THE ABUNDANCE AND DIVERSITY OF THE FIN AND SHELL FISH OF MID-CROSS RIVER, SOUTH-EAST, NIGERIA

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Abstract

Fish abundance and diversity in Mid-Cross River, Nigeria, were studied monthly for 18 months commencing from March 2005 in order to stimulate sustainable management of the fisheries of the entire Cross River. Fish samples were collected from fishermen at four landing points and abundance and diversity determined. A total of 3,142 fishes belonging to 69 species, 39 genera and 21 families were assessed in this study. Nine species of Mochokidae, eight species of Mormyridae and Cichlidae, seven species of Clariidae, three marine intrusive species; *Decapterus rhonchus, Trachinotus tersia* and *Caranx hippos*; and the freshwater prawn *Macrobranchium vollenhovenii,* and other *Macrobranchium sp* were identified. The Cichlidae (50.19%) was the dominant family and the predominant species was *Oreochromis niloticus* (13.14%). ANOVA showed significantly higher fish catch in the dry season compared to rainy season ($p< 0.001$). Five fish species previously reported for this region were not encountered while others showed remarkable population decline and 42% of the families were monospecific. The result of this study raised the need for urgent and effective management of the fisheries of the Cross River to halt population depletion and species extirpation. It is advocated that such strategy should include the indigenous people and the conservation of some lakes within the region.

Keywords: Cross River, floodplain, fish diversity, fish conservation, management.

Introduction

The Cross River in Nigeria has a significant fisheries' diversity and productivity. It is ranked among the most productive ecosystems in Africa (Teugels *et al* 1992; King, 1996; Mdaihli *et al* 2003) with over 165 identified fish species. These support viable artisanal fisheries (Moses, 1987; Okogwu and Ugwumba, 2009).

Recent evidence has shown over exploitation and decline in the stock size of some species (Ama-Abasi *et al* 2004). Fish diversity is also threatened by anthropogenic activities such as dredging, deforestation and organic pollution. Previous belief that artisanal fisheries have little impact on fish abundance and diversity has been disproved by recent studies (Njiru *et al* 2004; King, 2007; Silvano *et al* 2009). High impact of artisanal fisheries on fish diversity is mainly attributed to the employment of unorthodox fishing methods such as use of small mesh sized fishing nets and ichthyocides. Unorthodox fishing method is common in the Cross River (Etcheri and Lebo, 1983; Udolisa and Lebo, 1986).

Compared to the temperate, tropical inland waters are poorly studied. Within the Cross River Basin, the Mid-Cross is poorly studied compared to the Upper and Lower sections. King (1996) argued that only entire river management strategy can protect the fisheries of the Cross River. However, workable entire river policy is only achievable if there is sufficient information on the fisheries of the different sections of the river, as each section is unique in species' composition, exploitation rate, number and antics of fishers. This study was therefore carried out to evaluate the abundance and diversity of the fishes of the Mid-Cross River with a view to bridge the knowledge gap between this section of the Cross River and the other two regions. This would facilitate the development of a practical entire river management policy.

This study was accepted on 3rd November 2010.

Materials and methods

Study area

The study-area is Mid-Cross River. The entire Cross River system lies approximately between Longitude 3°30'E and 10°00'E and Latitude 4°N and 8°N (Figure 1). The river basin covers an area of 54,000 km² with 14,000 km² in Cameroon and 39,500 km² in Nigeria. The area, Mid-Cross, was subjectively ascribed to the region from Obubra to Itu with floodplain lakes; Ehoma, Iyieke, Bob Erie and Ibini inclusive. These lakes are found mainly between Obubra and Ikot Okpora where they are arranged roughly in a straight line west of Longitude 8°E and appear to mark the abandoned bed of the Cross River. Annually, during the onset of the rainy season, some catfishes and tilapia migrate to these lakes to spawn. Detailed information on the limnology, fisheries and geology of the river are available (King, 1996; Okogwu, 2008).

Fish were sampled monthly from March 2005 to August 2006. During each sampling day, fishes were collected from the catches of fishers (who set their nets from 18.00hr to 4.00hr) in six landing points within the Mid-Cross River (Iyieke Lake, Ehoma Lake, Itigidi, Orah, Ndibe beach and Uwanna). Data from these landing points were pooled together by simple addition to form a month's sample. Prior arrangement with the fishers ensured that they retain their catches intact until the arrival of the investigators. The fishes were caught using a fleet of gill nets (38.1 mm, 63.5 mm, 76.2 mm, 101.6

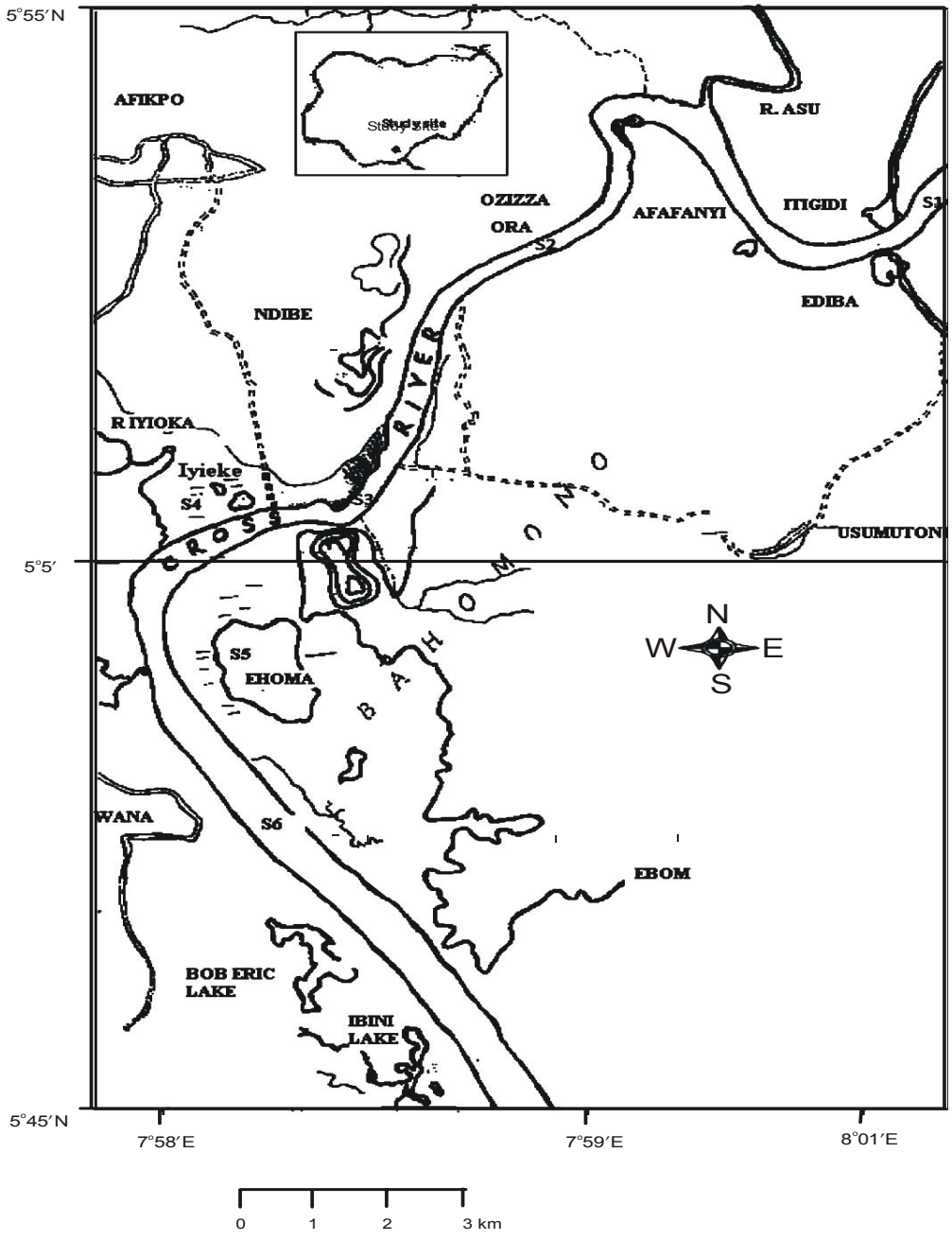

Figure 1: Map of Mid-Cross River showing the six sample sites (S1-6).

mm and 177.8 mm). The size and species selectivity of gill net was reduced by a fleet of nets. The catches of 4-8 boats were usually sampled per site. The samples were transported to the laboratory in plastic coolers containing ice block to prevent spoilage and then stored in a deep freezer to avert posthumous deterioration. The fish were then identified in the laboratory using meristic and morphological features with the guides of Teugels *et al* (1992), Olaosebikan and Raji (1998) and Idodo-Umeh (2003). Prior to identification, the fishes were taken out in batches from the freezer and allowed to thaw. Monthly abundance and diversity of fish were estimated from collections.

Data analysis

Species richness was calculated using Margalef's index:

$$d = S\text{-}1/\log N$$

Diversity was calculated using Shannon-Weaver index:

$$H = \Sigma p_1 \log p_1$$

and evenness estimated using the formula:

$$e = H/\log S$$

Where d = Margalef's species richness, S = number of species belonging to the ith group, N = total number of organisms in the sample. H = Shannon-Weaver diversity, p_1 = proportion of the group number to the whole number of organism, e = evenness. Analysis of variance (ANOVA) was used to test difference in seasonal variation in abundance, species richness and diversity.

Results

Species composition

A total of 3,142 fish belonging to 69 species, 39 genera and 21 families were captured in this study (Table 1). Nine species of Mochokidae, eight species of Mormyridae and Cichlidae and seven species of Clariidae were identified. Cyprinidae, Eleotridae, Gymnarchidae, Malapteruridae, Hepstidae, Ichthyoboridae, Osteoglossidae, Notoreridae and Protopteridae were mono-specific and constituted 42.86 % of the identified families in Mid-Cross River. *Oreochromis niloticus* (13.21%) was the most abundant species. Cichlids (50.19%) were dominant followed by Mochokidae (13.08%) and Clariidae (5.14%) (Figure 2). Malapteruridae was the least abundant (0.03%), represented by one individual in September 2005 during the study. Three marine intrusive species *Decapterus rhonchus, Trachinotus tersia* and *Caranx hippos* and the freshwater prawn *Macrobranchium vollenhovenii* were among the ichthyofauna of Mid-Cross River.

Table 1: A checklist of the identified ichthyofauna of Mid-Cross River.

S/N	Family/Species	% (No)
	MORMYRIDAE	**3.94**
1	*Mormyrops deliciosus* (Linnaeus, 1758)	0.19
2	*Mormyrus tapirus* (Pappenheim, 1905)	0.13
3	*Mormyrus rume* (Valeniennes, 1846)	2.32
4	*Petrocephalus bane* (Lacepede, 1803)	0.67
5	*Petrocephalus ansorgii* (Boulenger, 1902)	0.22
6	*Marcusenius mento* (Boulenger, 1890)	0.1
7	*Gnathonemus petersii* (Gunther, 1862)	0.13
8	*Brienomyrus branchystius* (Gil, 1863)	0.19
	MOCHOKIDAE	**13.08**
9	*Synodontis obesus* (Boulenger, 1898)	0.83
10	*Synodontis robbianus* (Smith, 1875)	0.35
11	*Synodontis schall* (Bloch and Schneider, 1801)	0.51
12	*Synodontis claris* (Linne,1758)	1.78
13	*Synodontis nigrita* (Valenciennes, 1840)	0.48
14	*Synodontis omais* (Gunther, 1864)	5.76
15	*Synodontis eupterus* (Boulenger, 1901)	2.77
16	*Synodontis batensoda*	0.35
17	*Synodontis sorex* (Gunther, 1864)	0.25
	CITHARINIDAE	**5.47**
18	*Citharinus latus* (Muller and Troschel, 1845)	1.88
19	*Citharinus citherus* (Geoffrey Saint Hilaire, 1809)	3.53
	MALAPTERURIDAE	**0.03**
20	*Malapterurus electricus* (Gmelin, 1789)	0.03
	CLARIIDAE	**11.46**
21	*Clarias gariepinus* (Burchell, 1822)	2.23
22	*Clarias macromystax* (Gunther, 1864)	0.22
23	*Clarias panchynema* (Boulenger, 1903)	0.127
24	*Clarias agboyiensis* (Sydenham, 1980)	7.22
25	*Clarias anguillaris* (Line, 1758)	1.43
26	*Heterobranchus bidorsalis* (Geoffrey Saint Hilaire, 1809)	0.1
27	*Heterobranchus longifilis* (Valenciennes, 1840)	0.13
	CHARACIDAE	**3.47**
28	*Hydrocynus vittatus* (Castelnau, 1861)	0.19
29	*Brycinus intermedius* (Boulenger, 1903)	0.03
30	*Brycinus nurse* (Ruppell, 1832)	1.34
31	*Alestes macrophthalmus* (Gunther, 1867)	0.19
32	*Alestes baremoze* (de Joannis, 1835)	0.35
33	*Miraletes humilis* (Boulenger, 1899)	0.06
	SCHILBEIDAE	**1.30**
34	*Parailia pellucida* (Boulenger, 1901)	0.16
35	*Schilbe mystus* (Linne, 1758)	0.57
36	*Schilbe micropogon* (Trewavas, 1943)	0.16
37	*Schilbe brevianalis* (Pellegrin (1929)	0.13
38	*Schilbe uranoscopus* (Ruppell, 1832)	0.29
	DISTICHODONTIDAE	**0.03**
39	*Distichodus brevipinnis* (Gunther, 1864)	0.25
40	*Distichodus engycephalus* (Gunther, 1864)	0.57
	CICHLIDAE	**50.19**
41	*Oreochromis niloticus* (Linne, 1758)	13.21
42	*Oreochromis sp*	2.13
43	*Tilapia mariae* (Boulenger, 1899)	2.48
44	*Tilapia zillii* (Gervais, 1848)	8.69
45	Tilapia guineensis (Bleeker, 1862)	11.68
46	*Hemichromis fasciatus* (Peters 1852)	10.18
47	*Hemichromis bimaculatus* (Gill, 1862)	1.43

S/N	Family/Species	% (No)
48	*Sarotherodon melanotheron* (Ruppell, 1852)	0.38
	OSTEOGLOSSIDAE	**3.09**
49	*Heterotis niloticus* (Cuvier, 1829)	3.09
	ICHTHYOBORIDAE	**0.13**
50	*Phago loricatus* (Gunther, 1865)	0.13
	OPHIOCEPHALIDAE	**0.29**
51	*Parachanna africana* (Steindachner, 1879)	0.1
52	*Parachanna obscura* (Gunther, 1861)	0.16
	BAGRIDAE	**3.18**
53	*Chrysichthys auratus* (Geoffrey Saint-Hilaaire, 1808)	0.38
54	*Chrysichthys aluuensis* (Risch, 1985)	0.16
55	*Chrysichthys nigrodigitatus* (Lacepede, 1803)	2.1
56	*Bagrus docmac* (Forsskall,1775)	0.32
57	*Auchenoglamis bisculatus* (Geoffrey Saint-Hilaaire, 1808)	0.1
58	*Clarotes laticeps* (Ruppell, 1829)	0.13
	HEPSTIDAE	**2.45**
59	*Hepsetus odoe* (Bloch, 1794)	2.45
	NOTORURIDAE	**0.32**
60	*Papyrocranus after* (Gunther, 1868)	0.32
	CYPRINIDAE	**0.41**
61	*Labeo coubie* (Ruppell, 1832)	0.41
	GYMNARCHIDAE	**0.16**
62	*Gymnarchus niloticus* (Cuvier,1829)	0.16
	PROTOPTERIDAE	**0.13**
63	*Protopterus annectens* (Owen, 1883)	0.13
	CARANGIDAE	**0.16**
64	*Decapterus rhonchus* (Geoffrey Saint Hilaire, 1817)	0.06
65	*Trachinotus tersia* (Curvier, 1832)	0.06
66	*Caranx hippos* (Linnaeus, 1766)	0.03
	ELEOTRIDAE	**0.1**
67	*Eleotris daganensis* (Steindachner, 1870)	0.1
	CRUSTACEAN	**1.21**
68	*Macrobrachium sp*	0.1
69	*Macrobrachium vollenhovenii* (Herklots 1857)	1.11

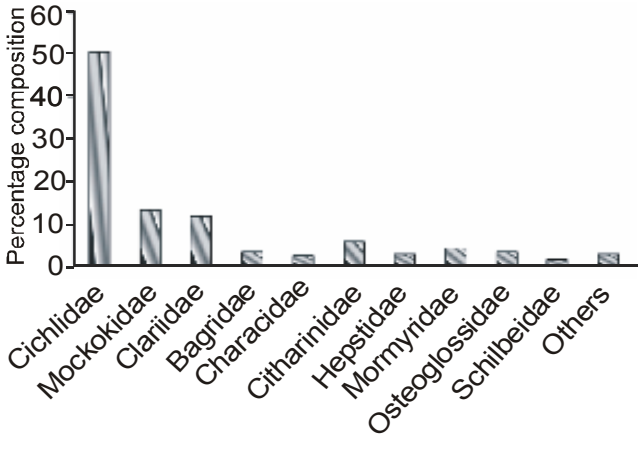

Figure 2: Percentage composition of the major fish families of Mid-Cross River.

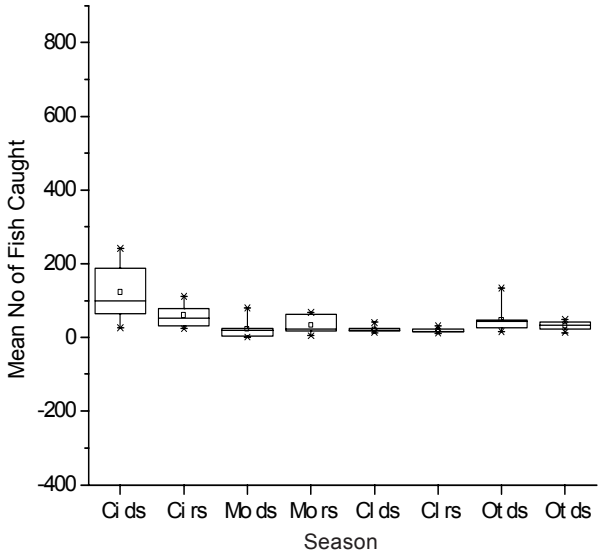

Figure 3: Mean (diamond point), maximum and minimum values (top and bottom of lines) and 75 and 25 percentiles (the box areas respectively above and under the line) of Cichlidae (Ci ds: dry season values, Ci rs : rainy season values), Mochokidae (Mo ds: dry season values, Mo rs: rainy season values), Claridae (Cl ds: dry season values, Cl rs : rainy season values) and other families (Ot ds: dry season values, Ot rs : rainy season values).

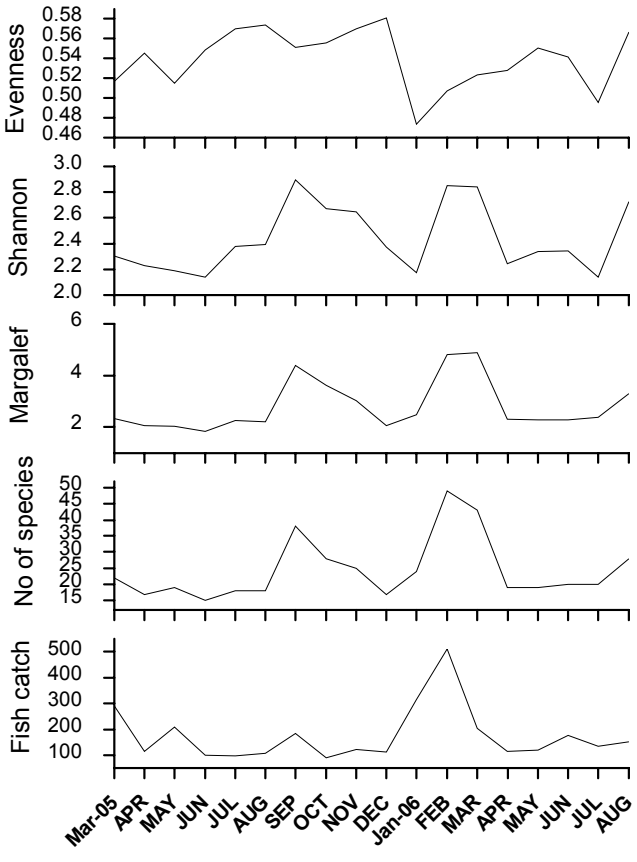

Figure 4: Monthly variation in total fish abundance, fish species, Margalef's index, Shannon-Weaver diversity and Evenness.

Fish abundance and diversity

Figure 3 shows that gill net catch of Cichlidae was significantly higher during dry season compared to the rainy season ($p< 0.05$) while the number of Clariidae and Mochokidae caught during the rainy season, though higher than the dry season values, did not differ significantly between seasons. Monthly variation in total fish abundance, fish species, Margalef's index, Shannon-Weaver diversity and evenness are shown in Figure 4. The highest number of fish was caught in February 2006 (511) and the lowest catch was in October 2005 (88).

The highest number of species was caught in March 2006 (49), and the lowest species diversity was in June 2005 (15). The highest Margalef's index was in March 2006 (4.87) while the lowest value was in January 2006 (1.8). The highest Shannon-Weaver diversity value (2.84) was recorded in February 2006 while the lowest was in June 2005 (2.14). The highest (0.58) and the lowest (0.47) evenness values were recorded in December 2006 and January 2006 respectively. ANOVA showed that fish catch and Shannon-Weaver index were significantly higher during the dry season compared to rainy season ($p<0.001$). However, there was no significant seasonal variation in Margalef's index, number of species caught and evenness.

Discussion

The 69 fish species identified only constitute 42% of the 165 fish species King (1996) estimated for the entire Cross River. However, it is higher than the 30 species Oti (2001) reported for Ehoma Lake, the 31 species belonging to 9 families identified by King (1997) in Okwangwo Division in Lower Cross River and 54 species reported by Mdaihli *et al* (2003) in Takamada Forest Reserve in Upper Cross River (Cameroon). Remarkably, *Chrysichthys aluuensis, Clarias agboyiensis, C. anguillaris, C. macromystax* and *Schilbe micropogon* considered endemic to the Lower Cross by King (1996) were found in the Mid-Cross River. This could be attributed to long migrations to the lakes in the Mid-Cross River. However, further studies on these species may be necessary to ascertain the timing and purpose of migration. It is of conservation importance to note that *Oreochromis jentinki, Clarias submarines, Hydrocyanus forsakali, H. lineatus* and *H. somonorium* reported by Oti (2001) in Ehoma Lake were not encountered in this study.

Also, Oti (2001) reported the numerical dominance of *Gymnarchus niloticus* but this contributed only 0.16% to the catch by number in this study. Other species encountered also showed remarkable population decline, for instance, only one individual of *Malapterurus electricus* was seen throughout this study. These indicate gross decline in the populations of these species and the dire need for effective management of the fisheries of the Cross River to avert continuous population decline and species' loss.

Three marine intrusive species (*Decapterus rhonchus*, *Trachinotus tersia* and *Caranx hippos)* further enriched the icthyofauna of the Mid-Cross River. This and the presence of nine mono-specific families buttress the need for effective management strategy. The loss of any of the mono-specific families means that the family is lost in its entirety. We therefore disagreed with Mdaihli *et al* (2003) who reported that the Cross River is under-fished but rather agreed with King (1996) and Ama-Abasi *et al* (2004) who believed that there was need for rational management.

Mdaihli *et al* (2003) assumed that since fisheries activities within the Cross River were mainly artisanal, the fishes were not impacted. However, recent evidence (King, 2007; Silvano *et al* 2009) showed that artisanal fisheries can reduce fish abundance and diversity. This is attributed to poor monitoring of artisanal fishers. Some of them employed unorthodox fishing methods such as use of small mesh-sized nets and fish poison to catch fish (Njiru *et al* 2004). The use of ichythyocide and explosives is common in the Cross River (Etcheri and Lebo, 1983; Udolisa and Lebo, 1986) and it was also observed during this study. These chemicals, which include Gammalin 20 and narcotic extracts from *Acacia pennata* and *Tephrosia vogelli* are generic killers and could destroy eggs, juveniles and adult fish of all species. Their use could endanger the rare species and mono-specific families.

Fish fauna in the Mid Cross River was dominated by the Cichlidae, similar finding was made by Moses (1979) and Mdaihli *et al* (2003) in the lower and upper Cross River respectively. However, they recorded Characidae to be the next in importance with the Mochokidae making insignificant contribution to fish catch. In this study, Mochokidae was next in importance to the Cichlidae with Characidae making only minimal contribution to fish catch.

Peak fish catch was recorded in February 2006. Peak fishery landing in the Cross River is associated with fishing of the numerous lakes around the basin of the Cross River (Mosses, 1987; King, 1996). These lakes are fished by local inhabitants during the low water period of the dry season (December to March). In the Mid-Cross, some of these lakes are conserved through the use of taboos to prevent fishing of the lakes outside the festive period, therefore, lake fishing is restricted to the months of February or March (depending on local calendar) annually. This practice ensured sufficient recruitment time for the fishes of the lakes (and consequently, sustainable yield of the lakes) which are exchanged with the rivers during period of connection. In recent times, due to reduced control on these lakes

by the indigenous communities, poaching activities have increased. The migratory catfishes are the main targets during the rainy-season. Increased poaching reduces recruitment successes of the major fisheries of the lakes (and the Cross River at large) and this would undoubtedly lead to decline in annual yield.

In conclusion, there are current trends in the Mid Cross imperiling future fish productivity and diversity in the Cross River. These include the targeting of migratory stock, year round fishing of once reserved lakes, the use of small mesh sized nets and ichthyocides by fishers, deforestation, dredging, unplanned urbanisation and introduction of exotic species. Therefore, it is pertinent that government becomes proactive in the conservation of the fisheries of Cross River through policies, stipulation and enforcement of conservation guides, ban on the use of ichthyocides and explosives as fishing gears and encouragement of effective local conservation methods for efficient and sustainable utilization of the fisheries of the Cross River. We advocate that such strategy should include the indigenous people and the re-establishment of no-take lakes that was in operation within the region.

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Okogwu, O.I. and Ugwumba, O.A.
© *The Zoologist* Vol. 8 2010, pp. 19-24, ISSN 1596 972X.
Zoological Society of Nigeria.