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ARTICLE

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MULTIDECADAL TRENDS AND RELATED CHALLENGES IN FISH PRODUCTION IN RIVER GANGA

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The study aimed in assessing multidecadal trends and related challenges in fish production in river Ganga. Time-series data on fish landings from 1950's to 2024, were collected using landing based approach and segregated according to the economically important fish groups. This decadal analysis of fish landings revealed significant temporal and spatial shifts in the productivity of the Ganga River's fishery resources. Historical data emphasize the river's rich fish diversity and productivity, recent trends underscore the urgent need for sustained ecological restoration and targeted policy interventions.

Introduction

The River Ganga holds immense cultural, historical, and economic significance in India[1]. Spanning approximately 2,525 kilometres from its origin at Gangotri to its endpoint at Gangasagar, it is recognized as the fifth-largest river in the world by discharge and the longest in India. Beyond its deep spiritual and emotional resonance, the Ganga has long served as a vital conduit for navigation and communication. It supports a rich diversity of fish species that form the backbone of livelihoods for thousands of people along its banks. Commercially valuable fish such as carp, catfish, and various small Indigenous species fetch high prices in local markets and are distributed to neighbouring states. The riverine fisheries of the Ganga are not only economically significant but also contribute to nutritional security[2]. The contribution of these species to commercial fisheries is typically assessed through landing data[3]. Historical records documented 141 commercially important fish species in the Ganga, including carp, catfish, and other indigenous fishes[4]. However, recent studies have revealed a marked decline in annual fish production across the Ganga basin. Populations of economically vital species such as carp and catfish have diminished significantly[5-7]. The construction of the Farakka Barrage has particularly affected the Hilsa fishery, resulting in a sharp reduction in Hilsa catches in the river's middle and lower stretches[8]. Additionally, a noticeable shift has occured in fish landings, with a reduction in major commercial groups and a rise in non-major and exotic species catches, which has substantially altered riverine production dynamics [9]. The decline of indigenous species such as Indian Major Carps (IMC's) is evident in the decreased availability of their spawn relative to other fish stocks[10]. To mitigate these challenges, accurate forecasting of fish landings is essential for effective and sustainable fisheries management. Trend analysis helps inform fishing regulations, stabilize market prices, and ensure a balanced supply-demand chain—benefiting both fishers and consumers. However, traditional forecasting techniques often fail to capture the complex dynamics influencing fish populations. Given the persistent decline in fish landings due to a combination of anthropogenic and natural factors, advanced and specific analysis are critical to predict future trends. This study aims to provide a comprehensive overview of the landing patterns of major commercially important fish species in the River Ganga.

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Fig 1. Middle stretch of River Ganga system

Materials and Methods

Historical data: Time-series data on fish landings (in tonnes) were collected from eight locations in the middle stretch of the river Ganga, viz. Prayagraj (Allahabad), Kanpur, Varanasi, Buxar, Ballia, Patna, Bhagalpur, and Farakka—across five decadal intervals: 1950–60, 1961–70, 1971–80, 1981–90, and 2016–24.

***Data Collection and Analysis*:** Fish landing data were obtained annually (2016-2024) from ten sites, including Bijnor, Narora, Farukhabad, Kanpur, Prayagraj, Varanasi, Buxar, Patna, Bhagalpur, and Farakka . The data were sourced from commercial landing centres in the vicinity of River Ganga, and the landings were categorized into three different groups viz. IMC, Exotics and Catfish. Annual landings were extrapolated using a stratified random sampling method. Decadal data for the period 1950 to 1990 were acquired from the repository of ICAR-Central Inland Fisheries Research Institute (CIFRI) for the sites at Prayagraj (Allahabad), Kanpur, Varanasi, Buxar, Patna, Bhagalpur and Farakka. All data were analyzed and the graphical representation of the fish landings were generated using MS Excel 2010.

Results

Fish Catch Statistics and Multidecadal Trend: The multidecadal assessment of fish landing from the middle stretch of River Ganga is depicted in Fig 1. Prayagraj experienced a substantial increase in fish landings from 338.93 tonnes in 1950–60 to a peak of 1748.66 tonnes in 1961–70. Subsequently, there was a sharp decline to 599.15 tonnes in 1971–80, with only marginal increases in subsequent decades, leading to a total of 552.35 tonnes in 2016–24. This trend implies a period of abundance followed by a prolonged decreased productivity, potentially due to reduced water flow or increased pollution. Kanpur showed modest landings in the early decades, with a peak of 620.83 tonnes in 2016–24. However, data for the period 1971–1990 are unavailable. A similar trend was observed in Varanasi, which experienced a substantial increase in landings in 1961–70 (751.34 tonnes), but no data were available for 1971–1990. Buxar and Patna demonstrated a more gradual trend. In 1961–70 (367.01 tonnes), Buxar showed the highest landing and then steadily declined to 70.93 tonnes by 2016–24. Patna also reflected the highest in the same decade (862.51 tonnes) and witnessed a significant decline in the subsequent decades, indicating long-term stress on fish

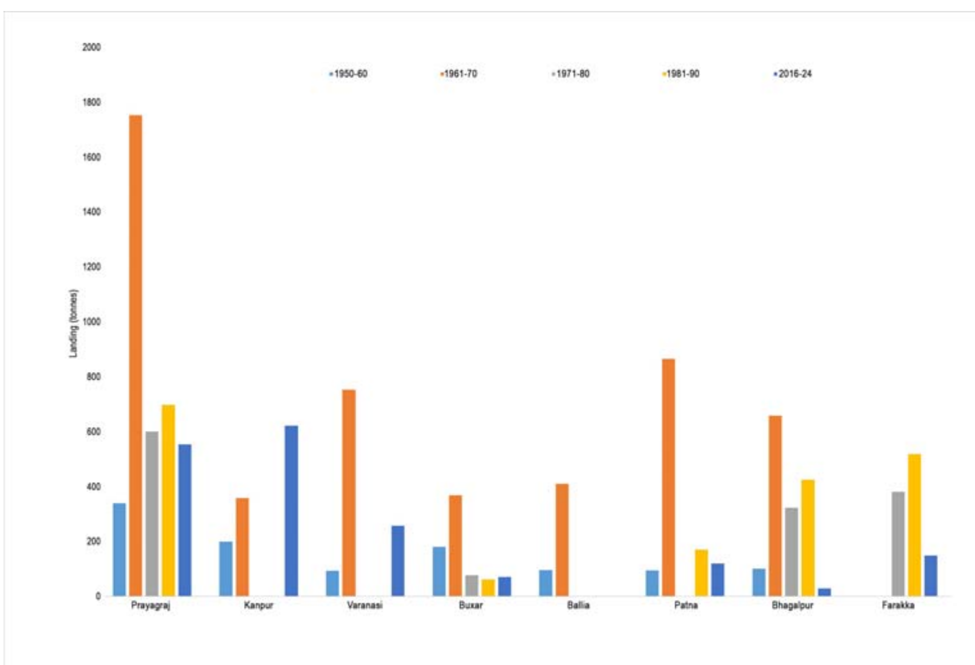

Fig 2. Multidecadal representation of fish landing from the middle stretch of River Ganga

populations. Bhagalpur exhibited a unique trend, with consistent landings across all decades. It peaked at 656.97 tonnes in 1961–70 and showed a secondary peak in 1981–90 (424.41 tonnes), followed by a sharp drop to 29.25 tonnes in the most recent decade (2016-2024). This sharp decline may be attributed to overexploitation or ecological degradation. In Farakka, data were available from 1971 onwards. The data showed notable fish landing records in 1971–80 (379.7 tonnes) and 1981–90 (517.1 tonnes), followed by a steep reduction to 148.35 tonnes by 2016–24. The initially high productivity may be related with dam construction and fish aggregation downstream.

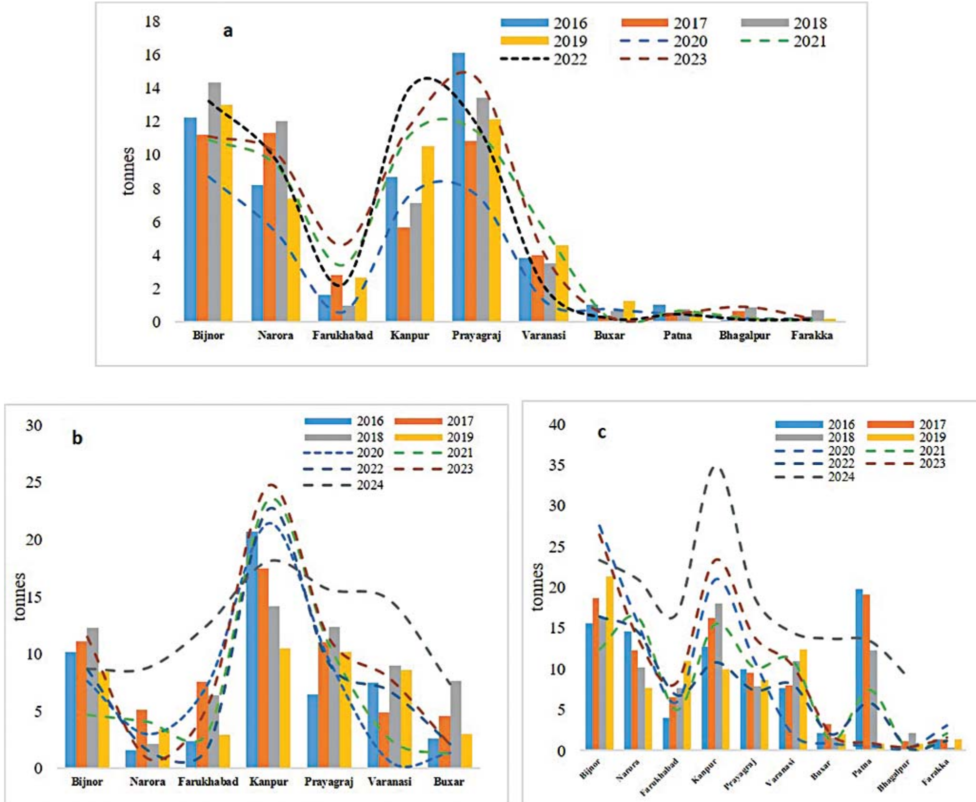

Fig 3 (a-c). Year-wise, fish landing in different sites of River Ganga comprising major groups a. Indian Major Carps b. Exotic fishes c. Catfish

Recent Landing of Significant Fish Groups: Year-wise landing data of IMCs from the River Ganga between 2016 and 2024 across ten key sites reveal significant spatial and temporal variations (Fig 2a). Upper stretch stations such as Bijnor and Narora recorded consistent landings throughout the years, peaking in 2024 at 27.71 and 29.28 tonnes, respectively—indicating favourable ecological conditions and possibly effective local conservation intiatives. In the middle stretch, sites like Kanpur and Prayagraj exhibited similarly strong trends. Kanpur, in particular, recorded the highest annual landing of IMCs in 2024 (49.98 tonnes), indicating enhanced fishery management or improved river health. Notably, downstream sites such as Buxar, Patna, Bhagalpur, and Farakka, which had consistently reported low landings in previous years, experienced significant increases in 2024, pointing to potential ecology recovery in these stretches.

Fig 4. Fish catch from river Ganga

This uniform rise in IMC landings across the basin suggests a basin-wide positive ecological response, possibly resulting from recent conservation efforts, better enforcement of fishing regulations, or improved water quality driven by large-scale interventions under programs like Namami Gange.

In constrast, the distribution of exotic fish showed different dynamics. Kanpur remained a primary hotspot, recording 24.7 tonnes in 2023 and 18.07 tonnes in 2024 (Fig 2b). Other mid to lower stretch sites, including Prayagraj, Farukhabad, and Varanasi also reported increased exotic fish landings in 2024, reaching 15.59, 12.56, and 14.68

tonnes, respe ctively, . Bijnor and Narora showed moderate landings of the exotic species. These trends suggest a growing presence of exotic species in the Ganga, underscoring the need for targeted management to mitigate their impact on native biodiversity and ecosystem balance. Regarding catfish, Kanpur recorded the highest landing in 2024 at 34.96 tonnes, establishing it as a key site for catfish fisheries (Fig 2c). Bijnor and Narora also made strong and steady contributions, with landings of 23.37 and 20.99 tonnes, respectively, indicating favourable habitat conditions in the upper stretches. Midstream sites like Farukhabad and Prayagraj exhibited gradual increases over time. Meanwhile, downstream stations such as Buxar, Patna, and Bhagalpur, which showed low catches in previous years, witnessed sharp increases in 2024, particularly Buxar (13.73 tonnes) and Patna (13.43 tonnes). These changes may indicate improved ecological conditions or increased fishing effort. Overall, these trends highlight a possible recovery of catfish populations across the Ganga basin and underscore the importance of continuous monitoring and sustainable harvest practices to maintain population health and ecosystem balance.

Discussion

Historically, the middle stretch of the Ganga River has served as a prime hub for fish production[11]. Over the years, however, a steady decline in the catch of valuable Indian major carps has been observed, accompanied by a significant rise in the abundance of smaller-sized species [12]. Current data from the Buxar to Bhagalpur stretch clearly shows a manifold increase in miscellaneous fish groups. A striking example of this decline is seen in the Prayagraj region, where major carp landings plummeted from 35.82 tonnes in 1981–1990 to just 5.97 tonnes in 2016–2019.

Migratory species such as Hilsa (*Tenualosa ilisha*) have also been severely impacted. Once a dominant catch at Buxar in the 1960s, contributing 33.48% (22.35 t) of the total fishery, Hilsa stocks began to decline sharply following the construction of the Farakka Barrage in the 1980s. Post-barrage data indicate a steep drop in Hilsa catches in the middle stretches from 160 to just 9 kg/km [13]. Today, fisheries in this region primarily rely on catfish and other miscellaneous species, while Hilsa abundance is now largely restricted to the downstream of the Farakka Barrage.

Patna reflects a similar downward trend, with major carp landings declining from 23.35 tonnes (21.48%) in the 1960s to just 2.16 tonnes (7.88%) during 2016–2019 though a notable resurgence was recorded in 2024. Concurrently, there has been a marked increase in the share of miscellaneous fish. At Bhagalpur, major carp catches dropped from 18.66 tonnes (20.18%) in the 1980s to only 1.98 tonnes (9.90%) in recent observations, aligning with trends reported in previous studies [14]. Smaller catfish species such as *Clupisoma garua*, *Eutropiichthys vacha*, and *Ailia coila* have become increasingly dominant, constituting 29–43% of the total catch across the studied sites. Commercial fishery contributions, typically assessed through landing data [9,10], clearly highlight these shifts in species composition.

Hydrological studies emphasize the detrimental effects of anthropogenic stressors such as pollution, irrigation, and man-made obstructions on the ecological integrity of the Ganga [7,12]. These impacts are especially evident in the sharp decline of native species like Indian Major Carps, which have shown a noticeable reduction in spawn availability [15]. Factors such as overfishing, pollution, and increasing aquaculture demand have also contributed to the decline in natural fish populations [3,16]. Furthermore, changing climatic conditions, including reduced rainfall, restricted water flow, and altered riverbed morphology, have disrupted peak-season hydrology, hindering natural breeding and recruitment cycles [7]. Meanwhile, the introduction and spread of exotic species like common carp and tilapia have further altered the ecological balance, contributing to overall increases in total catch but simultaneously altering the native species composition. This ongoing transformation in landing patterns from Indian major carps and large catfishes to minor cyprinids, small catfishes, shads, croakers, and spiny eels has been underway since the 1950s and 1960s. These changes signify a major reorganization in the river's fish assemblage structure[17].

Conclusion

This decadal analysis of fish landings reveals significant temporal and spatial shifts in the productivity of the Ganga River's fishery resources. While historical data emphasize the river's rich fish diversity and productivity, recent trends underscore the urgent need for sustained ecological restoration and targeted policy interventions. Key drivers of change include variations in fishing gear and differences in accessibility to fishing zones and a range of environmental stressors. As discussed earlier, factors such as water abstraction, reduced river flow, pollution, and climate change, when combined with the unscientific and indiscriminate fishing methods, have significantly affected the fisheries of the Ganga River. Additionally, the introduction and spread of exotic species has substantially altered the composition of fish landings, with their contribution becoming particularly prominent, particularly in the middle stretches of the river. To restore and sustain the river's ecological balance and fishery potential, continuous monitoring and long-term data collection are essential. Integrated basin-level management strategies, such as river ranching, will also play a critical role in reviving and preserving the Ganga's aquatic biodiversity.

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