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The length-weight relationship and condition factor of Flathead Mullet, *Mugil cephalus* (Linnaeus, 1758) from Amassoma flood plains. Niger Delta, Nigeria

Ezekiel, E.N[1] and Abowei J.F.N[2]

[1]Department of Science Laboratory Technology, School of Applied Science, Rivers State Polytechnic, Bori, Rivers State, Nigeria
[2]Department of Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria

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ABSTRACT

The length-weight relationship and condition factor of Mugil cephalus from Amassoma flood plains was studied for a period of six months (November – December, 2011 and January, 2012 for the dry season and May, June and July; 2012 for the Wet season).The maximum and minimum sizes recorded were 103cm and 11cm respectively with corresponding weights of 1236g and 121g. The Class marks: 2.50cm, 14.5cm and 106.5 cm was not recorded. Lowest frequency (1) was estimated for class marks 8.5cm and 100.5cm with 96.5.5g and 11070g respectively. The modal frequency (41) was estimated for 62.5 class mark with 750g. The frequencies for the class marks: 20.5cm, 26.5cm, 32.5cm, 38.5cm, 44.5cm, 50.5cm, 56.5cm, 68.5cm 76.5cm, 82.5cm, 88.5cm and 94.5cm with corresponding weight class marks: 246.0g, 318.0g, 390.0g, 462.0g, 534.0g, 606.0g, 678.0g, 834.0g, 918.0g and 990.0g, 1062.0 and 1134.0 were 4, 10, 18, 11, 25, 33, 13, 8, 13, 2 and 4 respectively. Generally, the frequency distribution of Mugil cephalus from Amassoma flood plains was binomial. The length weight regression equation was Log W = 1.077 + 3.23LogL with correlation coefficient value of 0.850 and Significance of correlation values of $P < 0.05, t = 26.2, df = 199$*.The "a" and "b" values were 1.077 and 3.23 respectively. The "r" value was positive (1.25). The condition index value range from 0.98 – 1.00 and the condition factor value was 0.995. Mugil cephalus exhibited allometric growth. There was strong association between length and weight of Mugil cephalus. Mugil cephalus was in a good condition.*

Key words: Growth parameters, *Mugil cephalus*, flood plain, Niger Delta, Nigeria

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INTRODUCTION

The flathead mullet, *Mugil cephalus*, (Plate 1) is a mullet of the genus Mugil in the family Mugilidae, Kingdom: Animalia; Class: Actinopterygii; and Order: Mugiliformes; found in coastal tropical and subtropical waters worldwide. The Striped Mullet have dark centers which give the appearance of a series (6-7) of dark horizontal stripes. The fish grow to lengths up to 60.0 cm with weights as high as 4.0 kg. Its length is typically 30 to 75 centimeters (12 to 30 in). This species occurs worldwide, attested by other common names for this fish: Black mullet - Cuba, US; Bully mullet - Australia, Vietnam; Callifaver mullet - Cuba, Netherlands Antilles, US**;** Common grey mullet **–** UK**;** Common mullet - Cuba, Netherlands Antilles, US**;** Flathead grey mullet - India, Philippines, UK**;** Flathead mullet - Europe, FAO, UN, Fish base**;** Grey mullet - Turkey, Australia, Taiwan, Cuba, Fiji, Hong Kong, Mauritius, Netherlands Antilles, New Zealand, Spain, Tonga, UK, US, Mediterranean, Egypt**;** Hardgut mullet **–** Australia**;** Mangrove mullet **–** Australia**;** Sea mullet - Australia, Fiji, Papua New Guinea, UK and Striped mullet - Australia, Cuba, Mexico, UK, US, Hawaii**.** The Striped Mullet is a mainly diurnal coastal species that often enters estuaries and rivers. The Striped Mullet usually schools over sand or mud bottoms, feeding on zooplankton. The Adult fish normally feed on algae in fresh water. The maximum size the Striped Mullet may reach is approximately 120 cm, with a max weight of about 8,000 g. The species is euryhaline meaning that the fish can acclimate to different levels of salinity; this combined with the acclimation of juveniles to high water temperatures appears to be a selective advantage. Its conservative status is lower risk.

The Striped Mullet historically ranged far up the Colorado River to the vicinity of Blythe and up the Gila River to perhaps Tacna. Because of the dams and restricted flows to the Sea of Cortez, the range in Arizona is restricted to the Colorado River below Laguna Dam and the lower end of the Gila River when there is water present. The Striped Mullet are often abundant in the mainstream and lateral canals in the Gila River region. The Striped Mullet normally occupies fresh, brackish and marine habitats in depths ranging between 0–120 meters and with temperatures between 8–24 °C. In the Colorado River mullet are pelagic in larger pools, sometimes moving into currents below dams, and generally occurring in small groups. The Striped Mullet populations are currently declining in Arizona, due to periods when the Colorado River does not reach the Sea of Cortez.

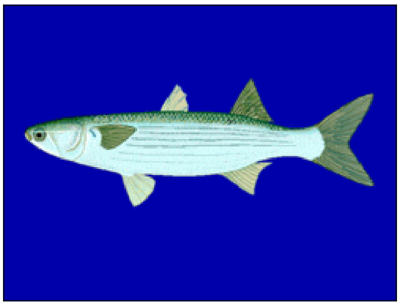

Plate 1 Flathead Mullet (Striped Mullet), ***Mugil cephalus***

The flathead mullet is an important food fish for many around the world, and can be both fished and farmed. The roe of this mullet is salted, dried, and compressed to make a specialty food across the world, such as Taiwanese Wuyutsu (Plate 2), Korean myeongran jeot, Japanese karasumi, Italian bottarga, Turkish Haviar and Egyptian batarekh. In Egypt, the fish itself is salted, dried, and pickled to make feseekh. On the coast of Northwest Florida and Alabama, this mullet, called the striped or black mullet, is often a specialty of seafood restaurants. Fried mullet is most popular, but smoked, baked, and canned mullet are also eaten. Local fishermen usually catch mullet in a cast net, though some use a hook. Mullet is a delicacy in this area and is most often consumed in the home. Mullet are usually filleted, and the remaining frames used for fish stock, used in chowders and stews. The mullet most commonly consumed in Florida however is the white mullet (*mugil curema*), because its preference for cleaner water gives it a cleaner and less muddy taste. Mullet does not keep well after it is caught. If kept on ice it may remain edible for approximately 72 hours, after which it becomes nearly inedible. The sooner it can be eaten after being caught, the better.

Plate 2. Drying mullet roe in Taiwan.

Population parameters evaluate the effect of fishing on a fishery as a basis for fishery management decisions [1]. The fundamental models used are based on four parameters: Growth, recruitment, natural and fishing mortality [2]. Age and growth are particularly important for describing the status of a fish population and for predicting the potential yield of the fishery. It also facilitates the assessment of production, stock size, recruitment to adult stock and mortalities [3]. Fish mortality is caused by several factors, which include, age [4; fish predation [5], environmental stress; parasites and diseases and fishing activity [4]. The exploitation rate is an index, which estimates the level of utilization of a fishery. The value of exploitation rate is based on the fact that sustainable yield is optimized when the fishing mortality coefficient is equal to natural mortality [6]. Many other scientists, but the studies were concerned primarily with temperate stocks. On the other hand, studies on the population dynamics of tropical fish stock have been limited by the difficulty of ageing tropical fish species, which from the ecological perspective inhabit 'steady state environment'.

The length-weight relationship of fish is an important fishery management tool. Its importance is pronounced in estimating the average weight at a given length group [7] and in assessing the relative well being of a fish population [8]. Consequently length-weight studies on fish are extensive. Notable among these are the reports of Shenouda *et al* (1994) for *Chrysichthys spp* from the southern most part of the River Nile (Egypt) [9]; Alfred – Ockiya and Njoku (1995) for mullet in New Calabar River [10], Ahmed and Saha (1996) for carps in lake kapitel, Bangladash [11]; King (1996) for Nigeria fresh water fishes [12]; Hart (1997) for *Mugil cephalus* in Bonny Estuary [13] and Diri (2002) for *Tilapia guinensis* in Elechi creek [14]

Condition factor compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a given length are in better condition [15]. Condition factors decreases with increase in length [16][17]; and also influences the reproductive cycle in fish. Condition factors of different species of cichlid fishes have been reported [18-23]. Condition factors reported for some other species include: Alfred-Ockiya (2000) for *Chana chana* in fresh water swamps of Niger Delta [24] and Hart (1997) for *Mugil cephalus* in Bonny estuary [13].

The flood plain of Amassoma is one of the low lands in Niger Delta providing nursery and breeding grounds for variety of both finfish and shell fish species. The Amassoma flood plain receives water from the Nun River. The Nun River is one of the most important river systems in the Niger Delta providing nursery and breeding grounds for a large variety of fish. Fishing in the river is intensified and catch per unit effort is low. Consequent upon speedy industrialization and other human activities, the river is fast becoming degraded. Fishing is carried out indiscriminately with various traditional and modern fishing gears [25]. Accurate fisheries statistics in Amassoma flood plains; and its adjourning flood plains is vital for the formulation of a sound fisheries management programme in the Nun River and similar flood plains water bodies. Several studies have been carried out [26-38],for different water bodies, there are no reliable data on the Fin- fish species distribution, abundance and seasonality, Length - weight relationships and condition factors of *M cephalus* from Amassoma flood plains. This is essential for formulation of development plan in the fishing industry, Amassoma flood plains, Nun River and similar water bodies.

MATERIALS AND METHODS

Study area

The study was carried out in the Amassoma flood plains (Plate 1) which receives water from the River Nun which bifurcates into the Nun and Forcados rivers about 20 miles (32 km) downstream from Aboh, the Nun flows through sparsely settled zones of freshwater and mangrove swamps and coastal sand ridges before completing its 100-mile (160-km) south-southwesterly course to the Gulf of Guinea, a wide inlet of the Atlantic Ocean, at Akassa. River Nun is one of the numerous low land rivers in the Niger Delta with the most important drainage feature of the Niger Basin River system about 2% of the surface area of Nigeria. The annual rainfall of the Niger Delta is between 2,000-3000mm per year [39]. The dry season lasts for four months from November to February with occasional rainfall. The Niger Delta region of Nigeria is bounded to the south by the Atlantic Ocean. This region, which is rich in biodiversity and organic mineral resources, has a coastline extending from the mouth of the Benin River in the west to the mouth of Imo River in the east and this spans about 500km. Since the early 1900s, this coastal region has been extensively used for navigation and port activities. The discovery of crude oil in commercial quantity in the region four decades ago further exacerbated developmental activities around the coast.

The River Nun is situated between latitude $5^0 01^1$ and $6^0 17^1$E. The stretch of the river is a long and wide meander whose outer concave bank is relatively shallow with sandy point bars [5]. The depth and width of the river varies slightly at different points [25]. The minimum and maximum widths are 200 and 250 meters respectively. The river is subject to tidal influence in the dry season. Water flows rapidly in one direction during the flood (May to October). At the peak of the dry season, the direction is slightly reversed by the rising tide. At full tide the flow is almost stagnant. The riparian vegetation is composed of a tree canopy made up of *Raphia hokeri*, *Nitrogena sp*, *Costus afer*, *Bambosa vulgaris*, *Alchornia cordiffolla*, *Alstonia boonei*, *Antodesima sp* and submerged macrophytes which include: *Utricularia sp, Nymphea lotus, Lemna erecta, Cyclosorus sp, Commelia sp and Hyponea sp* [25].

The Amassoma flood plains is one of the numerous low land rivers in the Niger Delta (Fig 1) with the most important drainage feature of the Niger Basin River system about 2% of the surface area of Nigeria. A floodplain is a broad, flat section of a valley floor filled with sand, gravel, and clay. Floodplains form when a river running along the valley floods and spills out of its channel. The river then deposits sediments as it flows over portions of the floodplain (Fig. 2). Since floodplains are constructed of the material being carried by the river, they are composed of relatively fine sediment. Most floodplains are composed of sand, silt, and clay, but floodplains of gravel occur where the water flows especially fast. As revealed in the sediments characteristics of the stations investigated, both the physical characteristics, the flora and fauna ecosystem were significantly affected by the flooding event, and this on further study and research is anticipated to have great effect on the local economy, especially as the primary occupation of most of the citizens in these settled areas are subsistence farming and fisheries.

The annual rainfall of the Niger Delta is between 2,000-3000mm per year [39]. The dry season lasts for four months from November to February with occasional rainfall. The Niger Delta region of Nigeria is bounded to the south by the Atlantic Ocean. This region, which is rich in biodiversity and organic mineral resources, has a coastline extending from the mouth of the Benin River in the west to the mouth of Imo River in the east and this spans about 500km. Since the early 1900s, this coastal region has been extensively used for navigation and port activities. The discovery of crude oil in commercial quantity in the region four decades ago further exacerbated developmental activities around the coast. Niger Delta is one of the world's largest wetlands covering an area of approximately 70, 000km^3.

Plate 1 Amassoma Floodplain

Figure 1: The Niger Delta showing Niger River basin
Source:http://upload.wikimedia.org/Wikipedia/commons/9/9d/Niger_River_map.svg

The area is economically important and rich in biodiversity over 80% Federal Government revenue is located with the Niger Delta region. Mangrove swamps and flood plain border the river and it's' numerous creeks and all there are well exposed at low tides. Amassoma is the head quarters of Ogboin clan as well as Ogboin in the North Rural Development Authority in Southern Ijaw Local Government Area of Bayelsa State (Nigeria) and the host community to the Nigeria University (NDU), Wilberforce Island, Bayelsa State. Amassoma is located about 40km to the south of Yenegoa, the State capital with an altitude of 512m about sea level. It is bounded to the North by River Nun, West by Otuan and Wilberforce Island, East by Toru Ebeni and the South by Ogobiri. Amassoma has a diameter of about 6km East to West and approximately 2km North to South.

Fin-fish Sample Collection

Fish specimens were obtained from fishers using gill nets, long lines, traps and stakes. Catches were isolated and conveyed in thermos cool boxes to the laboratory. Fish families were identified using monographs, descriptions checklist and keys [40-49]. The total length (TL) of the fish was measured from the tip of the anterior or part of the base of the pectoral fin to the caudal fin using meter rule calibrated in centimeter. Fish were measured to the nearest centimetre. Fish weight was measured after blot drying with a piece of clean hand towel. Weight was done with a table top weighing balance, to the nearest gram. The length measurements were converted into length frequencies with constant class intervals of 2cm. The mean lengths and weights of the classes were used for data analysis, the format accepted by FISAT [50]. The relationship between the length (h) and weight (w) of fish was expressed by the equation.

$$W = al^b \quad (1)$$

Where:

W	=	weight of fish in (g)
L	=	total length (TL) of fish in (cm)
a	=	constant (intercept)
b	=	the length exponent (slope)

The "a" and "b" values are obtained from a linear regression of the length and weight of fish. The correlation (r^2) that is the degree of association between the length and weight was computed from the linear regression analysis.

$$R = r^2 \quad (2)$$

The values of a and b were given a logarithm transformation according to the following formular

log W = log a + blog L[6] (3)

The intercept "a" in the formular was estimated with the formular:

$$a = \left[\frac{\sum y}{n} - \frac{(b\sum x)}{n}\right] \quad (4)$$

Or logarithm transformed as:

$$a = \left[\frac{\sum \log W^y}{n} - \frac{b\sum \log W^x}{n}\right] \quad (5)$$

While the slope "b" was estimated by the formular

$$b = \frac{\sum xg}{\sum x^2} - \frac{\frac{(\sum x)(\sum y)}{n}}{\frac{(\sum x)^2}{n}} \quad (6)$$

$$or\ b = \frac{n\sum xy}{n\sum x^2} - \frac{(\sum x)(\sum y)}{(\sum x)^2} \quad (7)$$

or log transformed as:

$$b = \frac{n\sum \log x - \log_{10} Y - (\sum \log_{10})(\sum \log_{10} Y)}{n\sum \log_{10} x^2 - \sum \log_{10}(x)} \quad (8)$$

Where
X = Length of fish
Y = Weight of fish
N = Number of fish (sample size)

The correlation i.e. the degree of association between the variables were determined by computing the correlation co-efficient (r) using the relationship.

The condition factor of the experimental fish was estimated from the relationship

$$K = \frac{100}{L^3} \quad (9)$$

Where:
K = Condition factor
W = Weight of fish
L = Length of fish (cm)

RESULTS

Table 1 shows the Length and frequency distribution of *Mugil cephalus* from Amassoma flood plains. The maximum and minimum sizes recorded were 103cm and 11cm respectively with corresponding weights of 1236g and 121g. The Class marks: 2.50cm, 14.5cm and 106.5 cm was not recorded. Lowest frequency (1) was estimated for class marks 8.5cm and 100.5cm with 96.5.5g and 11070g respectively. The modal frequency (41) was estimated for 62.5 class mark with 750g. The frequencies for the class marks: 20.5cm, 26.5cm, 32.5cm, 38.5cm, 44.5cm, 50.5cm, 56.5cm, 68.5cm 76.5cm, 82.5cm, 88.5cm and 94.5cm with corresponding weight class marks: 246.0g, 318.0g, 390.0g, 462.0g, 534.0g, 606.0g, 678.0g, 834.0g, 918.0g and 990.0g, 1062.0 and 1134.0 were 4, 10, 18, 11, 25, 33, 13, 8, 13, 2 and 4 respectively. Generally, the frequency distribution of *Mugil cephalus* from Amassoma flood plains was binomial.

Table 1 Length and weight frequency distribution of Mugil cephalus from Amassoma flood Plains.

Sl range(cm)	Sl ClassMark(cm)	wt range(g)	wt class mark(g)	Feq	C.F
000.0 – 005.0	2.50	00.0 – 060	30.0	-	0
006.0 – 011. 0	8.50	72 .0– 121	96.5	1	1
012 .0 – 017.0	14.5	144.0 – 204	174.0	-	1
018.0 – 023. 0	20.5	216.0 – 276	246.0	4	5
024. 0 - 029.0	26.5	288.0– 348	318.0	10	15
030.0 – 035.0	32.5	360.0– 420	390.0	18	33
036.0 – 041.0	38.5	432.0 - 492	462.0	16	49
042.0 – 047.0	44.5	504.0 - 564	534.0	11	60
048.0 – 053.0	50.5	576 .0– 636	606.0	25	85
054.0 – 059.0	56.5	648.0– 708	678.0	33	118
060.0 – 065.0	62.5	720.0 – 780	750.0	41	159
066.0 - 073.0	68.5	792.0 – 876	834.0	13	172
074.0 – 079.0	76.5	888.0 – 948	918.0	8	180
080.0- 085-0	82..5	960.0 – 1020	990.0	13	193
086.0 – 091.0	88.5	1032 - 1092	1062.0	2	195
092.0 – 097.0	94.5	1104 – 1164	1134.0	4	199
098.0 –103.0	100.5	1176 – 1236	1170.0	1	200
104. 0 - 109.0	106.5	1248 - 1308	1278.0	-	200

Table 2 and 3 show the Length weight relationships and regression analysis values of *Mugil cephalus* from Amassoma flood plains. The length weight regression equation was Log W = 1.077 + 3.23LogL with Correlation coefficient value of 0.850 and Significance of correlation values of $P < 0.05, t = 26.2, df = 199$.The "a" and "b" values were 1.077 and 3.23 respectively. The "r" value was positive (1.25). Table 4.shows the condition factors values of *Mugil cephalus* from Amassoma flood plains. The condition index value range from 0.98 – 1.00 and the condition factor value was 0.995.

Table 2. Length weight relationships of *Mugil cephalus* from Amassoma flood plains

S/no	Fish species	No	Length - weight relationship	Correlation coefficient	Significance of correlation
1	*Mugil cephalus*	200	Log W = 0.977 + 2.73LogL	0.910	$P < 0.05, t = 21.7, df = 199$

Table 3. Regression analysis values of *Mugil cephalus* from Amassoma flood plains

s/no	Species	a-value	b-value	r-value
1	*Mugil cephalus*	0.977	2.73	1.15

Table 4. The condition factors of *Mugil cephalus* from Amassoma flood plains

s/no	Species	Condition index value	Condition factor
1	*Mugil cephalus*	0.99 - 1.00	0.995

DISCUSSION

The maximum size attained by *Mugil cephalus* in this study varied with those of other reported [27]. It had however been shown that the maximum size attainable in fishes generally is location specific [51]. Sampling season is very important and determines the size of fish caught [24]. Another reason for the variation of fish size may either be genetic or environmental [25]. They attributed the differences to fishing pressure and environmental pollution in the freshwater reaches of the lower River.

The length exponent "b" = 2.73 *Mugil cephalus* showed growth was isometric based on Bagenal and Tesch (1978) with the criteria of "b" = 3 [14]. The length weight relationship is cuvililinear with the exponent ranging from 2.5 to 4.0. Growth is isometric when the length exponent is less than or equal to 3 and allometric when length exponent is greater than 3[14] (Bagenal and Tesch, 1978). Values of Length exponent in the length weight relationship of he fish studied increased in weight faster than the cube of its total length. Several other authors have reported allometric growths for other species of fish for different water bodies [51][52][35].

The high correlation coefficient "r" =1.15 obtained in this study showed that there was strong association between length and weight. This means that as the length of the fish increases, the weight also increases in the same proportion. High correlation coefficient "b" values have also been reported by different author in various fish species from different water bodies [53][51][52][35].The correlation coefficient "r" values was positive for *Mugil cephalus*. This means that there was a positive correlation between length and weight of *Mugil cephalus* from Amassoma flood plain. The fish is of fitting stoutness when it is of round and relatively thick shape [8][54]. Undernourished/thin fish has a condition factor of less than 1. Adequately fed or fat fish has a condition factor greater than 1.The condition factor usually increases when sexual maturation approaches.

The condition factor value "k" = 0.995 estimated in this study compared favourably with other reports from similar studies in similar water bodies. Condition factors of different species of cichlid fishes have been reported[17][18][19][20] [21][22][23]. Condition factors reported for some other species include: Alfred – Ockiya (2000) for *Chana chana* in fresh water swamps of Niger Delta [24] and Hart (1997) for *Mugil cephalus* in Bonny estuary [25]. From a sample size of 81 specimens, K value was 0.999 and the exponential equation was W_t == 0.05998 $(TL)^{2\ 719}$, indicating an isometric growth pattern. There was no temporal variation in the condition of the fish with condition index value 0.98- 1.00 and condition factor value of 0.995 is an indication of the fish species good condition. Although no study was carried out on the physical and chemical parameter to confirm this, Bagenal and Tesch (1978) reported that if the condition factor "k"$\geq$ 0.5, the fish is in a good condition [14].

CONCLUSION

- *Mugil cephalus* exhibited allometric growth
- There was strong association between length and weight of *Mugil cephalus*

- *Mugil cephalus* was in a good condition

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