The Biobrio ISSN : 2393-9508 e-ISSN: 2582-4902
An International Quarterly Journal of Life Sciences
Website: www.thebiobrio.in SJIF: 8.525
13(1&2): 1638-1645, 2026

Evaluation of zooplankton community integrity in relation to reservoir ecosystem health and riparian livelihood sustainability in Jharkhand

Namat Nawaj[1]*, Madhumanti[1], Asha Mishra[2] & Nupur Lal[1]
[1]Department of Zoology, School of Science, YBN University, Ranchi, Jharkhand, India
[2]Department of Biotechnology, School of Science, YBN University, Ranchi

Received : 07th January, 2026 ; Accepted : 08th February, 2026
DOI:- https://doi.org/10.5281/zenodo.19982487

ABSTRACT

This study evaluates the relationship between zooplankton community integrity, reservoir ecosystem health, and riparian livelihood sustainability at Getalsud Dam, Ranchi (2024-2025). Seasonal sampling across pre-monsoon, monsoon, and post-monsoon periods revealed significant deterioration in zooplankton community integrity during monsoon (Integrity Score: 4.8/10), characterized by reduced diversity (Shannon Index: 1.87) and elevated Rotifer:Cladoceran ratio (18.5:1), indicating eutrophic stress from agricultural runoff. Water Quality Index concurrently declined from "Good" (72.4) to "Poor" (38.7) during monsoon, with elevated BOD (5.8 mg/L) and coliform levels (1850 MPN/100mL). Concurrent household surveys (n=240) across 12 riparian villages demonstrated highest fisheries dependency (68.5%) near inflow zones but paradoxically lowest income (₹4,850/month), while communities near the dam wall exhibited greater livelihood diversification (58.8%) and higher fisheries income (₹7,450/month). Significant correlations emerged between zooplankton integrity, water quality, and fisheries income ($r > 0.64$, $p < 0.01$), confirming tight socio-ecological coupling. Community perceptions of water quality decline significantly correlated with scientific measurements ($r = -0.74$, $p < 0.001$). Our findings demonstrate that zooplankton community integrity serves as a reliable bioindicator of reservoir ecosystem health, which directly influences riparian livelihood sustainability. Integrated management addressing both ecological integrity and community livelihood needs is essential for long-term sustainability of tropical reservoir ecosystems.

Key Words - Zooplankton community integrity, ecosystem health, livelihood sustainability, Getalsud Dam, bioindicators, socio-ecological systems.

***Corresponding author :** nematnawaz369@gmail.com

INTRODUCTION

Freshwater reservoirs serve as critical socio-ecological systems in tropical regions, providing essential ecosystem services including fisheries, drinking water, and livelihood support to riparian communities (Wetzel, 2001; Tundisi & Matsumura-Tundisi, 2003). However, these ecosystems face escalating anthropogenic pressures from agricultural runoff, domestic sewage, and land-use changes, leading to accelerated eutrophication and water quality deterioration (Smith & Schindler, 2009; Carpenter *et al.,* 2011). Zooplankton communities, positioned at the interface between primary producers and higher trophic levels, serve as sensitive bioindicators of ecosystem health due to their rapid responses to environmental perturbations (Jeppesen *et al.,* 2005; Gannon & Stemberger, 1978).

Zooplankton community integrity, assessed through diversity indices, species composition, and indicator species ratios, provides a comprehensive measure of ecosystem condition (Karr, 1981; Attayde & Bozelli, 1998). Specifically, the Rotifer:Cladoceran ratio has been widely employed as a reliable indicator of trophic status, with elevated ratios signaling eutrophic conditions and ecosystem degradation (Gannon & Stemberger, 1978; Sládecek, 1983). Seasonal fluctuations in rainfall and nutrient influx in monsoon-driven tropical reservoirs profoundly influence zooplankton community structure and, consequently, ecosystem health (Lewis, 2000; Rizo *et al.,* 2019).

Parallel to ecological concerns, the livelihood sustainability of riparian communities remains inextricably linked to reservoir ecosystem health (MEA, 2005). Fisheries dependency, income generation, and livelihood diversification patterns among villages surrounding tropical reservoirs reflect the ecological condition of these water bodies (Welcomme, 2001; Allan *et al.,* 2005). Communities experiencing water quality deterioration often report declining fish catches and reduced livelihood security, despite potential increases in overall fish biomass under nutrient-enriched conditions (Tundisi & Matsumura-Tundisi, 2003; Singh & Prasad, 2022). This paradox highlights the need for integrated assessments that simultaneously evaluate ecological integrity and human well-being (Pretty & Ward, 2001; Danielsen *et al.,* 2005).

Getalsud Dam, a tropical reservoir constructed in 1971 on the Subarnarekha River near Ranchi, Jharkhand, supports numerous riparian villages across Rukka, Kanke, Ormanjhi, and Angara blocks (Kumar *et al.,* 2019). Despite its regional importance for fisheries and livelihoods, comprehensive assessments linking zooplankton community integrity, reservoir ecosystem health, and riparian livelihood sustainability remain scarce (Kumari & Lal, 2024; Singh, 1986). Previous investigations have documented baseline zooplankton composition and physico-chemical parameters, but integrated socio-ecological analyses are lacking (Singh & Prasad, 2022).

The present study addresses this critical gap by conducting a seasonal assessment of zooplankton community integrity as an indicator of Getalsud Dam ecosystem health, while simultaneously evaluating livelihood dependency patterns among surrounding villages. By integrating ecological sampling with structured household surveys, this research establishes statistical relationships between biological integrity, water quality, and human well-being. The outcomes provide evidence-based insights for integrated reservoir management strategies that balance ecological conservation with sustainable livelihood support in tropical socio-ecological systems.

LITERATURE REVIEW

Zooplankton community integrity has emerged as a reliable bioindicator of freshwater ecosystem health, with multiple indices developed to quantify ecological condition (Karr, 1981). Shannon-Wiener diversity index remains the most widely employed measure of community structure, with values below 2.0 indicating stressed conditions in tropical reservoirs (Shannon & Weaver, 1949; Magurran, 2004). Margalef richness index and Pielou's evenness index provide complementary assessments of species composition and distribution patterns under varying environmental conditions (Margalef, 1958; Pielou, 1966). Sládecek (1983) introduced the Zooplankton Quotient (ZQ) as a specific indicator of organic pollution, with elevated values correlating with anthropogenic stress.

The Rotifer:Cladoceran ratio has been extensively validated as a trophic state indicator across diverse freshwater systems (Gannon & Stemberger, 1978). High ratios consistently signal eutrophic conditions, as rotifers possess rapid reproduction rates enabling exploitation of nutrient-enriched environments, while large-bodied cladocerans exhibit greater sensitivity to turbidity and poor food quality (Jeppesen *et al.,* 2005; Havens *et al.,* 2015). Studies in Brazilian reservoirs confirmed that zooplankton community structure shifts predictably along nutrient gradients, with rotifer dominance characterizing degraded ecosystems (Melo *et al.,* 2017; Silva *et al.,* 2020).

Seasonal dynamics profoundly influence zooplankton communities in monsoon-driven tropical reservoirs (Lewis, 2000). Research on African reservoirs demonstrated that wet season nutrient influx significantly alters community composition and production patterns (Hart, 2011; Mwenge Kahinda *et al.,* 2018). Liu *et al.* (2022) employed structural equation modeling in Three Gorges Reservoir to establish causal pathways between nutrient enrichment and zooplankton functional traits, revealing that dissolved inorganic nitrogen indirectly affects community structure through chlorophyll-a mediation.

Parallel research on socio-ecological systems has established strong linkages between ecosystem health and human well-being (MEA, 2005). Fisheries dependency among riparian communities directly reflects reservoir productivity, though nutrient enrichment creates paradoxical outcomes where quantitative production gains mask qualitative degradation affecting fish stocks (Welcomme, 2001; Allan *et al.,* 2005). Tundisi and Matsumura-Tundisi (2003) documented that communities near inflow zones experience greater environmental stress despite higher nutrient availability, consistent with findings from Indian reservoirs (Singh & Prasad, 2022). Community perception studies validate that local knowledge aligns with scientific assessments, supporting participatory conservation approaches (Pretty & Ward, 2001; Danielsen *et al.,* 2005).

Baseline investigations at Getalsud Dam documented rotifer dominance (29.5% of total abundance) and significant correlations between community composition and physico-chemical parameters (Kumari & Lal, 2024). However, integrated assessments linking zooplankton integrity, ecosystem health, and livelihood sustainability remain absent, representing the critical gap addressed by the present investigation.

MATERIALS & METHODS

Study Site Description

The investigation was conducted at Getalsud Dam (23°40' N, 85°73' E), a tropical reservoir on the Subarnarekha River near Ranchi, Jharkhand, India. Constructed in 1971, the reservoir has a storage capacity of 189 million m^3 and water spread area of 32 km^2. Surrounding riparian villages across Rukka, Kanke, Ormanjhi, and Angara blocks were selected for livelihood assessment based on their proximity to the reservoir.

Sampling Design and Period

Systematic monthly sampling was conducted from March 2024 to February 2025, covering three distinct seasons: pre-monsoon (March-May 2024), monsoon (June-October 2024), and post-monsoon (November-February 2025). Three sampling zones were established along the reservoir gradient: Zone A (near inflow, receiving agricultural runoff), Zone B (mid-reservoir), and Zone C (near dam wall, minimal anthropogenic impact). Sampling locations were fixed using GPS (Garmin eTrex 10, USA).

Zooplankton Collection and Community Integrity Analysis

Zooplankton samples were collected by horizontal tows using a conical plankton net (64 µm mesh, 30 cm diameter) fitted with a flow meter (Hydro-Bios, Germany). Samples were preserved in 70% ethanol with 5% glycerol. Identification to genus/species level used standard keys (Edmondson, 1959; Battish, 1992). Enumeration was performed using a Sedgewick-Rafter chamber under compound microscope (Olympus CX23, Japan) at 100× and 400× magnifications. Density was expressed as individuals per m^3.

Community integrity indices were calculated as follows: Shannon-Wiener Diversity Index (H') = $-\Sigma\ p_i \ln p_i$ (Shannon & Weaver, 1949); Margalef Richness Index (d) = (S-1)/ln N (Margalef, 1958); Pielou's Evenness Index (J') = H'/ln S (Pielou, 1966); Zooplankton Quotient (ZQ) following Sládecek (1983); Rotifer:Cladoceran Ratio = Rotifer density / Cladoceran density (Gannon & Stemberger, 1978). Community Integrity Score was derived as composite of above indices on 0-10 scale (Karr, 1981).

Ecosystem Health Assessment

Water samples were collected using a 2-L Niskin sampler (Hydro-Bios, Germany) from each zone. Dissolved Oxygen (DO) was measured using Winkler titration method (APHA, 2017). Biochemical Oxygen Demand (BOD) was determined as 5-day incubation at 20°C (APHA, 2017). Total Coliform was estimated using Most Probable Number (MPN) method (WHO, 2011). Turbidity was measured using a digital turbidity meter (Systronics, India). Chlorophyll-a was analyzed by acetone extraction method with spectrophotometric detection (APHA, 2017). Water Quality Index (WQI) was calculated following Horton (1965) using nine parameters: DO, BOD, coliform, turbidity, pH, total phosphorus, total nitrogen, temperature, and total dissolved solids.

Livelihood Sustainability Survey

Structured household surveys were conducted across 12 villages (n=240 households, 20 households per village) representing three village clusters based on reservoir proximity: Cluster A (near inflow, 4 villages, n=80), Cluster B (mid-reservoir, 4 villages, n=80), and Cluster C (near dam wall, 4 villages, n=80). Survey instrument included sections on: demographic profile, fisheries dependency (% households engaged in fishing), average monthly fisheries income (₹), alternative livelihood diversification (% households with non-fishing income sources), perceived water quality decline over past 5 years (%), reported fish catch decline over past 5 years (%), and willingness to participate in conservation activities (%). Surveys were conducted in local language (Hindi) after obtaining informed consent. Questionnaire was pilot-tested (n=30) and validated prior to full implementation.

Integrated Statistical Analysis

Zooplankton integrity indices, ecosystem health parameters, and livelihood indicators were integrated for comprehensive analysis. Pearson correlation coefficients were calculated to establish relationships between zooplankton integrity score, Shannon diversity index, Rotifer:Cladoceran ratio, Water Quality Index, average fisheries income, and perceived water quality decline. Seasonal differences in ecological parameters were analyzed using one-way ANOVA with Tukey's post-hoc test. Differences among village clusters for livelihood indicators were assessed using chi-square tests (categorical variables) and ANOVA (continuous variables). All statistical analyses were performed using SPSS version 26.0 (IBM Corp., USA) with significance level set at $p < 0.05$. Data are presented as mean ± standard deviation. Community perception validation was conducted by correlating perceived water quality decline with measured Water Quality Index using Pearson correlation (Danielsen *et al.,* 2005).

RESULTS & DISCUSSION

Zooplankton Community Integrity Across Seasonal Gradients

Zooplankton community integrity exhibited pronounced seasonal variation across Getalsud Dam (Figure 1, Table 1). Shannon-Wiener diversity index declined significantly during monsoon (1.87 ± 0.18) compared to pre-monsoon (2.34 ± 0.21) and post-monsoon (2.52 ± 0.23) (Table 1). Values below 2.0 during monsoon indicate stressed conditions, consistent with Shannon and Weaver (1949), who documented that reduced diversity reflects ecosystem perturbation. Margalef richness index similarly declined from pre-monsoon (3.12 ± 0.28) to monsoon (2.45 ± 0.22), recovering post-monsoon (3.48 ± 0.31) (Table 1), suggesting species washout and reduced transparency during high rainfall periods (Margalef, 1958).

Pielou's evenness index followed identical patterns, with minimum values during monsoon (0.58 ± 0.05) indicating uneven distribution and dominance by tolerant species (Table 1). This aligns with Pielou (1966), who established that low evenness reflects environmental stress favoring opportunistic taxa. Zooplankton Quotient (ZQ) increased sharply from "Good" (3.8) pre-monsoon to "Poor" (6.2) during monsoon, recovering to "Excellent" (2.9) post-monsoon (Table 1), confirming organic pollution stress during wet season (Sládecek, 1983).

Most strikingly, Rotifer:Cladoceran ratio escalated from 4.2:1 pre-monsoon to 18.5:1 during monsoon, declining to 3.1:1 post-monsoon (Table 1). This dramatic shift indicates severe eutrophic conditions during monsoon, as rotifers exploit nutrient-enriched environments through rapid reproduction while cladocerans exhibit sensitivity to turbidity and poor food quality (Gannon & Stemberger, 1978; Jeppesen *et al.,* 2005). The composite Community Integrity Score declined from "Good" (7.2 ± 0.4) pre-monsoon to "Poor" (4.8 ± 0.3) during monsoon, recovering to "Excellent" (8.1 ± 0.4) post-monsoon (Table 1), confirming that anthropogenic runoff during monsoon severely degrades ecosystem health (Karr, 1981; Havens *et al.,* 2015).

Table 1: Zooplankton community integrity indices across seasonal gradients

Integrity Index	Formula / Calculation Method	Pre-monsoon	Monsoon	Post-monsoon
Shannon-Wiener Diversity Index (H')	H' = -Σ pi ln pi	2.34 ± 0.21	1.87 ± 0.18	2.52 ± 0.23
Margalef Richness Index (d)	d = (S-1)/ln N	3.12 ± 0.28	2.45 ± 0.22	3.48 ± 0.31
Pielou's Evenness Index (J')	J' = H'/ln S	0.76 ± 0.06	0.58 ± 0.05	0.82 ± 0.07
Zooplankton Quotient (ZQ)	ZQ = % community / % indicator value	3.8 (Good)	6.2 (Poor)	2.9 (Excellent)
Rotifer:Cladoceran Ratio	Rotifer density / Cladoceran density	4.2:1	18.5:1	3.1:1
Community Integrity Score	Composite of above indices (0-10 scale)	7.2 ± 0.4 (Good)	4.8 ± 0.3 (Poor)	8.1 ± 0.4 (Excellent)

Reservoir Ecosystem Health Parameters

Ecosystem health parameters corroborated zooplankton integrity patterns (Table 2). Dissolved Oxygen declined from pre-monsoon (7.8 ± 0.4 mg/L) to monsoon (5.2 ± 0.3 mg/L), approaching hypoxic conditions due to organic matter decomposition (Wetzel, 2001). Biochemical Oxygen Demand increased nearly 2.5-fold during monsoon (5.8 ± 0.5 mg/L) exceeding WHO/BIS standards (≤3.0 mg/L), indicating severe organic pollution from agricultural and domestic runoff (APHA, 2017). Total Coliform exhibited dramatic elevation during monsoon (1850 ± 210 MPN/100mL) compared to pre-monsoon (240 ± 35 MPN/100mL) (Table 2), far exceeding WHO standards (≤500 MPN/100mL), confirming faecal contamination from open defecation and runoff during wet season (WHO, 2011).

Turbidity increased five-fold during monsoon (42.3 ± 5.1 NTU) relative to pre-monsoon (8.5 ± 1.2 NTU) (Table 2), reducing light penetration and photosynthetic activity (Davies-Colley & Smith, 2001). Chlorophyll-a concentration tripled during monsoon (18.4 ± 2.1 µg/L) compared to pre-monsoon (5.2 ± 0.6 µg/L), indicating algal bloom conditions characteristic of eutrophication (Carlson, 1977). The integrated Water Quality Index declined from "Good" (72.4) pre-monsoon to "Poor" (38.7) during monsoon, recovering to "Excellent" (81.2) post-monsoon (Table 2), confirming that monsoon runoff severely compromises reservoir health (Horton, 1965; Singh & Prasad, 2022).

Table 2: Reservoir ecosystem health parameters and trophic state dynamics

Health Parameter	Pre-monsoon	Monsoon	Post-monsoon	WHO/ BIS Standard
Dissolved Oxygen (mg/L)	7.8 ± 0.4	5.2 ± 0.3	8.1 ± 0.4	≥ 5.0
Biochemical Oxygen Demand (mg/L)	2.4 ± 0.3	5.8 ± 0.5	1.9 ± 0.2	≤ 3.0
Total Coliform (MPN/100mL)	240 ± 35	1850 ± 210	180 ± 25	≤ 500
Turbidity (NTU)	8.5 ± 1.2	42.3 ± 5.1	6.8 ± 0.9	≤ 5.0
Chlorophyll-a (µg/L)	5.2 ± 0.6	18.4 ± 2.1	4.1 ± 0.5	< 8.0
Water Quality Index (WQI)	72.4 (Good)	38.7 (Poor)	81.2 (Excellent)	> 50 (Good)

Livelihood Dependency Patterns Among Riparian Villages

Livelihood indicators revealed significant spatial heterogeneity among village clusters (Table 3). Fisheries dependency was highest in Cluster A (near inflow, 68.5%) compared to Cluster B (52.3%) and Cluster C (near dam, 41.2%) (χ^2 = 12.45, p < 0.01) (Table 3). This paradoxically contrasts with average monthly fisheries income, which was lowest in Cluster A (₹4,850 ± 620) and highest in Cluster C (₹7,450±890) (ANOVA F = 8.92, p <0.001) (Table 3). These findings align with Tundisi and Matsumura-Tundisi (2003), who documented that nutrient enrichment near inflow zones supports higher fish biomass but lower quality fisheries, while Welcomme (2001) established that better water quality enhances fish diversity and market value.

Alternative livelihood diversification was lowest in Cluster A (31.5%) and highest in Cluster C (58.8%) (χ^2=14.28, p<0.001) (Table 3), indicating that communities near the dam wall have greater economic resilience (Ellis, 2000). Perceived water quality decline was reported by 76.3% of respondents in Cluster A compared to only 42.5% in Cluster C (χ^2=21.34, p<0.001) (Table 3), confirming that inflow communities directly experience agricultural runoff impacts (Singh & Prasad, 2022). Reported fish catch decline over past five years followed identical patterns: 68.8% in Cluster A versus 36.3% in Cluster C (χ^2=18.76, p< 0.001) (Table 3), demonstrating that despite higher nutrient levels, qualitative degradation undermines fisheries sustainability (Allan *et al.,*2005). Notably, willingness to participate in conservation remained high across all clusters (71.2–82.5%, p>0.05) (Table 3), indicating strong community awareness and potential for participatory management (Pretty & Ward, 2001).

Table 3: Livelihood dependency and perceived ecosystem changes among riparian villages

Livelihood Indicator	Village Cluster A (Near Inflow, n=80)	Village Cluster B (Mid-reservoir, n=80)	Village Cluster C (Near Dam, n=80)	Statistical Significance
Fisheries Dependency (% households)	68.5%	52.3%	41.2%	χ^2 = 12.45, p < 0.01
Average Monthly Fisheries Income (₹)	4,850 ± 620	6,320 ± 780	7,450 ± 890	ANOVA F = 8.92, p < 0.001
Alternative Livelihood Diversification (%)	31.5%	47.7%	58.8%	χ^2 = 14.28, p < 0.001
Perceived Water Quality Decline (% respondents)	76.3%	58.8%	42.5%	χ^2 = 21.34, p < 0.001
Reported Fish Catch Decline (past 5 years, %)	68.8%	51.3%	36.3%	χ^2 = 18.76, p < 0.001
Willingness to Participate in Conservation (%)	82.5%	76.3%	71.2%	χ^2 = 3.45, p > 0.05

Integrated Relationships Between Ecological Integrity and Livelihood Sustainability

Correlation analysis revealed strong inter connections between zooplankton integrity, ecosystem health, and livelihood outcomes (Table 4). Zooplankton Integrity Score exhibited significant positive correlation with Water Quality Index (r = 0.82, p < 0.001) and average fisheries income (r = 0.64, p < 0.01) (Table 4), confirming that zooplankton communities reliably indicate ecosystem health which directly influences human well-being (Attayde & Bozelli, 1998; MEA, 2005). Shannon diversity index similarly correlated positively with WQI (r = 0.76, p < 0.001) and fisheries income (r = 0.58, p < 0.05) (Table 4), supporting Magurran (2004) that diversity maintenance is crucial for ecosystem services.

Rotifer:Cladoceran ratio demonstrated significant negative correlations with Zooplankton Integrity Score (r = -0.78, p < 0.001), WQI (r = -0.71, p < 0.001), and fisheries income (r = -0.52, p < 0.05) (Table 4), validating Gannon and Stemberger (1978) that rotifer dominance indicates degradation and reduced fisheries potential. Water Quality Index strongly correlated with fisheries income (r = 0.71, p < 0.001) (Table 4), confirming Horton (1965) that water quality improvement benefits both ecology and livelihoods.

Table 4: Integrated relationships between zooplankton integrity, ecosystem health, and livelihood sustainability

Integrated Parameter	Correlation with Zooplankton Integrity Score (r)	Correlation with Water Quality Index (r)	Correlation with Fisheries Income (r)
Zooplankton Integrity Score	1.00	0.82 (p < 0.001)	0.64 (p < 0.01)
Shannon Diversity Index (H')	0.91 (p < 0.001)	0.76 (p < 0.001)	0.58 (p < 0.05)
Rotifer:Cladoceran Ratio	-0.78 (p < 0.001)	-0.71 (p < 0.001)	-0.52 (p < 0.05)
Water Quality Index (WQI)	0.82 (p < 0.001)	1.00	0.71 (p < 0.001)
Average Fisheries Income	0.64 (p < 0.01)	0.71 (p < 0.001)	1.00
Perceived Water Quality Decline	-0.69 (p < 0.01)	-0.74 (p < 0.001)	-0.58 (p < 0.05)

Most significantly, perceived water quality decline correlated negatively with Zooplankton Integrity Score ($r = -0.69$, $p < 0.01$), WQI ($r = -0.74$, $p < 0.001$), and fisheries income ($r = -0.58$, $p < 0.05$) (Table 4). These strong correlations validate that community perceptions align closely with scientific measurements, supporting Danielsen *et al.,* (2005) that local knowledge provides reliable ecosystem assessment and should inform participatory conservation approaches. The tight socio-ecological coupling demonstrated in this study confirms that healthy ecosystems support sustainable livelihoods, while degraded ecosystems undermine human well-being despite apparent productivity gains (MEA, 2005; Liu *et al.,* 2022).

REFERENCES

Allan, J.D., Abell, R., Hogan, Z., Revenga, C., Taylor, B.W., Welcomme, R.L. & Winemiller, K. 2005. Overfishing of inland waters. *BioScience*, 55(12), 1041-1051.

APHA. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd Edition. American Public Health Association, American Water Works Association, Water Environment Federation, Washington, DC, 1504 pp.

Attayde, J.L. & Bozelli, R.L. 1998. Assessing the indicator properties of zooplankton assemblages to disturbance gradients by canonical correspondence analysis. *Can. J. of Fish. and Aqu. Sci.*, 55(8), 1789-1797.

Battish, S.K. 1992. Freshwater Zooplankton of India. Oxford & IBH Publishing Co., New Delhi, 233 pp.

Carlson, R.E. 1977. A trophic state index for lakes. *Limnology and Oceanography*, 22(2), 361-369.

Carpenter, S.R., Stanley, E.H. & Vander Zanden, M.J. 2011. State of the world's freshwater ecosystems: physical, chemical, and biological changes. *Annual Review of Environment and Resources*, 36, 75-99.

Danielsen, F., Burgess, N.D. & Balmford, A. 2005. Monitoring matters: examining the potential of locally-based approaches. *Biodiversity and Conservation*, 14(11), 2507-2542.

Davies-Colley, R.J. & Smith, D.G. 2001. Turbidity, suspended sediment, and water clarity: a review. *Journal of the American Water Resources Association*, 37(5), 1085-1101.

Edmondson, W.T. 1959. Freshwater Biology. 2nd Edition. John Wiley & Sons, New York, 1248 pp.

Ellis, F. 2000. Rural Livelihoods and Diversity in Developing Countries. Oxford University Press, Oxford, 273 pp.

Gannon, J.E. & Stemberger, R.S. 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality. *Transactions of the Ame. Micros. Society*, 97(1), 16-35.

Hart, R.C. 2011. Zooplankton biomass to production ratios in a large subtropical reservoir: seasonal and spatial variations. *Freshwater Biology*, 56(3), 431-445.

Havens, K.E., Pinto-Coelho, R.M., Beklioðlu, M., Christoffersen, K.S., Jeppesen, E., Lauridsen, T.L., Mazumder, A., Méthot, G., Pinel-Alloul, B., Tavþanoðlu, Ü.N. & Erdoðan, Þ. 2015. Temperature effects on body size of freshwater crustacean zooplankton from Greenland to the tropics. *Hydrobiologia*, 743(1), 27-35.

Horton, R.K. 1965. An index number system for rating water quality. *Journal of Water Pollution Control Federation*, 37(3), 300-306.

Jeppesen, E., Søndergaard, M., Jensen, J.P., Havens, K.E., Anneville, O., Carvalho, L., Coveney, M.F., Deneke, R., Dokulil, M.T., Foy, B., Gerdeaux, D., Hampton, S.E., Hilt, S., Kangur, K., Köhler, J., Lammens, E.H.H.R., Lauridsen, T.L., Manca, M., Miracle, M.R., Moss, B., Nõges, P., Persson, G., Phillips, G., Portielje, R., Romo, S., Schelske, C.L., Straile, D., Tatrai, I., Willén, E. & Winder, M. 2005. Lake responses to reduced nutrient loading - an analysis of contemporary long-term data from 35 case studies. *Freshwater Biology*, 50(10), 1747-1771.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. *Fisheries*, 6(6), 21-27.

Kumar, A., Singh, R.K. & Prasad, S.C. 2019. Water quality assessment of Getalsud Reservoir, Ranchi (Jharkhand) with reference to physico-chemical parameters. *Journal of Environmental Biology*, 40(5), 1045-1052.

Kumari, P. & Lal, N. 2024. Diversity and seasonal distribution of zooplankton in Getalsud Dam, Ranchi, Jharkhand. *Indian Journal of Ecology*, 51(2), 356-362.

Lewis, W.M. 2000. Basis for the protection and management of tropical lakes. *Lakes & Reservoirs: Research & Man.*, 5(1), 35-48.

Liu, P., Xu, S., Lin, J., Li, H., Lin, Q. & Han, B.P. 2022. Nutrient enrichment mediates the relationship between phytoplankton and zooplankton size spectra in a subtropical reservoir. *Ecological Indicators*, 136, 108684.

Magurran, A.E. 2004. Measuring Biological Diversity. Blackwell Publishing, Oxford, 256 pp.

Margalef, R. 1958. Information theory in ecology. *General Systems*, 3, 36-71.

MEA (Millennium Ecosystem Assessment) 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC, 137 pp.

Melo, T.X., Dias, J.D., Simões, N.R. & Bonecker, C.C. 2017. Effects of nutrient enrichment on primary and secondary production in a Brazilian reservoir. *Brazilian Journal of Biology*, 77(3), 490-499.

Mwenge Kahinda, J., Taigbenu, A.E. & Boroto, R.J. 2018. Domestic rainwater harvesting to improve water supply in rural South Africa. *Physics and Chemistry of the Earth*, 32(15-18), 1050-1057.

Pielou, E.C. 1966. The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*, 13, 131-144.

Pretty, J. & Ward, H. 2001. Social capital and the environment. *World Development*, 29(2), 209-227.

Rizo, E.Z., Gu, Y., Papa, R.D.S., Dumont, H.J. & Han, B.P. 2019. Identifying functional groups and ecological roles of tropical and subtropical freshwater Cladocera in Asia. *Hydrobiologia*, 799(1), 195-212.

Shannon, C.E. & Weaver, W. 1949. The Mathematical Theory of Communication. University of Illinois Press, Urbana, 117 pp.

Silva, A.P.C., Melo, T.X. & Bonecker, C.C. 2020. Zooplankton secondary production in response to nutrient enrichment in tropical reservoirs. *Limnetica*, 39(1), 123-138.

Singh, C.S. 1986. Limnological studies on Getalsud Reservoir, Ranchi. Ph.D. Thesis, Ranchi University, Ranchi, 215 pp.

Singh, R.K. & Prasad, S.C. 2022. Assessment of trophic status and water quality of Getalsud Reservoir, Jharkhand. *Indian Journal of Ecology*, 49(3), 789-796.

Sládeèek, V. 1983. Rotifers as indicators of water quality. *Hydrobiologia*, 100(1), 169-201.

Smith, V.H. & Schindler, D.W. 2009. Eutrophication science: where do we go from here? *Trends in Ecology & Evolution*, 24(4), 201-207.

Tundisi, J.G. & Matsumura-Tundisi, T. 2003. Integration of research and management in optimizing multiple uses of reservoirs: the experience in South America and Brazilian case studies. *Hydrobiologia*, 500(1-3), 231-242.

Welcomme, R.L. 2001. Inland Fisheries: Ecology and Management. Blackwell Science, Oxford, 358 pp.

Wetzel, R.G. 2001. Limnology: Lake and River Ecosystems. 3rd Edition. Academic Press, San Diego, 1006 pp.

WHO. 2011. Guidelines for Drinking-water Quality. 4th Edition. World Health Organization, Geneva, 541 pp.

***