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Original Article

Repercussion of Baranai River Sanctuary on Protection and Restoration of Fish Diversity

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Abstract

Background: The research was conducted to reveal the impact of the Baranai river sanctuary on protection and restoration of fish diversity under Bagmara upazila in Rajshahi district. **Objective:** This research paper was discussed fish diversity in river adjacent to and removed from protected areas, current fishing practices, perceptions among local community members about the effectiveness of the Baranai river sanctuary and benefits that local fishers derive from the sanctuary. **Methodology:** This study method was followed to assess the objectives of the study were questionnaire interviews, FGD, catch observation. The study was conducted in Baranai river from January to December 2024. **Results:** During the study, it was found that a total of 28 fish species were recorded under different order. The most dominant order is Cypriniformes. It contains 32.1% fish of total fish catch. The second largest order is siluriformes (21.4%). During the study, it was found that 21 fish species were recorded with kheoya jal and ber jal in the sanctuary area. On the contrary, 11 fish species were recorded outside from sanctuary area. There are five fish species have been revived. *(Notopterusnotopterus, Nandus nandus. Botia dario, Wallago attu, Setipinna phasa*). The average fish production in the sanctuary area was 2.1 kg/2hour with Kheoya jal and berjal. The average production in the control site was 1.51 kg/ 2hour with kheoyajal and berjal. Findings also reveal that most of the respondents' beliefs about the effectiveness of the sanctuary concern increased fish diversity, though they also report some additional direct and indirect benefits from it. **Conclusion:** In conclusion, the overall fish diversity in Baranai river is increasing as a result of the establishment of the Baranai river Fish sanctuary. *[Journal of Current and Advance Medical Research, January 2025;12(1):27-36]*

Keywords: Fish sanctuary; fish diversity; baranai river; conservation

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Introduction

Bangladesh is renowned for its Haors, Baors, rivers, and Beels, which are vital ecosystems that support diverse aquatic life. There is an urgent need to restore fish habitats in rivers and other open waters, as the conservation of freshwater fisheries is recognized as a critical global concern[1]. Protected areas, functioning as a resource management tool, can play a significant role in restoring freshwater biodiversity[2]. Bangladesh ranks third in Asia in fish bio-diversity, with around 800 species in its fresh, brackish, and marine water bodies[3]. The inland fish production has declined from 50.0% to 35.0% of the total fish production due to factors such as overexploitation of inland water bodies, habitat degradation, and declining fish populations in natural water sources. However, marine fish production has remained stable over the past decade[4]. Fishermen in Bangladesh face socioeconomic challenges due to economic, social, and technical limitations, leading to poor income and limited support for their families. The decline in fish diversity is primarily due to lack of conservation measures, natural calamities, lack of skilled manpower, and insufficient management strategies. Poor flood management and unplanned drainage and irrigation projects also contribute to the decline of river, beels, haors, and floodplains.

Bangladesh possesses extensive inland water bodies, totaling 4,652,665 hectares, with 87.0% classified as open water and 13.0% as closed water. Its inland open-water fisheries are the third richest globally, after China and India. In 2009 to 2010, Bangladesh's total fish production reached 2,899,198 metric tons[5]. The fisheries sector is diverse, comprising 260 freshwater fish species, 475 marine species, and various prawn and shrimp species[6]. Dominant inland fish fauna includes major and minor carps, perches, catfishes, shads (including hilsa), snakeheads, loaches, and featherbacks. These groups, particularly shads, represent a significant portion (40.0%) of the total inland catch. The freshwater prawn genus *Macrobrachium* is represented by nine species. The climate and geography of Bangladesh are highly suitable for aquaculture and fisheries management, with abundant water resources and diverse cultivable species[7].

The government of Bangladesh and a number of non-government organizations have taken a number of regulatory and development interventions for sustainable management of the natural fisheries. In order to preserve the loosing trend and ensure sustainability of fish biodiversity and production from inland open water various measures for protection, conservation and management of fisheries resources have been adopted time to time. Among the measures are the implementation of fish protection and conservation act 1950 and related rules including new fisheries management policy like licensing and fishing rights directly to the true fisher, community-based fisheries management (CBFM), establishment of fish sanctuary in the strategic points of the rivers and floodplains, fish stock enhancement through releasing fish seed in seasonal floodplain and fish habitat improvement through establishment of sanctuaries.

The establishment of the Baranai River sanctuary in Bagmara Upazila, Rajshahi District, presents a crucial intervention for the protection and restoration of local fish diversity. Riverine sanctuaries, when effectively managed, serve as vital refugia for fish populations, allowing for breeding and growth, thus bolstering species richness and abundance[8]. These sanctuaries can mitigate the impacts of overfishing, habitat degradation, and pollution, which are significant threats to freshwater biodiversity in Bangladesh. By providing a protected environment, sanctuaries can facilitate the recovery of threatened and commercially important fish species, contributing to the long-term sustainability of fisheries resources. Furthermore, the success of such initiatives often depends on the active participation of local communities, who stand to benefit directly from the restored fish populations[9]. Therefore, the Baranai River sanctuary not only holds ecological significance but also represents a potential model for integrated conservation and resource management in similar riverine ecosystems across Bangladesh.

Between 1960 and 1965, the Department of Fisheries (DoF) established 23 fish sanctuaries in various floodplains, followed by 25 more from 1965 to 1970 and 10 in 1987 under the Integrated Fisheries Development Project. By 2007, a total of 464 permanent fish sanctuaries covering 1,746 hectares had been created[10]. These sanctuaries are recognized as the most effective conservation measure for preserving fish biodiversity, especially in challenging administrative and social contexts. Despite their significance, research in Bangladesh has largely concentrated on narrow aspects of fish sanctuaries[11-13]. Nonetheless, they have proven effective in managing and conserving fish and other aquatic organisms[10]. The sanctuaries are constructed using tree branches and roots, fixed with bamboo poles, and covered with water hyacinth, resembling Fish Aggregating Devices

(FADs). Fish sanctuaries serve as protected areas in aquatic environments, where fishing is strictly prohibited, allowing fish and other aquatic species to shelter, survive, and reproduce undisturbed[14-16].

Historically, the primary source of fish production in Bangladesh was the inland open water capture fisheries, which accounted for approximately 90.0% of the country's total fish production[17]. However, freshwater fisheries resources have experienced a significant decline over the past 30 years, adversely affecting fish biodiversity and the fishing community[18]. The fisheries sector provides full-time employment to an estimated 1.2 million fishermen[19-20], with around 10 million households approximately 64.0% of all households partially dependent on fishing for subsistence, particularly in flooded areas[21-22]. Additionally, another 10.0% of the poor and middle-class population engage in part-time fishing, aquaculture, fish seed production, shrimp seed collection, fish handling, processing, marketing, net making, and input supply[19].

Limited research on fish sanctuaries in Bangladesh focuses on their impact on fish diversity and livelihood conditions, with most studies lacking localized insights. It's unclear if these sanctuaries offer sustainable improvements or require additional policy measures. This research proposal focuses on the Baranai River in Rajshahi, Bangladesh, a unique ecological and socio-economic system. It aimed to analyze fish diversity integrating ecological conservation and socio-economic well-being. The study was also exploring local perceptions and engagement with fish sanctuaries, addressing challenges faced by fishermen and providing alternative livelihood support. The long-term sustainability of fish sanctuaries was assessed, providing recommendations for policy measures. The proposal also addressed the gap in localized impact assessment of fish sanctuaries, addressing the gap by providing a comprehensive analysis of the Baranai River case. Thus, the study aimed to assess fish diversity in the Baranai River, determine the impact of fish sanctuaries on fish diversity.

Methodology

Study Settings and Population: This was a cross-sectional study. This study was conducted in the Department of Fisheries, Faculty of Fisheries at University of Rajshahi, Rajshahi, Bangladesh.

Selection of the Study Area: The study was conducted for a period of one year from January to December 2025 in the Baranai river under Bagmara upazila in Rajshahi district.

Sample Collection Sites: In the study area, there is a large community of fisher man who earn their livelihood by fishing. Among the fishermen, a number of 25 experienced fishermen were chosen for data collection for the research. Most of the fishermen among the selected are poor and a few are in good economic condition. The targeted group lives in the area adjacent to Baranai river of Bagmara upazila in Rajshahi district.

Data Collection: The study used a questionnaire designed in two sections: close and open form, with descriptive questions to gather necessary information. A draft questionnaire was created for 10 fishermen, and new information was collected through unintended questions. Secondary data was gathered from literature and questionnaire interviews. Primary data was collected through questionnaire interviews, Participatory Rural Appraisal (PRA) tools like Focus Group Discussion (FGD), crosscheck interviews with experienced informants, and direct observation.

Figure I: Showing the Study Area

The questionnaire interviews were conducted with selected fishermen, who provided relevant and necessary information. FGD sessions were organized, with 5 to 10 participants each. Crosscheck interviews were conducted to check and evaluate data, correcting for misinformation and justification. Direct observation was used to observe different captured fish species, gears, and crafts crafts used for fishing, and nets.

The study also examined the impact of fish sanctuary on fish diversity and livelihood conditions of fishermen in the Baranai river. Fish catch was observed both within and outside the

sanctuary area, two kilometers away, and compared to the sanctuary area.

Statistical Analysis: The study utilized tabular technique for data processing and analysis, employing statistical tools like percentages and averages. Microsoft Excel was utilized for data visualization. Materials included notebooks, questionnaire sheets, pen and pencil, eraser, and digital cameras.

Ethical Consideration: This study were conducted following standard ethical guidelines. Informed consent was obtained from all participants before interviews or surveys, and participation were voluntary. The confidentiality and anonymity of respondents were maintained, and all collected information were used solely for academic purposes. Necessary permission was obtained from the relevant authorities before fieldwork. Fish diversity assessment and field observations were carried out without causing harm to the river ecosystem or fish populations, following the fisheries and environmental regulations of Bangladesh.

Results

Fish Diversity in the Baranai river: A systematic survey was conducted in the Baranai river from January to January 2025 to identify and evaluate fish diversity. Observations of fish catch and market, questionnaire interviews, and reliable sources were used to identify species. 28 fish species were found, categorized into 7 order and 13 families. Cypriniformes, the most dominant order, had the largest number of fish, comprising 9 species from two different families. Other order groups included Channiformes, Siluriformes, Clupiformes, Mastacembeliformes, Anabantiformes, and Perciformes. Cypriniformes was the most dominant order, accounting for 32.14% of the fish, followed by Channiformes, Mastacembeliformes, and Anabantiformes with 7.14%.

Table 1: List of Fish Species Found in the Baranai River During the Study Period

Order	**Family**	**Local name**	**Scientific name**	**Remarks**
Cypriniformes	cyprinidae	Rui	*Labeo rohita*	Rare
		Katla	*Catla catla*	Rare
		Bata	*Labeo bata*	Rare
		Kalibau	*Labeo kalbasu*	Abundant
		Punti	*Puntius ticto*	Abundant
		Chela	*Chela cachius*	Common
		Mola	*Amblypharyngodon mola*	Common
	Cobitidae	Falguchi	*Lepidocephalus guntea*	Common
		Rani	*Botia dario*	Common
Channiformes	Channidae	Shol	*Channa striatus*	Less common
		Taki	*Channa punctatus*	Abundant
Siluriformes	Siluridae	Boal	*Wallago attu*	Common
		Poba	*Ompok pabda*	Less common
Heteropneustid-ae		Shing	*Heteropneustus fossilis*	Less common
	Bagridae	Gulsha tengra	*Mystus cavasius*	Common
		Tengra	*Mystus tengra*	common
		Rita	*Rita rita*	common
Clupiformes	Notopteridae	Foli	*Notopterus notopterus*	Common
		Chital	*Notopterus chitala*	Less common
	Engarulidae	Phasa	*Setipinna phasa*	Rare
Mastacemb eliformes	Mastacembelidae	Tara baim	*Macrognathus aculeatus*	Abundant
		Guchi	*Mastacembelus armatus*	Abundant
Anabantiformes	Osphronemidae	Lal Kholisa	*Trichogaster lalius*	Common
		Kalo kholisa	*Trichopodus pectoralis*	Common
Perciformes	Gobidae	Bele	*Glossogobius giuris*	Common
	Decapoda	Chingri	*Macrobrachium lamrrei*	Less common
	Ambassidae	Nama chanda	*Chanda nama*	Common
		Lal chanda	*Parambassis lala*	Commom

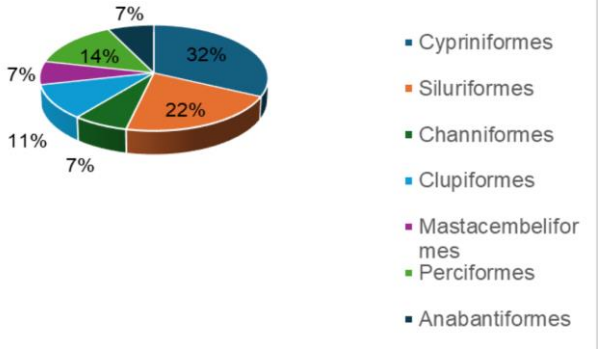

Figure II: Percentage Composition of Fish

Catch Composition: Among the fish species 32.14% fish are from the order Cypriniformes, 21.42 % fish are from siluriformes,14.28% fish are from perciformes, 10.7% are from Mastacembeliformes, the rest percentage and 7.1% are from consecutively anabantiformes and from channiformes. The most dominant order is Cypriniformes and the second most dominant order is siluriformes.

Impact of fish sanctuary on fish diversity: For the study of impact of fish sanctuaries special type of gear (kheuya) was fixed and definite time (2 hours) was considered.

Table 2: List of fish species found in the sanctuary area

Order	**Family**	**Local name**	**Common name**	***Scientific name***	**Abundance status**
Cypriniformes	Cyprinidae	Tit puti		*Puntius ticto*	Abundant
Cypriniformes	Cyprinidae		Swamp barb	*Puntius chola*	Anundant
Cypriniformes	Cyprinidae	Thai sarputi	Java barb	*Barbonymus gonionotus*	Common
Cypriniformes	Cyprinidae	Mola		*Amblypharyngodon mola*	Common
Cypriniformes	Cobidae	Falguchi		*Lepidocephalus guntea*	Common
Cypriniformes	Cobidae	Rani		*Botia dario*	Common
Siluriformes	Siluridae	Boal		*Wallago attu*	Less abundant
Siluriformes	Bagridae	Tengra		*Mystus tengra*	Less anundant
Clupiformes	Notopteridae	Foli		*Ki notopterus*	Less common
Clupiformes	Notopteridae	Chital		*Notopterus chitala*	Rare
Anabantiformes	Osphronemidae	Lal kholisa	Dwarf gourami	*Trichogaster lalius*	Common
Anabantiformes	Osphronemidae	Kalo kholisa	Snake skin gourami	*Trichopodus pectoralis*	Common
Perciformes	Gobiidae	Bele		*Glossogobius giuris*	Less common
Perciformes	Decapoda	Chingri		*Macrobrachium lamrrei*	Less common
Perciformes	Ambassidae	Lal chanda			Common
Cypriniformes	Cyprinidae	Sapoi	White Amur bream	*Parambramis pekinesis*	Rare
Perciformes	Ambassidae	Sada chanda		*Chanda nama*	Abundant
Mastacembeliformes	Mastacembelidae	Tarabaim		*Macrognathus aculeatus*	Common
Mastacembeliformes	Mastacembelidae		Stripped spiny eel	*Mastacembalus pancalus*	Common
Cypriniformes	Cyprinidae	Kalbaus		*Labeo calbasu*	Abundant

Order	**Family**	**Local name**	**Common name**	***Scientific name***	**Abundance status**
Siluriformes	Heteropneustid	Shing		*Heteropneustus fossilis*	Less common

Table 3: List of Fish Species Recorded Outside from Sanctuary Area

Order	**Family**	**Local name**	***Scientific name***	**Abundance status**
Cypriniformes	Cyprinidae	Tit puti	*Puntius ticto*	Abundant
Cypriniformes	Cyprinidae		*Puntius chola*	Abundant
Cypriniformes	Cyprinidae	Sarputi	*Puntius sophore*	Common
Cypriniformes	Cyprinidae	Raikor	*Cirrhinus reba*	Abundant
Cypriniformes	Cyprinidae	Mola	*Amblypharyngodon mola*	Common
Cypriniformes	Cobidae	Falguchi	*Lepidocephalus guntea*	Common
Siluriformes	Bagridae	Tengra	*Mystus tengra*	Less abundant
Anabantiformes	Osphronemidae	Lal kholisa	*Trichogaster lalius*	Common
Perciformes	Ambassidae	Sada chanda	*Chanda nama*	Abundant
Beloniformes	Belonidae	Kakila	*Xenetedon kakila*	Less common
Siluriformes	Heteropneustidae	Shing	*Heteropneustus fossilis*	Less common

The study found 21 fish species in the sanctuary area, with most under the Cypriniformes order (38.1%), followed by Perciformes (29.5%). The remaining species were Siluriformes (14.3%), Clupiformes (9.5%), Anabantiformes (9.5%), and Mastacembeliformes (9.5%). The number of fish species was twice that of the control site. The fish sanctuary positively impacted fish diversity, with five species revived after 5 years, including *Nandus Nandus, Setipinna phasa, Botia dario, Notopterus chitala* and *wallago attu.*

The study analyzed fish production in the sanctuary area and a control site. The sanctuary area had an average fish production of 2.1 kg, with a market value of 150-200 tk per kg. The control site had an average fish production of 1.51 kg. The fish sanctuary had a positive impact on the control site's production, with the sanctuary area having a higher average fish production than the control site. The fish catch in the sanctuary area was higher than in the control site, indicating a positive relationship between the two areas.

Impact of Fish Sanctuary on Fish Production: It was observed that the average fish production in the sanctuary area was 2.1 kg and the average fish production in the control site was 1.51 kg. It was estimated that the fish production in the sanctuary area was higher than that of control site. It had positive impact on the production of fish sanctuary.

Table 4: Average Fish Production according to Study Sites

Study Site	**Average Fish Production**	**Percent**
Sanctuary area (Thanar mor)	2.1 kg	58.2
Control site (Sasti Kali)	1.51 kg	41.8

Fish Species Revived after Establishment of Fish Sanctuary: According to the catch monitoring data and interviews with the farmer it comes out that there are five fish species were not seen for 5 years before the establishment of fish sanctuary. During the questionnaire interviews and catch observation it comes out that these five fish species (*Nandus Nandus, Setipinna phasa, Notopterus chitala, Botia dario, Wallago attu*) has been revived after the establishment of fish sanctuary.

Discussion

The present study demonstrates that the Baranai River Fish Sanctuary has made a substantial contribution to the restoration of fish biodiversity and enhancement of fish production, highlighting the ecological and socioeconomic value of freshwater fish sanctuaries as an effective fisheries management strategy. The sanctuary supported 21 fish species during the study period, with members of the order *Cypriniformes* representing the highest

proportion (38.1%) of the total fish community. This dominance is consistent with the ecological characteristics of many South Asian freshwater ecosystems, where cyprinid fishes constitute a major component of riverine biodiversity because of their broad ecological adaptability, diverse feeding habits, and high reproductive potential. The greater abundance of *Cypriniformes* also suggests that the sanctuary provides suitable habitat conditions, including improved water quality, food availability, and spawning grounds, which facilitate the survival and recruitment of these species[21].

A particularly significant finding of this study is that the sanctuary harbored twice as many fish species as the control site. This substantial difference clearly demonstrates the positive impact of habitat protection and regulated fishing on maintaining aquatic biodiversity[17]. Freshwater ecosystems throughout Bangladesh have experienced considerable declines in fish diversity due to habitat degradation, indiscriminate fishing, river modification, pollution, and climate-related changes. Under such conditions, protected areas such as fish sanctuaries provide safe refuges where fish populations can recover naturally without continuous anthropogenic disturbance. The higher species richness observed within the sanctuary indicates that conservation interventions have successfully restored ecological conditions necessary for sustaining diverse fish communities. Similar improvements in fish diversity following the establishment of sanctuaries have been reported from numerous freshwater ecosystems, where restricted exploitation and habitat enhancement have promoted species recovery and improved ecosystem resilience.

One of the most encouraging outcomes of the present investigation is the reappearance of five fish species—*Nandus nandus*, *Setipinna phasa*, *Notopterus chitala*, *Botia dario*, and *Wallago attu*—that had previously become rare or locally absent from the study area. The recovery of these species provides compelling evidence that the sanctuary has created favorable ecological conditions for their survival and reproduction. Many of these fishes are highly susceptible to habitat destruction and excessive fishing pressure because of their relatively slow growth, specialized habitat requirements, or declining natural populations[17]. Their re-establishment within the sanctuary suggests that reducing human disturbances can facilitate the natural recolonization of sensitive species. This recovery also reflects improvements in habitat quality, including enhanced aquatic vegetation, better water flow, increased shelter availability, and more suitable breeding and nursery grounds[11]. The successful revival of these species emphasizes that habitat conservation is often more effective than relying solely on stocking programs for restoring native fish populations.

Several management interventions likely contributed to the observed increase in biodiversity. The restriction of fishing activities within the sanctuary reduced direct fishing mortality and allowed adult fish to survive longer, reach sexual maturity, and reproduce successfully[9]. Habitat restoration measures may have increased structural complexity within the river by providing submerged vegetation, brush piles, or other sheltering structures that improve spawning success and juvenile survival. Furthermore, the reduction in overfishing decreased pressure on both commercially important and non-target species, allowing natural ecological processes to re-establish balanced fish communities. Together, these conservation measures created an environment conducive to population recovery, resulting in higher species richness and improved community composition[10].

The present study also demonstrated that the sanctuary contributed 58.17% of the total fish production recorded during the investigation, highlighting its significant role in enhancing fisheries productivity. This finding indicates that biodiversity conservation and fisheries production are not mutually exclusive objectives but can be achieved simultaneously through appropriate management practices. Increased fish production within the sanctuary is likely the result of greater breeding success, higher recruitment rates, lower mortality, and improved habitat conditions[13]. The availability of undisturbed breeding grounds allows fish populations to complete their reproductive cycles more successfully, leading to increased juvenile recruitment and subsequent growth of adult populations. As fish abundance increases over time, overall biomass also rises, contributing substantially to total fish production[12].

An additional ecological benefit of the sanctuary may be explained by the well-established "spillover effect." As fish populations increase within protected areas, competition for food and habitat may encourage adult fish and juveniles to disperse into adjacent non-protected waters. This movement can replenish fish stocks outside sanctuary boundaries and improve catches for local fishermen without compromising the sustainability of the protected population[15]. Although the present study primarily evaluated fish abundance within the

sanctuary, the relatively higher fish production and increased catches in nearby areas suggest that spillover may have contributed to enhanced fisheries in surrounding river sections. Similar ecological processes have been documented in both freshwater and marine protected areas, where protected populations serve as sources for recruitment into adjacent fishing grounds. Consequently, fish sanctuaries provide benefits that extend beyond their physical boundaries, supporting both conservation objectives and local livelihoods[11].

The socioeconomic implications of these findings are equally important. River-dependent communities rely heavily on fisheries as a source of food, income, and employment. Declining fish populations not only threaten aquatic biodiversity but also reduce household income and food security for fishing communities. By increasing fish abundance and promoting sustainable harvests, the Baranai River Fish Sanctuary contributes directly to improving the livelihoods of local fishermen. Enhanced fish availability may lead to increased catch per unit effort, reduced fishing costs, and more stable incomes, while simultaneously preserving fish populations for future generations[21]. Thus, the sanctuary represents an effective example of integrating biodiversity conservation with rural socioeconomic development.

Despite these encouraging outcomes, the long-term sustainability of the sanctuary requires continued management and monitoring. Fish populations remain vulnerable to illegal fishing, habitat degradation, pollution, and changing hydrological conditions. Without effective enforcement of sanctuary regulations, recovered fish stocks could rapidly decline if excessive harvesting resumes. Therefore, regular monitoring of species diversity, population dynamics, habitat quality, and fish production should be incorporated into adaptive management programs. Such monitoring will enable managers to evaluate the effectiveness of conservation measures, identify emerging threats, and modify management strategies as necessary.

Community participation is another critical component of successful sanctuary management. The active involvement of local fishermen, community leaders, government agencies, and conservation organizations can strengthen compliance with fishing regulations and foster a sense of shared responsibility for resource conservation[23]. Community-based management approaches have been widely recognized as effective because local stakeholders are more likely to support conservation initiatives when they directly benefit from improved fish production and sustainable resource use. Educational and awareness programs should therefore continue to emphasize the ecological and economic importance of fish sanctuaries, encouraging long-term stewardship of aquatic resources[24].

The findings of this study also have broader implications for fisheries management in Bangladesh and other countries facing similar challenges of freshwater biodiversity loss. Expanding the network of fish sanctuaries, particularly in ecologically important river systems, could substantially enhance fish population recovery, protect threatened species, and improve ecosystem resilience[25]. However, sanctuary establishment should be integrated with complementary conservation measures such as habitat restoration, pollution control, sustainable fishing regulations, and watershed management to maximize long-term ecological benefits.

The Baranai River Fish Sanctuary has demonstrated remarkable success in restoring fish biodiversity, increasing fish production, and supporting the recovery of previously declining fish species. The significantly higher species richness compared with the control site, the revival of five important native species, and the sanctuary's contribution to more than half of the total fish production collectively demonstrate the effectiveness of protected areas in freshwater ecosystem management. These findings reinforce the role of fish sanctuaries as an evidence-based conservation strategy capable of balancing ecological restoration with socioeconomic development. Continued protection, scientific monitoring, habitat improvement, and strong community engagement will be essential to sustain these achievements and ensure that the Baranai River Fish Sanctuary continues to serve as a model for freshwater fisheries conservation and sustainable livelihood development in Bangladesh and beyond.

Conclusion

This study demonstrates the significant positive impact of the Baranai River fish sanctuary on both fish diversity and the livelihoods of local fishermen in Bagmara Upazila, Rajshahi District. The sanctuary has effectively served as a refuge, supporting a rich diversity of fish species, with a notable revival of previously scarce species. The increased fish production within the sanctuary, coupled with the "spillover effect" benefiting adjacent areas, underscores the sanctuary's role in enhancing fish stocks and supporting local fishing

communities. The dominance of the Cypriniformes order and the overall increase in species richness highlight the ecological benefits of protected areas in restoring and maintaining aquatic biodiversity. The Baranai River fish sanctuary needs to be expanded and connected to promote biodiversity conservation. Community engagement and education are crucial for its maintenance and protection. A long-term monitoring program is needed to assess the sanctuary's ecological health. Alternative livelihoods for fishermen, such as aquaculture or ecotourism, can be promoted. Robust policies and regulatory frameworks are needed for long-term sustainability. Climate change adaptation strategies should be integrated into sanctuary management plans. Collaborative management among government agencies, NGOs, and local communities is also recommended.

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Conflict of Interest
The authors have no conflicts of interest to disclose

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Data Availability
Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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