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Fish Diversity in Extreme Flood in Epie Creek, Bayelsa State, Niger delta

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ABSTRACT

Floods have been of great concern in the Niger Delta in the recent years, precipitating this study. The research was conducted to investigate diversity of fish species in the October 2022 extreme flood in the Niger Delta. Samples were collected randomly from landings of artisanal fishers in five sample locations, sorted and identified to species level. Diversity was estimated using Shannon-Wiener's diversity H' and Simpson's diversity D indices. Richness R, Evenness E and Similarity between stations were analyzed accordingly. From the results, R was from 4.255-4.535, E was 0.789 to 0.899 and H' 1.734-1.974. Simpson's index D was between 0.162 and 0.226, while Simpson's index of diversity 1-D was from 0.774 to 0.838. Highest similarity value between stations was 0.286. Results from the study indicate the creek experienced a stable system during the October 2022 flood.

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INTRODUCTION

Floods in recent years have been reoccurring in the Niger Delta. Deltas are among the most biologically productive, ecologically diverse ecosystems in the world (Long and Pavelsky 2013) and they provide nursery grounds for aquatic organisms. Detailed knowledge of the impact of flood on the aquatic ecosystem as it affects fish production and diversity is important for the effective management of deltas.

Deltas contain manifold habitats that increases fish diversity and abundance and increased the possibility of fish moving to the interior such as canals, floodplains and backwaters (Perry et al. 2015) thereby encouraging fish reproduction and recruitment. In contrast, floods reduce fish production and abundance as it causes sediment erosion that changes the physicochemical properties of the water (Akankali and Jamabo 2012) which makes it unsuitable for fish to survive.

Floods bring about changes in the ecosystem that affects fish productivity, abundance and diversity when compared to stable flow regimes (Junk et al. 1988). It's effects vary depending on turbidity of the water, swimming strength, movement and behavior of fish, species diversity and abundance as well as habitat use (Bischoff and Wolter 2001 ; Kano et al. 2011).Severe floods can reduce fish biomass. Direct effects can lead to displacement and destruction of eggs and juveniles while the indirect impact could be habitat favor of a species that can withstand the flood over another. Such details could be vital to protect species concern and managing of the fisheries resources.

Factors such as suitable refuge, flood magnitude (Lake, 2000) and flood timing relative to the life history of resident species (Fausch et al. 2001) influence flood impact on fish communities.

The reason of the study was to investigate the impact of 2022 flood in Yenagoa on fish in Epie creek with the aim of evaluating fish species diversity, richness, Evenness and similarity between sample locations along the creek.

LITERATURE REVIEW

Biodiversity has become a popular topic of discussion within the context of sustainability in the last few years. Different hypotheses have been proposed to explain the concept of species diversity, with each focusing on particular processes of changes in the ecosystem and species interactions. Though all species and individuals are equal (Warwick and Clarke 2001) biodiversity remains difficult to measure even after concluding on the method to use . This is because no single index epitomizes the concept (Purvis and Hector 2000).

The foundational idea of a biodiversity index is to quantitatively assess the biological dynamics in space and time. It is composed of different components that can be used to compare biological entities. A measure of the total number of species in a community Richness (S), is the simplest application to represent diversity (Whittaker 1972), and remains the most commonly used method (Magurran 2004).It dependent on sampling size and effort. Two methods are used to estimate species richness. These are Margalef's diversity index and Menhinick's diversity index affected by sampling effort but can be useful in assessing organisms. Species abundance is also important for diversity, incorporated into indices representing diversity.

Shannon-Wiener's diversity and Simpson's diversity indices were created to combine measure of richness and abundance. Shannon's diversity (H') is based on information theory that represents uncertainty about the identity of an unknown individual. In an evenly distributed and much diverse system, an unidentified individual could belong to any species, leading to uncertainty in its identification, but easier in a less diverse community of few species (Shannon1948). Simpson's index of diversity (1-D) represents the probability that two randomly chosen individuals belong to different species (McCune and Grace 2002). The inverse of Simpson's original index (1/D) closely relates to Simpson's index of diversity (Simpson 1949). Both formulas tend to increase, as diversity is believed to increase.

Evenness E shows how individuals in a community are evenly distributed among the different **species.** Low values indicates one or a few species dominate, while high values indicates that relatively equal numbers of individuals belong to each species. Evenness is derived from compound diversity measures such as Shannon-Wiener's diversity(H') and Simpson's index of diversity (1-D)and Simpson's reciprocal index of diversity (1/D) as they inherently contain richness and evenness (Morris et al 2014). Predicatively, Evenness calculated from H' (J') is of limited use because it mathematically correlates with H' (DeBenedictis 1973) while Estimates from the reciprocal of Simpson's diversity index is mathematically independent of Simpson's diversity index (Smith and Wilson 1996), hence more useful measure of evenness.

Biodiversity indices are important in detecting changes in ecosystems. According to Pearson and Rosenberg (1978), biodiversity indices are greatly influenced by sampling size and methods. Hence, further study is required to interpret changes in the ecosystem. It requires further investigation, taking into account other ecosystem features, such as trophic structure, reproductive potential, competitive interaction, etc.

METHODOLOGY

The study was conducted during the October 2022 flood along Epie creek between longitudes 6^0 22′ 34.44″ to 6^0 20′ 10.20″E and latitudes 5^0 1′ 9.31″ and4^0 57′ 2.85″ N (Fig 1).

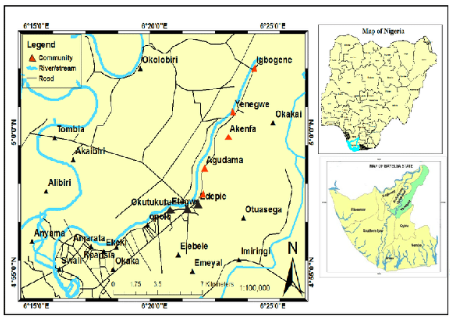

Figure 1. Map of study area

Source: Ngodigha et al 2023

Sample collection

Samples were collected randomly from the landings of artisanal fishers along the Epie creek from Igbogene to Ede-epie/Tombia axis. The samples were sorted, identified and grouped for diversity analysis.

Data analysis

Diversity was measured by Shannon-Wiener's diversity (Shannon-Weaver 1963) and Simpson's diversity (Simpson 1949) indices. Species richness and Evenness were estimated according to Odum (1971) and Margalef (1968) respectively. Species dominance was evaluated as proposed by Simpson (1949), while similarities between study stations were calculated from Jaccard (1908).

RESULTS AND DISCUSSION

Number of fish species collected were 71, 66, 68, 77 and 87 from Igbogene, Yenegwe, Akenfa, Agudama and Ede-epie/Tombia respectively. The fish species were grouped to 9 using the common names. These were: Breast fish (Protopteridae), Catfish (Bagridae, Clariidae, Ictaluridae), Snakehead (Channidae), Tilapia (Cichlidae), Trunk fish (Gymnarchidae), Perch (Distichodontidae), Pebble fish (Alestidae), Bony tongue (Osteoglossidae) and Polypteridae (African ropefish).

Shannon-Weiner diversity in the study area was between 1.734 at Igbogene and 1.974 at Tombia. Simpson's index of diversity was highest at Tombia (0.838) and lowest at Igbogene (0.774).Simpson's index (D) range was between 0.162 at Tombia which was the lowest and 0.226 the highest at Igbogene.

Simpson's reciprocal index of 6.173 was highest at Tombia and lowest at Igbogene (4.419). Evenness was highest at Tombia with a value of 0.899 and the lowest value of 0.789 was recorded at Igbogene. Species richness estimated ranged from 4.255 at Tombia and 4.535 at Yenegwe (Table 1).

Table1: Fish diversity indices in Epie creek during 2022 flood

Indices	**Study stations**				
	Igbogene	**Yenegwe**	**Akenfa**	**Agudama**	**Tombia**
R	4.457	4.535	4.503	4.374	4.255
E	0.789	0.846	0.828	0.872	0.899
H′	1.734	1.858	1.818	1.916	1.974
D	0.226	0.190	0.199	0.174	0.162
1-D	0.774	0.810	0.801	0.826	0.838
1/D	4.419	5.257	5.029	5.731	6.173
Number of individuals	71	66	68	77	87

As shown in Fig 2, lowest Similarity index of 0.059 was estimated between Yenegwe and Akenfa and highest was between Akenfa and Agudama (0.289).Similarity value of 0.200 was evaluated between Igbogene and Akenfa, Yenegwe and Agudama and Agudama and Tombia.

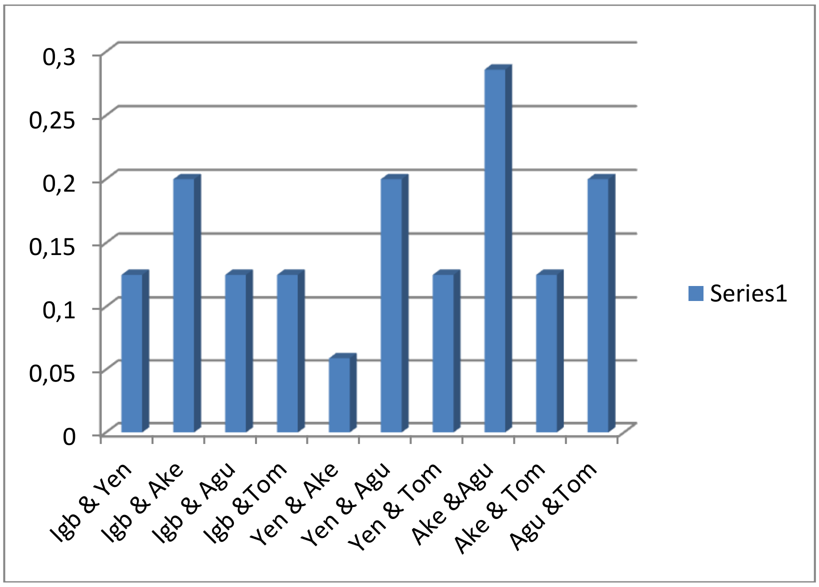

Figure 2. Similarity between study locations along Epie creek
Igb=Igbogene, Yen=Yenegwe, Ake=Akenfa, Agu= Agudama, Tom= Tombia, Opo=Opolo

DISCUSSION

Fish species identified in the study aligns with the findings of Ngodigha et al (2023a) and Ngodigha et al (2023b) in their different studies. Species richness S quantifies the number of different species in a given area. The measure strongly depends on sample size and effort. This was taken into consideration in the study. Species richness index used for the evaluation was Margalef's diversity index (Clifford and Stephenson 1975). Value estimated ranged from 4.255-4.535 indicating a stable ecosystem.Though species richness is often used as a measure of biodiversity, diversity indices that measures both species richness *and* abundance are of more interest to ecologists. Hence, the use of Shannon-Weiner diversity index H', Simpson's index D and Simpson's index of diversity 1-D.

The different species of fish in the Creek was higher in Tombia and lower in Igbogene from Shannon-Weiner diversity index H'. This could be due to the less fishing activities observed in Tombia axis. Shannon-Weiner diversity index H' evaluates the number of individuals in each growth step in a habitat community (Ulfa et al. 2019). The Shannon-Weiner diversity of $1 < H' \leq 3$ indicates a moderate diversity in Epie creek, suggesting a stable ecosystem (Odum 1993). The index represents doubts about the identity of an unknown individual that could belong to any species in a diverse system. In a highly diverse system, an unknown individual could belong to any species, leading to unreliability in predictions of identity.

To correct the uncertainty, Simpson's index and Simpson's index of diversity were used. Simpson's index D developed by Simpson (1949) measures probability of two randomly selected species to be the same in a less diversify system. The range is between 0-1, where the larger the value of D the lower the diversity. D estimated in all study locations were very low (0.162-0.226) indicating a diverse system. Simpson's index of diversity (1-D) was also developed to complement the first formula. The index represents the probability that two individuals randomly selected from a sample will belong to different species and ranges from 0-1.The higher the value the greater the diversity. Simpson's index of diversity (1-D) in this study was between 0.774 and 0.826 proves a diverse ecosystem that is stable. The stability of the aquatic system could be attributed to the downward migration of species and inflow of nutrients from upstream by the flood that leads to improvement in the physicochemical nature of the aqua system thereby nourishes the ecosystem.

Evenness E describes the relative abundance of each species and ranges from 0-1. The higher the value the higher the evenness. In this study, E was between 0.789 and 0.899 indicating a stable system. According to Krebs (1989) $0.75 < E \geq 1$ is a stable ecosystem that is healthy. This shows that no particular species dominates the system but all species are evenly distributed. The more evenly distributed individuals of species the more balance the system (Odum 1971).

Simpson's reciprocal index also evaluates dominant species because it gives weight to common species. The value has a minimum of 1. The values in this study were between 4.419 and 6.173 and so could be placed on moderate dominance because the highest number was 9 (number of families). The finding indicates that no particular species of fish dominated the creek during the 2022 flood in Yenagoa.

Similarity between study stations was very low. According to Jaccard (1912), similarity ranges from 0-1. The closer the value is to 1, the more common species both stations have. The dissimilarity in species composition could be due to the flood. Floods promotes diversity of the habitat in the aqua system by bringing with it different materials and organisms and as the water constantly flows downstream, structure and composition of the system changes which can eventually improve the ecosystem.

CONCLUSIONS AND RECOMMENDATIONS

Flooding in aquatic ecosystem creates habitat diversity of species for spawning, feeding and energy transfer, which results in high species diversity. Diversity values from The Shannon-Weiner diversity index indicates a stable system supported by the Simpson's diversity index.

This study provides information on fish diversity in Epie creek during the 2022 flood in the Niger Delta, hence should be useful in ecological studies.

FURTHER STUDY

Research should be conducted constantly in flooded areas in the Niger delta in the future to ascertain the effect on floods on fish diversity.

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