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POPULATION DYNAMICS OF *MORMYRUS RUME* (VALENCIENNES, 1847; OSTEOGLOSSIFORMES; MORMYRIDAE) OF IKERE-GORGE, ISEYIN, OYO STATE, NIGERIA.

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ABSTRACT

The structure of a fish population is determined by the equilibrium between growth, recruitment and total mortality. But, there is paucity of information on the growth and mortality of *Mormyrus rume* in Nigeria. Therefore this study is needful to determine its population parameters, with a view of evolving management strategies for its sustainable exploitation. Estimates of population parameters of *Mormyrus rume* were obtained from length-frequency data of 836 individuals collected monthly for a period of 24 months from January 2017 to December 2018. The estimated growth parameters were: asymptotic length (L_∞) was 100.8cm; growth coefficient (K) was 0.62/year; growth performance (Θ) was 3.8; length at maturity (L_m) was 52.57cm; reproductive load (L_m/L_∞) was 0.52 and optimum length (L_{opt}) was 65.10cm. Likewise, natural, fishing and total mortalities were 0.93, 1.46 and 2.39 respectively. The values of exploitation rate (0.61) and ratio of total mortality and growth coefficient (3.85) showed that *Mormyrus rume* is most exploited in Ikere-gorge. Therefore, appropriate fishing regulations should be enforced to regulate fishing gears and mesh size that will fish *Mormyrus rume* at sustainable level.

KEYWORDS: Recruitment, mortality, growth, exploitation, length

INTRODUCTION

Fishery management systems depend on regular stock assessments to determine stock status and to provide appropriate advice for management decision to achieve fishery and conservation objectives. Stock assessment involve provision of information on recruitment, mortality, migration, fishery monitoring, and resource surveys for estimating stock size and harvest rate relative to sustainable reference points. It compares the present and expected fish abundance at a particular period of time to determine the exploitation level of the stock whether the stock is overexploited or not; it also tells us if a catch level will maintain or change the abundance of the stock. Stock assessment also involves forecasting the response of the resource to alternative management scenarios. Stock assessment is usually carried out by applying statistical and mathematical models to make quantitative predictions about the reactions of fish populations to alternative management choices (Bonfil, 2005; Cadrin and Dickey-Collas, 2015).

The structure of a fish population is determined by the equilibrium between growth, recruitment and total mortality. Certain methods of fisheries assessment require the separation of total mortality into its components due to fishing and due to natural causes (Fatemi *et al*. 2009).

The fundamental purpose of fisheries management is to ensure sustainable production over time from fish stocks, preferably through regulatory and enhancement actions that promote economic and social well-being of the fishermen and industries that use the production. Management authorities must make very difficult and quantitative choices about how much development of fishing to encourage or permit, what specific limits to place on catches (times of fishing, sizes of fish, total landings, locations of fishing), how much financial resource to spend on enforcement of regulations versus enhancement of production, and so forth (Hilborn and Walters, 1992). *Mormyrus rume* (Elephant fish) is a species in the Mormyridae family. It is one of the important commercial fish species in Ikere-gorge. Small sized *M. rume* is used as bait for bigger fish like *Lates niloticus* while bigger and matured sizes have appreciable market value in Ikere-gorge. But, there is paucity of information on the growth and mortality of *Mormyrus rume* in Nigeria. Therefore this study is needful to determine its population parameters, with a

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view of evolving management strategies for its sustainable exploitation.

MATERIALS AND METHODS

The study site

Ikere-gorge is a 565 million cubic meters (mcm) multipurpose dam located at Ikere village, about 28km, North East of Iseyin in Oyo State. Ikere-gorge is located between longitude 8°10′ and 8° 20′N and latitude 3° 40′ and 3° 50′E. The southern parts of the dam is characterised with rocky hills and valley. The water bed comprised mainly fine and coarse sand particles and gravels. Along the bank of the dam are distributed forest and savanna trees and aquatic grasses and shrubs. The dam experience frequent current as a result of wind that blows on it from time to time. Sometimes, the current results to wave action which frequently spread across the dam and sometime it could be violent particularly during the raining season (Kehinde and Ayoade, 2012). Ikere-gorge took its source from Sepeteri about 40 km to Ikere through Asamu and Alagbon. Ikere-gorge has Ogun River as its major tributary and River Amaka, River Oowe and River Owu as its minor tributaries (Figure 1).

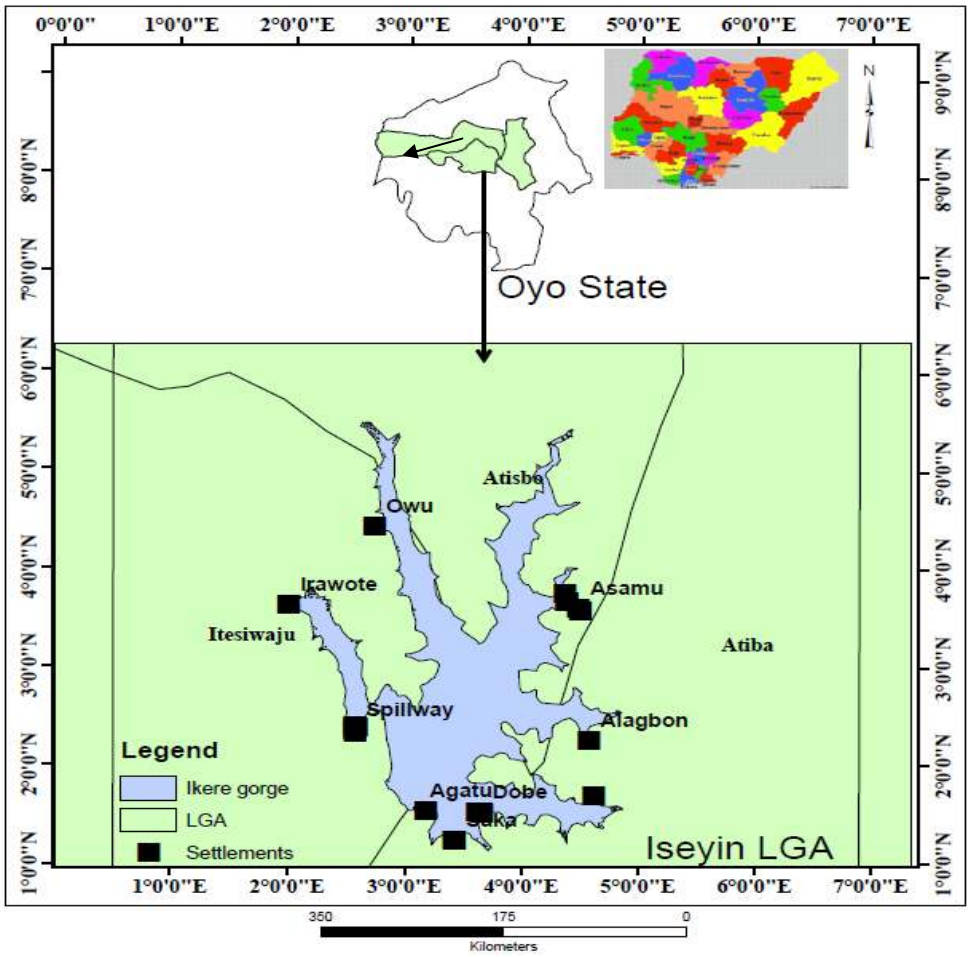

Figure 1: Map of Ikere-gorge (showing some fishing villages), Iseyin, Oyo State, Nigeria

FISH SAMPLING

Ikere-gorge has 12 fishing village which were divided into four stata. One fishing village was randomly selected from each stratum as study site. The selected fishing villages were Asamu, Agatu, Spillway and Irawote. Random samples of *M. rume were* collected from the selected fishing villages in Ikere-gorge during the sampling period from January 2017 to December 2018. Fish were sampled from fishermen catches. Fish were caught with different fishing gears such as gillnet, cats net, hook and line, gura (Malian) net and wire. The fish samples were sorted and identified to the species level using the guides of provided by Olaosebikan and Raji (2013). Total length to the nearest centimetres was taken for each individual specimen with fish measuring boards and recorded. The monthly length data were combined into a single pool in groups with 10 cm size class interval, representing one theoretical annual cycle and analyzed accordingly (Udoidiong *et al*. 2017).

ESTIMATION OF GROWTH AND MORTALITY PARAMETERS

The average of two years' (2017 and 2018) monthly length-frequency distribution of *M. rume* was pooled together as an annual data. They were analyzed using the procedure of Gayanilo Jr. *et al*. (2005) of the FiSAT II (version 1.2.2) computer software package of fish stock assessment. ELEFAN I and II subroutines of the software were used to estimate von Bertalanffy growth and mortality parameters, recruitment patterns and probability of capture.

The equation for growth in length is given by,

$L_t = L_\infty[1-\exp\{-K (t - t_0)\}]$ (1)

Where:

L_t is the predicted or estimated length at age t,

L_∞ **(cm)** is the asymptotic length in cm; parameter of the VBGF expressing the maximum length that the fish would reach if they were to grow indefinitely

K is a growth coefficient, the parameter of the VBGF, of dimension per year, expressing the rate at which the asymptotic length is approached

't_0' is the theoretical age at which fish would have had zero length if they had always grown according to the above equation (Abdul *et al*. 2012; Pauly, 1986)

MATURITY PARAMETERS

The average length at which fish of a given population mature for the first time L_m was obtained using the model of Froese and Binohlan (2000).

$\text{Log } L_m = 0.8776\text{Log } L_\infty - 0.38$ (2)

Optimum length (L_{opt}), the length at 50% maturity or the length at which the total biomass of a year-class reaches a maximum value in an unfished population can be calculated using Beverton, (1992).

$L_{opt} = L_\infty (3 / 3+MK)$ (3)

The overall growth performances index (Ø') for the *M. rume* was computed using the Pauly and Munro (1984):

$\Theta = \log10\ K + 2\ \log10\ L_\infty$ (4)

Longevity was obtained from the following equation (Pauly, 1983):

$t_{max} = t_0 + 3/K$ (5)

Where:

t_{max} is the approximate maximum age the fish of a given population would reach.

ESTIMATION OF NATURAL, FISHING AND TOTAL MORTALITY

Pauly (1980) empirical model was used to estimate natural mortality that represent death of fish from other sources like diseases, cannibalism, spawning stress, starvation and old age less death caused by fishing activities (mortality).

$\ln M = -0.0152 - 0.279 \ln L_\infty + 0.06543 \ln K + 0.4634 \ln \check{T}$ (6)

Where:

M is the natural mortality,

Ť is Annual mean surface water temperature (°C) for Ikere gorge dam being the locality where growth study was conducted which is taken as 28.14°C. Surface water temperature of Ikere-gorge was monthly measured with mercury-in-glass thermometer. The mean of the values was 28.14°C

The total mortality, Z, was obtained according to the model proposed by Ssentongo and Larkin (1973):

$Z = (nk/(n+1)) (\ln(L\infty - Lc) (L\infty - \acute{L}))^{-1}$ (7)

Where:

n is the number of fishes sampled

Lc is the length of the smallest fish in the sample

Ĺ is the average length in the samples

But, total fishing mortality is:

$Z = F + M$

Therefore, fishing mortality (F) can be estimated as:

$F = Z - M$

Therefore, exploitation rate (E) which is the mortality rate due to fishing activities can be estimated as:

$E = F/F+M$

$= F/Z$ (8)

RESULT

The size distribution of *M. rume* in Ikere-gorge varied between 16.5 and 96.0 cm with a mean of 37.5±12.9 cm. Figure 1 shows the von Bertalanffy growth curves for *M. rume.* The estimated growth parameters for *M. rume* are the asymptotic length or the theoretical maximum length a fish species would reach if it grow indefinitely (L_∞) was 100.80 cm; the growth coefficient or the rate at which a fish species attained its maximum length (K) was 0.62/year; the value of K-scan or surface response (R_n) was 0.34; the growth performance (Ø') was 3.80; the longevity was 4.84 years; length at first capture or 50 % of the stock vulnerable to fishing gear (L_{50}) was 11.0 cm (Figure 2). The length at first maturity **(**L_m) of *M. rume* was 52.57 cm while the optimum length (L_{opt}) which is the length at which the total biomass of a year-class reaches a maximum value was 65.10 cm. The reproductive load ($Lm/L\infty$) was 0.52 while the ratio of optimum length and asymptotic length (L_{opt} / L_∞) was 0.65. The recruitment patterns of *M. rume* in Ikere-gorge (Figure 3) shows two recruitment cycles per year. The first recruitment occurred between February and June with a peak in May. The second recruitment period occur between June and October with a peak in July.

Mormyrus rume instantaneous rate of total mortality per year (Z) estimated was 2.39 / year, the natural mortality was 0.93/year, the fishing mortality was 1.46/year and the exploitation rate was 0.61 at 28.14ºC local water temperature of Ikere-gorge (Figure 4). Ratios of natural mortality, VBGF growth coefficient (M/K) were 1.50 and Z/K was 3.85 respectively. The virtual population of *M. rume* in Ikere-gorge shows that fishing mortality is highest between the length range of 20 and 30 cm. This is the length range of *M. rume* that is heavily exploited in Ikere-gorge. Figure 5 shows that natural loses (natural mortality is as a result of predatory, diseases etc) predominate the length range of *M. rume* between 0 and 16 cm. This is unexploited length range. But, fishing mortality shown as the trend line begins to grow steadily from length range above 16 cm and predominate at length range 20 cm. There is full exploitation at size 36 cm and above. The virtual population diagram suggested that there is growth overfishing of *M. rume* in Ikere-gorge.

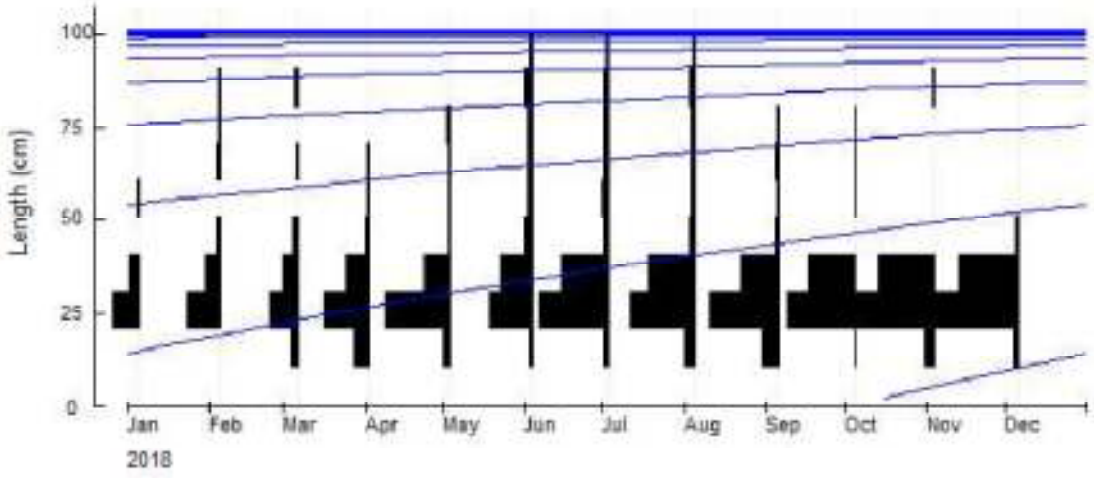

Figure 1: The von Bertalanffy growth function curves of *Mormyrus rume* on Ikere-gorge, Iseyin, Oyo State, Nigeria.

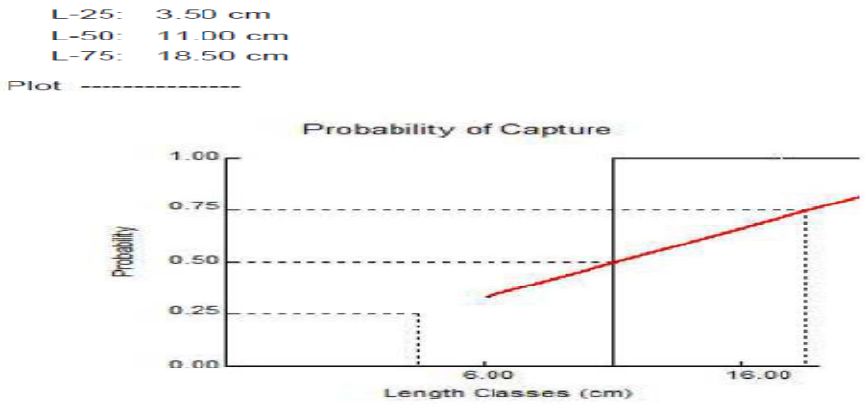

Figure 2: The probability of capture of *Mormyrus rume* in Ikere-gorge, Iseyin, Oyo State, Nigeria.

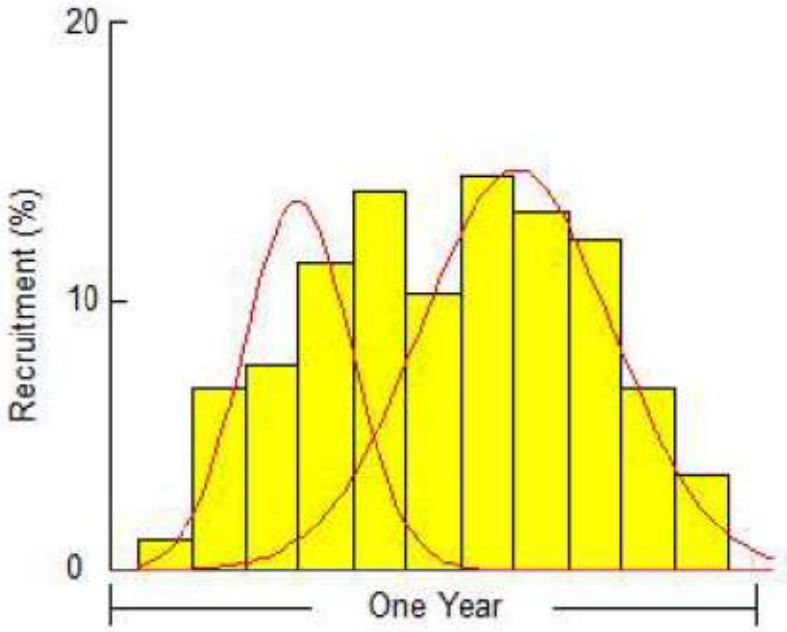

Figure 3: The recruitment pattern of *Mormyrus rume* in Ikere-gorge, Iseyin, Oyo State, Nigeria

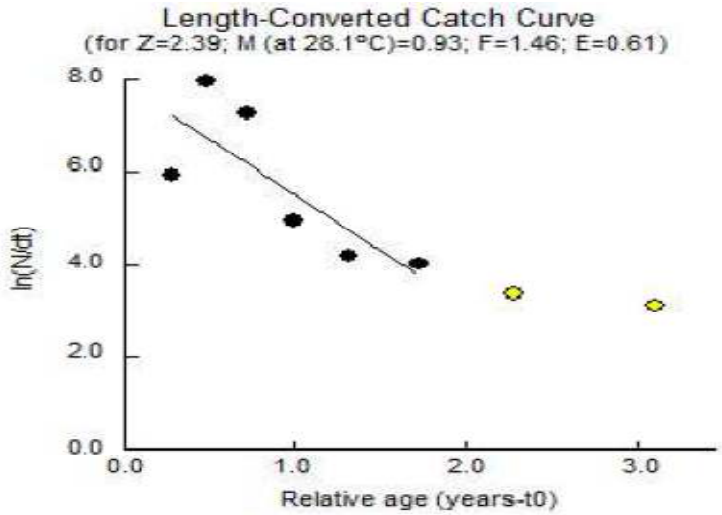

Figure 4: The length converted catch curve of *Mormyrus rume* in Ikere-gorge, Iseyin, Oyo State, Nigeria.

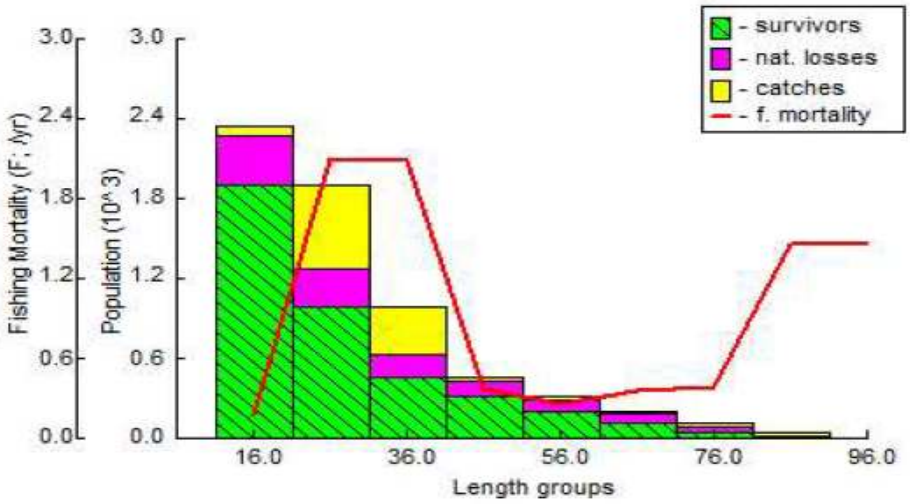

Figure 5: Virtual population analysis of *Mormyrus rume* in Ikere-gorge, Iseyin, Oyo State, Nigeria

DISCUSSION

The maximum length (L_{max}) of *M. rume* observed in this study is consistent with the report of Olaosebikan and Raji (2004) that adult *M. rume* can reach a maximum length of 100 cm. But, Odedeyi *et al*. (2007) reported a maximum length of 45cm for *Mormyrus rume* in River Ose, Southwestern Nigeria. Offem *et al*. (2009) also reported mean length of 25.2 ±2.5cm for *Mormyrus rume* in Cross River inland wetlands Nigeria. The disparity in these maximum lengths of *M. rume* may be as a result of different ecosystem and fishing pressure in different ecosystems. Likewise, the ratio of observed maximum length and estimated von Bertalanffy growth function asymptotic length was 0.95 (Mathews and Samuel 1990). But asymptotic length estimated in this study was higher than the value (L_∞ = 80.65cm) Ragheb (2016) reported for *Mormyrus kannume* in the Damietta branch of Nile, Egypt. Likewise, Imam *et al*. (2012) reported that asymptotic length of *Mormyrus kannume* from the Nile, Egypt was 53.11cm.

The rate at which fishes approach their asymptotic length is growth coefficient (K) and was estimated using K-scan in ELEFAN I. Pauly *et al*. (1984) reported that K-values for tropical fish stock fall within 0.39 and 1.6 per year. The K-values can be used to estimate longevity or life expectance for individual fish. There is also an inverse relationship between growth coefficient (K) and longevity. The K-value of *M. rume* reported in this study was 0.62 with longevity of 4.84 years while Amponsah *et al*. (2016) reported K-value of 1.3 years with longevity of 2 years for *Scomber japonicus* in eastern coastline of Ghana.

The ratio of optimum length and asymptotic length obtained in this study was 0.65. This is equivalent to the suggested value (L_{opt}/L_∞ = 0·63) reported by Froese and Binohlan (2000). *M. rume* of Ikere-gorge sexually matured at length 52.57cm with reproductive load of 0.52. This is in agreement with Binohlan (1998) that reported that fishes of about 200 cm maximum size mature at about 100 m (i.e., reproductive load of L_m/L_∞ to be 0.5). But, Imam *et al*. (2012) reported that females and males of *M. kannume* reached maturation at 31.7 and 31.5 cm with reproductive load of 0.754 and 0.748, respectively from the Nile, Egypt. The variation may be due to several physical and biological factors in time and fisheries in addition to the fishing efforts.

It is observed that length at first capture is far less than length at maturity for *M. rume* in this study. This observation is in agreement with the report of Amponsah *et al*. (2016) for *Scomber japonicus* with length at first capture of 13.19 cm and length at first maturity of 17.85 cm. The implication of this is that *M. rume* of Ikere-gorge were vulnerable to fishing gears before they are mature to reproduce. The mortality parameters reported in this study were lower than the values reported by Amponsah *et al*. (2016) for *Scomber japonicus* in eastern coastline of Ghana. However, they are with the recommended range for tropical fish species (Pauly *et al*. 1984). But it is observed that increasing fishing pressure in Ikere-gorge, is causing high fishing mortality which is responsible for more fish deaths than combined effects of diseases, predatory and cessation. Likewise, the ratio of total mortality to growth coefficient (Z/K = 3.85) and exploitation rate (E = 0.61) showed that *M. rume* of Ikere-gorge is highly exploited (Udoh *et al*. 2015). The virtual population analysis showed that there is growth overfishing of *M. rume* in Ikere-gorge. This observation is in agreement with the report of Udoh *et al*. (2015) with fishing mortality dominating and determining the population structure causing overfishing in the schooling areas by reducing the stock abundance.

CONCLUSION

This study examined the population parameters of *M. rume* of Ikere-gorge. All the estimated parameters were within acceptable range. It was observed that the exploitation of *M. rume* in Ikere-gorge is not sustainable. This is shown in the values of fishing mortality, exploitation rate and Z/K. Therefore, in order for the exploitation of *M. rume* in Ikere-gorge to be sustainable fishing mortality and exploitation rate have to be regulated in terms of fishing gears, fishing pressure and habitat improvement.

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