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Research Article

# Macroinvertebrate community structure and biomonitoring of pollution in Thomas Reservoir, Kano State, Nigeria: Implications for sustainable management

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**ABSTRACT**

This study assessed water quality in Thomas Reservoir, Nigeria, using macroinvertebrate communities as bioindicators from May 2019 to February 2020. Four sampling sites (A-D) representing varying anthropogenic impacts were examined using an Ekman grab and hand net collections. During the research, 2,086 individuals from 14 families and 17 species across three phyla (*Annelida*, *Mollusca*, and *Arthropoda*) were identified. Dominant taxa included pollution-tolerant Tubifex sp. (13.66%) and Chironomus sp. (11.27%), while sensitive Ameletus sp. showed minimal abundance (0.48%). Spatial analysis revealed the highest diversity at Site A (Shannon H'=0.367) and the lowest at Site C (H'=0.004), corresponding with pollution gradients from agricultural (Site A) and domestic (Site C) sources. The Biological Monitoring Working Party (BMWP) score of 69 classified the reservoir as Class III "moderately impacted", supported by low Average Score Per Taxon (ASPT) values (0.08-0.20). Seasonal variations showed 62.18% wet-season abundance versus 37.82% in dry periods ($p<0.05$). The prevalence of tolerant taxa (Tubificidae, Chironomidae) alongside depressed Ephemeroptera (7.91%) indicates chronic pollution stress from agrochemicals and detergents. These findings demonstrate the reservoir's ecological degradation and highlight the utility of macroinvertebrate biomonitoring in Nigerian freshwater systems. Immediate mitigation measures, including riparian buffer establishment and community education programs to restore water quality, were recommended.

**Key words:** Benthic macroinvertebrates, Water quality assessment, Tubificidae, BMWP score, Tropical reservoirs, Pollution biomonitoring

## INTRODUCTION

Freshwater ecosystems are among the most biodiverse yet threatened habitats globally, facing increasing pressures from anthropogenic activities such as agricultural runoff, industrial discharge, and urban development. Within these ecosystems, macroinvertebrates, including aquatic insects, mollusks, crustaceans, and annelids, serve as vital bioindicators of ecological health due to their diverse functional roles and sensitivity to environmental changes (Winterbourn *et al.,* 1981). These organisms play crucial roles in nutrient cycling, organic matter decomposition, and energy transfer within aquatic food webs, making them indispensable components of freshwater ecosystems (Hynes, 1970; Wallace & Webster, 1996). Their sedentary nature, taxon-specific pollution tolerances, and ease of sampling have established macroinvertebrates as fundamental tools in biomonitoring programs worldwide (Rosenberg & Resh, 1993; Bonada *et al.,* 2006).

Traditional water quality assessments relying solely on physicochemical parameters often fail to capture the cumulative and long-term impacts of pollution, as these measurements represent only snapshots of environmental conditions (Metcalfe, 1989). In contrast, macroinvertebrate communities integrate the effects of multiple stressors over time, providing a more comprehensive evaluation of ecosystem health (Buss *et al.,* 2004). Their predictable responses to pollution, such as the dominance of tolerant taxa (e.g., *Chironomidae*, *Tubificidae*) in degraded systems and the presence of sensitive groups (e.g., *Ephemeroptera*, *Plecoptera*) in pristine waters, enable the development of robust biotic indices like the Biological Monitoring Working Party (BMWP) score (Armitage *et al.,* 1983). These indices are now widely adopted in water resource management, offering a cost-effective and ecologically relevant approach to assessing freshwater quality (Hering *et al.,* 2006).

In Nigeria, freshwater ecosystems face escalating threats from rapid urbanization, agricultural intensification, and inadequate waste management (Akaahan *et al.,* 2016). Reservoirs like Thomas Dam in Kano State are particularly vulnerable, serving as critical water sources for domestic, agricultural, and industrial uses while receiving untreated effluents and runoff. Despite their ecological and socioeconomic importance, many Nigerian reservoirs lack systematic biomonitoring programs, resulting in limited data on their ecological status (Ogbeibu & Oribhabor, 2002). This knowledge gap hinders evidence-based conservation and management efforts, especially in the Sudan savanna region, where water scarcity and pollution are growing concerns (Mustapha, 2009).

This study addresses these gaps by conducting a comprehensive assessment of macroinvertebrate community structure in Thomas Reservoir. Specifically, to: (1) characterize the taxonomic composition and diversity of macroinvertebrates across spatially distinct sites, (2) evaluate water quality using established biotic indices (BMWP, ASPT), and (3) identify key anthropogenic stressors impacting the reservoir's ecological integrity. These findings provide baseline data for future monitoring and contribute to the growing body of research on tropical reservoir ecology. Furthermore, the study highlights the utility of macroinvertebrate-based biomonitoring in Nigeria, where such approaches remain underutilized despite their proven effectiveness in other regions (Dallas, 2007). By linking community shifts to specific pollution sources, the results can guide targeted mitigation strategies, supporting the sustainable management of Thomas Reservoir and similar water bodies in the Sudan savanna zone.

The study also explores seasonal dynamics of macroinvertebrate assemblages, addressing how wet and dry season variations influence community structure, a critical consideration in tropical systems with pronounced climatic seasonality (Jacobsen *et al.,* 1997). Ultimately, this research aims to bridge the gap between scientific understanding and practical water resource management, providing actionable insights for policymakers, environmental agencies, and local communities invested in preserving freshwater ecosystems.

## MATERIALS AND METHODS

### Study area

The research was conducted in Thomas Dam, which is located within Sudan savannah zone of Nigeria (Latitude 12° 17′ 47.8′ N - 12° 16′01.1′ N) and (Longitude 8° 31′34.7′ E -8° 30′ 54.9′ E) with two distinct wet and dry seasons (Figure 1). The dam is about 585 square meters, while its depth is about 30 m. The dam is sited near Danmarke village of Dambatta Local Government area of Kano State, 30 km away from the ancient Kano City (Kutama *et al.,* 2013).

### Sampling sites

Site A (12°17'47.8" N, 8°31'34.7" E): Located in the southern shallows, this area experiences significant agricultural pressure, particularly during dry seasons when irrigation draws water. The site receives substantial agrochemical runoff from adjacent fertilized fields.

Site B (12°17'52.0" N, 8°31'34.0" E): Positioned at mid-reservoir, this reference site maintains relatively minimal human disturbance, with only occasional fishing activities observed. The area serves as a control for assessing less- impacted conditions.

Site C (12°18'34.28" N, 8°30'40.23" E): This heavily utilized zone shows clear signs of domestic pollution from frequent washing activities (vehicles, laundry), introducing detergent-laden wastewater into the reservoir.

Site D (12°16'01.1" N, 8°30'54.9" E): The inflow region where oasis waters enter the reservoir, representing the system's primary freshwater source point with naturally occurring hydrological characteristics.

### Macroinvertebrate collection and processing

Benthic macroinvertebrates were systematically collected at each study site using a modified Ekman grab sampler (Maitland, 1978). The sampler was deployed vertically to the reservoir bottom, where it secured sediment samples containing benthic organisms. Upon retrieval, each sample was immediately transferred to pre-labeled polyethylene bags for preservation and transport.

Field preservation employed a 10% neutral-buffered formalin solution to maintain specimen integrity during transportation to the laboratory. For sample processing, a sequential sieving protocol was implemented using graduated mesh sizes (2 mm, 1 mm, and 0.5 mm) to separate organisms from sediments. This triple-sieving methodology ensured comprehensive capture of macroinvertebrates across size classes while eliminating fine particulate matter.

Specimen sorting was conducted in white enamel trays with controlled water volumes to enhance visibility of organisms (George *et al.,* 2009). Manual separation techniques were employed based on organism size: forceps were used for larger specimens (>2 mm), while fine-tipped pipettes facilitated the collection of smaller individuals. All sorted specimens were prepared for taxonomic identification under appropriate magnification.

### Taxonomic identification

Macroinvertebrate specimens were identified to the lowest possible taxonomic level using standardized dichotomous keys from the following authoritative sources: Andrews (1972) for general freshwater invertebrates, Mellanby (1977) for aquatic insect identification, Pennak (1978) for North American freshwater invertebrates, and Merritt and Cummins (1996) for aquatic insects of North America ($3^{rd}$ edition).

### Specimen processing and enumeration

Sediment samples underwent a standardized washing protocol through a nested series of stainless steel sieves (2 mm, 1 mm, and 0.5 mm mesh sizes) using dechlorinated water. The retained macroinvertebrates were transferred to glass petri dishes and examined under a dissecting microscope (10-40× magnification) for counting and preliminary identification. Organisms were carefully separated from debris using fine-tipped forceps and soft-bristled brushes.

### Ecological indices calculation

*Shannon-Wiener Diversity Index (H')*

The index was calculated as:

$$H' = -\Sigma (p_i \times \ln p_i)$$

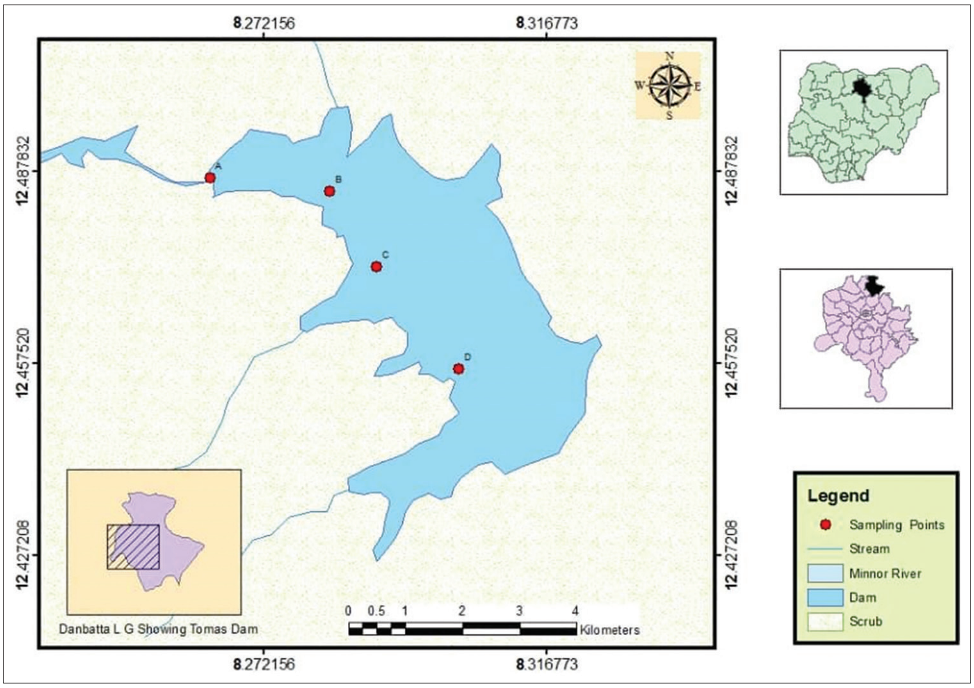


**Figure 1:** Map of Thomas Dam Showing Selected Sampling Sites (Source: Cartography Lab., Geography Dept., Bayero University, Kano, 2019)

**Table 1:** The Biological Monitoring Working Party Score (BMWP)

| Common names | Families | Score |
|---|---|---|
| Mayflies, Stoneflies, Riverbug, Caddisflies, or Sedgeflies | Siphlonuridae, Heptageniidae, Leptophlebiidae, Ephemerellidae, Potamanthidae, Ephemeridae, Taeniopterygidae, Leuctridae, Capniidae, Perlodidae, Perlidae, Chloroperlid, Aphelocheridae, Phryganeidae, Molannidae, Beraeidae, Odontocerie, Leptocerida, Goeridae, Lepidostomatidae, Brachycentridae, Sericostomatidea | 10 |
| Crayfish, Dragonflies | Astacidae, Lestidae, Agriidae, Gomphidae, Cordulegasteridae, Aeshnidae, Corduliidae, Libellulidae | 8 |
| Mayflies, Stoneflies, Caddisflies, or Sedge flies | Caenidae, Nemouridae, Rhyacophilidae, Polycentropodidae, Limnephilidae | 7 |
| Snails, Caddisflies or Sedge flies, Mussels, Gammarids, Dragonflies | Neritidae, Viviparidae, Ancylidae, Hydroptilidae, Unionidae, Corophiidae, Gammarida, Platycnemididae, Coenagrionidae | 6 |
| Bugs, Beetles, Caddisflies or Sedgeflies, Craneflies/Black flies, Flatworms | Mesoveliidae, Hydrometridae, Gerridae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae, Haliplidae, Hygrobiidae, Dytiscidae, Gyrinidae, Hydrophilidae, Clambidae, Helodidae, Dryopidae, Elmidae, Chrysomelidae, Curculionidae, Hydropsychidae, Tipulidae, Simuliidae, Planariidae, Dendrocoelida | 5 |
| Mayflies, Alderflies, Leeches, Water mites | Baetidae, Sialidae, Piscicolidae | 4 |
| Snails, Cockles, Leeches, Hog louse | Valvatidae, Hydrobiidae, Lymnaeidae, Physidae, Planorbidae, Sphaeriidae, Glossiphoniidae, Hirudidae, Erpobdellidae, Asellidae | 3 |
| Midges | Chironomidae | 2 |
| Worms | Oligochaeta (whole class) | 1 |

Source: Mason (1989)

where:
$p_i$ = proportion of individuals belonging to species i
ln = natural logarithm

*Margalef's Richness Index (d)*

Species richness was calculated as:

$$d = (S-1)/\ln(N)$$

where:
S = number of species
N = total number of individuals

*Biological Monitoring Working Party (BMWP) Score*

The index was computed as:

$$BMWP = \Sigma \text{ (tolerance values of all families present)}$$

Family-level tolerance values followed Suleiman and Abdullahi (2011) and Uherek and Gouveia (2014) classifications.

*Average Score Per Taxon (ASPT)*

ASPT was derived as:

$$ASPT = BMWP/\text{total number of scoring taxa}$$

### Statistical analysis

All diversity metrics were compared across sites using one-way ANOVA ($\alpha$=0.05) in SPSS Statistics 19.0. Post-hoc Tukey tests identified significant pairwise differences when ANOVA results were significant ($p<0.05$). The following variables were analyzed: Shannon-Wiener diversity index (H'), Margalef's richness index (d), BMWP, and ASPT scores (Shannon & Wiener, 1949; Margalef, 1967).

The taxonomic composition and abundance patterns of macroinvertebrates across the sampling locations are summarized in Table 3. During the study, 2,086 macroinvertebrate specimens were collected and analyzed, representing 8 taxonomic groups and 17 distinct species from four sampling stations. The most diverse groups included Mollusca (0.053), Diptera (0.002), Odonata (0.028), and Annelida (0.010), while Plecoptera and Hemiptera showed the lowest diversity, with only one species each recorded.

Spatial analysis (Table 3) demonstrated that Site A contained the highest abundance (766 individuals, 37.20%), followed by Site C (759 individuals, 36.86%), Site B (332 individuals, 16.12%), and Site D (229 individuals, 11.12%). Statistical analysis ($p=0.05$) indicated no significant differences in abundance between sites. The molluscan community comprised *Planorbidae* and *Myrtaceae* families, while arthropods included representatives from *Leuctridae*, *Baetidae*, *Aeshnidae*, *Lestidae*, *Dytiscidae*, *Chironomidae*, *Simuliidae*, *Ameletidae*, and *Hydrophilidae*. Annelids were represented by the *Tubificidae* and *Naididae* families.

As illustrated in Figure 2, the dominant macroinvertebrate families followed this abundance pattern: *Naididae* (16.06%) >*Planorbidae* (14.71%) >*Tubificidae* (13.36%) >*Chironomidae* (11.27%) >*Simuliidae* (10.12%) >*Lestidae* (5.03%) >*Nepidae* (3.84%) >*Myrtaceae* (2.78%) >*Dytiscidae* (2.68%) >*Hydrophilidae* (1.97%) >*Leuctridae* (1.01%) >*Ameletidae* (0.48%). The most numerous species was *Tubifex* sp. (285 individuals, 13.66%), followed by *Chironomus* sp. (235 individuals, 11.27%), while *Ameletus* sp. showed the lowest abundance (10 individuals, 0.48%).

Seasonal comparisons revealed significantly higher macroinvertebrate counts during the wet season (June-October; 1,297 individuals, 62.18%) compared to the dry season (May-February; 789 individuals, 37.82%) at $p>0.05$ (Table 5). Diversity metrics showed maximum Shannon-Weiner (H=0.367) and Evenness (E=0.048) values at Site A, with minimum values recorded at Site C (H=0.004; E=0.003). ASPT scores ranged from 0.08 to 0.20 across sites A-D. Margalef's species richness index peaked at Site A (100.09) and reached its lowest value at Site D (43.31) (Table 4). Seasonal diversity patterns showed Shannon-Weiner indices of 0.296 (wet) and 0.367 (dry), Evenness values of 0.04 (wet) and 0.05 (dry), and consistent Margalef's indices of 169.70 for both seasons.

**Table 2:** BMWP Classes, Scores, Categories and Interpretation of the result

| BMWP score | Category | Class | Interpretation |
|---|---|---|---|
| >100 | Very good | I | Unpolluted/Unimpacted |
| 71-100 | Good | II | Clean But Slightly Polluted/Impacted |
| 41-70 | Moderate | III | Moderately Impacted |
| 11-40 | Poor | IV | Polluted/Impacted |
| 0-10 | Very poor | V | Heavily Polluted/Impacted |

Source: Ojija and Laizer (2016)

## DISCUSSION

This study provides a comprehensive assessment of water quality in Thomas Reservoir using macroinvertebrate biotic indices, revealing significant ecological insights about this important freshwater system in Nigeria's Sudan savannah zone. The findings of this study demonstrate that the reservoir currently exists in a moderately impacted state (BMWP score: 69; Class III), with clear spatial and temporal variations in ecological quality that warrant careful consideration.

The dominance of pollution-tolerant taxa, particularly Tubificidae (13.36%) and Chironomidae (11.27%), strongly indicates organic pollution stress in the reservoir (Table 3). These results align with numerous studies documenting these families as reliable indicators of degraded water quality (Bonada *et al.,* 2006; Sharma *et al.,* 2013). The presence of these tolerant species, coupled with the relatively low abundance of sensitive *Ephemeroptera* (7.91%), suggests chronic exposure to pollutants, likely from agricultural runoff and domestic wastewater inputs near Sites A and C. This pattern mirrors findings from other Nigerian water bodies experiencing similar anthropogenic pressures (Ogbeibu & Oribhabor, 2002; Akaahan *et al.,* 2016).

Spatial analysis revealed significant differences in ecological quality across sampling sites. Site D, representing the reservoir's

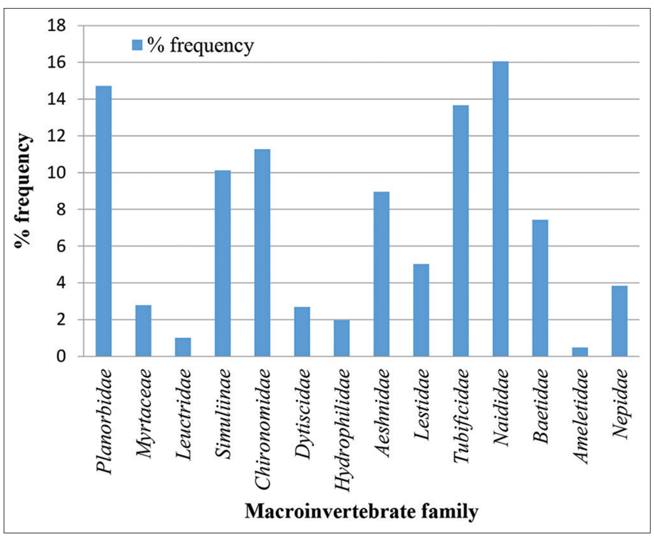


**Figure 2:** Percentage Composition of Macro-invertebrates family Identified at the Sampling sites (May, 2019 – February, 2020)

**Table 3:** Macro invertebrates Species Composition, Abundance and Distribution in Thomas reservoir Dambatta, Kano (May, 2019 – February, 2020)

| Macroinvertebrates taxa | BMWP Score | Sites | | | | Total | %Frequency |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | | |
| **Bottom Dwellers** | | | | | | | |
| Mollusca | | | | | | | |
| Family: Planorbidae | | | | | | | |
| *Bulinus* sp. | 3 | 75 | 20 | 74 | 28 | 197 | 9.44 |
| *Biomphalaria* sp. | 3 | 34 | 17 | 37 | 22 | 110 | 5.27 |
| Family: Myrtaceae | | | | | | | |
| *Pisiduim* sp. | | 19 | 5 | 24 | 10 | 58 | 2.78 |
| Arthropoda | | | | | | | |
| Plecoptera (stone flies) | | | | | | | |
| Family: Leuctridae | | | | | | | |
| *Leuctra* sp. | 10 | 0 | 0 | 0 | 21 | 21 | 1.01 |
| Diptera (true flies) | | | | | | | |
| Family: simuliidae (Black flies) | | | | | | | |
| *Simulium* sp. | 5 | 87 | 28 | 79 | 17 | 211 | 10.12 |
| Family: Chronomidae (Midges) | | | | | | | |
| *Chironomus* sp. | 2 | 111 | 18 | 77 | 29 | 235 | 11.27 |
| Odonata (dragonflies and damsel flies) | | | | | | | |
| Family: Aeshnidae | | | | | | | |
| *Aeshna* sp. | 8 | 52 | 36 | 0 | 25 | 113 | 5.42 |
| Family: Lestidae | | | | | | | |
| *Lestes* sp. | 8 | 33 | 22 | 0 | 10 | 65 | 3.12 |
| Ephemeroptera (mayflies) | | | | | | | |
| Family: Baetidae | | | | | | | |
| *Baetis* sp. | 3 | 43 | 39 | 29 | 18 | 129 | 6.18 |
| *Callibaetic* sp. | 3 | 7 | 0 | 0 | 93 | 86 | 4.12 |
| Family: Amelelidae | | | | | | | |
| *Ameletus* sp. | 3 | 10 | 0 | 0 | 40 | 50 | 2.40 |
| Annelida | | | | | | | |
| Family: Tubificidae | | | | | | | |
| *Tubifex* sp. | 1 | 109 | 52 | 96 | 28 | 285 | 13.66 |
| Family: Naididae | | | | | | | |
| *Limnodrilus* sp. | 1 | 76 | 29 | 94 | 15 | 214 | 10.26 |
| *Eclipdrlus* sp. | 1 | 46 | 13 | 53 | 9 | 121 | 5.80 |
| **Surface Dwellers** | | | | | | | |
| Hemiptera (True bugs) | | | | | | | |
| Family: Nepidae | | | | | | | |
| *Nepidae* sp. | 5 | 26 | 15 | 32 | 7 | 80 | 3.84 |
| Coloeptera (beetles) | | | | | | | |
| Family: Dytiscidae | | | | | | | |
| *Dytiscus* sp. | 5 | 12 | 18 | 22 | 4 | 56 | 2.68 |
| Family Hydrophilidae | | | | | | | |
| *Hydrobius* sp. | 5 | 30 | 5 | 0 | 6 | 41 | 1.97 |
| No. of family | | 12 | 13 | 10 | 14 | | |
| No. of taxa | | 8.00 | 8.00 | 8.00 | 8.00 | | |
| Abundance | | 766 | 332 | 759 | 229 | 2086 | |
| % of Abundance | | 37.20 | 16.12 | 36.86 | 11.12 | 100 | |
| ASPT | | 0.08 | 0.18 | 0.09 | 0.28 | | |
| Shannon-diversity (H) | | 0.367 | 0.292 | 0.004 | 0.243 | | |
| Evenness (E) | | 100.09 | 43.31 | 99.18 | 29.53 | | |
| Margalef index (d) | | 0.048 | 0.038 | 0.003 | 0.032 | | |

**Table 4:** Seasonal Comparism of Macroinvertebrate Family Identified From the Sampling Sites in Thomas Reservoir (May, 2019 – February, 2020)

| Macroinvertebrate Taxa | Dry season | Wet season | Total |
|---|---|---|---|
| Mollusca | | | |
| Family: *Planorbidae* | 126 | 183 | 309 |
| Family: *Myrtaceae* | 14 | 42 | 56 |
| Arthropoda | | | |
| Family: *Leuctridae* | 2 | 19 | 21 |
| Family: *Simuliidae* | 73 | 115 | 188 |
| Family: *Chironomidae* | 68 | 163 | 231 |
| Family: *Dytiscidae* | 20 | 40 | 60 |
| Family: *Hydrophilidae* | 6 | 37 | 43 |
| Family: *Aeshnidae* | 77 | 112 | 189 |
| Family: *Lestidae* | 42 | 51 | 93 |
| Family: *Baetidae* | 45 | 104 | 149 |
| Family: *Ameletidae* | 12 | 3 | 15 |
| Annelida | | | |
| Family: *Tubificidae* | 116 | 161 | 277 |
| Family: *Naididae* | 155 | 203 | 358 |
| Hemiptera | | | |
| Family: *Nepidae* | 20 | 64 | 84 |
| No of family | 14 | 14 | 28 |
| Abundance | 789 | 1297 | 2086 |
| % of Abundance | 37.82 | 62.18 | |
| Shannon-diversity (H) | 0.367 | 0.295 | |
| Evenness (E) | 0.05 | 0.04 | |
| Margalef index (d) | 103.10 | 169.70 | |

**Table 5:** Biological Monitoring Working Party (BMWP) Scores Obtained

| Species | Family | A | B | C | D |
|---|---|---|---|---|---|
| *Bulinus* sp. | *Planorbidae* | 3 | 3 | 3 | 3 |
| *Biomphalaria* sp. | *Planorbidae* | 3 | 3 | 3 | 3 |
| *Pisiduim* sp. | *Myrtaceae* | 3 | 3 | 3 | 3 |
| *Leuctra* sp. | *Leuctridae* | - | - | - | 10 |
| *Simulium* sp. | *Simuliidae* | 5 | 5 | 5 | 5 |
| *Chironomus* sp. | *Chronomidae* | 2 | 2 | 2 | 2 |
| *Aeshna* sp. | *Aeshnidae* | - | 8 | - | 8 |
| *Lestes* sp. | *Lestidae* | - | 8 | - | 8 |
| *Baetis* sp. | *Baetidae* | 4 | 4 | 4 | 4 |
| *Callibaetic* sp. | *Baetidae* | 4 | - | - | 4 |
| *Ameletus* sp. | *Amelelidae* | 4 | 4 | 4 | 4 |
| *Tubifex* sp. | *Tubificidae* | 1 | 1 | 1 | 1 |
| *Limnodrilus* sp. | *Naididae* | 1 | 1 | 1 | 1 |
| *Eclipdrlus* sp. | *Naididae* | 1 | 1 | 1 | 1 |
| *Nepidae* sp. | *Nepidae* | 5 | 5 | 5 | 5 |
| *Dytiscus* sp. | *Dytiscidae* | 5 | 5 | 5 | 5 |
| *Hydrobius* sp. | *Hydrophilidae* | 5 | 5 | - | 5 |
| Total | - | 46 | 58 | 37 | 72 |

inflow area, maintained the best water quality (BMWP Class II) (Table 2), consistent with its relative isolation from direct human impacts. In contrast, Site C showed the poorest ecological conditions, likely due to its exposure to laundry activities and vehicle washing, introducing detergents and hydrocarbons. These spatial patterns emphasize the localized nature of pollution impacts in the reservoir and corroborate findings from similar lentic systems in sub-Saharan Africa (Tampus *et al.,* 2012; Kefas *et al.,* 2015).

The recorded taxonomic richness (8 taxa, 17 species) (Table 4) appears relatively low compared to other Nigerian freshwater systems (Emere & Nasiru, 2008; John & Abdurrahman, 2014). This reduced diversity may result from several factors: (1) the reservoir's relatively young age (implying limited colonization time), (2) physicochemical fluctuations, particularly in dissolved oxygen and pH, and (3) cumulative stress from multiple anthropogenic activities. The Shannon diversity indices (0.004-0.367) further support this interpretation, falling below ranges typically observed in undisturbed tropical freshwater ecosystems (Rosenberg & Resh, 1993).

Seasonal dynamics significantly influenced macroinvertebrate communities, with wet season samples showing 62.18% of total abundance compared to 37.82% in the dry season. This pattern likely reflects both increased habitat availability during rains and the flushing of terrestrial organisms into the reservoir. Similar seasonal variations have been documented in other tropical water bodies (Li *et al.,* 2001; Sporka *et al.,* 2006), highlighting the importance of considering temporal factors in biomonitoring programs.

The BMWP scoring system proved effective for assessing ecological quality in this tropical reservoir, despite being originally developed for European streams. These results support previous work demonstrating the adaptability of this index to African freshwater systems (Suleiman & Abdullahi, 2011; Uherek & Gouveia, 2014). However, the consistently low ASPT values (0.08-0.20) across all sites suggest the need for potential calibration of these indices for tropical conditions, as noted by other researchers working in similar environments (Bonada *et al.,* 2006).

The study's findings have important implications for water resource management in Nigeria's semi-arid regions. The moderate ecological impairment observed, coupled with the reservoir's importance for irrigation and potential domestic use, necessitates immediate intervention. Of particular concern is the apparent accumulation of agricultural pollutants, which may lead to further degradation if left unmanaged. These results echo warnings from earlier studies about the vulnerability of savannah water resources to anthropogenic impacts (Akaahan *et al.,* 2010; Ibrahim & Nafiu, 2017).

While this study provides valuable baseline data, some limitations should be acknowledged. The single-year sampling period may not capture interannual variability, and the focus on macroinvertebrates alone could be complemented by parallel physicochemical analyses in future work. Nevertheless, our findings clearly demonstrate the utility of macroinvertebrate biomonitoring for assessing tropical reservoir health and identifying priority areas for management intervention.

**Table 6:** Quality Evaluation of Thomas Reservoir at four Sampling Sites (A, B, C and D) as Compared with Ojija and Laizer (2016) Water quality assessment of a stream

| Sites | BMWP Score | Category | Class | Interpretation | Water Quality Assessment | Category | Class | Interpretation |
|---|---|---|---|---|---|---|---|---|
| A | 46 | Moderate | III | Moderately Impacted | >100 | Very Good | I | Unpolluted/Unimpacted |
| B | 58 | Moderate | III | Moderately Impacted | 71-100 | Good | II | Clean But Slightly Polluted/Impacted |
| C | 37 | Poor | IV | Polluted/Impacted | 41-70 | Moderate | III | Moderately Impacted |
| D | 72 | Good | II | Clean But Slightly Polluted/Impacted | 11-40 | Poor | IV | Polluted/Impacted |

## CONCLUSION

The study assessed the water quality of Thomas Reservoir, Kano State, Nigeria, using macroinvertebrate biotic indices over a ten-month period (Table 6). The results revealed a moderately impacted water body (Class III, BMWP score: 69), characterized by the dominance of pollution-tolerant taxa such as *Tubifex* sp. (13.66%) and *Chironomus* sp. (11.27%). The low diversity indices (Shannon-Weiner: 0.004-0.367; Evenness: 0.003-0.048) and the presence of sensitive taxa like Ephemeroptera (7.91%) suggest localized pollution stress, likely due to anthropogenic activities such as irrigation runoff, detergents, and agrochemical discharge. Seasonal variations showed higher macroinvertebrate abundance during the wet season (62.18%), emphasizing the influence of hydrological dynamics on community structure. The findings align with global trends where benthic macroinvertebrates serve as reliable bioindicators of aquatic ecosystems.

## RECOMMENDATIONS

### Pollution control measures

Regulatory efforts should curb uncontrolled agrochemical discharge and detergent-laden runoff into the reservoir, particularly near Sites A and C, which showed significant pollution indicators.

### Community engagement

Public awareness programs on sustainable water use and pollution mitigation should be implemented to reduce anthropogenic pressures.

### Long-term monitoring

Continuous biomonitoring using macroinvertebrates, complemented by physicochemical analyses, is recommended to track ecological changes and evaluate remediation efforts.

### Habitat restoration

Riparian buffer zones should be established to reduce sedimentation and filter pollutants from adjacent farmlands.

### Policy enforcement

Existing environmental laws on water quality standards (e.g., WHO guidelines) must be enforced to safeguard the reservoir's ecological integrity.

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