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Influence of Habitat Structure and Ecological Zones on Amphibian Diversity in Rivers State, Nigeria

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Abstract

This study investigates the influence of habitat structure on the species diversity of anurans of Rivers State, Nigeria. This research was conducted between 2015 and 2019. The survey covered seven Local Government Areas (LGAs) and three ecological zones (lowland forest, freshwater swamp and short mangrove). The habitats included farmlands, fallow areas, swamps, streams and inundated areas, bush paths, human settlements and forested areas. Visual encounter and acoustic survey methods were used and species identification was aided by appropriate taxonomical keys. Diversity indices were computed using Past-exe statistical software. Nineteen amphibian species were encountered including members of the Arthroleptidae, Bufonidae, Dicroglossidae, Ranidae, Hyperoliidae, Ptychadenidae and Pipidae. Freshwater swamps and short mangrove ecological zones (characterized by human settlements and farmlands) had the lowest diversity of two and five amphibian species, respectively. The highest diversity comprised of eighteen amphibian species was recorded in forested habitats of the lowland forest/freshwater swamp ecological zone. 569 individuals were encountered at lowland forest/freshwater swamp ecological zone; 215 at lowland forest; 60 at short mangrove; and 28 at freshwater swamp ecological zone. Shannon diversity was highest in the lowland/freshwater swamp ecological zone (H=2.12) and lowest in the freshwater swamp zone (H=0.52). The results show that forested habitats comprised of the combination of lowland forest and freshwater swamp ecosystems host a greater diversity of amphibian species. We therefore recommend that lowland and freshwater swamp ecosystems in the State should be protected to support greater diversity of amphibians.

Introduction

Structure and ecological characteristics of habitats affect their biological diversity (Acevedo-Charry and Aide, 2019). Amphibians are generally terrestrial and aquatic ecosystem dwellers though a large number are also arboreal. They all require water for reproduction but this dependence varies for species, and the water body must be a freshwater ecosystem (Hua and Pierce, 2013). There are reports however, of a few species that can tolerate salt water (Kearney et al., 2012).

Anthropogenic alterations of ecosystems result in loss or reduction of forest cover and environmental pollution which can remarkably alter the diversity of amphibians. Natural ecosystems also vary (Hashim et al. 2016; Ndriantsoa et al., 2017) and the distribution of amphibian species in each ecosystem or ecological zone depends on the preference of the amphibian or the suitability of the habitat for its ecosystem functions.

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Here we compile the results of independent amphibian surveys, since 2015, in locations covering seven Local Government Areas of Rivers State, Nigeria, and three ecological zones, to deduce the impact of habitat structure and ecology on amphibian species diversity. This will aid policy makers in planning amphibian conservation strategies and programs.

Methods

Amphibian surveys were done in seven Local Government Areas and three ecological zones (lowland forest, freshwater swamp and short mangrove) of Rivers State, Nigeria, between 2015 and 2019. The locations surveyed were Isiokpo in Ikwerre LGA; Rumuji and Ndele in Emohua LGA; Fiberesima Polo, ATC sandfill and Greame Ama in Okrika LGA; Bori and Kaani 1 in Khana LGA; Omoku in Ogba-Egbema-Ndoni LGA; Ahoada main town and Ikata in Ahoada East LGA; and Agbada, Rumuagholu and Rumuesara in Obio-Akpor LGA. Figures 1 and 2 show the positions of the LGAs of Rivers State and their ecological zones and GPS information.

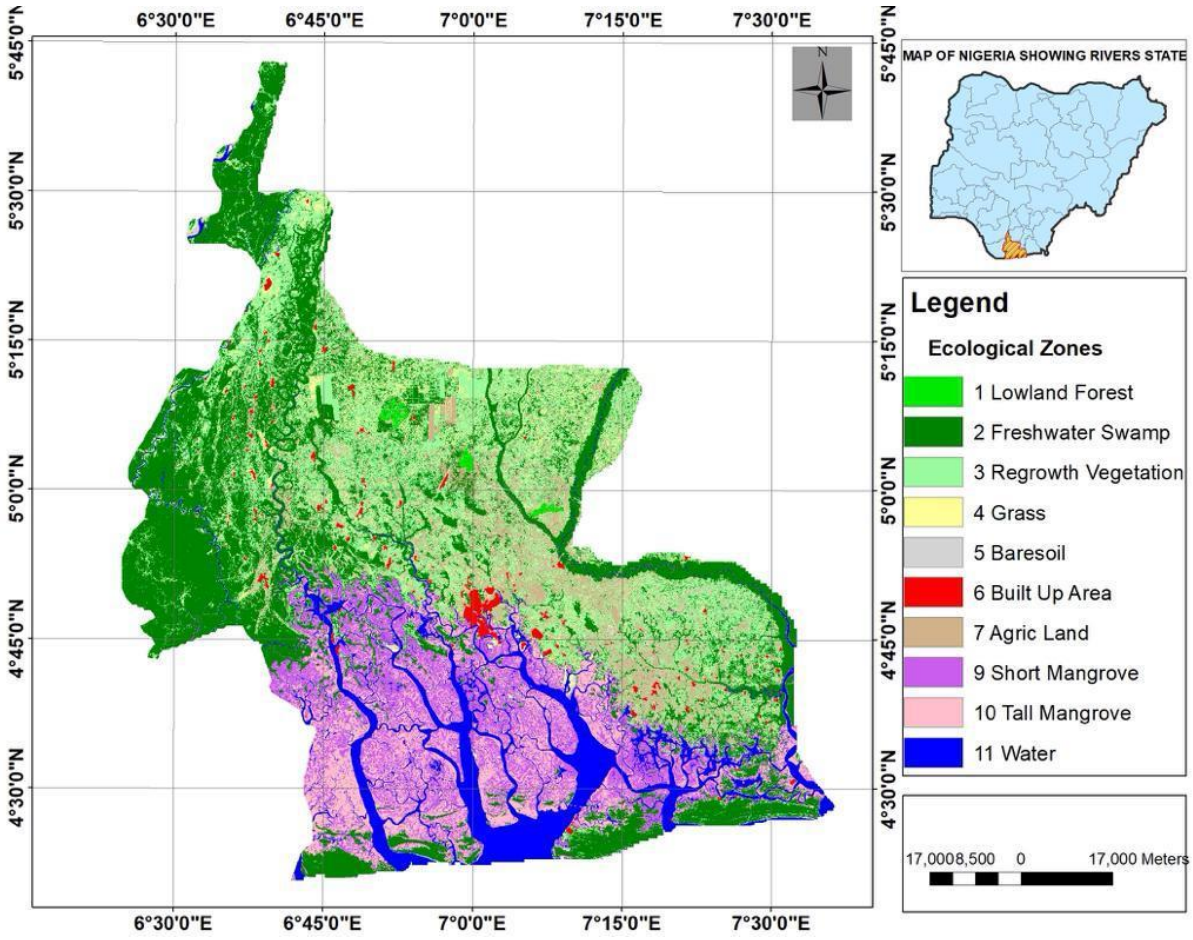

Figure 1. Map showing the ecological zones of Rivers State, Nigeria

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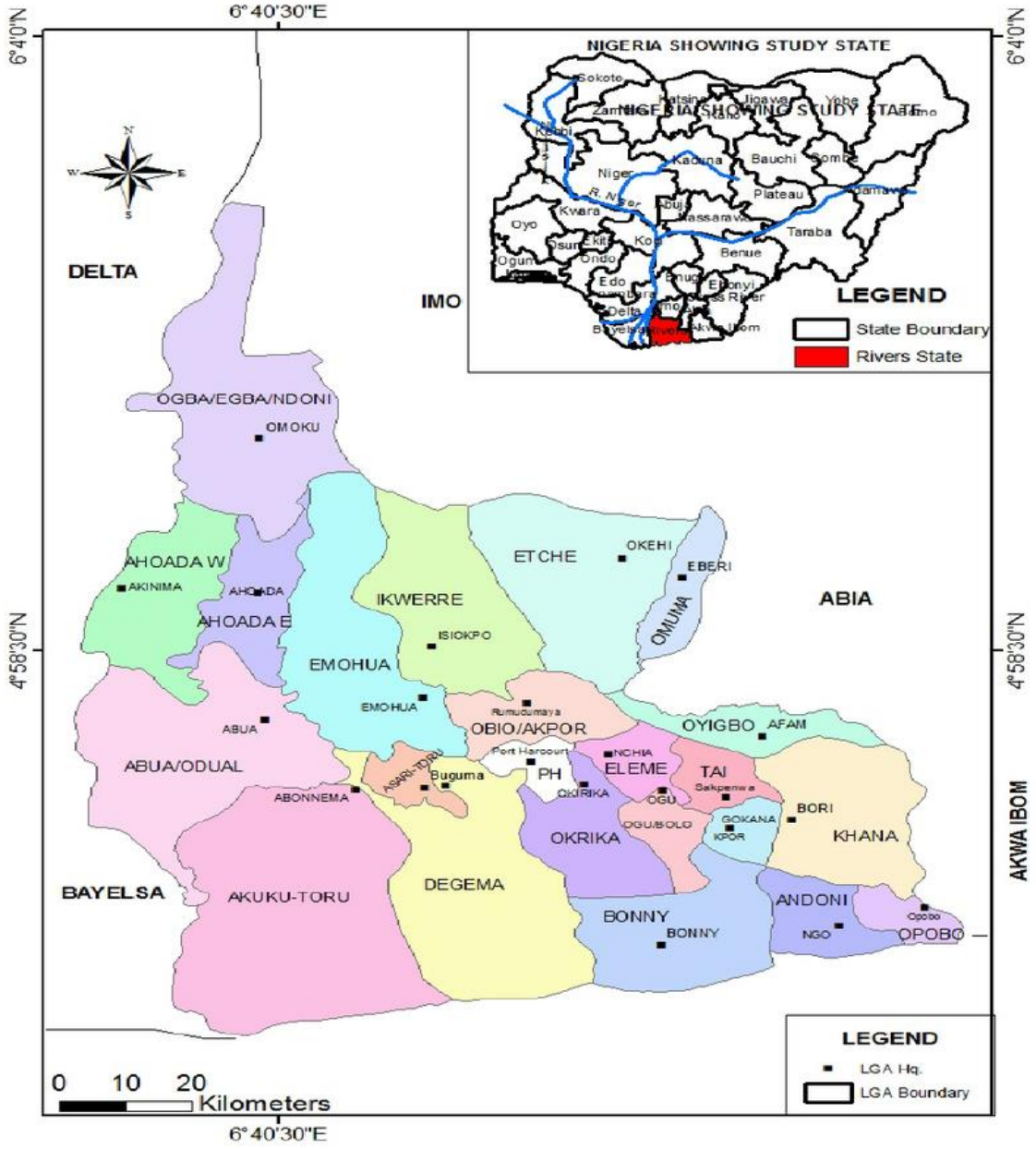

Figure 2. Map showing Local Government Areas in Rivers State, Nigeria (Source: Google Maps)

The surveys were carried out mostly during the rains in all locations. However, at Obio-Akpor parts of the dry season were also surveyed. This was accomplished in all locations using visual encounter and acoustic survey methods. Diversity indices were computed using Past-exe statistical software. Species identification was aided by keys from Schiotz (1999) and Rodel (2000).

Results and Discussion

Nineteen amphibian species were encountered in the course of the survey yielding a total number of 872 individuals being comprised of seven families. These were Arthroleptidae (*Leptopelis viridis*), Bufonidae (*Sclerophrys maculata, S. regularis, S. camerunensis*), Dicroglossidae (*Hoplobatrachus occipitalis*), Ranidae (*Hylarana galamensis*), Hyperoliidae

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(*Hyperolius* spp., *Afrixalus fulvovittatus*), Ptychadenidae (*Ptychadena* spp.) and Pipidae (*Hymenochirus* sp., and *Silurana tropicalis*). All the species encountered are listed as Least Concern by the IUCN (2014).

The amphibian species encountered in each Local Government Area are listed in Table 1, with the dominant species in bold letters. The ecological zones and habitat characteristics of the surveyed locations are also indicated. For instance, in Emohua LGA, the habitats were farmlands, fallow areas and ponds. This LGA is within the lowland forest ecological zone, and *Sclerophrys maculata*, *S. camerunensis*, *S. regularis*, *Hoplobatrachus occipitalis*, *Hymenochirus* sp., *Ptychadena oxyrhynchus*, *P. bibroni*, *P. pumilio*, *P. mascareniensis*, *P. schubotzi* and *P. oxyrhynchus* were encountered, but *S. maculata*, *P. pumilio* and *P. mascareniensis* were dominant over the other species. Obio/Akpor LGA had the highest diversity of species while the lowest was found in Ogba-Egbema-Ndoni and Ikwerre LGAs. It will be noticed that habitats with forested locations had higher amphibian species diversity. Those characterized by farmlands, human settlements, or streams had fewer species diversity.

Based on the distribution of species across the geographical zones, freshwater swamp zone had only two amphibian species, followed by short mangrove ecological zone with five species. Lowland forest zone had 10 species while habitats comprised of the characteristics of both lowland forest and freshwater swamp had 18 species of amphibians (Table 2).

Table 1. Amphibian diversity (dominant species in bold) in surveyed Local Government Areas (LGAs) of Rivers State, Nigeria (2015-2019)

Year	**LGA**	**Habitat type**	**Ecological zone**	**Amphibian diversity**
2016-2018	Emohua (Rumuji, Ndele)	Farm land, fallow area, pond	Lowland forest	***Sclerophrys maculata***, *S. camerunensis*, *S. regularis*, *Hoplobatrachus occipitalis*, *Hymenochirus* sp., *Ptychadena oxyrhynchus*, *P. bibroni*, ***P. pumilio***, ***P. mascareniensis***, *P. schubotzi*, *P. oxyrhynchus.*
2017	Khana (Bori, Kaani-1)	Freshwater body, inundated land	Lowland forest/Freshwater swamp	*P. pumilio*, ***P. mascareniensis***, ***S. regularis***, *S. maculata*.
2017	Ogba-Egbema-Ndoni (Omoku)	Freshwater body	Freshwater swamp	***Hymenochirus*** sp., *H. occipitalis.*
2017-2018	Ahoada East (Ikata, Ahoada main town)	Fallow land, Bush paths	Lowland forest/ Freshwater swamp	***H. occipitalis***, S. *maculata*, *P. bibroni*, *P. oxyrhynchus*, *P. mascareniensis*, *P. pumilio*, *Silurana tropicalis*, *Hymenochirus* sp.
2015-2017	Obio-Akpor (Rumuagholu, Rumueasara, Agbada)	Forests, Freshwater body, human settlement with fallow land	Lowland forest/ Freshwater swamp	*Hyperolius* sp., *H. guttulatus*, *H. fusciventris*, *H. fusc. burtoni*, *Leptopelis viridis*, *Ptychadena* sp., *P. schubotzi*, *P. oxyrhynchus*, *P. bibroni*, *P. pumilio*, ***P.***

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				mascareniensis, H. occipitalis, *Hylarana galamensis, S. tropicalis, Afrixalus fulvovittatus,* ***S. maculata***, ***S. camerunensis***, *S. regularis*.
2018-2019	Okrika (Fiberesima Polo, ATC sandfill, Greame Ama)	Fallow land; few isolated temporary freshwater ponds	Short mangrove	***S. maculata***, ***P. pumilio***, *P. mascareniensis, S. tropicalis, H. occipitalis.*
2019	Ikwerre (Isiokpo)	Farmlands; human settlements	Lowland forest	***S. maculata***, *H. occipitalis.*

Table 2. Summary of amphibian diversity based on the ecological zoning of all surveyed locations

Amphibian spp.	**Lowland forest**	**Lowland forest/freshwater swamp**	**Freshwater swamp**	**Short mangrove**
Sclerophrys maculata	76	64	0	31
S. camerunensis	1	20	0	0
S. regularis	6	142	0	0
Hoplobatrachus occipitalis	29	119	6	7
Hymenochirus sp.	1	0	22	0
Ptychadena oxyrhynchus	3	19	0	0
P. bibroni	1	22	0	0
P. pumilio	57	42	0	15
P. mascareniensis	40	91	0	6
P. schubotzi	1	5	0	0
Ptychadena sp.	0	1	0	0
Silurana tropicalis	0	14	0	1
Afrixalus fulvovittatus	0	3	0	0
Hyperolius guttulatus	0	1	0	0
H. fusciventris	0	1	0	0
H. fusciventris burtoni	0	2	0	0
Hyperolius sp.	0	1	0	0
Leptopelis viridis	0	1	0	0
Hylarana galamensis	0	21	0	0
Total	**215**	**569**	**28**	**60**

Diversity tests showed that dominance was highest in freshwater swamp ecological zone (0.66), followed by short mangrove (0.35), lowland forest (0.25), and was least in lowland forest/freshwater forest ecological zone (0.16). On the other hand, Shannon-Wiener diversity index was highest in the lowland forest/freshwater swamp ecological zone (2.12), followed by the lowland forest (1.56), the short mangrove (1.24) and least in the freshwater swamp (0.51) (Table 3).

Habitat structure influences the species diversity of amphibians and other vertebrates (Acevedo-Charry and Aide, 2019). Vallan (2000) reported that though forest fragmentation had lower impact on amphibians than on other taxa, amphibian species numbers were higher

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in larger forest fragments than in smaller ones. Altered habitats tend to be richer in disturbance-tolerant amphibian species (Pearman, 1997), while tree frogs and those less tolerant of disturbed landscapes are found in forests. As, such amphibian distribution in different habitats vary according to the habitat type and mirror the preferred habitat of the species.

Natural ecological zones also vary in their amphibian species composition, due to their suitability or otherwise for the biological requirements of the species. Here, we find that a combination of lowland forest and freshwater swamp ecological zones supported higher amphibian diversity. This is due to the different micro-habitats provided by such ecosystems providing niche for a diverse array of amphibian species (Biaggini and Corti, 2015).

In their research in Gashaka Gumti National Park, Nigeria, Nneji et al. (2019) reported higher diversity of herpetofauna at the forest and savannah regions of the park against the wetland/swampy areas and agricultural fields. In our research, it was observed that habitats characterized by lowland forest and freshwater swamp had higher diversity than either alone, but considered alone, the lowland forest had higher diversity than the freshwater swamp. A similar research at south-eastern Nigeria (Rahman et al., 2020) reported a higher diversity of amphibians in forest and swamps over agricultural fields and savannah. These reports all point to the need to limit anthropogenic threats to Nigerian forests. Forestation efforts should therefore be encouraged throughout Rivers State, Nigeria, in order to conserve a wide diversity of amphibians and associated wildlife.

Table 3. Diversity indices of amphibians in surveyed ecological zones, Rivers State, Nigeria

Diversity index	Lowland forest	Lowland forest/Freshwater swamp	Freshwater swamp	Short mangrove
Taxa	10	18	2	5
Individuals	215	569	28	60
Dominance	0.25	0.16	0.66	0.35
Simpson	0.75	0.84	0.34	0.65
Shannon-Weiner	1.56	2.12	0.52	1.24
Margalef	1.68	2.68	0.30	0.98

Conclusion

In conclusion, this survey is not conclusive as several locations remain to be investigated even in the LGAs reported here. However, from the results obtained, it is concluded that forested habitats comprised of the combination of lowland forest and freshwater swamp ecological zones host a greater diversity of amphibian species than either alone, and short mangrove ecological zones harbor less.

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