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Evaluation of Water Quality and Identification of Faunal Composition of Nuapokhari an Urban Freshwater System Near Bhubaneswar, Odisha

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ABSTRACT: India holds an eminent position in the realm of inland fishery resources, with its indigenous aquatic biodiversity playing a pivotal role in sustaining both the ecosystem and the livelihoods of rural fishing communities. The economically disadvantaged inland fishers and local populations rely profoundly on these native fish species for their sustenance and economic well-being.

Since fishery resources are intrinsically tied to the availability and quality of water, the present study was meticulously undertaken to identify fish species and assess the water quality parameters of the Nuapokhari Pond. This distinguished water body lies in close proximity to Bhubaneswar, geographically positioned at 20°15′N latitude and 85°85′E longitude, elevated approximately 54 meters above sea level. Encompassing a vast expanse of 46,114.01 m² (496,367.09 ft²), with a perimeter measuring 827.02 m² (2,713.31 ft), the pond serves as a crucial aquatic habitat.

During the survey, a total of ten fish species and one crustacean species were documented. Among these, the Cyprinidae family emerged as the most dominant, comprising four species, followed by the Bagridae, Heteropneustidae, Mastacembelidae, and Channidae families, each represented by a single species. To further elucidate the ecological status of Nuapokhari Pond, a comprehensive and systematic study was conducted to evaluate and monitor its chemical and biological parameters. For this purpose, ten sampling sites were strategically selected across the pond.

The investigation encompassed an analysis of several physical and chemical parameters—temperature, pH, conductivity, dissolved oxygen (DO), chloride concentration, and alkalinity—over a span of three months (February, March, and April). The pH levels of the water fluctuated between 7.1 and 7.5, while dissolved oxygen (DO) concentrations varied from 3.4 mg/L to 5.4 mg/L, indicating a significant degree of organic pollution at Site 8 and minimal pollution at Site 1. The temperature ranged from 24°C to 30.3°C, while alkalinity levels were recorded between 480.1 mg/L and 486.2 mg/L. Additionally, the conductivity of the water was observed within the range of 331 µS to 383 µS, and chloride concentrations fluctuated between 71.3 mg/L and 95.5 mg/L.

These findings provide valuable insights into the aquatic ecosystem of Nuapokhari Pond, shedding light on its ecological balance and the implications for sustainable fishery management.

Keywords: Nuapokhari Pond, Bagridae, Heteropneustidae, Mastacembelidae, Channidae.

INTRODUCTION

India's rich biological heritage establishes it as one of the world's mega-diverse nations, with its freshwater ecosystems playing a pivotal role in sustaining livelihoods. The fishing trade, a crucial auxiliary of the primary sector, remains integral to India's economy. However, untapped opportunities in this sector necessitate strategic efforts to maximize its potential. Currently ranked ninth globally in fish production, India's fisheries and aquaculture sectors contribute significantly to nutritional security, exports, and employment, engaging nearly fourteen million people and serving as a substantial source of foreign exchange. Following agriculture and weaving, fishing stands as the third-largest livelihood sector in the country.

The evolution of fishing techniques has led to heightened efficiency, yet global fish catch has plateaued at 80 million metric tons per year due to overexploitation, particularly in inland waters. This depletion underscores the rising importance of aquaculture, which has witnessed a consistent annual growth of 8–14% since 1984. Aquaculture mitigates market shortages, stabilizes prices, and strengthens export-driven economies worldwide.

Nuapokhari Pond, the focal point of this study, is a historic, man-made waterbody located 16 km southeast of Bhubaneswar in Odisha. Positioned at 20°15′N latitude and 85°85′E longitude, at an elevation of 54 meters, it spans 46,114.01 m² with a perimeter of 827.02 m². Seasonal rainfall expands its catchment area, briefly transforming it into a lake-like ecosystem, while a perennial underground spring ensures water availability during summer. However, two sewage inlets pollute the pond, while an outlet regulates excess water into adjacent fields. The pond is bordered by agricultural lands, fruit orchards, and dense groves of jackfruit, fig, and mango trees, with a village on one side. Depth measurements indicate 10 feet in summer and up to 18 feet in the monsoon. Historically, Mukundadev Maharaja, the Gajapati King of Odisha, commissioned its construction, later restored by a local Zamindar in 1897. Post-independence, its stewardship was entrusted to three villages, which continue its maintenance.

The biological productivity of aquatic ecosystems directly correlates with their physico-chemical attributes, influencing both trophic dynamics and fisheries potential. Water quality profoundly governs aquatic life, dictating survival, reproduction, and productivity. Standard parameters—temperature, dissolved oxygen (DO), pH, conductivity, and alkalinity—are critical for aquaculture sustainability. Dissolved oxygen, a key indicator of water purity, fluctuates with temperature and organic matter influx, impacting nutrient solubility and ecosystem productivity.

A declining fish biodiversity coupled with increasing anthropogenic pressures threatens freshwater ecosystems. Regular ecological monitoring, proper inventorying of aquatic diversity, and improved water quality management are imperative to sustaining fisheries and enhancing livelihoods. Beyond its ecological significance, the fisheries sector bolsters global economies, provides employment, and fosters subsidiary industries, making its conservation a priority for long-term prosperity.

MATERIAL AND METHODOLOGY

Study Area: Nuapokhari is a large, man-made pond located 16 km southeast of Bhubaneswar, Odisha, at 20°15′N latitude and 85°85′E longitude, with an elevation of 54 meters above sea level. The pond covers an extensive 46,114.01 m² (496,367.09 ft²), with a perimeter of 827.02 m (2,713.31 ft). It maintains a steady water level throughout the year due to a perennial underground spring, ensuring water availability even during dry seasons.

The pond has a natural catchment area that expands during heavy rainfall, briefly transforming into a lake-like ecosystem. However, anthropogenic influences impact water quality, with two sewage inlets from nearby villages introducing pollutants, while a single outlet discharges excess water into adjacent agricultural fields. The surrounding landscape consists of farmland, fruit orchards, and dense groves of jackfruit, fig, and mango trees, contributing to its ecological diversity.

During different seasons, the pond's depth varies significantly, measuring approximately 10 feet in summer and reaching up to 18 feet during the monsoon. Given its historical significance, Nuapokhari was originally constructed by Mukundadev Maharaja, the Gajapati King of Odisha, and later renovated by a local Zamindar in 1897. Post-independence, its management was entrusted to three villages, which continue to oversee its upkeep.

Collection, Preservation, and Identification of Fish Fauna. Fish samples were systematically collected from multiple sampling sites within the pond, ensuring representation of diverse aquatic habitats. Local fishermen assisted in the collection process using cast nets, a widely employed traditional fishing technique.

Once captured, the fish specimens were thoroughly washed to remove debris, mud, and bloodstains. The samples collected were photographed for documentation purposes. The fish specimens were identified up to the species level using standard fish databases and taxonomic keys. Each fish specimen was examined for morphological features, fin structure, body coloration, and other distinguishing characteristics to ensure accurate species identification.

Physico-Chemical Analysis of Pond Water. To evaluate the water quality and ecological status of Nuapokhari Pond, a systematic physico-chemical assessment was conducted.

Sampling Strategy. Water samples were collected from ten strategically selected sites, ensuring comprehensive coverage of:

1. Shallow and deep zones to capture depth-related variations.
2. Inflow and outflow points to assess pollution levels and water movement.
3. Areas affected by human activities such as washing, bathing, and fishing.

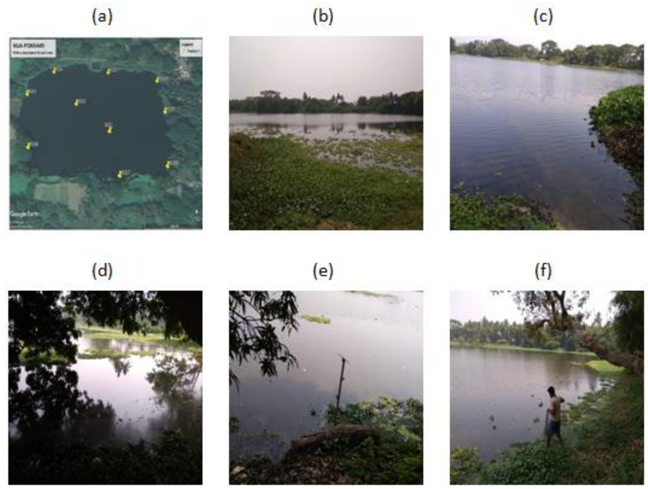

Fig. 1 (a) Sampling sites using Google Earth (SS) across the pond (b) SS-3 (c) SS-4 (d) SS-6 (e) SS-7 (f) Netting for fish collection.

Sampling Procedure. Sampling was carried out monthly from February to April. At each site, 1L inert plastic bottles (pre-rinsed with distilled water) and BOD bottles were used for sample collection. The sampling protocol followed standard procedures to prevent contamination and maintain sample integrity: Each bottle was submerged 10 cm below the water surface before being opened and resealed underwater to capture a representative sample. The collected samples were immediately preserved to prevent chemical alterations. Sample containers were securely sealed, labelled, and documented, including details such as sampling site, date, time, and environmental conditions at the time of collection.

Physico-Chemical Parameters of water: The key water quality parameters like temperature, pH, conductivity, dissolved oxygen, chloride concentration were assessed during the experiment. The temperature was measured in situ using a digital thermometer to record variations across different sampling sites. pH & conductivity was determined using a digital pH and conductivity meter (Spectronic India) to assess water acidity, alkalinity, and ionic content. The dissolved oxygen (DO) content was evaluated using Winkler's methodwhich uses a standard technique for measuring oxygen availability, crucial for aquatic life. The chloride concentration was analyzed to assess the level of dissolved salts and potential contamination.

The analysis of these parameters provided insights into water quality fluctuations, ecological balance, and potential impacts on aquatic biodiversity. By employing a scientific and structured approach, this study aimed to evaluate the health of Nuapokhari Pond, document its fish diversity, and contribute to sustainable fishery management practices.

RESULT

The ichthyofaunal assemblage documented during the study period was meticulously analyzed to evaluate the fish diversity of Nuapokhari pond. The taxonomic classification of the recorded fish species was conducted in accordance with the standardized nomenclature provided by Fish Base (http://www.Fishbase.org), while the conservation status of each species was corroborated against the International Union for Conservation of Nature (IUCN) Red List (IUCN, 2015).

A total of nine fish species and one crustacean species were identified during the survey. However, among the nine ichthyofaunal specimens, one species remained unclassified due to taxonomic ambiguity. The remaining eight species were systematically categorized into four distinct orders and five taxonomic families.

The family Cyprinidae emerged as the most ecologically dominant taxonomic group, comprising four species, followed by the families Bagridae, Heteropneustidae, Mastacembelidae, Channidae, and Penaeidae, each represented by a single species.

1. *Labeo rohita* (Hamilton): *L. rohita*, a prominent Indian major carp, can grow up to 1 meter. A bottom feeder, it thrives on plant matter and decaying vegetation. Reaching maturity by its second year, it spawns in flooded rivers, with riverine specimens being more active and robust than their tank-reared counterparts.

2. *Labeo bata* (Hamilton): Native to India, Bangladesh, and Pakistan, L. bata is also cultivated in reservoirs. It attains a maximum length of 30–35 cm, spawning between June and October. A bottom dweller, it primarily feeds on rotting plants, algae, and plankton.

3. Puntius amphibious (Valenciennes): Commonly known as the scarlet-banded barb, P. amphibious inhabits streams of India and Sri Lanka. It reaches 15 cm in length and feeds on decaying organic matter and algae. Notably, it is also used as a larvicidal fish.

4. *Amblypharyngodon mola* (Hamilton): *A. mola*, a small freshwater fish, grows up to 100 mm and holds high market value in Eastern India. Found across India,

Pakistan, Bangladesh, and Myanmar, it inhabits ponds, canals, slow-moving streams, and paddy fields.

5. *Clarias batrachus* (Linnaeus): *C. batrachus*, a hardy air-breathing fish, reaches 45 cm and thrives in swampy waters. Possessing auxiliary breathing organs, it can survive out of water and even traverse land. Its diet includes insect larvae, worms, shrimps, small fish, aquatic plants, and debris.

6. *Heteropneustes fossilis* (Bloch): *H. fossilis*, renowned for its high nutritional value, grows up to 300 mm and is prized for quick recovery from illness. It holds economic significance and is found in India, Bangladesh, and Nepal.

7. *Macrognathus aculeatus* (Bloch): The lesser spiny eel, *M. aculeatus*, a nocturnal burrower, is native to Southeast Asia, including Thailand, the Malay Peninsula, and India. Though rare in aquariums, it preys on small fish and exhibits crepuscular behaviour.

8. *Channa punctata* (Bloch): *C. punctata*, widely distributed from Afghanistan to China, prefers stagnant waters with muddy substrates. It predominantly feeds on worms, insects, and small fish. While averaging 15 cm, some specimens have been recorded at 31 cm.

9. *Metapenaeus dobsonii* (Miers): *M. dobsonii*, known as chingri, kadal chemmeen, or poovalan chemmeen in India, is native to the west coast of India, the Philippines, and New Guinea. It holds commercial significance in fisheries.

A comprehensive tabular representation has been formulated to elucidate the scientific nomenclature, vernacular (common) names, taxonomic orders, familial classifications, and respective conservation statuses of these aquatic species, as per IUCN (2015).

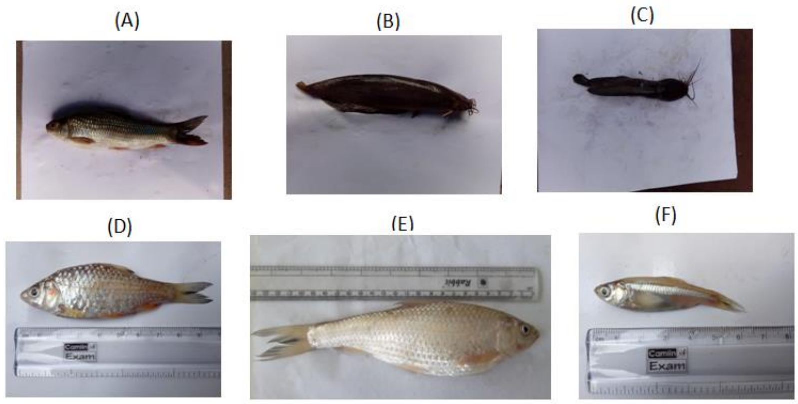

Fig. 2 (A) *Labeo rohita* (B) *Heteropneustes fossilis* (C) *Clarius batrachus* (D) *Puntius species* (E) *Labeo bata* (F) *Amblypharyngodon mola.*

Table 1: The parameters to assess water quality is tabulated for different sites *(n=10)* of the pond across different months.

Month of sampling	Temperature (◦C)	pH	Conductivity (μs)	DO(mg/l)	Bi- carbonate (mg/l)	Free CO_2(mg/l)	Chloride (mg/l)
February	25.8±0.12	6.14±0.19	350.3±1.12	4.27±0.06	244.32±0.58	484.07±0.09	77.52±0.75
March	27.75±0.11	7.21±0.01	362.8±1.12	4.27±0.05	463.32±0.67	483.97±0.14	78.28±0.85
April	29.04±0.16	7.21±0.01	364.6±1.04	4.29±0.05	243.44±0.63	480.57±0.87	78.87±0.87

The pH of water ranged between 7.1 to 7.5. The DO ranged between 3.4mg/L to 5.4 mg/L indicating that site 8 has high level of organic pollution and the site 1 has minimal organic pollution. The temperature ranged between 24◦C to 30.3◦C. The alkalinity ranged between 480.1mg/L to 486.2mgL, the conductivity ranged between 331μS to 383μS and the chloride ranged between 71.3mg/L to 95.5mg/L.

DISCUSSION

Alwar and Jhingran (1991) conducted a seminal study on the inland fish fauna of India, underscoring the pivotal role of fish as an invaluable source of protein and an integral component of the socioeconomic framework of South Asian nations. Over the past quarter-century, burgeoning population growth, accelerated industrialization, and intensive agricultural practices have placed immense pressure on aquatic ecosystems, necessitating novel conservation and management approaches rooted in fundamental research. To ensure the judicious exploitation of these aquatic environments, a comprehensive understanding of biodiversity is imperative. However, compared to developed nations, India's vast and diverse ecosystems remain largely underexplored, with the existing body of research being fragmentary and lacking a holistic perspective. Kelso *et al*. (1999) further contributed to this discourse by investigating the impact of carbon substrates on nitrate accumulation in freshwater systems.

A detailed ichthyofaunal survey conducted by Saha *et al.* (2013) in the Damodar River of West Bengal documented the presence of 46 fish species, classified under seven orders, 18 families, and 26 genera. The study revealed that Cyprinidontiformes constituted the dominant group, comprising 38% of the total fish population, followed by Perciformes (30%) and Siluriformes (26%). Meanwhile, Vijayshree and Krishnan (2014) identified 62 freshwater species across 17 families in Kerala's Kuttanad River, while Kundu *et al.* (2012) investigated seasonal fish diversity under tidal influences within the intertidal mudflats of the Indian Sundarbans.

Expanding upon regional studies, Baliarsing *et al.* (2014) examined the riverine fish diversity of Ganjam district in Odisha, recording 97 species spanning 58 genera, 31 families, and nine orders. Their findings highlighted the Cyprinidae family as the most dominant, comprising 36% of the observed species, followed by Bagridae at 9.2%. Similarly, Singh (2013) conducted an ichthyofaunal assessment of the Mahanadi River, identifying 56 fish species distributed across 35 genera, 19 families, and seven orders.

In terms of environmental influences, Lessard and Daniel (2013) explored the ramifications of elevated water temperatures on fish and macroinvertebrate assemblages downstream of small dams, emphasizing the ecological disruptions caused by summer impoundment-induced thermal alterations. Further, Bhat *et al*. (2014) assessed the critical role of estuarine ecosystems in sustaining marine fisheries, with a case study focusing on the Aghanashini Estuary in Uttara Kannada along Karnataka's western coastline.

Aquaponic systems, which integrate fish rearing with hydroponic agriculture, were investigated by Munshi and Munshi (2015), who examined the interplay between fish welfare, water quality, feed composition, and waste management. This study emphasized the need for a holistic approach in aquaponic operations, ensuring the well-being of co-cultured organisms—including fish, biofilter-associated bacteria, and aquatic plants. Similarly, Mala-Maria (2016) explored the intricate relationship between fish well-being and water quality in Romania's Morii Lake, highlighting its broader implications for human welfare.

The physicochemical and ecological dynamics of lacustrine environments have also been a subject of extensive study. Choudhury and Majumdar (1987) examined basin morphology in relation to lake chemistry, while Edmunds and Miles (2013) provided a geochemical assessment of bath thermal waters. Given that water quality is a fundamental determinant of aquatic health, it remains a primary concern in aquaculture hazard assessments. Essential water parameters—including dissolved oxygen, carbon dioxide, ammonia, nitrate, nitrite, and pH—must be maintained within species-specific tolerances to sustain optimal fish growth. Any abrupt fluctuations in stocking density, feeding regimes, or water volume can precipitate rapid water quality deterioration, with detrimental consequences for fish physiology, metabolic efficiency, and survival.

The ecological interactions within aquatic ecosystems extend beyond fish populations to macroinvertebrates and phytoplankton. The macroinvertebrate distributions in the littoral zones of Lake Coleridge, New Zealand, while Licandro and Ibaney (2000) analyzed the spatial variability of aquatic macrophytes in Lake Waikaremoana. Seasonal fluctuations in freshwater phytoplankton assemblages were documented by Joshi (2011) in the Southern Hemisphere, while Pandey *et al.* (2013) examined phytoplankton dynamics in two tropical lakes, including Sangre Isle Lake in Oklahoma, USA. Vandysh (2004) further studied the correlation between physicochemical parameters and zooplankton communities in the Kola Peninsula, Russia.

The assessment of fish populations in conjunction with physicochemical water parameters provides valuable insights into ecosystem health. Surface water quality is inherently influenced by chemical, physical, and biological pollutants, which exert profound effects on the biosphere and aquatic biodiversity. While micromycetes play a crucial role in maintaining ecological balance, their excessive proliferation poses a potential risk to water quality and aquatic fauna, necessitating vigilant monitoring and sustainable management practices.

Nuapokhari Pond exhibits a moderate diversity of fish species supported by generally favorable water quality parameters. However, localized areas of concern, particularly regarding dissolved oxygen levels and potential organic pollution, necessitate proactive management interventions. By addressing these challenges through comprehensive monitoring and sustainable practices, the ecological integrity of Nuapokhari Pond can be preserved, supporting both biodiversity and the livelihoods of local fishing communities.

CONCLUSIONS

The present study underscores the ecological significance of Nuapokhari Pond as a vital aquatic ecosystem supporting diverse fish species and local livelihoods. The identification of ten fish species and one crustacean species, with Cyprinidae as the dominant family, highlights the pond's rich biodiversity. However, the assessment of physico-chemical parameters reveals fluctuations in water quality, with notable variations in pH, dissolved oxygen, temperature, alkalinity, conductivity, and chloride concentration across different sampling sites.

These findings indicate that while the pond sustains a thriving fish population, organic pollution at certain sites poses a potential threat to aquatic health. The presence of sewage inflows and agricultural runoff underscores the necessity for sustainable water management practices to mitigate pollution and maintain ecological stability.

Given the reliance of local fishing communities on these water resources, implementing conservation strategies, periodic water quality assessments, and community-driven initiatives will be essential for safeguarding both biodiversity and the socio-economic well-being of inland fishers. A holistic approach to pond management can ensure the long-term sustainability of Nuapokhari Pond as a productive and resilient fishery resource.

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