was in 2024, showing better management and environmental conditions. The results show that sustainable fisheries management is possible in the Ganges River because there is a steady increase in Hilsa catches, that indicates improved ecosystem health and local fishermen's livelihoods.

Keywords: *Hilsa (Tenualosa ilisha), Anadromous migration, Seasonal catch patterns, Sustainable fisheries management*

Introduction

Animal proteins are one of the major needs for the human body in various ways; compared to other animal protein sources, fish are more readily available and reasonably priced, making them one of the most prominent sources of high-quality animal proteins. With a high content of polyunsaturated fatty acids (PUFAs), particularly ω-3 PUFAs, fish are a healthy food. At the other end of the nutritional spectrum, fish is a healthy food for all people due to its proteins, oils, vitamins, and minerals, as well as the health benefits of eating small, native fish[1]. The heart-healthy ω-3 fatty acids are found particularly in marine fish, that's why experts strongly advise eating fish on a regular basis. This is thought to be one of the main reasons why Eskimos have a lower risk of cardiovascular illnesses[2]. Some have proposed that the increased diet of fish and shellfish by Nordic and Japanese populations may contribute to their longer lifespans. Many additional health issues, including mental disease and blindness, are said to be prevented by eating oily fish. Accordingly, fish has therapeutic and medicinal significance[3] and people are becoming more aware of the health advantages of eating fish[4].

One of the most significant tropical fishes in the Indo-Pacific area, *Tenualosa ilisha* (Hamilton, 1822) belongs to the subfamily Alosinae, family Dorosomatidae, order Clupeiformes. Because of its flavour, taste, and culinary qualities, it has taken the top spot among edible fishes. This fast-moving euryhaline also referred to as Hilsa, is renowned for its worldwide distribution in brackish water estuaries, marine settings, and riverine environments where it migrates for reproduction in the Indo-Pacific fauna. About 95% of the world's Hilsa is caught in Bangladesh, India, and Myanmar. Naturally, Hilsa has a high consumer

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preference and is in high demand worldwide, particularly in the Asian globe. It is an excellent currency earner due to its great commercial demand.

The tropical Asian region is home to five different species of *Tenualosa* sp. (*T. toli* from Malaysia, *T. macrura* from Indonesia, *T. thibaudeaui* from Mekong, *T. reevesii* from Southern China, and *T. ilisha* from India, Bangladesh, and Myanmar) of which *T. ilisha*, along with *T. toli* and *Hilsa kelee* to a lesser degree, are common in Indian waters[5]. Different species have different migratory habits regarding usual habitat, age, growth, and trend. *T. ilisha* is the main fisheries component in the Ganga- Brahmaputra-Padma river system out of the five species.

Hilsa are known to spawn upstream[6-9], and both the spent fish and their offspring travel downstream into lower estuaries and coastal regions[7]. Although Hilsa are a marine species by nature, they travel to fresh and estuary environments for breeding. Hilsa are mostly anadromous; adults move from the sea into freshwater for spawning, and the young, after hatching, raise in river channels and estuaries before heading back to the sea for additional development. The Hilsa fishery is essential to the nation's ability to generate foreign cash as well as jobs and income for individuals involved. Hilsa, West Bengal's state fish, make about 15–25% of all fish landings in the Hooghly Estuary[9]. Bangladesh's national fish, Hilsa, makes a significant contribution to the country's GDP.

This study focuses mainly on the catch data of Hilsa at downstream of Farakka Barrage within a radius of 3 kilometres and it's catch pattern over the past 3 years. Downstream of Farakka Barrage being a freshwater zone accumulates a large number of fishes, mainly Hilsa.

The primary aim was to analyse trends in yield and catch patterns of Hilsa. In addition to primary data on fish distribution and abundance collected for a period of three years, the secondary data from different data sources and by interaction with fishermen, have also been used to understand the change in distribution pattern of fishes in the Ganges.

Materials and Methods

Study Area: Daily Hilsa catches were recorded from 14 selected fishing boats that were especially deployed in fishing in the Beniagram site (Figure 1), near the Farakka barrage. All the 14 hired boats are mechanized and are operating with 90–95 mm mesh size gill nets following authenticated decorum of the Government of West Bengal, India. The monofilament gill nets were used in the study having a uniform length of 200 m and the height of the nets were 4 m and the mesh size was 90 mm knot to knot. Monthly Hilsa catch data were presented in the form of catch per unit effort (CPUE) (kg/effort). To standardize the CPUE, fishing time remained fixed for all boats. We consider 4hours of active fishing for this study. The daily CPUE of every individual boat was calculated by summing all the Hilsa fish catch data of all the fourteen boats individually and then dividing it by 4 hr (as every boat was actively deployed for 4 hr each). Monthly Hilsa capture data from January to December of the continuous three years (2022 to 2024) were taken for analysis. A total of 36 months of sampling are divided into 4 quarters for each year, like January to March-Q1, April to June-Q2, July to September-Q-3 and October to December-Q4. Along with monthly and yearly catch pattern analysis quarter wise analysis were also calculated in this work.

Results and Discussion

Hilsa Catch: In the last three years (2022-2024) Hilsa catch at Beniagram on a monthly basis shows a distinct pattern. In the months of January to March and from October to December, Hilsa catch was maximum ranging from 0.35-0.48 ton/month and 0.16 to 0.50 ton/ month, respectively. It was also evident that the total Hilsa catch was maximum during January to March every year at 3.54 tons compared to October to November, which is 3.26 tons. Between April to September, the Hilsa catch was at an all-time low in the last three years ranging from 0.02-0.11 tons almost 5-8 times less than the peak Hilsa catch season (Fig. 2).

Table 1. Quarter-wise total number of Hilsa catches from 2022 to 2024

Year-Quarter	Total number of Hilsa Catch
2022-Q1	12,768
2022-Q2	1,948
2022-Q3	441
2022-Q4	1,1478
2023-Q1	1,2376
2023-Q2	524
2023-Q3	3,028
2023-Q4	8,585
2024-Q1	23,440
2024-Q2	1,313
2024-Q3	2,885
2024-Q4	20,206

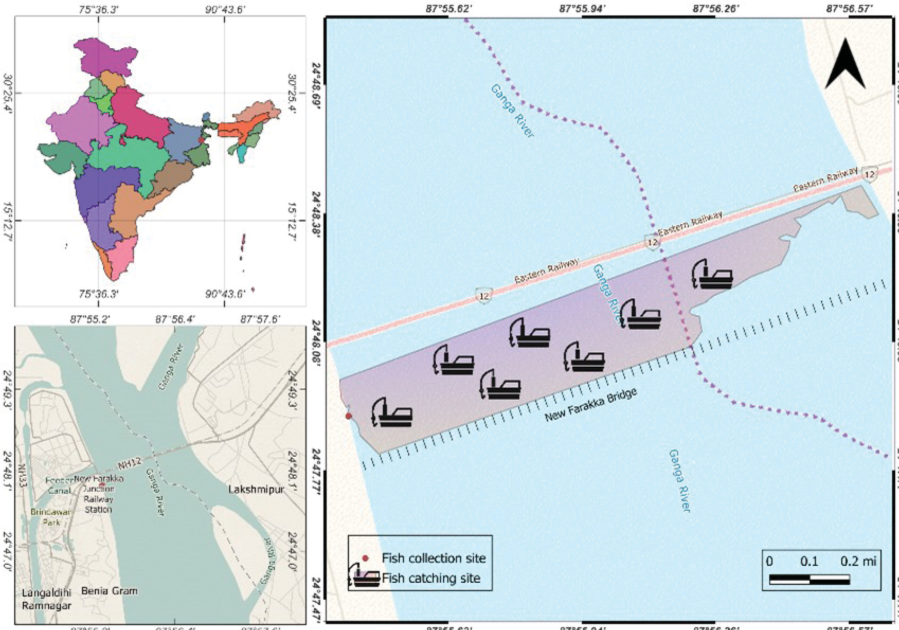

Fig. 1. Study area map of Hilsa catching site

In Hilsa (*Tenualosa ilisha*) ranching, the annual cycle is divided into four quarters. Analysis over three consecutive years revealed two peak quarters for Hilsa catch: Quarter 1 (Q1) and Quarter 4 (Q4). The catch during these periods ranged from 0.68 to 1.7 tons per quarter. Conversely, the lowest catches were observed in Quarter 2 (Q2) and Quarter 3 (Q3), with yields ranging from 0.04 to 0.12 tons per quarter. Quarters 1 and 4, spanning October to March, correspond to the peak months of Hilsa migration (Figure 3). This period aligns with the anadromous migration behaviour of Hilsa[9], where the species migrates upstream from marine environments to freshwater systems for spawning. Such migratory behaviour likely contributes to the significantly higher catch rates during these quarters. Table. 1 illustrates the total number of Hilsa catches distributed across different quarters from 2022 to 2024, revealing significant seasonal variations. The highest catches consistently occur in Q1 (January–March), with the peak in 2024-Q1 (23,440 fish), followed by 2024-Q4 (20,206 fish). In contrast, the lowest catches are recorded in Q3 (July–September) each year, with the minimum in 2022-Q3 (441 fish), indicating this period is unfavourable for Hilsa fishing. Over time, there is a noticeable increase in the total Hilsa catch during peak quarters, suggesting improved fishing practices, higher Hilsa abundance, or better management strategies. The mid-year quarters (Q2 and Q3) remain consistently low, showing minimal improvement. These trends may be influenced by Hilsa breeding and migration patterns, environmental factors, and fishery management policies. Overall, the data highlights a strong seasonal pattern, with Q1 consistently yielding the highest catches, and an upward trend in Hilsa catch, particularly evident in 2024.

In year wise Hilsa catch data also reveals that among the last three years, the highest Hilsa catch

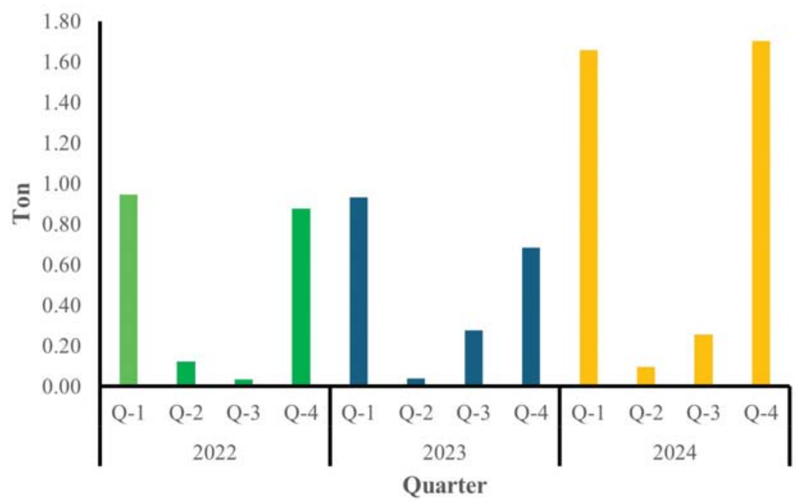

Fig. 2. Month-wise pattern of the total Hilsa catches from 2022 to 2024

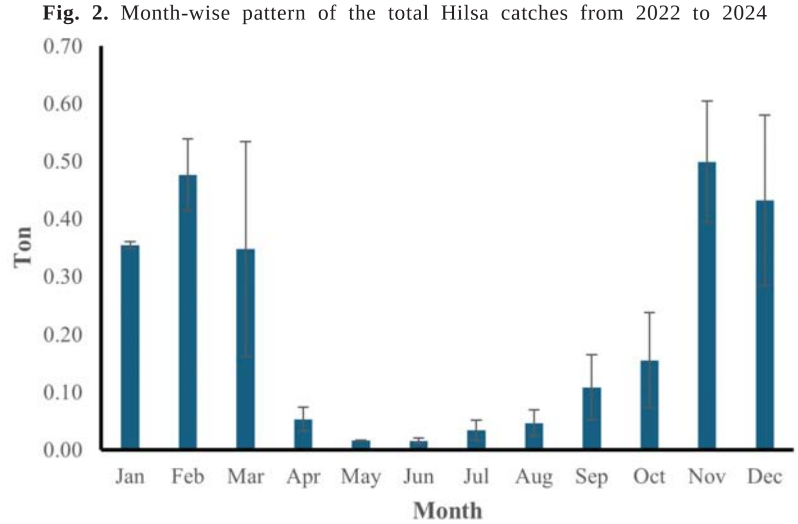

Fig. 3. Quarter-wise pattern of the total Hilsa catches from 2022 to 2024

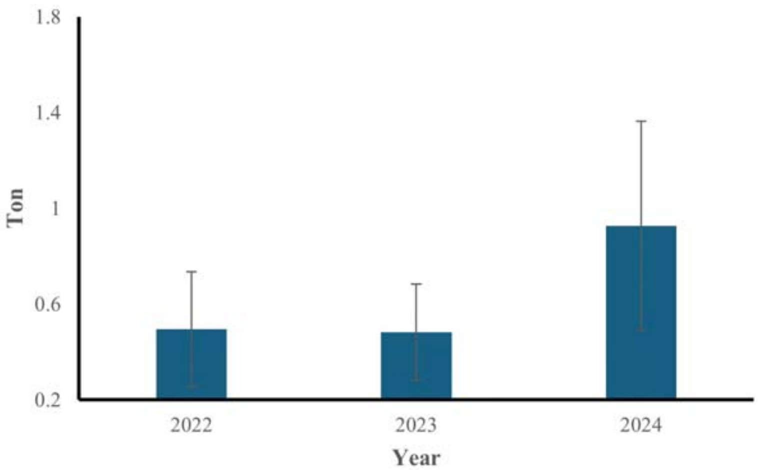

Fig. 4. Year wise pattern of the total Hilsa catches from 2022 to 2024

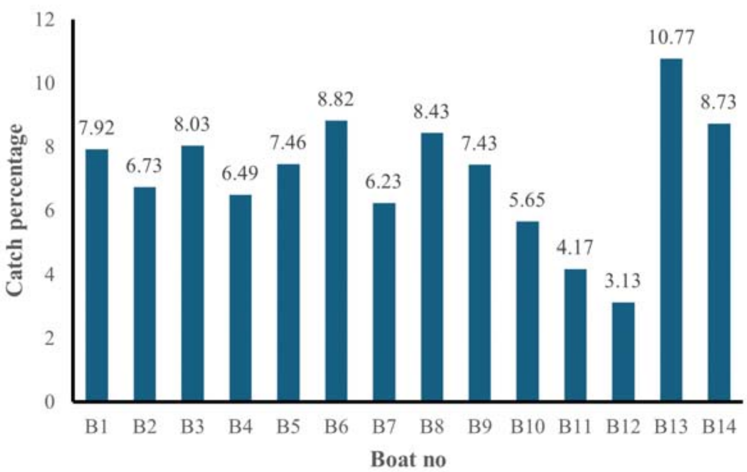

Fig. 5. Boat-wise Hilsa catch percentage (%) from 2022 to 2024

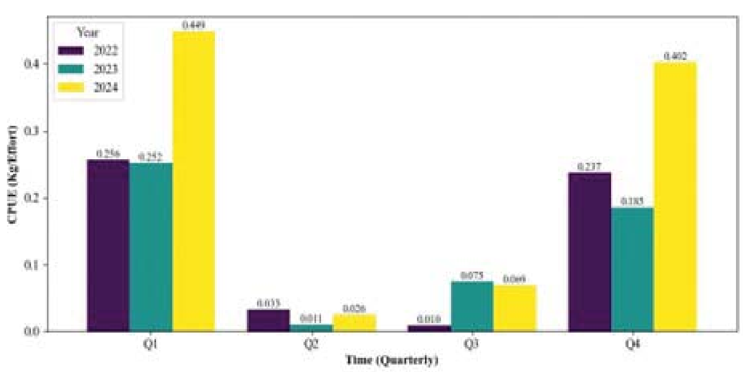

Fig. 6. Quarter-wise comparison of CPUE (Kg/Effort) of Hilsa catches from 2022 to 2024

was observed during 2024. In 2022 and 2023, the average total Hilsa catch almost remains the same (0.49± 0.24 & 0.48± 0.20 tons) due to the unavailability of the species in this region due to adverse climatic conditions like high temperatures, less rainfall, etc. In 2024 the total fish catch hikes up to 0.93± 0.43 tons almost 1.9 times higher than last two seasons (Fig. 4) may be due to favourable condition.

Boat Wise Hilsa Catch Ratio

Figure 5 represents the percentage contribution of each boat to the total Hilsa catch. Among the boats, B13 has the highest contribution, accounting for 10.77% of the total catch, followed by B6 and B14 with 8.82% and 8.73%, respectively. Boats B3 and B8 also significantly contribute 8.03% and 8.43%, respectively. On the lower end, B12 contributes the least at 3.13%, followed by B11 at 4.17%. Boats B7 and B10 also have relatively smaller contributions, with 6.23% and 5.65%, respectively. Overall, the data shows variability in catch contributions among the boats, with a few boats significantly outperforming others regarding their share in the total Hilsa catch.

Quarter-wise Catch per Unit Effort (CPUE)

The CPUE data illustrates the quarterly trends of Hilsa catch across 2022, 2023, and 2024 revealing distinct seasonal variations. CPUE peaked in Q1, with 2024 showing the highest value (0.449 kg/effort), indicating this quarter was the most productive for Hilsa fishing. A significant decline occurred in Q2 for all years, with minimal productivity (around 0.01 kg/effort), likely due to seasonal or ecological factors. In Q3, CPUE slightly recovered, with 2023 slightly outperforming the other years. By Q4, CPUE increased again, with 2024 achieving the highest value (0.402 kg/effort), suggesting improved conditions or management practices. Overall, 2024 consistently recorded the highest

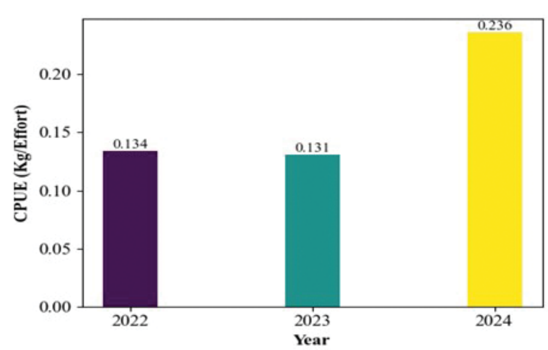

Fig. 7. Year wise CPUE variation of Hilsa catch from 2022-2024

CPUE values, while Q2 remained the least productive quarter across all three years (Fig. 6).

The annual CPUE (Catch Per Unit Effort) for Hilsa across 2022, 2023, and 2024, shows a steady increase in CPUE over the years, with 2024 achieving the highest value of 0.236 kg/effort, indicating a significant improvement in Hilsa catch efficiency. In contrast, 2022 and 2023 recorded lower and relatively similar CPUE values of 0.134 kg/effort and 0.131 kg/effort, respectively (Fig. 7). This trend suggests that factors such as enhanced management practices, environmental conditions, or fishing efforts might have contributed to the marked increase in Hilsa catch efficiency in 2024.

Conclusion

The catch pattern of Hilsa varies greatly depending on the season. The highest Hilsa catch generally occurs in quarter 1 in all three consecutive years. The year 2024 shows the highest catch among all the years, almost 2 times higher than the previous two years. Gradual increases in Hilsa catch also signify better ecosystem health for the river Ganga, as Hilsa is an indicator species. Also, the socioeconomic condition of the fishers is going to be better as the Hilsa catch increased steadily in the last few years.

Acknowledgments

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