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Effect of Flooding On Benthic Macro-Fauna in Efi Lake, Kalama, Sabagreia, Kolokuma/Opokuma Lga, Bayelsa State Nigeria.

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ABSTRACT
An assessment of benthic macro-fauna in Efi lake Sabagreia Kolokuma/Opokuma Local Government Area was conducted before, during and after the floods. This was done in order to gauge the impact of the flood on the ecological status of the lake considering its enormous importance as a source for fish and other aquatic resource and the biggest tourist fish festival in the Niger Delta. Five sampling stations were identified and samples collected. Identification of samples were conducted using standard procedures and keys. Data were analyzed using several diversity indices: Shannon evenness index (E), and Simpson diversity index (D), Menhinicks' index [D], Margalef index and Evenness index. EPT index was also employed to give an overall picture of the ecological health of the lake. Result indicated a spatial variation of all the measured indices within the lake. Early samples before flood recorded the lowest abundance, the peak of the flood recorded the highest and samples at the recede of flood had the highest insect abundance. These data can be attributed to availability of food resources, inflow or out flow of organic matter and the intensity of disturbance by flood. EPT index was 15.23 which indicated an ecosystem that was proportionately well populated by pollution intolerant insects. It can therefore be concluded that the lake is in good health and much fish harvest may be expected by tourist and the local people. Flooding therefore do not have a negative impact on the ecosystem of lake Efi.
Key words: Efi lake, Benthic, Macro-fauna, Flood, Sabagreia, Bayelsa State, Nigeria.

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I. Introduction

Yenagoa and indeed most of the fresh water coastal cities in Bayelsa State lie several feet below sea level. They are thus prone to seasonal flooding and are inundated with water for most parts of the rainy season. A sad reality which has become their fate for a decade due to global warming. Generally, floods are caused by many factors such as heavy rainfall, highly accelerated snowmelt, severe winds over water, unusual high tides, tsunamis, or failure of dams, levees, retention ponds, or other structures that retain water.

Some of the negatives of flooding include the intrusion of portable waters by sewage causing diarrhea, erosion of high grounds causing gully erosion and the overflow of ponds, tanks, lakes and other man-made receptacles leading to the escape of fish and the modification of such aquatic ecosystems.

Efi lake situated in Sabagreia presents a unique example of a lake that is bedeviled by the ritual of annual flooding. Touted as the most productive lake in the Niger Delta, it has achieved the repute and status of the venue of a fishing festival because of its fish diversity and abundance.

Sadly, the yearly process of flooding has resulted in the modification of aquatic ecosystems including Efi lake by the introduction of runoff water containing myriads of anthropogenic inputs.

Fresh water fauna especially benthic macroinvertebrates are greatly affected by variations in water quality and chemistry. The structure of macro-fauna communities depends on abiotic and biotic factors that vary across spatial scales from regional to habitat specific locations ([1], [2], [3]. [4], [5]). As the biology of the habitat of benthic organisms, often determine the abundance and decline and the impacts of pollution and habitat degradation. There is an acute need to monitor benthic macro-fauna diversity and abundance in Efi Lake along spatial ranges in order to determine its ecological status considering its enormous importance in our fisheries and tourism. This will determine the ecological status and gauge our expectations of fish harvest of the lake as we await yet another fishing festival and tourism expo.

II. Materials and Methods

2.1 Study area

Efi Lake is located in Kalama community of Sabagreia town in Kolokuma/Opokuma Local Government Area, Bayelsa State Nigeria.

2.2 Sampling Stations

Sampling for benthos was done in five (5) stations along the lake. There coordinates are expressed below

Table.1: Coordinates of the sampling locations

STATIONS	LONGITUDE	LATITUDE
I	E006°15' 01.9"	N05°02' 18.3"
II	E006°15' 02.1"	N05°02' 20.3"
III	E006°15' 01.1"	N05°20' 20.9"
IV	E006°15' 01.9"	N04°02' 17.7"
V	E006°15' 03.5"	N05°02' 17.7"

2.3 Sample collection

Sediment samples were collected before, at the peak of the floods and after the flood using an Eckman grab. Three hauls were made at each sampling station by sending the grab down into the bottom and using the messenger to close and grab some quantity of sediment.

The benthic samples were then washed through 4, 6, and 36-mm mesh size sieves to collect the benthic organisms. The washed sediment with macro-invertebrates were poured into a wide mouth labelled plastic container and preserved with 40% formalin solution. The preserved samples were taken to the laboratory for further analysis.

2.4 Laboratory Analysis

The washed and preserved sediment with the benthic macro-invertebrates were then stained with Rose-Bengal stain and then poured into a white enamel tray and sorted in the laboratory. For effective sorting, moderate volume of water was added into the container to improve visibility. Forceps were used to pick large benthos while smaller ones were pipetted out. The benthos was later identified to their lowest taxonomic group using standard keys under light and stereo dissecting microscope and then counted.

2.5 Data Analysis

In order to characterize and interpret the benthic macroinvertebrates community data into explainable values, five (5) diversity indices were used. Namely, Shannon evenness index (E), and Simpson diversity index (D), Menhinicks' index [D], Margalef index and Evenness index Microsoft excel was used to plot the charts and graphs.

Evenness Index (E): This is the ratio observed diversity (H) to the maximum diversity (H_{max}) is taken as a measure of evenness (E).

$$\text{Evennes} = \frac{H}{H_{max}} = \frac{H}{\text{Log } S}$$

Where:

H = Shannon Wiener's Index

S = the total number of species

Margalef D Index was also used in the index analysis [6].

$$D = \frac{S - 1}{\text{Log}_e N}$$

Where:

S = Number of species, and

N = Total number of individuals

Shannon-Wiener Index [7] (H') is used to combine both richness and abundance

$$H' = -\sum\left[\left(\frac{ni}{N}\right) \times \ln\left(\frac{ni}{N}\right)\right]$$

Where:
Ni = number of individuals or amount of each species
N = total number of individuals or amount for the site, and
In = the natural log of the number

Simpsons' Index:

$\sum (Pi^2)$

Where:

Pi = Number of individuals divided by total number of individuals.

Mehinicks Index; $\frac{S}{\sqrt{N}}$

Where;

S = Number of species

N= Total number of Individuals

EPT index was also calculated using the formular

I = N(EPT)X100/N(T)

Where:

I = EPT index

N(EPT) = Number of Taxa present in Ephemeroptera, Plecoptera and Trichoptera.

N(T) = Total number of all Taxa present

III. Results

The result of this study is presented in Tables 2 to 5 and Figures 1 to 10.
A total of 78 individuals of benthic fauna were collected, comprising mainly of three taxa (Mollusca, Arthropoda and Chordata) and one unknown (Table 5). The phylum Mollusca recorded the highest with (49) individuals, phylum Arthropoda recorded a total of (23) individuals. Phylum chordate recorded a total of (2) individuals and the Unknown or unidentified benthos were a total of (4) individuals (Table 5). The result show spatial variations of the observed benthos in the lake under investigation.

Table 2: Pre-flood Distribution of Benthos in sample

SN	TAXA	COMMON NAME	I	II	III	IV	V	ABUNDANCE
	MOLLUSCA							
1	mollusc shell		2	1	0	1	1	5
2	*Pisidium spp*	Finger nail clam	0	1	0	0	0	1
	ARTHROPODA							
3	*Unionicola spp*	Water mite	0	0	1	0	0	1
4	*Anax spp*	Dragon fly larvae	0	0	0	1	0	1

5	Insect exoskeleton		0	1	0	0	0	1
6	*Formica spp*	Ant	0	0	0	1	0	1
7	*Lycoriella spp*	Fungus gnat	0	0	0	1	0	1
	CHORDATA							
8	Frog egg mass		0	0	0	0	1	1
9	**UNKNOWN**		1	0	1	0	0	2
	Total		3	3	2	4	2	14

Table 3: Benthic distribution at peak of flood

SN	TAXA	COMMON NAME	I	II	III	IV	V	ABUNDANCE
	MOLLUSCA							
1	*Umbonium vestiarium*		0	1	0	0	0	1
2	*Pisidium spp*	Finger nail clam	23	0	4	1	3	31
	ARTHROPODA							
3	Insect exoskeleton		0	1	0	1	0	2
4	*Formica spp*	Ant	0	1	0	0	0	1
5	*Lycoriella spp*	Fungus gnat	0	0	0	0	1	1
6	*Oocyclus rupicola*	Black scavenger beetle	0	0	1	0	0	1
7	**UNKNOWN**		0	0	0	1	1	2
	Total		23	3	5	3	5	39

Table 4: Benthic distribution after flood

S/N	Taxa	COMMON NAME	I	II	III	IV	V	ABUNDANCE
	MOLLUSCA							
1	*Pisidium spp*	Finger nail clam	8	0	3	0	0	11
	ARTHROPODA							
2	*Anax spp*	Dragon fly larvae	0	0	0	1	0	1
3	*Chronomus spp*	Midge fly	2	3	0	0	0	5
4	*Formica spp*	Ant	0	0	1	0	0	2
5	*Simulium trifasciatum*	Black fly	0	0	1	0	0	1
6	*Corticaria longicallis*	Brown scavenger beetle	0	0	1	0	0	1
7	insect egg case		0	0	0	0	1	1
8	Insect exoskeleton		0	0	0	3	0	3
	CHORDATA							
9	Fish		0	0	1	0	0	1
	Total		10	3	7	4	1	25

Table 5: Cumulative benthic composition and distribution in the five sampling stations

SN	TAXA	COMMON NAME	I	II	III	IV	V
	MOLLUSCA						
1	*Umbonium vestiarium*		0	1	0	0	0
2	Shell of mollusc		2	1	0	1	1

3	*Pisidium spp*	Finger nail clam	31	1	7	1	3
	ARTHROPODA						
4	*Unionicola spp*	Water mite	0	0	1	0	0
5	*Anax spp*	Dragon fly latvae	0	0	0	2	0
7	*Chronomus spp*	Midge fly	2	3	0	0	0
8	*Lycoriella spp*	Fungus gnat	0	0	0	1	1
9	*Corticaria longicallis*	Brown water scavenger beetle	0	0	1	0	0
10	*Oocyclus rupicola*	Black water scavenger beetle	0	0	1	0	0
11	*Formica spp*	Ant	1	0	1	1	0
12	*Simulium trifasciatum*	Black fly	0	0	1	0	0
13	Insect exoskeleton		0	2	0	4	0
14	Insect egg case		0	0	0	0	1
15	**UNKNOWN**		1	0	1	1	1
	CHORDATA						
16	Frog egg mass		0	0	0	0	1
17	Fish		0	0	1	0	0
TOTAL			37	8	14	11	8

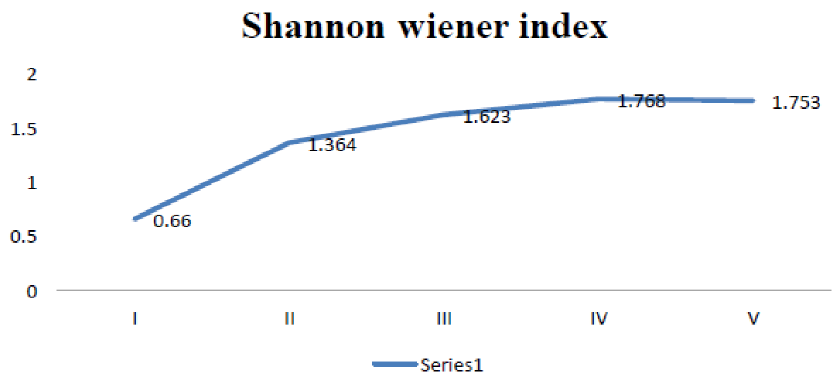

Figure 1: Shannon wiener's index across the sampling stations

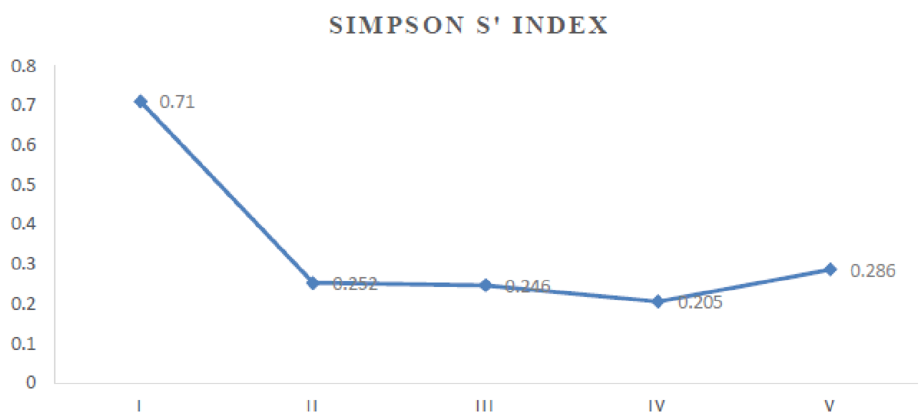

Figure 2: Simpson's index across the sampling stations

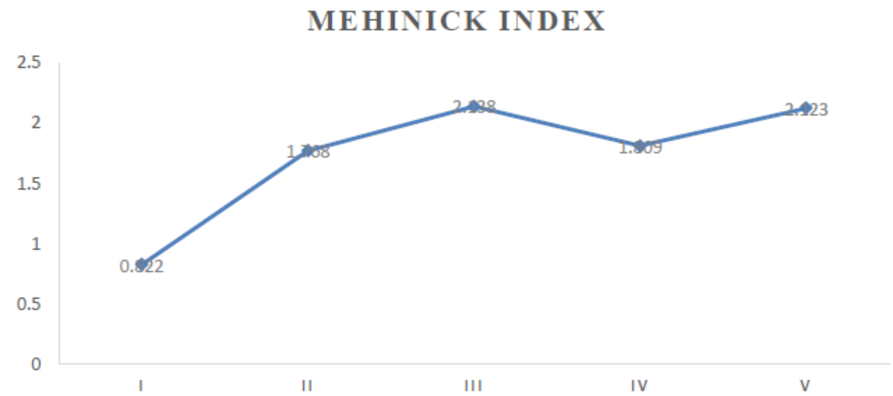

Figure 3: line graph showing the value of Meihinick's index across the sampling stations

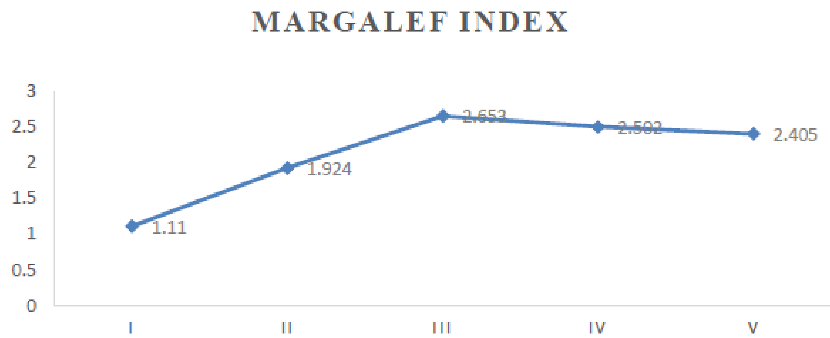

Figure 4: Margalef's index across the sampling station

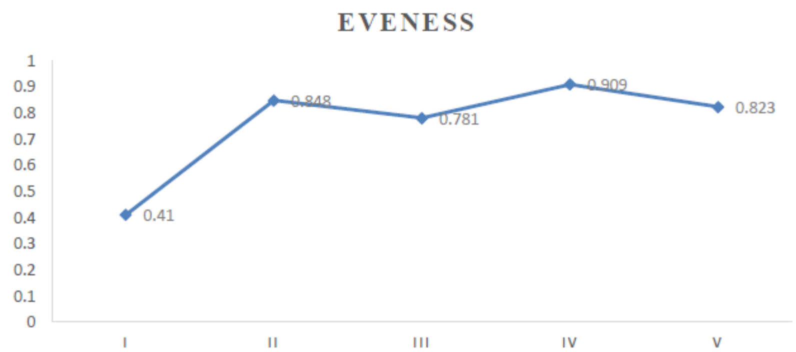

Figure 5: Evenness index across the sampling station

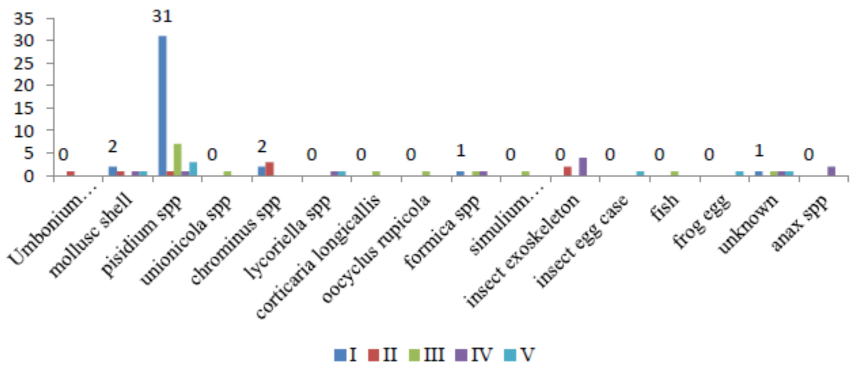

Figure 6: Bar chart showing the distribution of all phyla across the stations

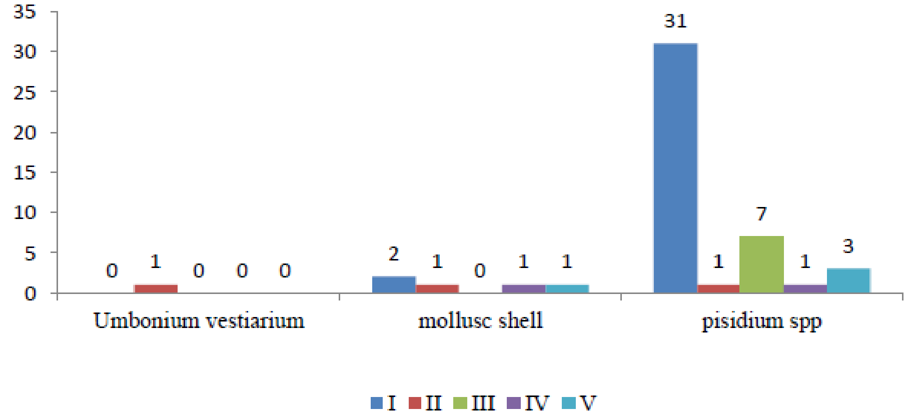

Figure 7: Distribution of phylum Mollusca across the stations

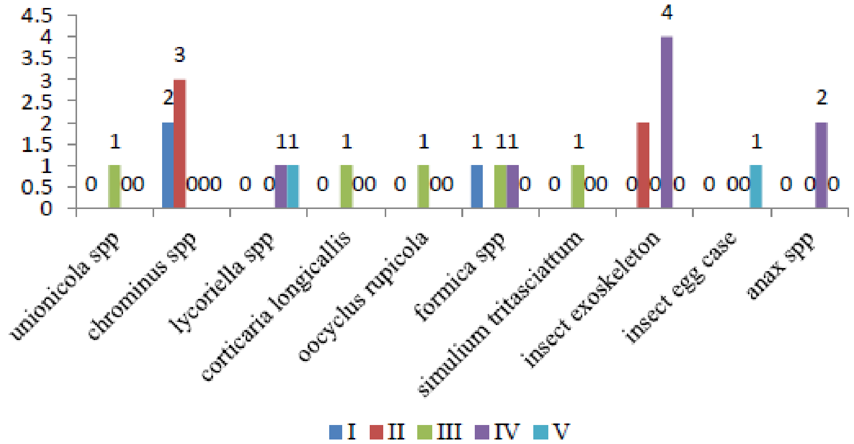

Figure 8: Distribution of phylum Arthropoda across the stations

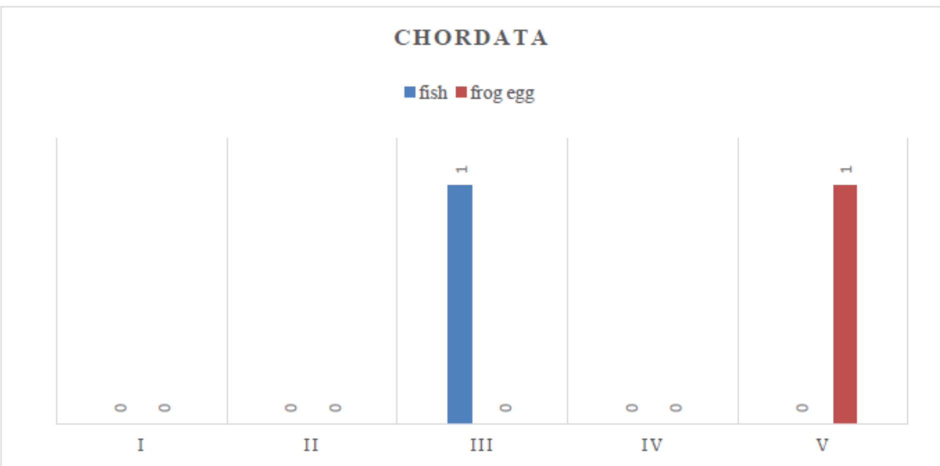

Figure 9: Distribution of Phylum Chordata across the stations

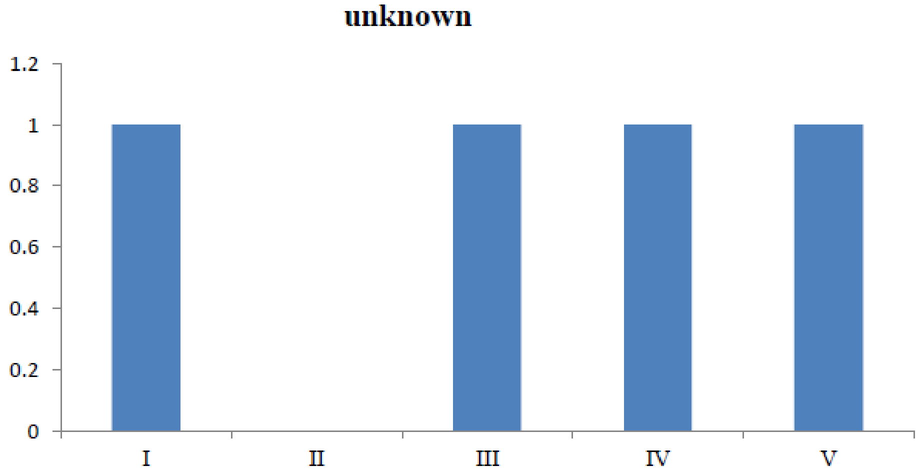

Figure 10: Distribution of Unknown Benthos across the stations

Table 6: EPT index ranges and their corresponding water quality ratings.

Rating	Excellent	Good	Good-fair	Fair	Poor
EPT	>27	21-27	14-20	7-13	0-6

Modified from NCDENR, 1997.

3.1 Discussion

Benthic macro-faunas are important in monitoring environmental effects because they are either sessile or of limited movement and therefore cannot readily avoid pollution. Their dynamics thus, reflect the local conditions of the aquatic ecosystem [8]. Their presence or absence provides an indication of water quality conditions over a period of time.

In this study, early flood sampling accounted for the lowest number of individuals (Table 2).

This could be as a result of the beginning of most species coming out from their hibernation, less food, unstable weather pattern etc. Also, benthic macro invertebrate fauna for the peak of flooding recorded the highest number of individuals (Table 3). This may be caused by inflow of water to Lake as a reservoir for housing different aquatic lives. Furthermore, the availability of food, organic matters, high current flow rate may have transported them to the Lake. This is in accordance with the observation of Chattopadhay *et al*. [9] whom noted that flow velocity in general was suitable for benthic macroinvertebrate community. Faster flow velocity helps in organic matter transport ([10], [11]). In contrast, faster water velocity could be detrimental to benthic macroinvertebrate community by washing away the food resources and altering substrate composition ([12], [13]).

At the recede of the flood, insects recorded the highest number of individuals due to less organic load. Insects are good biological indicators of water quality, which shows that there was less pollution in the Lake. There is recolonization of species such as midge fly, black fly which is in agreement with the observations of Chattopadhay *et al*. [9], where sampling was conducted within 2 to 3 weeks after flood peak. This may have allowed some recolonization and could explain why there was only a small decrease in abundance.

Mollusca was the most abundant taxa in the lake. This was followed by Arthropoda, chordate and the Unknown taxa respectively. The Finger nail clam was the most abundant of all mollusk species. Fingernail clams are known to exhibit adaptations to environmentally stressed habitats, by their early maturity, small adult size and increased energetic reproduction [14]. This could explain their high abundance especially during the peak of flood. They also exhibit slow growth rates, low fecundity, and release large, fully developed young which is associated with their adaptation to stable habitats [14].

The study also observed an EPT index of 15.23. This is translated as good water quality by the recommended standards as suggested by North Carolina Department of Environment, Health, and Natural Resources [15] (Table 6).

Comparing stations, station I recorded the highest number of species with a total of 37 individuals, station III recorded (14), station IV (11), station II and V recorded 8 each respectively (Table 5).

The diversity of macro-benthic fauna estimated by Margalef, Shannon weiner, Simpson's, evenness and mehinicks were generally low but compares to the findings of Onyena, [16] who reported low values in Margalef and Shannon Weiner index. The Shannon-Weiner, Margalef, Evenness and Mehinick index however shows increase across the station. Shannon wieners' index ranges from 0.66 to 1.768 value, having station 4 as the highest. Simpsons' index ranges from 0.71 to 0.286, with station 5 as the highest. The Evenness index ranges from 0.41 to 0.909, with station 4 as the highest. Margalef index ranges from 1.11 to 2.653, having station 3 as the highest. Mehinicks' index ranges from 0.822 to 2.138, with station 3 as the highest.

IV. Conclusion

The study conducted and evaluated the response of benthic organisms to flood. Early samples before flood recorded the lowest abundance, the peak of the flood recorded the highest and samples at the recede of flood had the highest insect abundance. These data can be attributed to availability of food resources, inflow or out flow of organic matter and the intensity of disturbance by flood.

Although flooding causes changes in the dynamics of lakes, it does not pose a serious threat to ecosystem dysfunction and stability.

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Appendix I: Pictures of Benthic macro-fauna in Efi Lake

Unknown

mollusc shell

Pisidium spp

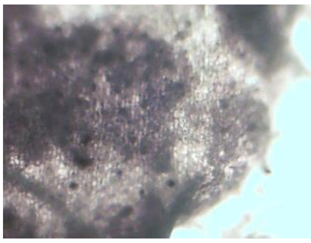
Insect exoskeleton

unknown

Unionicola spp


Insect exoskeleton


Dragon fly larvae

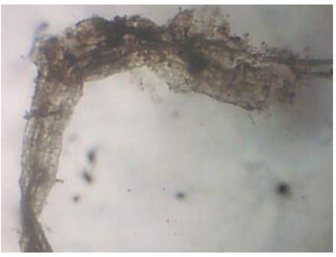

frog egg mass


Formica spp


Umbonium vestiarium


Unknown


Unknown


Midge fly larvae


Oocyclus rupicola


Fish


Simulium trifasciatum


Insect egg case