REPRODUCTIVE ASPECTS OF COMMON FRESHWATER FISHES IN THE CROSS RIVER, NIGERIA

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ABSTRACT

Sexual maturity, fecundity, and breeding seasons of 46 freshwater fish species belonging to 28 genera and 16 families comprising 1060 individuals from Cross River were analysed between January 2004 and December 2006. Mean fecundity vary with species from 215 ±193 eggs *(Oreochromis niloticus*) to 110,000 ± 12,000 eggs (*Labeo coubie*). Few eggs (215) were produced by mouth brooders (*O. niloticus*) more eggs (1,268) by guarders (*Sarotherodon*) while the substrate spawners (*Clarias gariepinis* and *Labeo coubie*) without parental care produced highest number of eggs (71,963±9084 and110,000 ±12000) respectively). Positive relationship was observed between fecundity of individual fish of a species and body size. The correlation coefficient (r) was highest in Cyprinids (0.98) and lowest among Clupeids (0.28). Size at sexual maturity, vary with species from 1.8cm standard length (*Petrocephalus ansorgii)* to 31.4cm (*Calamoichthys calabaricus*). Seasonal variation in fecundity of 25 species (56%) revealed an increase in the gonadal ripe stage from January and peaked at months of July - August; 6 species (13%) had peak fecundity at September - October and only 1 species (*Hepsetus odoe*) peaked at March – April. Eggs were scarce in 14 species (30.4%). Significantly higher number of fish species in Cross River inland wetlands breed during early rains (July-August) and the large number of eggs recorded in some species is evidence that the fish population can provide excellent broostock.

Key words: fecundity, breeding seasons, maturity, freshwater fishes, gonadosomatic index, egg size, physico-chemical parameters.

INTRODUCTION

Reproduction in fishes is one of the basic biological features enabling survival and continuation of species. It may also have divisive effect on their population size because of the diversity of aquatic environment. The differences in the amount of deposited eggs are observed not only in individual species but also in population from different bodies of water or different parts of the same body of water. In the developing countries in particular, economic recession has given rise to a new orientation for sustainability and survival with emphasis on "economically important" species meaning in essence species commonly caught and sold for food. Determination of fish fecundity of these species is particularly significant because of their vulnerability to overfishing related to bad fishing practice in Nigeria. Knowledge of fecundity is also important in stock size assessment, stock discrimination (Holden and Raitt, 1974) and rational utilization of stock (Morales, 1991).

Studies on breeding seasons and factors associated with it are needed to protect new recruits and predict recruitment variability (Leone, 1967). Fecundity was also used as criteria for separating three populations of Surf smelt; *Hypomesus pretiosus* (Girard). (Ekanem, 1986) examined the quality of populations of *Chrysichthys nigrodigitatus* in different water bodies in Nigeria, through fecundity studies, to see which of these could be used as good broodstock. Larger sizes and higher number of eggs could indicate higher quality of eggs (Ekanem, 1986). Studies was undertaken in the egg size of *Chrysichthys nigrodigitatus* (Lacépède) in Lake Kainji (Ajayi, 1972), *Chrysichthys walker* (Gunther) in Lekki Lagoon (Imevbore, 1970; Ajayi, 1972) trophic biology of *Chysichthys filamentosus* (Boulenger) in Oguta Lake (Nwadiaro and Okorie, 1986), sex ratio and fecundity of *C. gariepinus* in Opa Reservoir in Ile Ife (Komolafe and Arowomo, 1996) and their reproductive behavior (Wooton, 1992). Research studies had also been carried out on a number of factors such as age, size of fish, species, condition of fish and environmental factors (food, water quality, temperature, season and reproductive behaviour) that influence fecundity (Scot, 1962, Bagenal, 1966, Imevbore, 1970, Larger *et al*., 1977, Peters, 1983, Wooton, 1992, Ekwu, 2006). All these studies were focussed towards individual species. No study had been carried out on a wide scale involving a large number of species.

This study aims to provide a checklist of the reproductive potential and breeding seasons of

economically important freshwater fishes in Nigeria and to determine the influence of environment and location on reproductive activities of the six economically important fish species (*Chrysichthys nigrodigitatus, Chrysichthys auratus, Heterotis niloticus, Oreochromis niloticus, Clarias anguillaris* and *Larbeo coubie*) in Cross River.

MATERIALS AND METHODS

Study site: The study site is the Cross River, a floodplain river located at the south eastern part of Nigeria (Figure 1) on Latitude 4^0, 25´– 7^0.00´N, Longitude 7^0, 15´– 90.30´E. It is bounded in the south by the Atlantic Ocean, East by the Republic of Cameroun, the Nigerian states of Benue in the North, Ebonyi and Abia in the West and Akwa Ibom; South West. Climate of the study area is defined by dry season and wet season. The wet season (April- October) is characterized by high precipitation (3050 ± 230mm), while the dry season (November-March) is marked by low precipitation (300 ± 23mm). Mean annual temperature ranged from 15.5 ± 7.6ºC (wet season) to 32.6 ± 5.4ºC (dry season). For the purpose of this study three sampling sites were selected along the length of the river, with one site randomly selected in each of the following reaches; upriver, middle river and downriver. Upriver was located 3Km from the river source with rocky, gravel and sandy substratum. The shoreline is covered with savanna grassland and has wood and paper industries located close to the source. The middleriver was 100Km from river source with rocky substratum and shoreline sparsely shaded by forest and savanna grassland. Downriver had a muddy substratum and opens up into the Cross River estuary, with shoreline thickly shaded with rainforest.

Physico-chemical sampling: Physico-chemical parameters were determined once every month for two years (January 2006 -December 2007). Standard methods for the examination of water and waste water (APHA, 1987) were used for all measurements. Monthly rainfall data for the study area was obtained from weather meteorological stations, located in each of the three reaches. Habitat variables; water level, river width and flow velocity were measured in three places in each reach and the average was taken.

Ichthyofaunal sampling: The ichthyofuana of the river was sampled at the same time of physico-chemical sampling in all the reaches using variety of fishing gears which included; gill net (22-76mm stretched mesh size), seine net (10mm stretched mesh size) and cast net (10mm stretched mesh). On each occasion sampling was done between 09.00 and 12.00am. The samples were trasported in ice boxes at 4 ^{0}C the laboratory for fecundity studies. Genus and species identifications was carried out following Elvira (1987) for the Cyprinids; Erkakan *et al*., (2007) for the Bagrids, Teugels (1982) for the Clariidae; Fischer, *et al*. (1987) for the Clupeidae and Mugilidae. Fish weights were measured to nearest 0.1g using a triple beam balance and total length (TL) to nearest 1mm with Meter rule. Sex determination was by gross visual observation.

Analysis of fecundity was limited to the peak spawning period (May-July) and only ripe female fish (494) were used for the estimation. Ovaries were excised from body cavity of each fish and preserved in Gilson fluid (Simpson, 1951). This preservation hardened the eggs, break down ovarian tissues and liberate the eggs. Ovaries of each fish were preserved for a minimum of five days before the eggs were counted. The preserved ovaries were washed to remove the preservative. Eggs were separated from tissue and placed on filter paper to remove excess water before being weighed using metler P 1210 chemical balance. Only the largest eggs (2.0-3.0mm) in each sample were used for fecundity estimation. Eggs in a l-gram sub-sample were counted. Counting was done for five similar sub samples. The mean number of eggs in the five sub samples gave the number of eggs per gram of weight. Fecundity was calculated by multiplying the total weight of eggs by the number of eggs per gram weight. "Relative fecundity (RF) was measured as number of eggs per unit length (cm) and absolute fecundity (F) as total number of eggs in the ovaries" (Bagenal, 1978).

Gonadosomatic index, egg size and breeding seasons

Six economically important fish species were used to study the influence of environment and location on the fresh water species of Cross River.

Gonad cycle was determined from gonado - somatic index (I_G) expressed according to De Vlaming (1982) as:

$$I_G = \frac{\text{Gonad weight} \times 100}{\text{Body weight}}$$

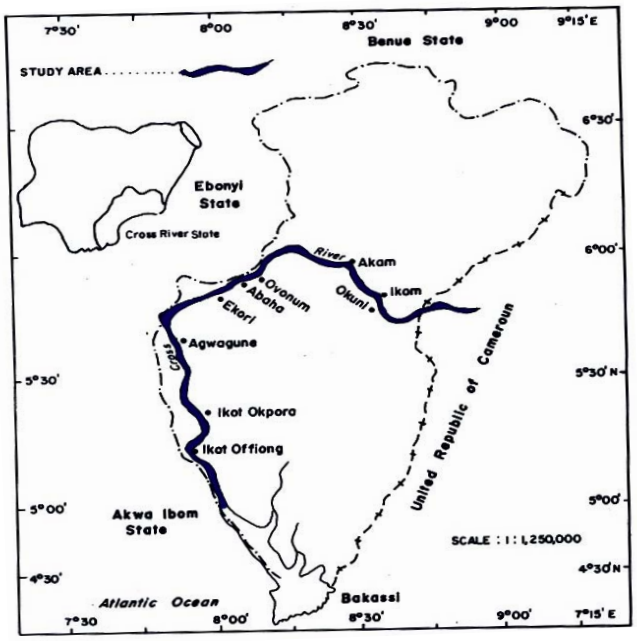
I_G was used to follow seasonal changes in the gonads.

To determine the spawning and breeding periodicity, egg diameter was measured from samples collected from different parts of the ovary (anterior, middle and posterior parts) using ocular micrometer mounted on a binocular microscope. Monthly progression was recorded according to Imevbore (1970). Mean percentage frequency of eggs of different diameter in matured ovaries was plotted against different months (Hickling and Rutenberg, 1936).

Data treatment: data collected were collated and analysed using descriptive statistics (mean, standard deviation and percentage). Statistical comparision of data between and within zones were carried out using analysis of variance (ANOVA) according to Steel *et al*. (1997). Linear regression was employed to determine the type of

relationship between any given pairs of variables and their linear equations. Correlation (r) analysis was used to ascertain the significance of these relationships.

Fig. 1: Map of cross river state showing study area (Top left: map of Nigeria showing location of cross river state).



MAP OF CROSS RIVER STATE SHOWING STUDY AREA

RESULTS

Physico-chemical properties: Significant seasonal variations in the physico-chemical parameters of the river were observed with the wet season values of transparency, flow velocity, water level and width higher than the dry season ($p<0.05$). However, dry season values of water temperature and dissolved oxygen were higher than wet season (Table 1). Seasonal hydrogen ion concentrations remain relatively constant. Among all the physico-chemical parameters measured, temperature values were significantly different between reaches ($P < 0.05$) with higher values in Upper reach (27.3^0C) than lower reach (24.1^0C).Water level was highest (47.9m) in the Lower reach and lowest (8.9m) in the Upper reach and was positively correlated ($r = 0.885$, 10df, $p< 0.05$,) with rainfall (Table 2). River was widest downstream (360.5) and narrowest (102.6m) upstream. Flow rate fluctuated greatly between sampling sites. It was swiftest (0.28 ± 0.17 m/s) upriver and reduced significantly ($p< 0.05$) as it flows downwards. Variation in the transparrency, dissolved oxygen and pH values between reaches were not significant ($p>0.05$). Generally water quality was considered suitable for fish growth in all the reaches studied.

Absolute fecundity and breeding season: The absolute fecundity and breeding seasons for 46 species belonging to 28 genera and 16 families comprising 1060 individuals are presented Table 3. Sample size ranged from 10 - 65 (mean=37.7 ± 27.3).

Mean absolute fecundity varies with species from 215 ± 193 eggs (*Oreochromis niloticus*) to 110,000 ± 12000 eggs (L*abeo coubie*). Absolute Fecundity also varied with individual fish of a species and was related to the fish length in all the species according to the exponential equation; $F=aL^b$ where F=absolute fecundity, a = proportionality constant L=total length, b = regression coefficient. The correlation (r) between fecundity and body length expressed relationship, among the different species, was highest in the Cyprinids (r=0.98) and lowest among the Clupeids (r = 0.26). Size at sexual maturity vary with species from 1.8cm *(Petrocephalus ansorgii)* to 31.4cm *(Erpetoichthys calabaricus)*

Seasonal variation in absolute fecundity showed a general increase in gonadal ripe stage from January and peaked at months of July - August in 25 species (*Oreochromis niloticus, Tilapia zilli , T. mariae, T. guinensis, Sarotherodon galilaeus , Hemichromis fasciatus, H. bimaculatus, Denticep clupeoides, pellonula vorax, Heterotis niloticus, Mormyrus rume, Petrocephalus ansorgi, Alestes nurse, Clarias anguilaris, C. cameronensis, C . jaensis, C . gariepinus C. pachynema, Heterobranchus longifilis, Bagrus docmak, Chrysichthys nigrodigitatus, C. auratus, C. filamentosus, Labeo coubie and L. senegalensis*); September-October in 6 species (*Malapterurus electricus, Synodontis robianus, Synodontis omias , Erpetoichthys calabaricus Polypterus senegalensis and Protopterus annectens*) and March-April in only1species (*Hepsetus odoe*) followed by a general decrease to December. Eggs were scarce in 14 species consisting of *Odaxothrissa mento, Mormyrops anguiloides, Mormyrus tapirus, Petrocephalus bovei, Hydrocynus vittatus, Brycinus macrolepidotus, Distichodus rostratus, Auchenoglanis occidentalis, parauchenoglanis laennbergi, Synodontis schall, Synodontis obesus, Labeo parvus, Schilbe niloticus, and Schilbe micropogon.*

Spatial analysis showed that *Labeo coubie* recorded the highest mean absolute fecundity across the reaches (I: 111784 ± 21456, II: 116,456± 8965, III: 112,234 ± 13453). *Oreochromis niloticus* recorded the lowest mean absolute fecundity, with a count of 176 ± 78, 189 ± 67 and 223±45 for sampling reaches I, II and III respectively. Results of analysis of variance show that there was significant difference in fecundity across the three sampling reaches at $p < 0.05$ levels of significance for *Chrysichthys nigrodigitatus, Oreochromis niloticus, Chrysichthys auratus* and *Heterotis niloticus*. Absolute fecundity values for *Clarias anguillaris* and *Labeo coubie* were however not significant ($p> 0.05$) across the reaches.

Gonadosomatic index: Mean gonado-somatic index (GSI) ranged from 8.4 ± 1.5 to 22.1 ± 4.2 across the reaches. The results have shown that *C. nigrodigitatus* had the highest mean GSI of 15.3 ± 3.2, 18.4 ± 2.4 and 22.1 ± 4.2 in sampling reaches I, II, III respectively, while *H. niloticus* had the lowest mean GSI of 6.4 ± 1.4, 8.7 ± 2.2 and 10.3 ± 1.7 from sampling reaches I, II, III respectively. Generally GSI values were higher in samples obtained from reach III.than other reaches. Analysis of variance revealed significant difference ($p<0.05$) in GSI for all the six species between the three reaches with higher GSI values in reach III than other reaches.

Egg size: The mean egg sizes of fishes ranged from 1.1 ± 0.07 to 3.7 ± 0.87mm across the sampling reaches. Large eggs of 3.4 ± 0.67, 3.7 ± 0.87 and 3.2 ± 0.56mm in diameter were observed in *O. niloticus* in reaches I, II and III while the smallest egg sizes of 1.1 ± 0.07, 1.2 ± 0.22 and 1.1 ± 0.21mm were observed in *C. nigrodigitatus, C. auratus* and *Labeo coubie* respectively, in reach I. The results showed that variation in the egg sizes observed in *C. nigrodigitatus, O. niloticus, C. auratus* and *Labeo coubie* were not significant ($p>0.05$) between reaches while egg sizes of *C. anguillaris* and *Heterotis niloticus* were significant ($p < 0.05$) between reaches with higher sizes observed in reach III for *H. niloticus* and reach I for *C. anguillaris*.

DISCUSSION

Marked variations in the physico-chemical parameters of water observed at the three sampling stations indicate different environmental conditions. Variation in amount and duration of rainfall had been found (Egborge 1994) to affect physico-chemical parameters which in turn affects fish growth and production (Adebisi, 1981). Generally, rainfall values are highest at the lower reaches and lowest in the upper portion of the Cross River. Low temperatures recorded in the three locations during the rains may be associated with thicker cloud cover, which Egborge (1994), in a similar study found to have a reducing effect on solar radiation and concentration of suspended particles which absorbs and scatter heat rays. Higher temperature values in the upper reach may be as a result of lower rainfall in the region. The range of water temperature during the study period was within limits of 25-30^{0}C recorded for tropical rivers (Adebisi, 1981). Secchi disc trasparency of the three sites were within the range considered suitable for fish growth. Low transparrency observed in the sites during the rains could be caused by influx from runoff into the river which decreased light penetration. The pH values of the water in the three sites are within the range (5.5-9.0) set by Boyd (1979) as most suitable for fish production. The high concentration of dissolved oxygen was satisfactory for fish production. Low organic enrichment of a river had been suggested (Mason (1992) as the possible reason responsible for such high oxygen values. Seasonal variation observed in dissolved oxygen content with higher values during the rains could be due to lower water temperature and increased aeration.

Study of reproductive biology had been documented by many workers (Largler, *et al*, 1977; Wooton, 1992; Bagenal, 1966; Imevbore, 1970; Holden and Reed, 1972; Olaosebikan and Raji, 1998).Their observations that fecundity is influenced by a number of factors such as; size of fish, species, season and reproductive behaviour example parental care system is applicable to the study under consideration. Larger fish had higher fecundity in this study. For example average size of *C. anguillaris* of length ; 15.5cm had 3003 eggs while a fairly large of same species had 7219 eggs, *C. nigrodigitatus* of size; 22.3cm produced 3072 eggs; same species of size 48.3cm had 9300 eggs; *Labeo senegalensis*, size 18.4cm recorded 65,004 eggs; same species of size 30.8cm recorded 107,004 eggs. This agrees with the observation by Largler *et al* (1977) and Wooton (1992) that fecundity of fish increases with body size. The volume of eggs a fish can produce depends on space available in the body cavity to accommodate the eggs before spawning. Many works on fecundity of other species indicates similar phenomenon. Lamai (1993) observed fecundity of 51,183 eggs for *C. anguillaris* at an average size of 0.7 kg. Abayomi and Arowomo (1996) obtained fecundity range of 15,667-650,625 eggs for *C. gariepinus* at size range 39.5-82.5cm length. Ugumba and Ugumba (1988) obtained fecundity of the range 14,000-56,000 eggs for *C. gariepinus* at size range of 320-600 g total weight. Gudkov (1994) obtained fecundity of 510-2,288 eggs for Teranet Char *Salvalinus teranetzi* at size range of 27–44cm total length. Mekeyeva (1984) obtained fecundity range of 400-500 eggs per cm^3 for silver carp at size range of 60-65cm total length.

Although fecundity increased as body size increased in this study, very low relationship (correlation coefficient = r) was obtained between fecundity and total length in *Odaxothrissa mento* (r = 0.36), *Pellonula vorax* (r=0.26) *Protopterus annectens* (r=0.56), *Polypterus senegalensis* (r = 0.41), *Erpetoichthys calabaricus* (r = 0.51) and *S. schall* (r = 0.58). Similar observations were made by Douglas (1979) on *C. gariepinus and C. lazera* by Peters (1983) on Tilapias (cichlidae).

Fecundity was also observed to vary with species and their reproductive behaviour. For example few eggs were produced by mouth brooders like *O. niloticus* (215 eggs) and guarders; *T. mariae* (162 eggs), *Sarotherodon* (1268 eggs) *H. niloticus* (341eggs) *P. annectens* (624eggs) and *P. senegalensis* (331eggs). Substrate spawners without parental care produced large numbers of eggs; *C. anguillaris* (5111 eggs), *C. gariepinus* (71,963 eggs), *L. coubie* (110,000eggs) and *C.*

nigrodigitatus (10,816 eggs). Imevbore, (1970), Peters (1983) and Wooton (1992) had similar observations averred that in substrate spawners with no parental care, eggs are small and numerous, where as species with parental care, eggs are few but large with yolk so that the hatchling grow reasonably big before leaving the parent.

Disparity was noted between fecundity of fish in this study area and that of fish populations of other localities. *C. nigrodigitatus* populations of Lake Adejere recorded maximum number of eggs as 2884 (Fagede and Adebisi, 1979) as against 10,816 eggs in this study. The lake population therefore has lower fecundity. This can be attributed to the greater abundance of food in the river. However, fecundity of 8146 eggs recorded in this study for *C. nigrodigitatus* of total length; 48.3cm is less than 12,602 eggs recorded for the same species of similar size in Badagry Lagoon and 11,316 eggs in Imo River and even much lower than the 16,300 eggs recorded for fish in Warri Creek by Ezenwa *et al* (1986). The Warri Creek populations are therefore more superior than the others and can be better broodstocks in the farms. Such location-related differences in fecundity of the same species had been observed in Salmon (Rounsefell, 1957), in American plaice; *Hippoglosoides platessoides* in Grand Banks (Pitt, 1964), in the Pacific herring; *Clupea pallasi* , in the British Columbia (Nagasaki, 1958) and in *O. aureus* in Adolf Lopez Mateos dam, in Mexico (Palacious, 1995) and were attributed to environmental factors such as differential abundance of food and water quality.

Observation that peak breeding season for most of the species under study coincide (June–August) with early rains may probably be due to the fact that the young had to follow the flood to areas of abundant food in their floodplains (Fagede and Adebisi, 1979).

The mean egg size of 2.1 ± 0.23mm for *C. anguillaris* was low compared to 3.5 ± 0.77 mean diameter for *Clarias* species reported by Oteme (1993). Small egg size implies that survival rate of the progeny will be low (Bagenal, 1978). Therefore, with larger egg sizes of *C. aguillaris* and *H. niloticus* in reaches I and III respectively implied that these reaches provide more suitable habitat for the species.

The low GSI, fecundity and variation in the egg sizes observed for some species in this study may be attributed to the sudden change in the environmental factors especially the physico-chemical parameters of the water due to the variation in the vegetation type and climatic condition of the three reaches of the study area and the location of industries on the shoreline of reach I. Similar observations have been reported by Asuquo *et al* (1998). A change in the environmental factors results in significant changes in the fecundity (Odiete 1999). The implication of these results is that the reproductive potential of some fish species in Cross River is greatly affected by the environmental factors and human activities.

Table 1 Seasonal variation in the physico-chemical parameters and the t-values of the student's t-test in Cross River

Parameters	Wet season	Dry season	t-value	Prob.
Physical				
Temperature (^{0}C)	24.2 ± 5.4	29.6 ± 3.3	2.78	p<0.05
Transparrency (m)	73.0 ± 8.4	15.3 ± 4.8	5.22	p<0.05
Water level (m)	58.8 ± 12.1	8.2 ± 2.5	6.14	p<0.05
Water width (m)	461.5 ± 108.8	128.8 ± 9.2	5.99	p<0.05
Flow velocity (ms^{-1})	0.5 ± 0.2	0.2 ± 0.1	2.87	p<0.05
Chemical				
Dissolved oxygen (mgl^{-1})	5.5 ± 2.1	7.7 ± 1.5	2.66	p<0.05
Hydrogen ion concentration (pH)	6.9 ± 1.8	7.9 ± 0.8	0.78	p>0.05

Table 2: Mean variation and F-values of the analysis of variance (ANOVA) of physico-chemical parameters of water measured at three sampling sites. I: Upriver, II: Mid-river, III: Downriver

Properties				ANOVA	
Physical	**I**	**II**	**III**	**F-value**	**Prob.**
Water temperature (0C)	27.4±1.5	25.9 ± 1.4	24.1±1.4	3.36	P<0.05
Water depth (m)	6.4 ± 4.6	7.5 ± 4.8	9.7 ± 6.6	4.32	P<0.05
Water width (m)	134.2±32	196.5±12.7	316.5±4.4	5.8	p<0.05
Flow velocity (m/s)	0.28±0.17	0.19 ± 0.06	0.15±0.05	4.32	p<0.05
Transparrency (cm)	42.1±22.9	37.2 ± 19.5	33.8±14.3	1.56	p>0.05
Chemical					
Dissolved oxygen (mg/l)	6.6 ± 0.8	6.8 ± 0.9	7.7 ± 0.7	0.98	p>0.05
pH	6.6 ± 0.9	7.2 ± 0.7	7.0 ± 0.7	1.43	p>0.05

Table 3. Fecundity and Breeding season of 46 fish species in Cross River Inland Wetlands.

Fish families and species	*Sample size*	*Standard Length (cm)*		*Mean Fecundity*	*Correlation Coefficient (r)*	**Peak breeding Season.**
Cichlidae	**N**	**Min.**	**Max**	**No.**		**Months**
Oreochromis niloticus	65	12.4	35.6	215 ± 193	0.90	July-August
Tilapia guineensis	48	13.9	26.7	716 ± 212	0.84	,,
Tilapia mariae	27	14.8	24.8	162 ± 163	0.91	,,
Tilapia zilli	20	12.6	22.4	931 ± 216	0.77	,,
Sarotherodon galilaeus	16	13.9	28.4	1268 ± 1014	0.71	,,
Hemichromis fasciatus	11	9.4	12.2	586 ± 165	0.61	,,
Hemichromis bimaculatus	13	8.2	13.3	713 ± 86	0.88	,,
Protopteriade						
Protopterus annectens	10	21.6	43.5	624 ± 224	0.56	Sept.-October
Polypteridae						
Polypterus senegalus	21	20.5	51.7	331 ± 156	0.41	,,
Erpetoichthys calabaricus	36	31.4	60.4	426 ± 103	0.54	,,
Denticeptidae						
Denticeps clupeoides	42	4.5	12.8	661 ± 155	0.61	July-August
Clupeidae						
Odaxothrissa mento	30	3.8	8.8	Scarce	-	-
Pellonula vorax	56	2.8	6.5	867 ± 324	0.26	July-August
Osteoglossidae						
Heterotis niloticus	24	18.8	40.2	3,414±1101	0.77	July-August
Mormyridae						
Mormyrus rume	18	18.3	36.7	1364±818	0.81	July-August
Mormyrus tapirus	14	15.5	33.3	Scarce	-	-
Mormyrops anguilloides	12	18.3	35.6	Scarce	-	-
Petrocephalus ansorgii	33	1.8	10.8	866 ± 278	0.64	July-august
Petrocephalus bovei	21	2.3	9.9	Scarce	-	
Hepsetidae						
Hepsetus odoe	10	16.5	38.7	8061±201	0.91	March-May
Alestidae						
Hydrocynus vittatus	43	11.8	28.5	Scarce	-	
Brycinus nurse	30	8.4	18.6	610±112	0.77	July-Sept.
Brycinus macrolepidotus	13	9.4	20.3	Scarce	-	-
Distichodontidae						
Distichodus rostratus	9	4.5	5.4	Scarce	-	-
Clariidae						
Clarias anguillaris	44	15.5	51.6	5111±2108	0.76	July-August
Clarias cameronensis	31	9.0	16.2	10114±6234	0.81	,,
Clarias jaensis	4	11.6	25.8	3162±2142	0.88	,,
Clarias gariepinus	17	15.7	38.9	71963±9084	0.88	,,
Clarias pachynema	12	9.5	18.7	1216±8142	0.80	,,
Heterobranchus longifilis	23	18.5	61.2	31012±7142	0.91	,,
Claroteidae						
Bagrus docmak	4	15.8	32.4	34,061±8141	0.64	July-August
Chrysichthys nigrodigitatus	57	22.3	48.3	6186±3114	0.81	,,
Chrysichthys auratus	22	12.3	20.4	8146±5314	0.80	,,
Chrysichthys filamentosus	15	10.3	19.8	10,123±8124	0.91	,,
Auchenoglanis Occidentalis	10	14.4	28.3	Scarce	-	-
Parauchenoglanis loennbergi	8	5.1	12.3	Scarce	-	-
Mochokidae						
Synodontis omias	21	5.3	14.8	1164±725	0.58	Sept.-Oct.
Synodontis schall	18	6.6	18.3	Scarce	-	-
Synodontis obesus	10	4.6	15.6	Scarce	-	-
Synodontis robbianus	70	5.5	18.8	864±341	0.66	Sept.-Oct.
Malapteruridae						
Malapterurus electricus	5	13.8	21.8	253±1142	0.58	Sept.-October
Cyprinidae						
Labeo coubie	2	20.5	40.6	110,000±12,000	0.98	July-August
Labeo senegalensis	5	18.4	30.8	86,000±21,000	0.84	,,
Labeo parvus	8	15.5	28.5	Scarce	-	-
Schilbeidae	25	8.8	16.4	Scarce	-	-
Schilbe mystus	15	5.4	14.6	Scarce	-	-
Schilbe micropogon	12	2.5	15.8	Scarce	-	-

Table 4 Mean and standard deviation values of Fecundity, Egg Size and Gonado-somatic index (GSI) of some commercially important species in the Cross River.

Sampling reaches	Species	Mean fecundity	Mean GSI	Mean egg size(mm)
Upper reach	Chrysichthys nigrodigitatus	56,012 ± 11,234	15.3 ± 3.2	1.1 ± 0.07
	Oreochromis niloticus	176 ± 78	8.4 ± 1.5	3.4± 0.67
	Clarias anguillaris	5234± 2134	14.4 ± 2.3	3.3 ± 0.44
	Chrysichthys auratus	5345 ± 2343	14.2 ± 4.3	1.2 ± 0.22
	Heterotis niloticus	1033± 597	6.4 ± 1.4	1.5 ± 0.41
	Labeo coubie	111,784±21,456	14.6 ± 3.6	1.1 ± 0.21
Middle reach	Chrysichthys nigrodigitatus	68,234 ± 17459	18.4 ± 2.4	2.0 ± 0.12
	Oreochromis niloticus	189 ± 67	10.5 ± 3.2	3.7 ± 0.87
	Clarias anguillaris	4256 ± 2101	12.7 ± 4.1	1.9 ± 0.88
	Chrysichthys auratus	8874± 3455	16.7 ± 5.3	1.9 ± 0.42
	Heterotis niloticus	3110 ± 1266	8.7 ± 2.2	2.1 ± 0.58
	Labeo coubie	116,456 ± 8965	17.9 ± 6.6	1.6 ± 0.11
Lower reach	Chrysichthys nigrodigitatus	85,239±46,344	22.1 ± 4.2	2.8 ± 0.76
	Oreochromis niloticus	223 ± 45	13.2 ± 3.8	3.2 ± 0.56
	Clarias anguillarisi	4835± 1999	12.8 ± 5.3	2.1 ± 0.77
	Chrysichthys auratus	11,212 ± 2722	18.8 ± 2.8	2.7 ± 0.66
	Heterotis niloticus	5431 ± 2177	10.3 ± 1.7	3.3 ± 0.99
	Labeo coubie	112,234±13,453	21.7 ± 3.9	1.4 ± 0.15

Conclusion: The reproductive potential of the freshwater fishes in Cross River inland wetlands vary with the species, size, environmental factors and season. Peak breeding season for the species was either between July and August or September and October. The data generated in this study can provide knowledge on rational stock utilization, protection of new recruits and the prediction of recruitment variability for the freshwater fishes in the inland wetlands of Cross River, Nigeria.

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