African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 8, Issue 2, 2025 (pp. 94-101)
www.abjournals.org

ASSESSMENT OF HEAVY METAL CONTAMINATION IN MULLET FISH (*MUGIL CEPHALUS*) FROM THE NEW CALABAR RIVER, RIVERS STATE, NIGERIA.

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Cite this article:

Owoh, A. A., Green, A. F., Timothy, C. F., Anaero-Nweke, G. N., Uche, P. I. (2025), Assessment of Heavy Metal Contamination in Mullet Fish (Mugil cephalus) from the New Calabar River, Rivers State, Nigeria. African Journal of Environment and Natural Science Research 8(2), 94-101. DOI: 10.52589/AJENSR-FSQEYIZQ

Manuscript History

Received: 19 Jun 2025

Accepted: 21 Jul 2025

Published: 6 Aug 2025

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ABSTRACT: *This study investigates the influence of human activities on mullet fish (*Mugil cephalus*) by analyzing the levels of heavy metals in fish samples obtained from the New Calabar River in Rivers State. Fish were collected from three different sites over a three-month period (June to August), and tested for the presence of Lead (Pb), Zinc (Zn), and Cadmium (Cd). The concentration of these metals in the fish tissues was measured to evaluate their potential toxicity, the environmental impact on the river, and the suitability of the fish for human consumption. All three heavy metals were detected in the samples, with concentrations showing both spatial and temporal variations. Spatially, Lead ranged from 0.009 ± 0.001 mg/kg at station 1 to 0.021 ± 0.002 mg/kg at station 3; Zinc ranged from 2.24 ± 0.02 mg/kg at station 1 to 2.41 ± 0.05 mg/kg at station 3; and Cadmium ranged from 0.28 ± 0.04 mg/kg at station 1 to 0.37 ± 0.04 mg/kg at station 3. Temporally, Lead levels ranged from 0.01 ± 0.06 mg/kg in June to 0.02 ± 0.01 mg/kg in August; Zinc from 2.08 ± 0.34 mg/kg in June to 2.13 ± 0.34 mg/kg in August; and Cadmium from 0.34 ± 0.07 mg/kg in June to 0.36 ± 0.07 mg/kg in August. The measured concentrations were all below the safety thresholds established by the World Health Organization (WHO) and the Federal Environmental Protection Agency (FEPA), indicating that the fish are safe for human consumption.*

KEYWORDS: Heavy metals, Mugil cephalus, New Calabar River, Assessment.

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INTRODUCTION

Anthropogenic impact refers to the effects and changes on the natural environment caused by human activities. Globally, small-scale fisheries employ millions of fishers and are significant sources of nutrition, food security, and livelihood, catering for many people (FAO, 2018). However, increasing anthropogenic pressures threaten the sustainability of many small-scale fisheries (Jouffray *et al.*, 2020). Major anthropogenic threats include pollution and habitat degradation from coastal developments and overfishing (Zamora-Ledezma *et al*., 2021). These human activities pose severe sustainability threats to small pelagic species, which support food security in West Africa (Belhabib *et al.*, 2015). These stresses damage breeding grounds, reduce productivity and threaten important species like *Mugil cephalus* (Lotze *et al*., 2019).

Therefore, the development of human activities without due regard for environmental criteria is affecting human health and the state of aquatic systems, in some cases causing irreversible changes (Gopchak *et al*., 2020). The marked deterioration of surface water bodies makes its evaluation a priority in order to control and mitigate the level of risk that will be decisive for the complexity and costs of treating water for human consumption (Japitana *et al*., 2019).

MATERIALS AND METHODS

Description of Study Area

The study area is situated at coordinates 4.0893610N and 6.9286670E, along the New Calabar River, Port Harcourt, which is significantly impacted by extensive human activities such as sand mining and industrial effluent. The effluent load in this region is further increased by fishermen who employ illegal methods, such as using dynamite, to catch fish. Additionally, the area is linked to an underground drainage system that transports wastewater, sewage, sludge, and human waste from nearby communities.

Research Design

This study was carried out for three months and three stations (Choba, Rumualogu and Ozuoba) sampled and evaluation of the effects of human activities in Mullet collected from New Calabar River. The area of study was chosen based on the daily use by or/and contact with humans and presence of draggers on the water ways and industries in the community while sampling stations were chosen based on the width and length of the river.

Fish Sample

Fish samples were collected from three distinct sampling stations using monofilament gill nets with mesh sizes of 40 mm. The locations were selected to represent different habitats and environmental conditions. The fish samples were properly and carefully washed and stored in ice chest container pending analysis.

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Heavy Metal Analysis

The heavy metal present in the samples were analyzed using atomic absorption spectrophotometer. Two (2) grams of the respective sample was transferred into a Kjeldahl; 20ml of concentrated nitric acid (HNO_3) was added and the sample pre-digestion by heating gently for 20mins. More acid was thereafter added and digestion continues Digestion was stopped when a clear digest was obtained. The flask was cooled and the content transferred into 50ml volumetric flask and made to the mark with distilled water. The digested samples were analyzed for heavy metals (Lead, Zinc and Cadmium) by Atomic Absorption Spectrophotometer (AAS) of UNICAM 919 model. The equipment absorbed the digested sample and gives the concentration of the metals present in the sample (WHO, 2011).

Statistical Analysis

Data collected to various statistical inferences using Microsoft Excel.

RESULT AND DISCUSSION

Table 1: Spatial distribution of Heavy metal contents in tissues of *Mugil cephalus* from New Calabar River, Rivers State

Stations	Lead	Zinc	Cadmium
1	$0.009^{c} \pm 0.001$	$2.24^{b} \pm 0.02$	$0.28^{b} \pm 0.04$
2	$0.016^{b} \pm 0.001$	$1.67^{c} \pm 0.06$	$0.41^{a} \pm 0.04$
3	$0.021^{a} \pm 0.002$	$2.41^{a} \pm 0.05$	$0.37^{a} \pm 0.04$

*Means that share a letter down the column are not significantly different at 5% probability level

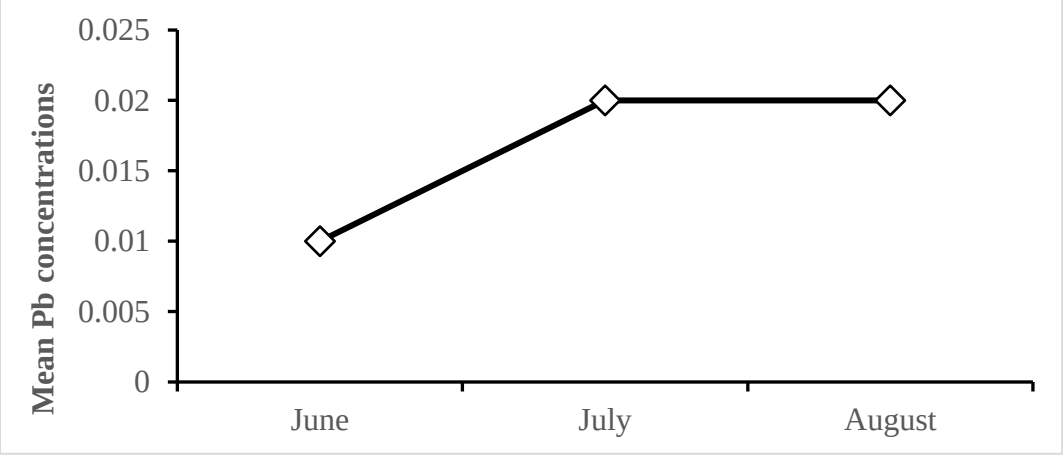

Fig 1: Mean temporal distribution of Lead (Pb) in tissues of *Mugil cephalus* from New Calabar River, Rivers State

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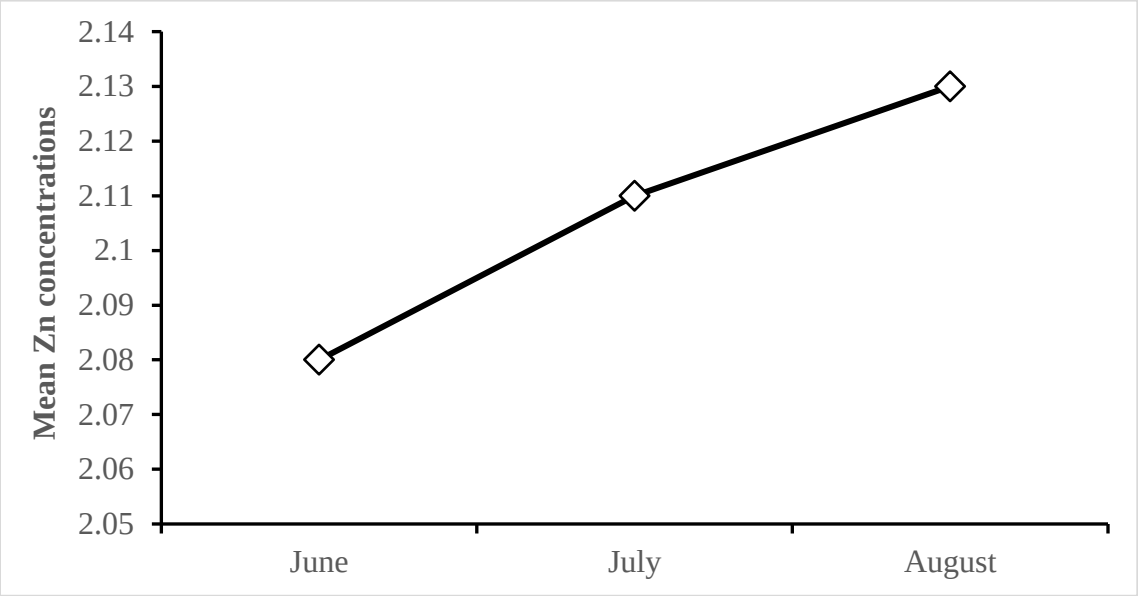

Fig 2: Mean temporal distribution of Zinc (Zn) in tissues of *Mugil cephalus* from New Calabar River, Rivers State

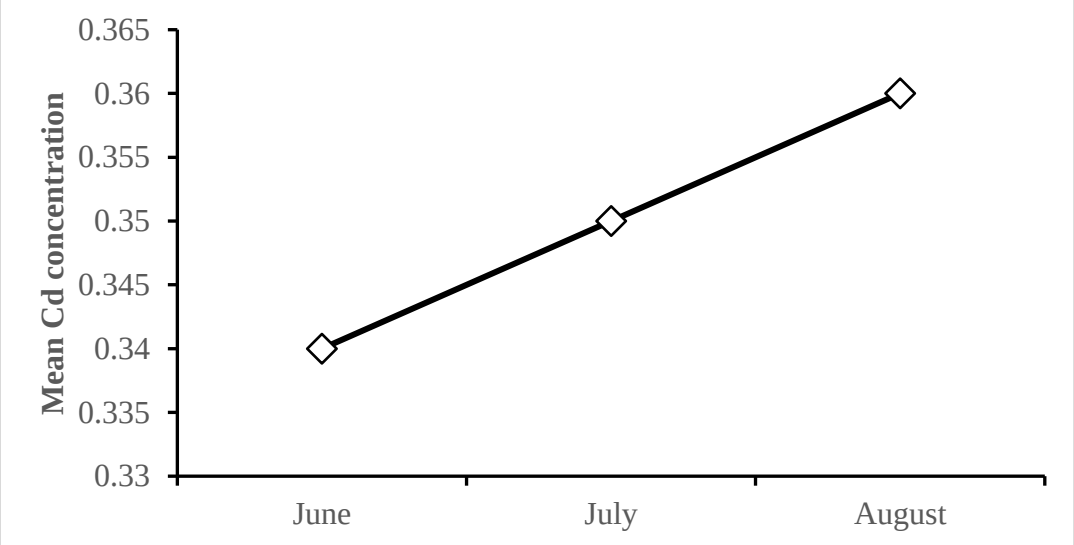

Fig 3: Mean temporal distribution of Cadmium (Cd) in tissues of *Mugil cephalus* from New Calabar River, Rivers State

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The result of Pb concentration obtained from the different stations sampled from the New Calabar River shows significant difference ($P<0.05$) in the different stations. However station 2 and 3 are significantly higher than station 1 where there is significant difference (Table1).The highest value was observed in SW3 (0.021 ± 0.002) and the lowest in SW1(0.009 ± 0.001). When compared, the values were lower than the 1.05 mg/kg reported by Owoh and Wokoma (2022) in *T. guineensis* from Andoni River, and less than the range of 0.3-1.63 mg/kg recorded by Abu and Nwokoma (2016), 0.17-0.23 mg/kg mean reported by Wokoma (2014) in fish from Sombreiro River. However, these levels are within the permissible limits set by WHO (2011) and FEPA (2003).

The result of Zn concentration obtained from the different stations sampled on the New Calabar River shows significant difference ($P<0.05$) in the different stations indicating site-specific contamination likely linked to domestic waste, boat traffic, or runoff from zinc-containing materials such as galvanized pipes. The highest value was observed in station 3 (2.41 ± 0.05) and the lowest in station 2 (1.67 ± 0.06). Though, station 1 and 3 are significantly higher than station 2 (Table 1). The Zn level in this study slightly higher than the range of 0.043 ± 0.026 – 0.031 ± 0.005 values reported by Abdullah *et al*. (2007). Although lower than the 84.76 – 136.9 mg/kg reported by Yilmaz (2009) for *Oreochromis niloticus* in Koycegiz Lake, lower than the 12.70 ± 0.54 mg/kg reported by Owoh and Wokoma (2022) in *Tilapia guineensis* from Andoni River also lower than 8.96 – 20.35 mg/kg Concentration observed by Farombi *et al*., (2007) in various organs of *Clarias gariepinus* from Ogun River. More so, temporal patterns (Fig 2) suggest periodic increases in Zn levels, which may be attributed to increased surface runoff or anthropogenic activity during certain times of the year. Similar patterns have been reported in other urban river systems, highlighting the influence of local land use and waste management practices (Yilmaz *et al*., 2010).

The mean (Cd) concentrations ranged from 0.28 ± 0.04 to 0.41 ± 0.04 mg/kg, showing the pattern Station 2 > Station 3 > Station 1. These values are lower than the 0.74 mg/kg reported in *O. niloticus* from Okujagu Ama Creek by Ekweozor *et al*., (2017), and also lower than the 30.438 ± 0.05 and 12.1 ± 0.29 mg/kg found in shrimp (*P. scuptilis*) and crab (*T. crenata*) by Bakia *et al*. (2018). Although all values are within the FAO/WHO guideline limit of 0.5 mg/kg, cadmium's cumulative toxicity is concerning due to its carcinogenic and nephrotoxic properties (ATSDR, 2012). The temporal distribution (Fig.3) exhibits mild fluctuations in Cd concentration, potentially driven by changes in sediment resuspension or water chemistry (Rainbow, 2002). Seasonal patterns in Cd contamination are often associated with erosion processes and industrial activity spikes during dry periods (Akinrotimi *et al*., 2018).

CONCLUSION

Overall, the spatial and temporal variations in heavy metal concentrations in *Mugil cephalus* tissues indicate site-specific pollution patterns in the New Calabar River. While recorded values are below international safety limits, continuous monitoring is essential given the cumulative and

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toxic nature of heavy metals. These findings emphasize the need for effective waste management and pollution control strategies to safeguard aquatic ecosystems and human health.

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