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ECOLOGY AND POPULATION DYNAMICS OF SILVER CATFISH, *CHRYSICHTHYS NIGRODIGITATUS* (SILURIFORMES: CLAROTEIDAE), OF THE CROSS RIVER, NIGERIA'.

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ABSTRACT

Chrysichthys nigrodigitatus forms the most commercially important freshwater single species fishery in the Cross River, Nigeria. Studies were conducted on the dynamics of the exploited population of the species and the influence of rainfall on its catch rate. The objectives were to assess the level of exploitation and impacts of rainfall on its catch rate. A time series of length frequency and meteorological parameters was conducted. Length frequency data were analyzed using FiSAT software to estimate population parameters. The asymptotic length, L_{∞} was 105 cm, growth constant (K) was 0.68 $year^{-1}$, total mortality (Z) was 2.48 $year^{-1}$, Natural mortality (M) was 0.99 $year^{-1}$ and fishing mortality (F) was 1.49 $year^{-1}$. The exploitation rate was 0.60 $year^{-1}$, indicating overfishing. Natural mortality accounted 40% of the total mortality, presenting a worrisome trend in the fishery. There was a correlation between rainfall and catch rate, which increased at the onset of rains but decreased at the peak of the rains due to increased depth of the river. For management purposes, it is recommended that the fishing effort should be reduced by the regulation of the number of boat-days; for conservation, domestication of the species should be adopted as an adaptation to climatic influence.

KEYWORDS: Freshwater Catfish, Fishing Mortality, Exploitation Rate, Overfishing, Rainfall Impact, Niger Delta.

1. INTRODUCTION

Chrysichthys nigrodigitatus also known as silver catfish, is a highly valued food fish occurring in several African waters. It is among the dominant fish species of commercial importance. According to Holzloehner, Enin, Ama-Abasi, and Nwosu (2007), the species is the third most important commercial fish species in the Cross River Estuary after *Pseudotolithuselongatus* and *Ethmalsoafimbriata*. Ama-Abasi, Uyoh, Udo, Job, and Edide (2017) reported that in the Cross River system, *C. nigrodigitatus* is the most important single species of commercial significance occurring all year round with peak abundance in the rainy season, and that *Chrysichthys* fisheries provide several employments to the teeming population in the riverine communities of Niger Delta of Nigeria, thus enhancing the socio-economic status of the people. Lately the species has found its way into the International market thereby making it a source of foreign exchange earnings in Nigeria. A recent report indicates that the species is under the IUCN list of threatened species (da Costa, Abdelhamid, Lalaye, & Moelants, 2010). Moses (2001) reported that flood regime was important in recruitment and abundance in succeeding years of spawning, as a result of climatic phenomena, including rainfall and flooding. Uyoh et al. (2020) reported that *Chrysichthys nigrodigitatus* of the Cross River has very low genetic diversity and that such low genetic diversity can lead to population eradication in the face of environmental variability. The linkage of the species to climatic phenomena, the enlisting of it in the IUCN Red list of endangered species and the reported low genetic diversity underscore the need for regular assessment of its population to provide proactive management measures in the face of climate change and environmental variability.

Population dynamics describes the pathways in which a given population grows and shrinks over time as controlled by birth, death and emigration or immigration (King, 1995).Major causes of death are fishing by humans and natural mortality caused by environmental factors including climatic factors like temperature and

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rainfall. Schwamborn, Mildenberger and Taylor (2019), expressed concern over the list of collapsed or collapsing stocks by Hilborn and Otando (2014) and Garcia-Carreras, Jennings and Le Quesne (2016). Also a decreasing overall biomass of populations under severe fishing pressure, have given rise to speculations on possible failure of current approaches to fish stock assessment (Wolff, 2015, Garcia Carreras, et al; 2016). A new thought has been proposed to include assessment of the risk of overfishing and stock collapse. The list of these risks are sources of uncertainty inter alia, future environmental conditions, Hilborn and Peterman, (1996), and uncertainty in the variability introduced by effects of variable abiotic factors (Caddy and Mahon, 1995). Therefore, the need to investigate the direct influence of environmental factors like rainfall and temperature in the catches of *Chrysichthys nigrodigitatus* is very germane.

In spite of the importance of *C. nigrodigitatus* in the socio-economic life of the people of the river basin, there is dearth of information on the species' biology and ecology. Previous work on its population dynamics are scanty and limited to only a small segment of the lower reaches of the river (Ajang et al., 2013, Udoh et al., 2015). The middle section of the river has never been included in population studies of *Chrysichthys* even though the population is one, thereby limiting the understanding of the dynamics of the wider population. Due to increased concern for the sustainable exploitation and conservation of the species, coupled with recent threats from climate change and pollution, there is need to regularly assess a wider population of the fishery for its effective management. The objectives of this paper were to estimate the exploitation rate and the status of the fishery using length frequency data and to evaluate the direct impact of rainfall regimes on the catch rate of the species.

2. MATERIALS AND METHODS

2.1 The study Area

The study area is the lower Cross River between latitudes 05º 00. 07. 97′ and 05º 45.67′ N and longitudes 008º 06.438′ and 07º 58.248 ′E. This is the section of the river that is in Nigeria. The River takes its origin from the Cameroon mountains and meanders through rainforest area for over 200 kilometres before emptying into the Atlantic Ocean in south east Nigeria. For the purpose of this study the river was arbitrarily divided into the downstream and upstream reaches, Fig 1.

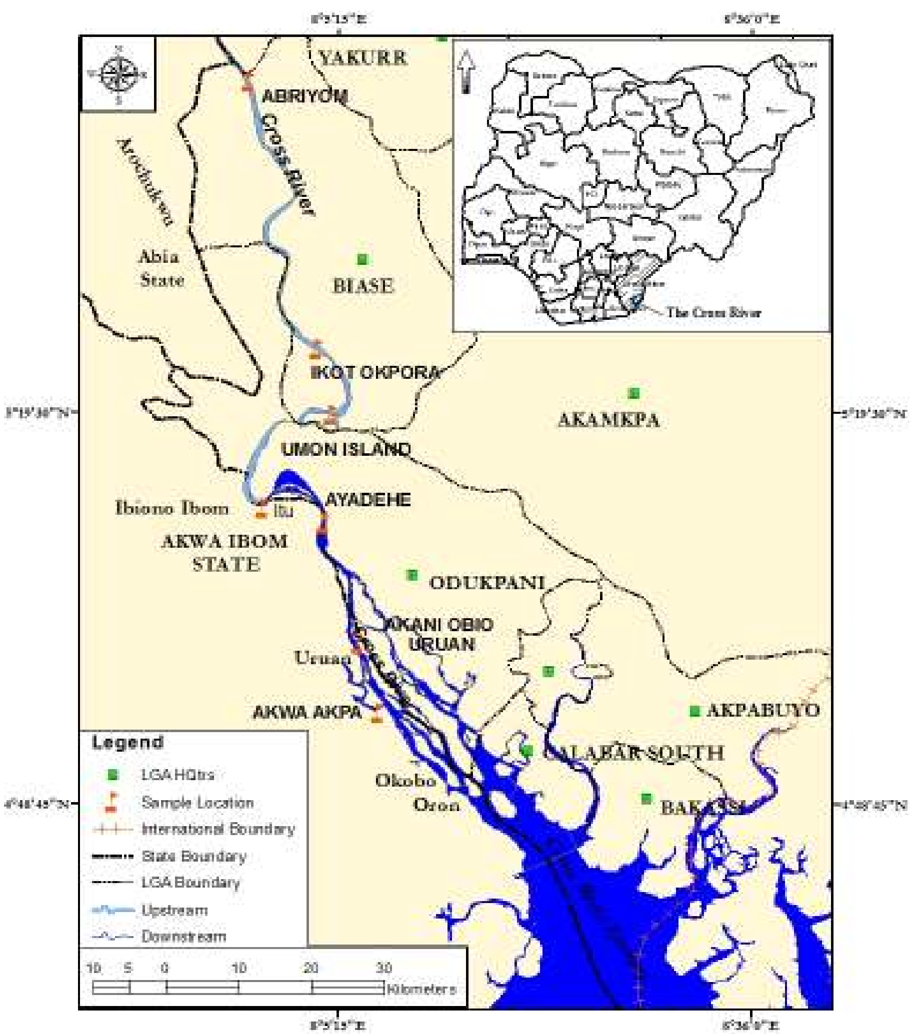

Fig. 1: Map of the Cross River showing the sampling locations

The limnology of Cross River was studied by Lowenberg and Kunzel (1992), and its effects on the fisheries highlighted by Ama-Abasi et al. (2017). There are two seasons in southern Nigeria, the dry season (November –March) and the wet season (April-October). The main occupations of the riverine communities are fishing (which is all year round) and farming of the arable land adjoining the river course. At the peak of the rains, the river overflows its banks and during this period the fishers resort to harvesting of the farm produce. The people also engage in trading and hunting.

2.2. SAMPLING SITES AND TECHNIQUE

Time series of *C. nigrodigitatus* was conducted from January 2017 to April 2018. The method of Gulland and Rosenberg (1992), improved upon by Sparre and Venema (1992) was used for the length frequency data collection. Seven fishing ports were chosen for the sampling. These were Akwa Akpa, Akani Obio Uruan, Ayadehe, Itu in the downstream of the Cross River and Umon Island, Ikot Okpara in the upstream reaches of the river(Fig 1). The sampling sites span a length of more than 140 km. Such a wide sampling strategy was informed by the itinerant habit of *C. nigrodigitatus* (Ama-Abasi, et al., 2017). This was to ensure that all size classes available for the fishery were captured, (Ama-Abasi,2004). Sampling was done twice monthly in both the upper and lower reaches of the river at neap and spring tides, respectively. Fish samples were obtained from commercial fishers who landed their catches along the study area. Fishes were caught daily using the set gill-nets. Fish samples were measured using a wooden metre board to the nearest 1.0 cm total length and weighed on a Salter balance to the nearest 0.1 g. The measured fish were however grouped into 5 cm size classes. All the samples were pooled together to get monthly length frequency data. Surface water was collected in a plastic bucket and the temperature value was read off from dual purpose Oxygen-temperature meter. River depth was measured using echo sounder SONAR FISHFINDER MODEL DF48. Daily rainfall data were obtained from the Meteorology Unit of the Department of Geography and Environmental Studies of the University of Calabar, and processed into mean monthly values.

2.3 ESTIMATION OF GROWTH PARAMETERS

Growth parameters were determined using FiSAT (FAO-ICLARM Fish Stock Assessment Tool) software version 1.2.2 (2000-2005). According to Ama-Abasi, Holzloehner, and Enin, (2004), the model incorporated in FiSAT for expressing the seasonally oscillating length growth of fishes was put forward by Pauly and Gaschutz (1979) and later modified by Sommers (1988). It takes the form:

Lt = L [1- e - (K(t-t0)- CK/2π) {sin 2π (t-ts) –sin2π (t0-ts) }] (1)

where L is the asymptotic length, K the von Bertalanffy growth coefficient, Lt the length at time t, C the amplitude of seasonal growth oscillation, t_0 the age of fish at zero length and t_s the time from birth to the start of growth oscillations. With ELEFAN 1, Eq (1) is modified with two of the original parameters replaced by others. First ts is replaced by the winter point (WP) which designates the period of the year (expressed as a fraction of a year) when the growth is slowest. The WP is related to ts through:

$$t_s + 0.5 = WP \quad (2)$$

Eq (1) was fitted to the length – frequency data and used to quantify the growth in length of individual *C. nigrodigitatus* in the Cross River. Since t_0 cannot be estimated from length frequency data alone, the software uses a different approach to position the growth curve on the data. This is by use of the so-called starting point. This defines the coordinates (sample number and a length) through which the growth curve must pass (Gayanilo and Pauly, 1997). Starting point, may be fixed or variable. The variable starting point allows for several possible choices of the starting points and only that with the best fit is retained. The seeded value of L used was Lmax , the largest length observed during the course of this study, which was 100cm total length. For comparison of the von Bertalanffy growth of *C. nigrodigitatus* studied with other claroteidae species, the growth performance index was calculated from the formula given by Pauly and Munro (1984):

L= log 10 K + 2log 10 L (3)

The length–converted catch curve was employed to estimate the total mortality, as incorporated in FiSAT (Pauly, Moreau, & Abad,1995). Natural mortality, fishing mortality and exploitation rates were all calculated as given by FiSAT (Gayanilo & Pauly, 1997). For the calculation of the natural mortality, the mean environmental temperature, in this case 28.8ºC was incorporated into formula as found in FiSAT. The exploitation rate was estimated using the formula:

E= F/Z 4

The relative yield -per -recruit model of Beverton and Holt as modified by Pauly and Soriano (1986) and incorporated in the FiSAT Programme, was compared with the expected values of Emax (the value of exploitation rate giving maximum relative yield-per-recruit), $E_{0.1}$ (the value of E at which marginal increase in Y/R is 10% of its value at E = 0) and $E_{0.5}$ (the value of E at 50% of the unexploited relative biomass-per-recruit) (Sparre and Venema, 1992; Gayanilo and Pauly, 1997). The potential longevity of *C. nigrodigitatus* was calculated using the formula of Pauly and Munro (1984):

Tmax = 3/K (5)

The yield isopleth diagram was used to assess the impact on yield created by changes of exploitation rate E and the ratio of length-at-first capture/asymptotic length (Lc/L) in relation to mesh size. Catch- per-unit effort, temperature, rainfall and depth data were analyzed using Gen Stat Release 8.1 (PC/windows) Lawes

Agricultural Trust (2005) version to determine any correlation amongst the parameters. We also analyzed previous work to compare the level of variation on some of the population parameters like natural mortality with this study.

3.0 RESULTS AND DISCUSSION

The mean monthly environmental parameters of temperature, rainfall, river depth and catch per -unit effort of the study area are given in Fig 2.

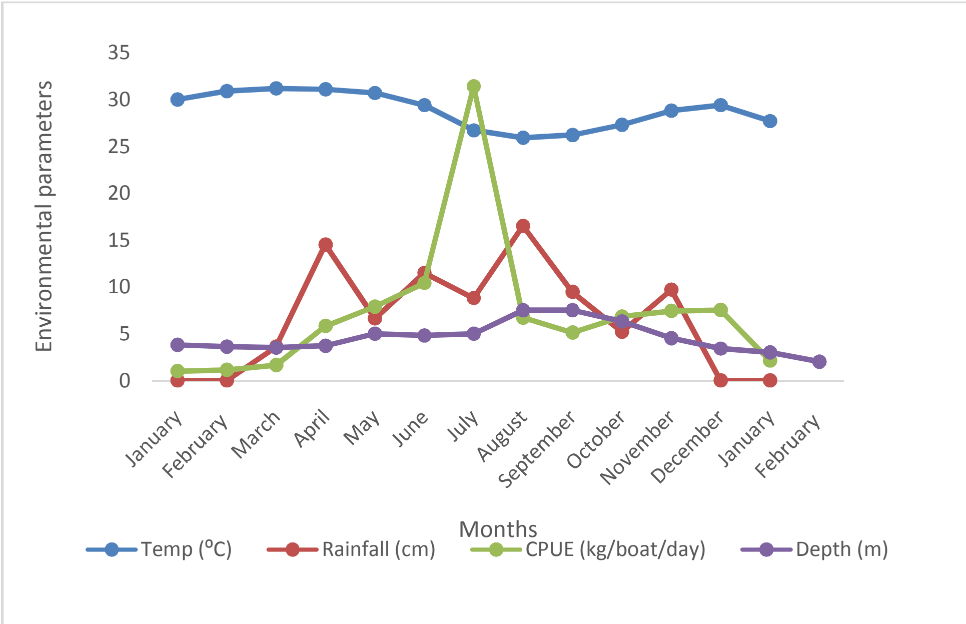

Fig 2: Environmental parameters of temperature, rainfall and depth against catch-per-unit effort of *Chrysichthys nigrodigitatus*.

The graph indicates three peaks period of rainfall namely, April, August and November, while catch-per-unit- effort of the fishery shows two peaks in July and December. With mean monthly rainfall as high as 15cm in April, a corresponding rise in the CPUE of *C. nigrodigitatus* was obtained. The correlation matrix of the environmental parameters studied is given in Table 1. A positive correlation coefficient value of 0.33 was obtained between CPUE and rainfall. This value was, however not statistically significant (P>0.5). The lack of statistical significance does not in any way rule out the impact of rains on the ecology of the species, but it is because the rains have both negative and positive impacts on the catch rates thereby attenuating strong statistical significance in the correlation. Ama-Abasi et al. (2017, 2019) noted that rainfall acts as a cue to commencement of reproductive activities. At the onset of rains, the species swarm out in large numbers for the purpose of reproduction. This is when the potamodromous migration begins (Ama-Abasi et al; 2019). This is also when the fishers employ additional gear like drums apart from gill nets to trap the spawning males and females, thus the observed increase in CPUE values during April to July. The figure also shows that low temperatures of between 27ºC and 25°C and high rainfall of 16.5 m within the period synchronized with low catches during August to October. The high rainfall increased the river depth to 7.5 m during August to September. Although there was a positive correlation between catch per-unit effort and river depth, this again was not significant (r = 0.25, P>0.05). The drop in CPUE from August to October was perhaps caused by further increase in river depth. This is explained by the fact that the river volume was too high for the fishers' small crafts to operate. The fishers are afraid for their lives and so majority of them do not dare the water in these months of high river volume. During this period the fishers relocate to the hinterland because their thatch houses are also swept over by the flood water. Secondly, the species being benthic, at this time are incubating and nursing their eggs and hatchlings at the river bottom, making them out of reach of the fishers. This reproductive tactic is ecologically beneficial to the fish as it allows the incubation to progress unperturbed. Hence this is an ecological adaptation for species population sustainability. The small peak observed in December was contributed by the young recruits that were in the creeks but as the flood water receded, they returned to the main river, thus being more susceptible to exploitation due to reduced water level. The correlation between catch per unit effort and temperature was significant at value of (r=0.395, P< 0.05). This is obvious since temperature decreases as the river depth increases as seen in Table 1.

Table 1: Correlation matrix of environmental factors and fish catch rate

Parameters	**Correlation values**			
Temperature	1.000			
Rainfall	-0.328	1.000		
Depth	-0.707*	0.647*	1.000	
CPUE	-0.395*	0.331	0.252	1.000
	Temperature	Rainfall	Depth	CPUE

* significant values

The two hydrologic parameters of depth, and temperature are direct consequences of rainfall. Therefore, rainfall has overall influence on *Chrysichthys* catch rate. Moses (2001) also posited that the reproductive activities of the species coincide with the rainy season, making it possible for the young hatchlings to depend on the allochthonous food supply as the water overflows the river banks into the terrestrial vegetation thereby providing shelter and food source for the young ones. The implication here is that since rainfall provides the cues for the commencement of reproductive activities, there could be a distortion of the biological clock of the species by climate change, including change in phenology, where suitable life history events may be mismatched with resultant failure in the reproductive outcomes.

The monthly length-frequency data for the estimation of growth parameters of *C. nigrodigitatus* was restructured into growth curve. The growth curve is superimposed on the restructured length frequency data (Fig 3).

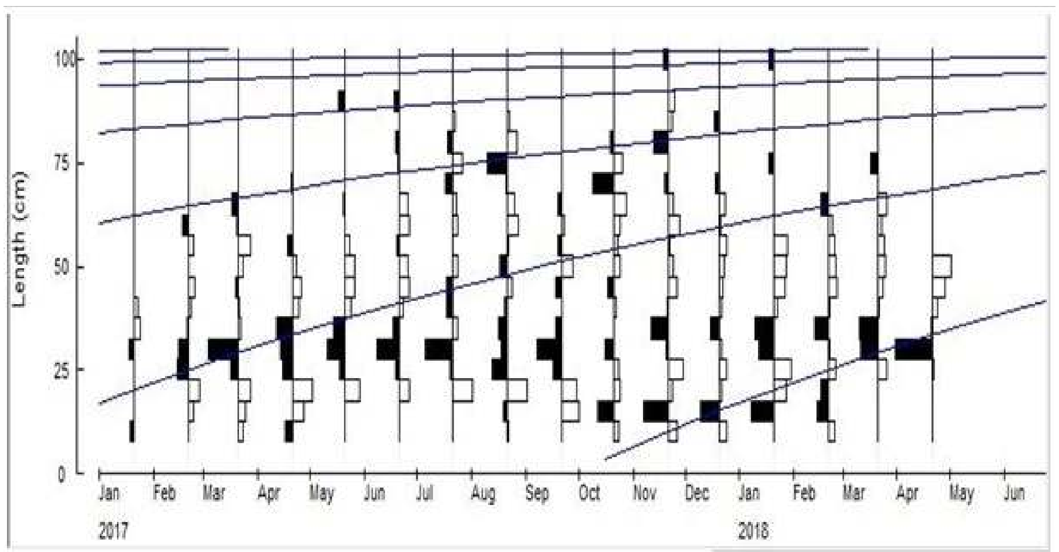

Fig 3. Restructured length frequency histogram with superimposed growth curve of *Chrysichthys nigrodigitatus* of the Cross River. (Asymptotic length, L∞= 105 cm, growth rate, K= 0.68, growth performance index, □ = 3.88, goodness of fit, Rn = 0.163).

The best estimates of growth parameters were given as follows: asymptotic length (L□) was 105 cm; growth rate (K) was 0.68 per year, the goodness of fit (Rn) was 0.163, while growth performance index (□) was 3.88. From the length-converted catch curve procedure (Fig. 4)

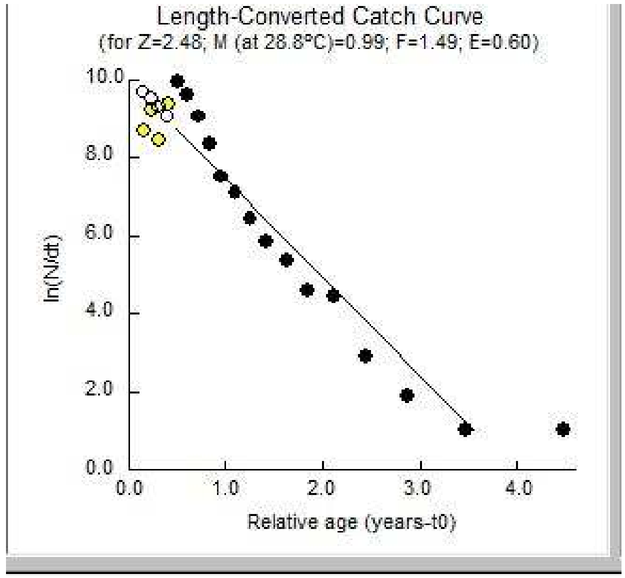

Fig 4. Length –converted catch curve of *C. nigrodigitatus* in the Cross River. (Total mortality, Z= 2.48 yr^{-1}, Natural mortality, M = 0.99 yr^{-1}, Fishing mortality, F= 1.49 yr^{-1} ,Exploitation E, 0.60 yr^{-1}

total mortality (Z) was estimated at Z=2.48 $year^{-1}$, while natural mortality (M) of 0.99 $year^{-1}$ was calculated from Pauly (1980) empirical formula. The fishing mortality (F) of 1.49 $year^{-1}$ was estimated. The exploitation rate (E) was estimated as 0.60 $year^{-1}$. The Beverton -Holt relative yield-per-recruit is shown in Fig 5.

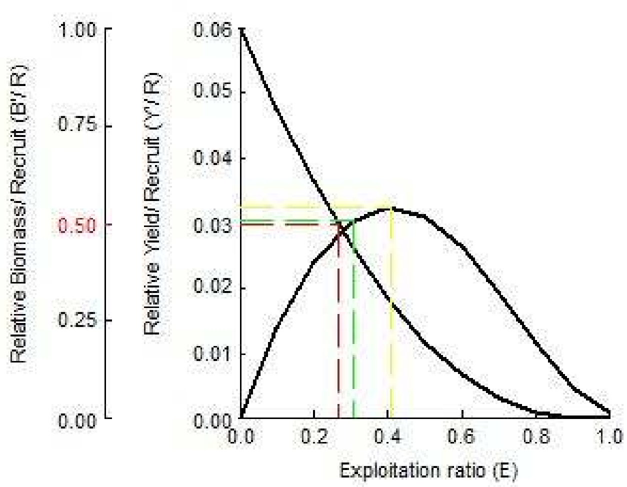

Fig 5. Relative yield per recruits against the exploitation rate. The yield –per- recruit, E_{10}= 0.305, E_{50}, E_{max} = 0.411.

The estimate using the knife-edge selection was as follows: E_{10} = 0.305, E_{50} = 0.265. E_{max} = 0.411. E_{max} is the exploitation rate in which maximum yield is obtained. The yield isopleth is given in Fig 6 with the critical value of Lc/L∞ as 0.11.

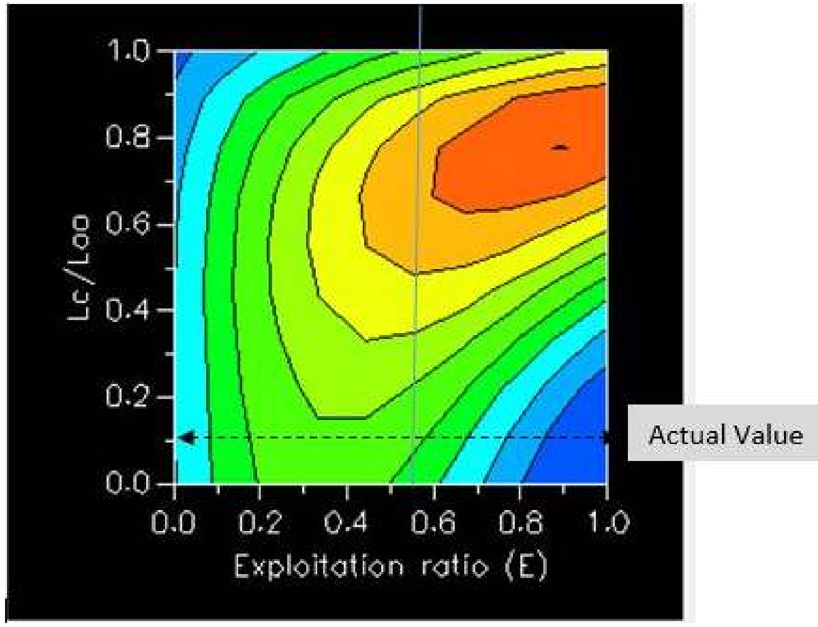

Fig 6: Yield Isopleths. (The yield isopleth contours predict the response of elative yield- per-recruit of fish to changes in L_C(length at first capture) and E_0 (exploitation rate). $L_C/L\infty$ values represent varying scenarios equivalent to change in mesh size. E corresponds to changing levels of F/Z. The actual value is 0.11)

With respect to the suitability of the length-frequency data for the estimation of *C. nigrodigitatus* growth parameters, there are a number of criteria for determining this. For instance, Pauly, (1984) developed a system for assessing length data for growth studies based on the need to obtain a sufficient number of increments well distributed over time. Pauly's rule of thumb provides that samples accumulated over a period of 6 months and above are required for such analysis. Gulland and Rosenberg (1992) recommended 1500 fish specimens with sampling covering at least 14 months, i.e. the whole annual cycle with enough overlap to check on year-to –year differences. The sample used in the present study for *C. nigrodigitatus*, was a total of 3,654, fish spread over 16 months, thus satisfying these criteria. Moreover, growth comparison is a multivariate problem hence must take into consideration both the growth rate (K) and the asymptotic length (L□). A comparison of growth performance of *C. nigrodigitatus* with previous works by Ajang, et al., (2013), Abowei and Hart (2007), Ofori-Danson, et al (2002), Ekpo & Udoh (2013), showed some similarities. Generally, the growth performance indices (phi prime ø) are species-specific parameters, i.e. their values are usually similar within related taxa and have narrow normal distributions. Gross dissimilarity of phi prime values for a number of stocks of the same species or related species is an indicator of the unreliability in the accuracy of estimated growth parameters (Moreau, Bambino, & Pauly 1986). The coefficient of variation (16.4%) together with other measures of dispersion (range = 1.31, variance = 0.25, standard deviation = 0.50) for phi prime values is low, lending credence to the validity and reliability of the estimated growth parameters. A comparison of the growth parameters of *C. nigrodigitatus* in this study with that of Ajang et al. (2013) on the same species showed a higher growth rate than the ones in this study. This may be due to the limited sampling area of Ajang et al., some differences between the specimens of the middle section of the Cross River and those of the lower section in their reproductive efficiency. These observations justified the wide sampling strategy adopted in this present study. However, the growth performance index of 3.88 in this study was slightly higher than the 3.08 of Ajang et al. (2013), again accentuating the importance of wide sampling strategies. The mortality values indicate that fishing pressure causes more deaths than the combined effects of disease, predation and senescence. The high fishing mortality implies that high fishing effort is being exerted on the *C. nigrodigitatus* fishery. Such exertion is observed mainly in the rainy season months of April to July when the reproductive activities are at the peak leading to high catch rates as already mentioned and observed from figure 2 and also as the rainy season runs to a close in November and December. The excessive fishing pressure is confirmed by the exploitation rate of 0.60. According to Pauly (1987) when the exploitation rate, E is equal to 0.5, the fishery is at optimum level of exploitation; when it is less than 0.5 it is lightly exploited and if it is above 0.5, it is overexploited. The exploitation rate of 0.60 for *C. nigrodigitatus* fishery of the Cross River, implies that the fishery is over exploited. Previous work by Ajang et al. (2013) reported on the overfishing experienced by the fishery in the lower Cross River, with exploitation rate as high as 0.81 $year^{-1}$. In this report the exploitation level has reduced to 0.60 per year. Both the instantaneous rate of total mortality and the exploitation rate have shown some drastic decline over those of Ajang et al., (2013). Most reports on the dynamics of the exploited populations of various fisheries including those of *C. nigrodigitatus* in the Cross River, other rivers in Niger Delta and the Tropics have been that of overfishing (Abowei & Hart, 2007., Ofori-Danson et al 2002., Ekpo & Udoh, 2013., Etim, Lebo, & King, 1999; Moses, 1988; Ama- Abasi, et al., 2004,). This marks the first report of

Cross River in over three decades. The drop in the exploitation level may be an indication of a trend toward the recovery of the fishery after the reported high exploitation rate by Ajang, et al., (2013). Various reasons may be responsible for the observed reduction in exploitation rate including the expansion of the sampling regime to the middle Cross River. Previous authors had been working only in the lower reaches of the Cross River. Also, the incessant and oftentimes violent, communal conflicts between the riverine communities exploiting the resource. These conflicts have spanned from 2014 to the present. This has limited the number of fishers and the frequency of fishing along the river system with a concomitant reduction in the effort. This preposition therefore accentuates both temporal and spatial closures, and limiting the number of fishing units as major fishery regulatory measures (King, 1995). Thirdly, the diversification of the economy of the people of the riverine communities might have contributed to some level of easing off the pressure on the fishery. Much of the Cross River basin is very fertile arable land with numerous fruits, vegetables and crops that provide steady income for the riverine dwellers as an alternative source of livelihood. This reduction in exploitation rate however, is not enough to relax the excessive pressure on the resource. The natural mortality of 0.99 $year^{-1}$represents 40% of the instantaneous rate of total mortality. That means natural causes contribute to 40% of the deaths of *Chrysichthys nigrodigitatus* in the Cross River. Possible causes of this natural death may be pollution, Kanu and Idowu (2017),and high temperatures. According to Goldman & Horne (1994) high mean temperatures in rivers restrict the spread of some organisms while clearance of riverside vegetation increases water temperature and together with the loss of tree root habitats, can cause dramatic reduction in fish production (Ringler and Hall 1975). In this study there was a significant negative correlation between temperature and *Chrysichthys* abundance and catch rates (Table 1). Ama-Abasi et al; (2019) observed that the fish species has a very high oxygen demand. Increase in surface temperature decreases dissolved oxygen content of the river. This will in turn decrease the abundance of the fish. So persistent high river temperatures could result in mortalities. This may also be the reason the species are less in abundance in the dry season with high temperatures. Moreover, Uyoh et al. (2020) and Adelieje, et al; (2020) reported that *Chrysichthys nigrodigitatus* population of the Cross River has very low genetic diversity. Such low genetic variation could lead to spontaneous wipe out of populations in the face of environmental variability and may likely contribute to the increase in natural mortality observed here. When comparing the percentage of natural mortality of previous works, Ajang et al, (2013), 19%, Udoh et al (2015), 37% and this study, 40 %, there is drastic increase in the percentage natural mortality in the past 10 years. Jorgensen and Holt (2013), stated that several studies are now noticing temporal trends towards increasing natural mortality. Swain (2011), and Swain and Chouinard, (2008) reported that Atlantic cod, *Gadusmorhua* in the Gulf of St. Lawrence had natural mortality of 0.1- 0.2 $year^{-1}$ in the 1980's but by 2000's it had risen to value as high as 0.6 yr^{-1}.Jorgensen and Holt, (2013) opined that such increases in natural mortality may be part of the explanation collapsed stocks are not recovering. This drastic increase in the percentage natural mortality of *Chrysichthys nigrodigitatus* of the Cross River is very worrisome and portends severe threat to the fishery and its sustainability.

The yield per recruit Emax of 0. 453 is lower than the exploitation rate, still confirming that the fishery is over-exploited. The yield isopleth contours predict the response of relative yield – per- recruit of fish to changes in Lc (Length at first capture) and E_0(exploitation rate). Lc/ L∞ values represent varying scenarios equivalent to change in mesh size. E corresponds to changing levels of F/Z. The Lc/ L∞ value of 0.11 in this study is in quadrant D of Pauly and Soriano (1986). The implication is that the small fish are caught at higher effort level. This can be readily confirmed from Figure7

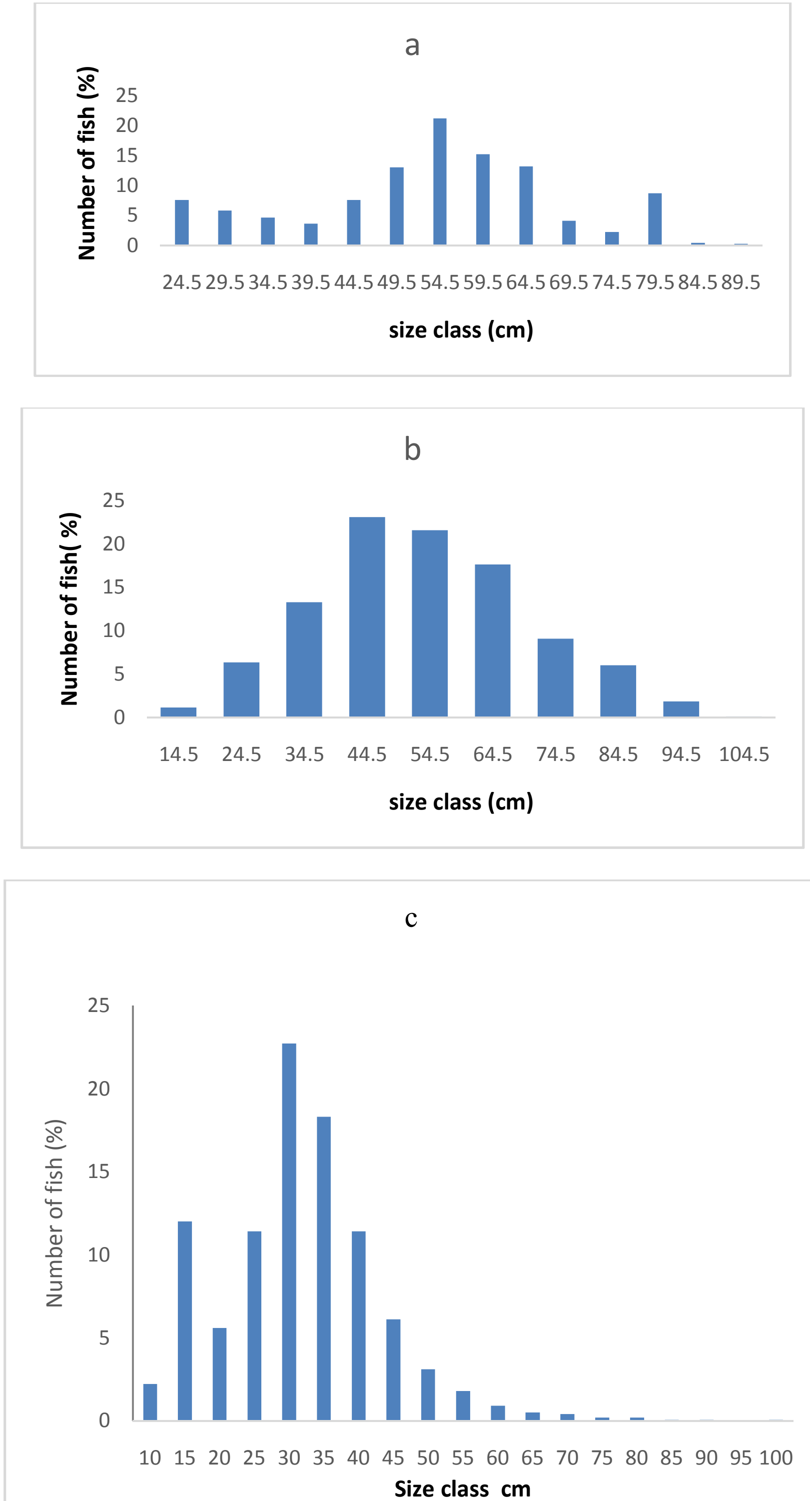

Fig 7: A decadal trend in the modal class of exploited population of *Chrysichthys nigrodigitatus* in the Cross River, (a)54.5 cm, Ajang et al; (2013),(b)44.5 cm, Udoh et al;(2015) (c) 30cm, This study.

where the size classes of 15 - 35 cm alone form 70% of the total catch while the rest formed 30%. Consequently, the fishery requires reduction in catching efficiency by increasing the mesh size to reduce exploitation pressure on the young fish. The catching of the small fish might have been enhanced by the spiny nature of the first fin ray of the pectoral and dorsal fins. This feature increases the catchability efficiency of the gear so that a young fish that could have escaped from the net with a given mesh size, were it to be girthed, is entangled at the spines. Consequently, the *Chrysichthys* fishery of the Cross River is suffering from growth overfishing. This again underscores our suggestion for increase in mesh size to enable escape of the young fish.

Beverton and Holt (1959) found that values of the ratio M/K mostly lie in the range of 1.5- 2.5. In this study the M/K for *Chrysichthys nigrodigitatus* was 1.5. This adds credence to the validity of the results in this present study. The longevity of *C. nigrodigitatus* is estimated to be 4.4 years, Tmax= 3/K. Fish species with a high K-value have been shown to have a high mortality value, and species with low K-value have a low natural mortality. As a rule of thumb, if Z/K ratio is less than 1 (using the Powell–Wetheral plot), then the population is growth–dominated; if it is greater than 1, then it is mortality dominated; if it is 1, then mortality balances growth in such population. In mortality-dominated population, if Z/K is approximately 2, then it is lightly exploited. In this study, Z/K was 3.6 showing that the fishery is both mortalities dominated and heavily exploited. Another worrisome scenario is the rapid decline in the number of bigger size classes available for the fishery. Udoh et al., (2015) recorded the highest percentage catch from the size class of 40-60 cm (62.29%) and size class of 14.5-34.5, 20.6%. In contrast, this study has recorded higher percentage catch of 70% from the size class of 15-35 cm and 20.6% for size class of 40-60 cm. Also, from figure 7, there is a rapid shift in the modal class between 2008 and 2018. This shift in the size class available for exploitation over a decade shows a systematic move towards the depletion of the resource, which calls for an urgent management intervention.

CONCLUSION.

This study has observed rainfall influence on the ecology of *Chrysichthys nigrodigitatu*s, with a possible impact on the phenology of the species in the face of climate change. With the exploitation rate at 0.60, the *Chrysichthys nigrodigitatus* fisheries of the Cross River is experiencing overfishing. With the observed overfishing, coupled with high natural mortality and a threat towards the depletion of *Chrysichthys* resource, it is recommended that there should be a further reduction in the effort through the willingness of the riverine communities and the fisher folks to regulate the number of boat-days, especially during the spawning period in May to July and in November and December when the young ones are preponderant. Also, as a conservation strategy, *Chrysichthys nigrodigitatus* should be domesticated, thus shielding it from the vagaries of environmental variability like climate change and pollution

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Highlights

1. Rainfall has overriding influence on *Chrysichthys* abundance and catch rate.
2. The correlation between rainfall regime and catch predisposes the fishery to climate change impact.
3. There is excessive fishing pressure on the fishery with confirmed status of overfishing.
4. A high fishing mortality combined with high natural mortality means the species is under severe threat.
5. Management strategies should include reduction in number of boat-days and domestication of the species