

Fish Mortalities and Management Measures of Fish Species of the Andoni River, Niger Delta, Nigeria

Amiye Francis and Erondu Ebere Samuel
Department of Animal Science and Fisheries, Faculty of Agriculture,
University of Port Harcourt, P.M.B. 5323, Choba, Rivers State, Nigeria

Abstract: Length-frequency data of 11 fish species sampled from catches of five randomly selected artisanal fishers that use unmotorized canoe were fed into FISAT (FAO-ICLARM Stock Assessment Tool). The total natural and fishing mortality coefficient result showed that *Sarotherodon melanotheron* (R.) (2.24 year^{-1}), *Galeoides decadactylus* (B.) (1.96 year^{-1}), *Eucinostomus melanopterus* (B.) (1.58 year^{-1}), *Tilapia guineensis* (B.) (1.44 year^{-1}), *Pseudotolithus elongatus* (B.) (1.22 year^{-1}) and *Ilisha africana* (B.) (1.08 year^{-1}) had the highest natural mortality rates and indicative of fast growth [i.e., rapidly approaching asymptotic length (L_{∞})] with the reverse being true for *Chrysichthys nigrodigitatus* (Lacepede) (0.66 year^{-1}); *Pomadasys jubelini* (C.) (0.74 year^{-1}); *Ethmalosa fimbriata* (B.) (0.78 year^{-1}); *Lutjanus goreensis* (V.) and *Liza grandisquamis* (V.) (0.87 year^{-1}). The generally high total mortality values of $0.88\text{--}3.83 \text{ year}^{-1}$ points to death due not only to legal fishing activities but also great impacts from illegal and obnoxious fishing practices, pollution and environmental degradation and the consequent need for management of this fishery. Management measures should include enforced licensing and registration of fishers and fishing craft, establishment of marine reserve areas and fishing registration centers.

Key words: Fish mortalities Andoni river, fisheries management, primary production, spawning, Nigeria

INTRODUCTION

Total mortality (Z), the sum total of the rates of Fishing (F) and natural Mortalities (M) determines the population dynamics of fish stocks (Buijse, 1992). It is a necessary component of fish stock assessment (Marshall, 1992). In fisheries management, mortality coefficients come into play when optimum levels of efforts are to be set. Causes of fish mortality include oil pollution (Ezenwa *et al.*, 1987); predation (Chifamba, 1992); diseases (Biotoxins, 2006), both legal and illegal fishing activities and environmental change (Millennium Ecosystem Assessment).

Tobor (1991) reported that the value of natural Mortality (M) for majority of the Gulf of Guinea fish stocks range from 0.5-1.00 and that a value of 0.7 was a good estimate for natural mortality. Capture fisheries worldwide is undergoing stock depletion (Millennium Ecosystem Assessment). Fish from the wild and its products cannot be done away with being rich food for the teeming rural poor in developing countries that have the natural aquatic ecosystem. Fishes are an inestimable source of livelihood for billions the world over. The fact that fish species in the wild are being imperiled or

undergoing extinction has necessitated the packaging of the management of fisheries especially in the tropics so as to ensure conservation of biodiversity and sustainable use of the fishery resource.

Effective management measures cannot be successfully put in place without accurate statistical data on fish stocks. Though management of the tropical fisheries is made difficult by the multi-species nature of the fishery, concerted effort is imperative if there will be advancement and sustainability in the nature of fishery exploitation in Nigeria.

The employment of seemingly complex fishery management approaches such as the co-management (cooperative management), community based management and Ecosystem Approach to Fisheries management (EAF) or Ecosystem-Based approach to Fisheries Management (EBFM) operative in developed countries should not deter trial in the development of the national fisheries through established management measures which of course have to be based on available fish stock data and engagement of all stakeholders. Much gap exists in fish stock assessment and fisheries as a discipline in Nigeria. The results of this study aims at filling up part of this gap.

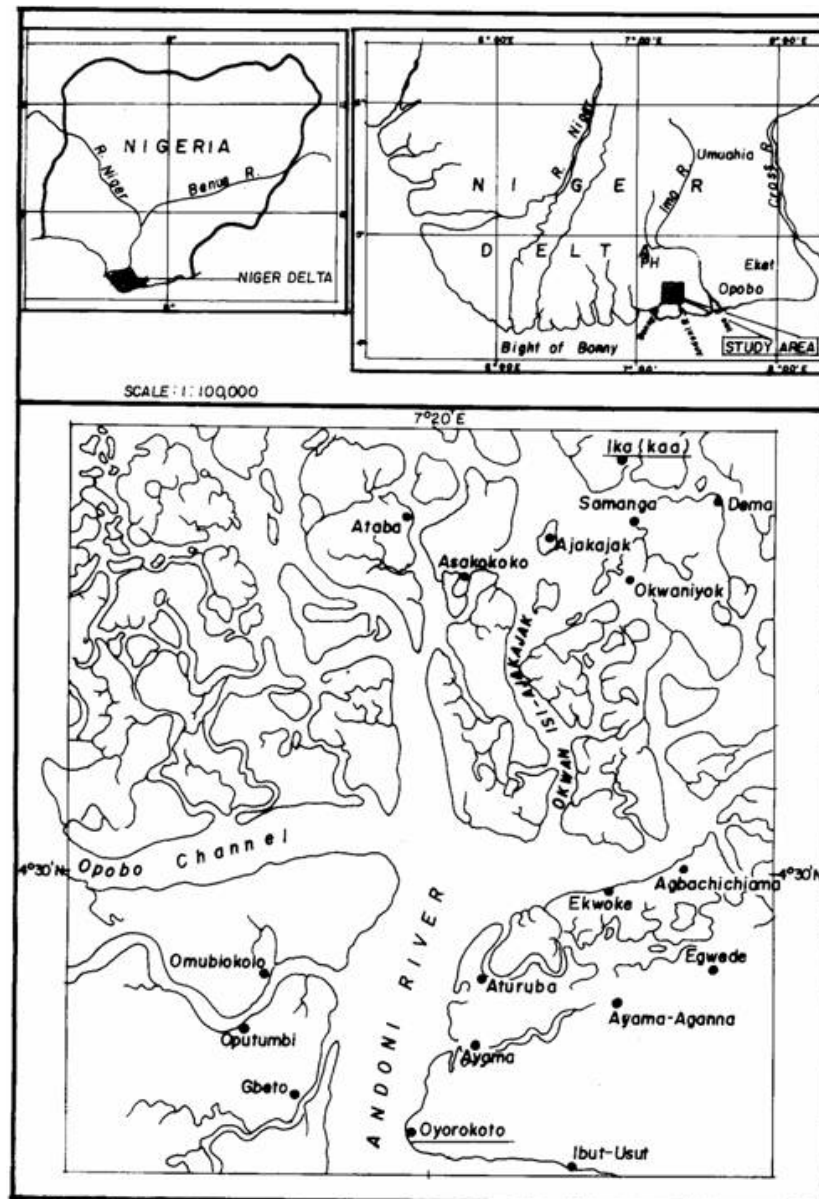


Fig. 1: Part of Nigeria delta showing Andoni river system

Study area: The Andoni river, located on $4^{\circ}28' - 4^{\circ}45'$ North and longitudes $7^{\circ}45'$ East is one of the rivers forming the Niger Delta in Nigeria (Fig. 1). The Niger Delta itself, one of the world's largest wetlands and covering an area of approximately 20,000 km² is economically important in terms of fisheries, mineral deposits, gas and biodiversity. The Andoni river, one of the numerous rivers that drain rivers Niger and Benue into the Atlantic Ocean is located within the rainforest belt of Nigeria. The climate is made up of a short dry season of about four months (November to March).

The dry season, however is usually dotted with rains every now and then. The longer rainy season period spans from about April to October with heavy rains experienced from around May. The river itself is brackish in content. Numerous creeks, rivulets, mudflats, sand beaches, *Rhizophora* and *Avicenia* sp. mark the river and its banks.

The Andoni artisanal fishers land their catches at two main sites: Kaa (Ika) waterfront and Oyorokoto which is closer to the Atlantic Ocean. The Kaa waterfront is more hinterland than Oyorokoto (Fig. 1).

MATERIALS AND METHODS

Fish sampling: Fish samples used for this study were procured from the artisanal fishers that land their catches for sale at Kaa waterfront (Fig. 1). About 20 dug-out canoes propelled by paddle are landed daily at this site, out of which five landed canoes were randomly selected per field trip. The field trip was conducted bi-weekly (every other week) from January to December, 1999.

Length measurement: During each field trip length measurements were taken from all the landed fishes in the five selected canoes using the procedure of Pauly (1983). With the aid of transparent plastic ruler the Total Length (TL) in centimeters was taken as the length from the anterior-most part of the snout to the tip of the caudal fin. All the length measurements which were of 1 cm class interval were converted to monthly length frequencies and grouped into six samples of two months each. These six samples formed the input into FiSAT (FAO-ICLARM Fish Stock Assessment Tool). The asymptotic Length (L_{∞}) was calculated using the Powell-Wetherall plot routine, while the scan of K-value routine was used to calculate the K (growth coefficient) of the fish species.

Statistics: The outputs (L_{∞} and K) formed the input into length converted catch curves procedure for the calculation of Z (total mortality) and latter M (natural mortality). For more clarity, Z was estimated through the catch curve method. The formula integrating the interrelationship between mortality, size and temperature (Pauly 1980, 1983) was used for Natural mortality calculations thus:

$$\log_{10}(M) = -0.0066 - 0.279 \log_{10}L_{\infty} + 0.6543 \log_{10}K + 0.4634 \log_{10}T$$

Where:

- M = Natural mortality
 L_{∞} = Asymptotic length
 K = Growth coefficient
 T = Mean temperature of the water body

Therefore, Fishing mortality (F) was thus calculated: $F = Z - M$, where the letters in the formula remain as explained earlier.

RESULTS AND DISCUSSION

The fish mortality coefficients of 11 commercially important fish species from the Andoni river system is shown in Table 1. Sample of catch curve used for calculation of Z is in Appendix 1. The total mortality values had a range of 0.88 year⁻¹ (*Chrysichthys nigrodigitatus*) -3.83 year⁻¹ for *Pseudotolithus elongatus*; 0.66-2.24 year⁻¹ for natural mortality coefficients and 0.22-2.61 year⁻¹ for fishing mortality rates. The natural mortality values can either be approximated to 0.7 or said to be earlier 0.7 while for fishing mortality only the values for two fish species *C. nigrodigitatus* and *Galeoides decadactylus* had values that were <0.7 year⁻¹.

Also, the fish species that suffered death most (i.e., total mortality, both from natural causes and fishing activities) were *Pseudotolithus elongatus* followed by *Sarotherodon melanotheron*, *Eucinostomus melanopterus* and *Tilapia guineensis* but least in *C. nigrodigitatus* and increasing in order to *P. jubelini*, *L. grandisquamis* and *E. fimbriata*.

Death from natural causes occurred highest in *S. melanotheron* followed in descending order to *G. decadactylus* and *Ethmalosa fimbriata*. Death due to fishing activity (F) was highest in *P. elongatus*, descending in value to three fish species having F-value of 1.34 year⁻¹ each: *E. melanopterus*, *Ilisha africana* and *T. guineensis*. Compared to natural mortality value of 0.7, the mortality values in Table 1 are generally high. Employed as a tool, the M/K (natural mortality to growth coefficient (K) (rate at which fish proceeds to the asymptotic length (L_{∞}) ratio is supposed to be constant for a group of species or closely related families or taxa. The values of this ratio usually fall between 1.0 and 2.5 (Beverton and Holt, 1959) for any result to be valid for scientific interpretations and deductions. In this study,

Table 1: Mortality rates of fish species from the andoni river system (1999 data)

Fish species	total mortality Z (year ⁻¹)	Natural mortality M (year ⁻¹)	Fishing mortality F (year ⁻¹)	E exploitation ratio	M/K
<i>Chrysichthys nigrodigitatus</i> (Lacepede)	0.88	0.660	0.220	0.2500	2.220
<i>Ethmalosa fimbriata</i> (B.)	1.64	0.780	0.860	0.5240	1.660
<i>Eucinostomus melanopterus</i> (B.)	2.92	1.580	1.340	0.4589	2.230
<i>Galeoides decadactylus</i> (B.)	2.45	1.960	0.490	0.2000	2.108
<i>Ilisha africana</i> (B.)	2.42	1.080	1.340	0.5540	2.250
<i>Liza grandisquamis</i> (V.)	1.60	0.870	0.730	0.4560	2.230
<i>Lutjanus goreensis</i> (V.)	1.79	0.870	0.920	0.5140	2.230
<i>Pomadoury jubelini</i> (C.)	1.57	0.740	0.830	0.5290	2.310
<i>Pseudotolithus elongatus</i> (B.)	3.83	1.220	2.610	0.6814	1.770
<i>Sarotherodon melanotheron</i> (R.)	3.27	2.240	1.030	0.3150	1.720
<i>Tilapia guineensis</i> (B.)	2.78	1.440	1.340	0.4820	1.950

the M/K ratio fell within the accepted range thereby rendering these mortality values valid for scientific inferences and consequently for management purposes. This ratio can also be used to determine the dominant factor in the total mortality rate whether it is the fishing or natural mortality coefficient.

Francis (2003) had reported that 72.73% of the 11 commercially important fish species from the Andoni river system were at optimum level of exploitation (Table 1 and Appendix 2). Therefore, the high total mortality rates reported in this study seem to corroborate the fact that factors other than overfishing are responsible for fish stock depletion within this aquatic ecosystem. Environmental degradation, illegal and obnoxious fishing practices, oil pollution, gas flaring, canalization, urbanization, use of speed boat as means of water transport which are rampant in the Niger Delta though absent or almost non-existent some 30 years back can collectively cause high fish mortality.

These earlier mentioned factors can affect the physico-chemistry of the aquatic environment with a consequent alteration in the physiology and metabolism of the aquatic organisms. Sudden or even continuous exposure of these fishes to deleterious levels of physico-chemical parameters in the long run lead to death of fishes (Ajani *et al.*, 2007) resulting in high fish mortality. In addition, these factors can affect the turbidity of the water thereby rendering the fishes vulnerable to entanglement or become easy prey to predators and man. Besides, the turbidity can reduce penetration of light, adversely affect primary production and primary consumption and on and on along the trophic gradient.

The high natural mortality coefficients of *S. melanotheron*, *G. decadactylus*, *E. melanopterus* and *T. guineensis* is indicative of their fast growth rate (Beverton and Holt, 1959) which results from high tropical temperature (Pauly, 1998) that enhances their metabolic rates when compared to their temperate counterparts. The explanation given for the high total mortality rates also applies here for high natural mortality coefficients.

Correspondingly, the low natural mortality of *C. nigrodigitatus*, *Pomadasys jubelini*, *E. fimbriata*, *Liza grandisquamis* and *Lutjanus goreensis* point to their slow growth to attain (L_{∞}) asymptotic length (Beverton and Holt, 1959). Slow growth and low natural mortality rates seem to be characteristic of predators because most of the fishes in this category are predators/carnivores (Table 1). Furthermore, the high fishing mortality rates recorded for *P. elongatus*, *S. melanotheron*, *E. melanopterus* and *T. guineensis* may be the result of an almost all year round spawning, their consequent growth and recruitment into the fishing ground and hence, the target of all year round fishing activities within this river system. Though, statistically there was no significant difference in the

overall values of natural and fishing mortality coefficients, 2 fish species *C. nigrodigitatus* and *G. decadactylus* had F-values that were $<0.7 \text{ year}^{-1}$ which Tobor (1991) said is a good natural mortality value for most of the Gulf of Guinea fish stock whose range fall between 0.50 and 1.00 year^{-1} (Table 1). This result of non-significance between the mortality values for F and M implies that increase in fishing effort on this river cannot be encouraged, since only higher figures of natural mortality rates necessitate the increase of fishing efforts and which in turn should bring about increased fish yield.

The mortality values in this present study at best can only be compared to those of closely related species since only these were obtained from literature. King (1991) had mortality values of $Z = 0.87$, $M = 0.663$ and $F = 0.23 \text{ year}^{-1}$ for *Tilapia mariae* captured from Iba Oku Stream in Akwa Ibom, Nigeria.

These quoted figures are in disparity with those of the present study due may be to differences in the gene pool, ecosystem differences, selectivity of fishing gear and the introduction of bias.

Abohweyere (1989) reported Z of 0.36 year^{-1} for *G. decadactylus*. The difference in mortality values between this and the value in Table 1 could have been due to selectivity of fishing gear, introduction of bias and ecological differences in the ecosystem of the two fish stocks.

Management measures: The Ecosystem Approach to Fisheries management (EAF) that has elements of both the community-based and adaptive management approaches, National Marine Fisheries Service (1999) embedded within its practice focuses on sustainability in the use and development of our fisheries resources. The functionality and result, nature of this EAF approach has fish stock assessment as its foundation (FAO, 2003). Based on the result in this study that the mortality rates were high, the following measures below have been suggested for consideration in fisheries policy decisions.

CONCLUSION

The high mortality rates in this study is indicative of heavy pressure on the ichthyofauna and consequently on the ecosystem; thereby making the under listed measures imperative. Furthermore, since the whole essence of fisheries management is for an authorized body to have grip on the resource and decide what fishery resource should be removed, how and when management of the coastal fisheries within the Niger Delta can be thus managed:

- Enforced licensing of fishers, vessels, motorized and unmotorized canoes and gear

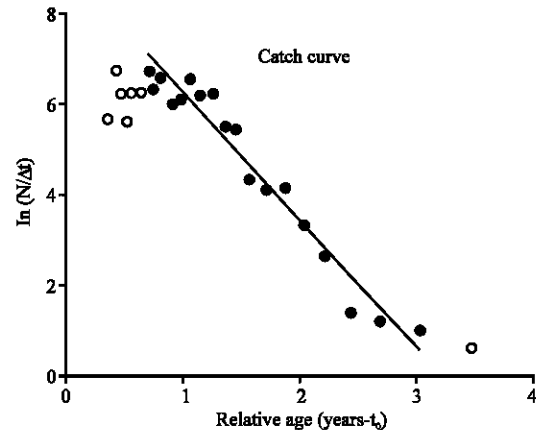
- Establishment of fish registration centres at the main fish landing sites. Information can be disseminated to fishers through such offices
- Establishment of brackish water protected areas in order to protect spawning and breeding grounds of fish species like mullets, tilapias and mudskippers; thereby handling the problem of recruitment over fishing
- Enforce the keeping of operational standards by oil prospecting, production and servicing companies/industries against oil spills and gas flaring and their consequent green house effect within the delta region of Nigeria
- Awareness campaign of all stakeholders on the evils of destructive use of the fishery resources and the gains from their sustainable exploitation and development. The evils of environmental degradation, various types of pollution, obnoxious and illegal fishing practices including over fishing should be highlighted during such enlightenment programmes
- Empowerment of the Monitoring, Control and Surveillance (MCS) unit of the federal and state departments of Fisheries to function effectively. The work of this unit actually depends on set fishery objectives which they through the feedbacks and checks from their daily routines employ in the achievement of set national and State fishery goals
- Provision of stiffer penalties to offenders of the fishery regulations than what exists in the present national fishery policy
- Rivers state should formulate its own fishery laws and regulations as done in some states of Nigeria

RECOMMENDATIONS

- Identification and mapping out of various spawning and breeding grounds of resident estuarine fish species such as the Cichlidae, Gobiidae, Eleotridae, Syngnathidae and Periophthalmidae
- Survey of fishing gear and their implications on the fishery and ecosystem within the coastal waters, the results of which will be enmeshed within the new national fishery laws and regulations that is long over due in Nigeria
- Mass fish stock assessment of the ichthyofauna for the fresh, brackish and marine aquatic environments so as to have enough data for the establishment of the new national fisheries management objectives, plan, strategies, measures and the fisheries policy as a whole

APPENDIXES

Appendix 1: Catch curve used in the calculation of total mortality of *Tilapia guineensis* using FiSAT.



Species name:

- *Tilapia guineensis*

Other file identifiers:

- Andoni river 1999

File name CTGUAR2 Wt. Mode (1a)

Growth parameters:

L_{∞} : 33.00 cm

K : 0.75

C : 0.00

WP : 0.00

Regression statistics:

n = 8.00

Slope (b) = -2.78

Corr. Coef. (R) = .976

Z from catch curve = 2.78

(CI of Z : 3.11-2.45)

Range of length observations:

- 6-71 cm Class aize
- 1 cm

Appendix 2: Exploitation ratio of fish species from the Andoni river system, Niger Delta, Nigeria (1999 Data)

S/N	Fish species	Exploitation ratio (F/Z)	Exploitation as %
1	<i>C. nigrodigitatus</i>	0.2500 ^b	25.00
2	<i>E. fimbriata</i>	•0.5240	52.40
3	<i>E. melanopterus</i>	•0.4589	46.00
4	<i>G. decadactylus</i>	0.2000 ^b	20.00
5	<i>I. africana</i>	•0.5540	55.40
6	<i>L. grandisquamis</i>	•0.4560	46.00
7	<i>L. goreensis</i>	•0.5140	51.40
8	<i>P. jubelini</i>	•0.5290	52.90
9	<i>P. elongatus</i>	0.6814 ^a	68.14
10	<i>S. melanotheron</i>	0.3150 ^b	32.00
11	<i>T. guineensis</i>	•0.4820	48.20

Francis (2003)

- = Optimum level of exploitation
- a = Over exploitation
- b = Under exploitation

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