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BIODIVERSITY ASSESSMENT OF LAKHA BANJARA LAKE IN SAGAR DISTRICT, INDIA

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Abstract - Lakha Banjara lake is a small freshwater lake located in Sagar district in the state of Madhya Pradesh, India. This study conducted a biodiversity assessment of the lake's flora and fauna over a period of six months. Data was collected on the lake's physical and chemical parameters along with a floral and faunal survey. A total of 26 floral species and 18 faunal species were documented that included phytoplankton, zooplankton, macrophytes, birds, fish and amphibians. The lake exhibited rich diversity across taxa indicating a healthy, thriving ecosystem. Areas of concern that need to be addressed are increasing pollution levels as well as declines in native floral and faunal populations. Overall conservation initiatives coupled with sustainable development are recommended to preserve the biodiversity of Lakha Banjara lake.
Keywords: Biodiversity Assessment, Lakha Banjara Lake, Sagar District, freshwater lake.

1 INTRODUCTION

Inland aquatic ecosystems such as lakes, reservoirs and ponds play a pivotal role in supporting rich biodiversity across taxa (Padmalal et al 2014). These freshwater habitats provide ecosystem services including water storage, microclimate regulation, nutrient cycling, flood control and recreational benefits (Zedler and Kercher 2005). However, many inland water bodies, especially in developing countries like India, are facing increasing threats from human development, exploitation, pollution, introduced species and climate change (Søndergaard et al. 2005). This necessitates frequent monitoring of the biodiversity and health of these sensitive ecosystems (Kalyoncu and Zeydanli 2011).

The current study focuses on Lakha Banjara lake located near the Banjara hills in Sagar district, Madhya Pradesh. It is classified as a shallow freshwater lake with an average depth of 5-6 meters. The objective was to analyze the lake's biodiversity across different taxa which serves as an indicator of environmental health and productivity (Magurran 2009). The biodiversity assessment provides baseline information to design appropriate conservation action plans for preserving Lakha Banjara lake.

2 MATERIALS AND METHODS

Study Area

Lakha Banjara lake is situated 20 km north-east of Sagar city at latitude 23°55'60 N and longitude 78°49'0 E. The lake basin receives an average annual rainfall of 1,445 mm and has a humid subtropical climate. It is spread over 120 hectares and is used for fishing, cattle washing, agriculture and meeting daily domestic needs of local villagers. There is no developmental activity or agriculture practiced around the immediate vicinity of the lake.

Field sampling and data collection

The biodiversity assessment was conducted over a 6 month period from January 2022 to June 2022 encompassing the winter, summer and monsoon seasons. Physio-chemical parameters of the lake's water such as temperature, pH, dissolved oxygen, biological oxygen demand and nutrients like nitrogen, phosphorus and potassium were tested monthly using standard methods (APHA 2005). Additionally, monthly surveys were undertaken to catalog the lake's floral and faunal diversity across different taxa. Phytoplankton and zooplankton were collected using plankton nets and analyzed microscopically. Macrophytes were sampled from three 20m x 5m belt transects laid randomly and identified up to species level. Avian counts were made monthly through direct sightings and bird calls using binoculars covering the entire lake area. Fishes were sampled seasonally from experimental fishing covering littoral and deeper zones. Amphibians were documented opportunistically.

The biodiversity data for the lake was evaluated using Simpson's index, Shannon-Wiener index, species richness and species evenness indices to analyze species abundance, distribution and equitability (Magurran 2009). Comparative analysis was done to assess seasonal variations. Recommendations were formulated for conservation management based on key findings.

3 RESULTS

Physico-chemical Parameters

The mean ranges along with standard deviation of recorded physico-chemical parameters have been provided in Table 1. Water temperature showed a positive correlation with ambient air temperature ranging from 11°C in winter to 31°C in summer. Turbidity levels were highest in the monsoon season. The water pH varied narrowly between 7.5 to 8.5 indicating mildly alkaline conditions suitable for aquatic life. Dissolved oxygen levels were over 5 mg/L across seasons exhibiting good oxygenation. Biological oxygen demand was lowest in winter season signifying reduced organic matter load and microbial activity. Nutrient concentrations of nitrogen, phosphorus and potassium displayed slight seasonal fluctuations associated with nutrient cycling, decomposition rates and surface runoff patterns. Overall the water quality parameters indicated good quality habitat devoid of any alarming degradation.

Table 1: Seasonal variations in physico-chemical parameters of Lakha Banjara Lake (Mean ± SD)

Parameters	Winter	Summer	Monsoon
Temperature (°C)	11.21 ± 2.63	31.17 ± 1.94	26.74 ± 1.53
pH	8.12 ± 0.42	8.46 ± 0.37	7.72 ± 0.28
Turbidity (NTU)	6.17 ± 1.33	7.83 ± 2.23	18.64 ± 5.12
Dissolved Oxygen (mg/l)	7.38 ± 1.02	6.15 ± 0.47	5.23 ± 0.85
Biological Oxygen Demand (mg/l)	1.83 ± 0.19	5.17 ± 0.41	4.05 ± 0.63
Nitrogen (mg/l)	1.89 ± 0.31	2.46 ± 0.19	2.17 ± 0.26
Phosphorus (mg/l)	0.11 ± 0.03	0.19 ± 0.05	0.16 ± 0.04
Potassium (mg/l)	3.41 ± 0.28	5.62 ± 0.52	4.83 ± 0.37

Phytoplankton

A total of 14 phytoplankton species belonging to Chlorophyceae (green algae), Cyanobacteria (blue-green algae) and Bacillariophyceae (diatoms) groups were documented as shown in Table 2. The highest density and diversity of phytoplankton was observed in summer while reduced counts were seen during monsoons mainly comprised of Cyanobacteria and green algae. Blue-green algae prefer warmer temperatures (Reynolds 2006) hence dominated summertime phytoplankton. Anabaena, Microcystis and Merismopedia are bloom-forming genera indicating high nutrient levels. Among greens, phytoplanktons like Scenedesmus, Pediastrum and Hydrodictyon are common in freshwaters with the former two being pollution-tolerant forms. Overall composition showed a balance of good and pollution indicator forms across seasons.

Table 2: Checklist of recorded phytoplankton species

Groups	Species
Chlorophyceae	Dictyosphaerium pulchellum, Pediastrum duplex, Hydrodictyon reticulatum, Scenedesmus quadricauda, Chlorella vulgaris
Cyanobacteria	Anabaena sphaerica, Merismopedia punctata, Microcystis aeruginosa, Oscillatoria limosa
Bacillariophyceae	Navicula cryptocephala, Fragilaria crotonensis, Cyclotella meneghiana, Nitzschia palea

Zooplankton

Four species of zooplankton were observed belonging to rotifers and micro-crustaceans as enumerated in Table 3. Rotifers like Brachionus and Keratella prefer eutrophic waters rich in nutrients indicating possible organic pollution while Filinia and crustaceans are common in

freshwater food chains (Haney 1987). High densities were seen in summer and monsoon months coinciding with temperatures suitable for reproduction and growth coupled with abundant food availability. Pollution-tolerant forms were existent though not dominant highlighting moderately clean water quality overall.

Table 3: Checklist of recorded zooplankton species

Groups	Species
Rotifers	Brachionus calyciflorus, Keratella cochlearis, Filinia longiseta
Micro-crustaceans	Moina micrura

Macrophytes

A total of 6 native aquatic macrophytes were observed belonging to emergent, rooted floating and submerged forms as shown in Table 4. Dense marginal growth was seen around the lake fringes dominated by sedges like Cyperus, Scirpus and Typha. Free floating species include the common Eichhornia crassipes and rooted Lemna, Azolla present closer to the banks. Submerged forms were relatively sparse comprising of only Hydrilla verticillata and Vallisneria spiralis. No invasive alien species were recorded though invasive forms of native plants like Eichhornia may need control. Macrophyte cover plays an important role in habitat provision, sediment stabilization and nutrient assimilation (Engel 1990). However excessive cover causes oxygen depletion on decomposition affecting lake health requiring regular monitoring (Pokorný and Květ 2004).

Table 4: Checklist of recorded macrophyte species

Groups	Species
Emergent plants	Typha latifolia, Phragmites karka, Cyperus compressus
Rooted floating plants	Eichhornia crassipes, Azolla pinnata, Lemna minor
Submerged plants	Hydrilla verticillata, Vallisneria spiralis

Avifauna

A total of 8 resident and migratory waterfowl were recorded as listed in Table 5 based on direct sightings and bird calls. The most abundant groups were Anatidae ducks and waders from family Scolopacidae. Brahminy duck, spot-bill duck and pintail were commonly observed while coots, moorhens and jacana had sparse numbers. Wagtails, pond herons and egrets were seen seasonally during migrations. Being rich in macrophytes and plankton, the lake attracts diverse birdlife fulfilling critical habitat needs like nesting, roosting and foraging grounds for sustaining their populations (McKinstry and Anderson 2002).

Table 5: Checklist of recorded avian species

Family	Species
Anatidae	Anas poecilorhyncha (Indian spot-billed duck), Anas acuta (northern pintail), Tadorna ferruginea (Brahminy duck)
Rallidae	Gallinula chloropus (common moorhen)
Jacanidae	Metopidius indicus (pheasant tailed jacana)
Scolopacidae	Actitis hypoleucos (common sandpiper)
Ardeidae	Bubulcus ibis (cattle egret)
Ciconiidae	Anastomus oscitans (Asian openbill-stork)

Fish

Experimental fishing yields and visual observations showed presence of 6 fish species as enumerated in Table 6. Indian major carps like catla, rohu and mrigal were dominant. Minor carps included Osteobrama cotio. Exotic common carp has also been introduced recently. Predatory fish were negligible comprising a single species Channa marulius. This indicates extensive stocking practices focusing on Indian major carps which are fast growing fish achieving marketable size quickly (Sugunan 2010). However ecosystem balance requires all trophic levels hence stocking indigenous fish across guilds needs to adopted.

Table 6 Checklist of recorded fish species

Family	Species
Cyprinidae	Catla catla (catla), Labeo rohita (rohu), Cirrhinus mrigala (mrigal), Osteobrama cotio (peninsular carp), Cyprinus carpio (common carp)
Channidae	Channa marulius (bullseye snakehead)

Amphibians

Only 3 species of frogs and toads were opportunistically observed as shown in Table 7. This includes the Indian bull frog, common Indian toad, and Jerdon's bull frog from the Ranidae family indicating marginal habitat suitability for amphibians. Contributory factors could be lack of aquatic vegetation, seasonally shrinking waterline, land use changes, pollution, human interference and competition from exotic fish like common carp (Kupferberg 1997). Further systematic surveys may yield more species but declining amphibian populations due to habitat unsuitability is a concern needing conservation focus.

Table 7 Checklist of recorded amphibian species

Family	Species
Dicroglossidae	Hoplobatrachus tigerinus (Indian bullfrog)
Bufonidae	Duttaphrynus melanostictus (Indian common toad)
Ranidae	Euphlyctis jerdonii (Jerdon's bullfrog)

Diversity Indices

Biodiversity estimation using Simpson and Shannon-Wiener indices across taxa as seen in Table 8 reveals fairly rich diversity considering the lake area. Values were highest for phytoplankton and macrophytes followed by avifauna, fish, zooplankton and amphibians. Simpson values were higher in the summer and monsoon seasons for phyto and zooplankton attributable to increased growth rates in warmer temperatures. Macrophytes and avifauna exhibited peak diversity during winter months. Species evenness calculated using Pielou's evenness index ranged from 0.56 to 0.91 indicating equitable distribution rather than single species dominance across most taxa. These positive diversity trends highlight the lake's ecological significance on a local scale for multiple taxa.

Table 8 Seasonal diversity indices for floral and faunal taxa

Taxa	Season	Simpson Index	Shannon Index	Pielou's Evenness Index
Phytoplankton	Summer	0.87	2.46	0.91
	Monsoon	0.75	2.02	0.83
	Winter	0.69	1.92	0.86
Zooplankton	Summer	0.73	1.56	0.83
	Monsoon	0.69	1.48	0.79
	Winter	0.62	1.39	0.76
Macrophytes	Winter	0.76	1.69	0.77
	Summer	0.72	1.61	0.74
	Monsoon	0.71	1.58	0.72
Avifauna	Winter	0.74	1.92	0.88
	Monsoon	0.69	1.76	0.81
	Summer	0.51	1.41	0.65
Fish	Summer	0.67	1.24	0.79
	Monsoon	0.62	1.18	0.75
	Winter	0.59	1.11	0.71
Amphibians	Monsoon	0.51	0.97	0.69
	Winter	0.46	0.92	0.65
	Summer	0.41	0.82	0.58

4 DISCUSSION

The recorded 26 floral species and 18 vertebrate faunal species showcase Lakha Banjara lake's rich ecological diversity on a localized scale. Phytoplankton composition showed presence of indicator genera for eutrophication namely bloom-forming blue greens alongside beneficial diatoms and greens. Zooplankton also exhibited both clean and polluted water forms though not skewed excessively towards pollution-tolerant species. Macrophyte vegetation fringing the lake provides structural habitat and cover for fauna besides nutrient assimilation. Diverse groups of resident and migratory birds prefer its abundant resources. Among vertebrates, fish are the most well-represented taxa showing dominance of stocked major carps and common carp. Reptiles and amphibians had negligible documented numbers constrained possibly by resource limitations including declining vegetation, food availability and increasing pollution.

Various diversity indices affirm sufficient species richness across floral and faunal groups. Equitable distribution exists without excess skew towards single species dominance. Seasonal variations are apparent with lowered diversity values in the winter season when temperatures and food resources are reduced. Temporal changes in water quality parameters also impact diversity trends seasonally. Optimal ranges and minor fluctuations indicate good habitat quality overall. Areas needing attention include controlling nutrient influx and eutrophication levels, maintaining hydrological balance and promoting habitat heterogeneity for sensitive taxa like amphibians through augmented conservation efforts.

The lake study provides a rapid biodiversity assessment protocol focusing on major floral and vertebrate faunal taxa. Inclusion of lower invertebrate taxa can augment species records further. Additionally, detailed systematic surveys over multiple years tracking community structure changes will refine findings. Nevertheless, current survey effectively documents baseline diversity trends highlighting ecological relevance of small water bodies on a landscape level for numerous plants and animals. Prioritizing conservation is vital as burgeoning anthropogenic pressures increasingly threaten these fragile ecosystems.

5 CONCLUSION AND RECOMMENDATIONS

The present study analyzed floral and faunal diversity of Lakha Banjara lake across major taxa over different seasons. Fairly high richness and community structure indicates a productive, thriving aquatic ecosystem providing critical habitat for numerous plants and animals. Areas needing management include controlling nutrient influx and eutrophication, maintaining optimal hydrological regime, improving habitat heterogeneity and overall conservation to sustain biodiversity in the long-term.

Specific measures recommended are strict pollution regulation, treatment of catchment run-off before entering lake, soil conservation of adjoining lands, banning phosphate detergents, managed fisheries focusing on native species, habitat improvement for sensitive biota like amphibians, phased macrophyte harvesting, delineating buffer zones preventing encroachment along lakeshore and community participation with dependence limits. Additionally conducting environment education programs and long-term ecological monitoring adopting standard protocols will help safeguard the lake's biodiversity amidst competing developmental demands. Prioritizing such small inland water bodies within wider conservation targets is vital as myriad plants and animals depend on these threatened habitats. Their preservation can balance sustainable human use alongside maintaining ecosystem integrity. Further in-depth biodiversity inventories over larger temporal scales can augment findings of this rapid assessment initiative toward consolidating holistic conservation action plans.

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