Current Research Journal of Biological Sciences 1 (1): 21-27, 2009
ISSN: 2041-0778

Aspects of Sphyraena Barracuda (*Wallbaum*, 1992) Population Dynamics from the Fresh Water Reaches of Lower Nun River, Niger Delta, Nigeria

[1]J.F.N. Abowei and [2]O.A. Davies
[1]Department of Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Amassoma, Bayelsa State, Nigeria
[2]Department of Fisheries and Aquatic Environment, Faculty of Agriculture, Rivers State University of Science and Technology, Rivers State, Nigeria

Abstract: Aspects of *Sphyraena barracuda* population dynamics from the fresh water reaches of the lower Nun River in Niger Delta, Nigeria was studied for one year, using five hundred specimens. The largest specimen measured 30.4 cm and weighed 249.3g at age 5^+. Growth increment in length was highest in 1-2 years while growth in weight was highest in 2-3 years. The maximum length at age attained L_{max} was 34.1 cm weighing 249.3g. The length attained at infinity ($L\infty$) was 40.4 cm. Growth exponent (b) was 2.84. Growth coefficient (K) value was 0.55. The hypothetical age at which length is zero (T_o) was –0.25 and the maximum age estimated was 5 years. There was no temporal variation in the condition of the fish throughout the year with condition index value ranging from 0.83 – 1.00 and condition factor value of 0.94. Total mortality (Z) value was $1.6yr^{-1}$. Natural Mortality (M) value was 0.79; fishing mortality (F) value was 0.81. *Sphyraena barracuda* populations from the fresh water reaches of the lower nun river was above the optimal value for sustainable yield for the exploitation of the fishery. This fish therefore stands the risk of over exploitation if urgent measures are not taken to develop the fishery.

Key words: *Sphyraena barracuda*, population dynamics, growth parameters, sustainable yield, exploitation rate, Nun River

INTRODUCTION

The Great Barracuda is a species of barracuda. It is of the genus Sphyraena, the only genus in the family Sphyraenidae. Its binomial name is *Sphyraena barracuda*. Great barracudas often grow over 6 feet (1.8 m) long (Wikipedia, 2009). The great barracuda is a type of ray-finned fish. Barracudas are elongated fish with powerful jaws. The lower jaw of the large mouth juts out beyond the upper. Barracudas possess strong, fang-like teeth. These are unequal in size and set in sockets in the jaws on the roof of the mouth. The head is quite large and is pointed and pike-like in appearance. The gill-covers does not have spines and are covered with small scales. The two dorsal fins are widely separated, with the first having five spines and the second having one spine and nine soft rays. The second dorsal fin equals the anal fin in size and is situated more or less above it. The lateral line is prominent and extends straight from head to tail. The spinouts dorsal fin is placed above the pelvis. The hind end of the caudal fin is forked or concave. It is set at the end of a stout peduncle. The pectoral fins are placed low down on the sides. The barracuda swim bladder is large. In general, the barracuda's coloration is dark green or a blue type coloration or grey above chalky-white below. This varies somewhat, sometimes there is a row of darker crossbars or black spots on each side. The fins may be yellowish or dusky.

Barracudas appear in open seas. They are voracious predators and hunt using a classic example of lie-in-wait orambush. They rely on surprise and short bursts of speed (up to 27 mph (43 km h^{-1}) to overrun their prey, sacrificing maneuverability. Barracudas are more or less solitary in their habits. Young and half-grown fish frequently congregate in shoals. Their food is composed almost totally of fishes of all kinds. Large barracudas, when gorged, may attempt to herd a shoal of prey fish in shallow water, where they guard over them until they are ready for another meal. It is a salt-water fish, and is found in tropical and subtropical oceans worldwide. The species was reported present in the fresh water reaches of the lower Nun River (Abowei, 2000).

They play an important role in the ecology and fisheries of West Africa and other inland waters. They constitute an important trophic web of this ecosystem and have been introduced into many artificial lakes and reservoirs such as kivu, Kariba and Tiga dam in parts of Africa (Coulter, 1970). Prior to their introduction into artificial lakes, they had colonized artificial lakes from natural riverine habitats.

Fish stock assessment evaluates the effect of fishing on a fishery as a basis for fishery management decisions (Sissenwine *et al*., 1979). The fundamental models used are based on four parameters: Growth, recruitment, natural and fishing mortality (Ricker, 1975). Age and growth are particularly important for describing the status

Corresponding Author: O.A. Davies, Department of Fisheries and Aquatic Environment, Faculty of Agriculture, Rivers State University of Science and Technology, Rivers State, Nigeria

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 (Lowe McConnel, 1987).

Fish mortality is caused by several factors, which include, age (King, 1991); fish predation (Otobo, 1993); environmental stress (Chapman and Van Well, 1978); parasites and diseases (Landau, 1979) and fishing activity (King, 1991). 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 (Pauly, 1983).

Significant contribution on growth studies have been made by Schaefer (1954), Boverton and Holt (1957), Ricker (1975), Gulland (1969) also among many other scientists, but their 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 (Beyer, 1987) and in assessing the relative well being of a fish population (Bolger and Connoly, 1989). 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); Alfred – Ockiya and Njoku (1995) for mullet in New Calabar River, Ahmed and Sahai (1996) for carps in lake kapitel, Bangladash; King (1996) for Nigeria fresh water fishes; Hart (1997) for *Mugil cephalus* in Bonny Estuary (Diri, 2002) for *Tilapia guinensis* in Elechi creek.

Following the adoption of Peterson length frequency distribution method for ageing tropical fishes. There have been notable contributions by Longhurst (1964), Gulland (1969) and Pauly (1980) in this area of fisheries research. In spite of these efforts, length-weight, Length-breadth, growth, mortality and exploitation rate data on many tropical fish species are still lacking.

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 (Bagenal and Tesch, 1978). Condition factors decreases with increase in length (Bakare, 1970; Fagade, 1979) and also influences the reproductive cycle in fish (Welcomme, 1979). Condition factors of different species of cichlid fishes have been reported by Siddique (1977), Fagade (1979, 1983), Dadzie and Wangila (1980), Arawomo (1982) and Oni *et al.*, (1983). Condition factors reported for some other species include: Alfred – Ockiya (2000) for *Chana chana* in fresh water swamps of Niger (Delta and Hart, 1997) for *Mugil cephalus* in Bonny estuary.

Age studies of fishes form an important aspect of their biology and relationship with their environment. Lackey and Hubert (1981) observed, that it aids in the productivity, longevity, periods of maturity, recruitment of various year classes and determination of potential yield of fish stock. Information obtained on age could contribute to the optimal, or at least a rational exploitation of a fishery.

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 gear (Sikoki *et al.*, 1998). In spite of the importance of the Barracuda and Nun River fishery, no attempt had been made to assess the population parameters of *Sphyraena barracuda* from the Nun River. Available data on similar or the same water body but different aspects are often scattered in unpublished reports, consultancy and related studies including the works of Ogbo (1982), (Otamiri River); Dokubo (1982), (Sombreiro River); Akari (1982) (Orashi River); Nwandiaro (1989), (Oguta Lake); Orji and Akobuche (1989), (Otamiri River); Chindah and Osuamkpa (1994), (Bonny River); Sikoki and Hart (1999), (Brass River); Abowei (2000) (Nun River) and Ezekiel *et al.* (2002); (Oduhioku Ekpeye flood plain). This study provide biological and statistical information on *Sphyraena barracuda* from the Nun River.

MATERIALS AND METHODS

Study area: The study was carried out in the fresh water reaches of the lower Nun River. The Nun River is one of the numerous low land rivers in the Niger Delta. The Niger Delta Basin covers all the land between latitude 4°14^{1}N and 5°35^{1}N and longitude 5°26^{1}E and 7°37^{1}E. (Powell *et al.*, 1985). It extends along the coast from the rivers basin in the West of Bonny River with characteristic extensive interconnection of creeks. It is the most important drainage feature of the Niger Basin River system with about 2% of the surface area of Nigeria. The annual rainfall of the Niger Delta is between 2,000-3000 mm per year (Abowei, 2000). The dry season lasts for 4 months from November to February with occasional rainfall.

The lower Nun River is situated between latitude 5°01^1 and 6°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 (Otobo, 1993). The depth and width of the river varies slightly at different points (Sikoki *et al.*, 1998). The minimum and maximum widths are 200 and 250 m, 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.* (Sikoki *et al*., 1998).

Fish Sampling: Sampling was carried out forth nightly for one year, using gillnets, long lines, traps and stakes. Catches were isolated and conveyed in thermos cool boxes to the laboratory on each sampling day. Fish specimens were identified using monographs, descriptions, checklist and keys (Bosseman, 1963; Reed *et al*., 1967; Holden and Reed 1972; Poll, 1974; Whyte, 1975; Jiri, 1976; Whitehead, 1984; Loveque *et al*., 1991). Total length and weight of the fish specimens were measured to the nearest centimeter and gramme, respectively to obtain the required data. The weight of each fish was obtained after draining from the buccal cavity and blot drying samples.

Age was estimated from the length frequency distribution plot using six hundred fish specimens, following the integrated Peterson method (Pauly, 1983). The diagram was repeated six times along the time axis and a single continuous growth curve was flitted. The relative age (in years) and the corresponding modal lengths were determined from the plot. Total length and weight of fish specimens were measured to the nearest centimeter and grammes, respectively to obtain data on the length-weight relationship.

Length-weight and length-breadth relationship of fish specimens were determined using the exponential equation (Roff, 1986):

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

Where, b is an exponent with a value nearly always between 2 and 4, often close to 3. The value b=3 indicates that the fish grow symmetrically or isometrically (provided its specific gravity remains constant). Values other than 3 indicate allometric growth: If b>3, the fish becomes heavier for its length as it grows larger.

The methods used to obtain the growth parameters of the Von Bertalanffy's growth formula (VBGF) were:

- Ford Walfored plot: Lt + 1 was plotted against Lt where Lt + 1 are lengths separated by a year interval. The value of Lt at the point of interception of the regression line with the 45^0 lines gave L_∞.
- Graphs of length and weight increment $\blacktriangle$L at age against the original length L_t and W_t.

The degree of association between the length and weight was expressed by a correlation coefficient "r". The correlation coefficient could take values ranging between – 1 and +1. When "r" is negative, it means that one variable tends to decrease as the other increases; there is a negative correlation (corresponding to a negative value of 'b' in regression analysis). When r is positive, on the other hand, it means that the one variable increases with the one (which corresponds to a positive value of b in regression analysis) (Pauly, 1983).
However, whether the correlation that was identified could have arisen by chance alone, the 'r' value was tested for 'significance'. That is, whether the (absolute) value of "r" was higher than or equal to a critical value of "r" as given in a statistical table.
Length-breadth relationship was determined using:

$$M = a\,(T_L)^j \qquad (2)$$

Where a = initial growth constant, J = growth rate exponent and T_L = total length of fish. Both coefficients were determined by least square regression analysis after logarithmically transforming all data into the from:

$$\text{Log } M = \text{Log } a + J \log T_L \qquad (3)$$

If J = 1.0 then M growth rate is constant and equal to the initial growth consistent (isometric growth), otherwise there is a negative (J<1.0) or positive (J>1.0) allometric growth.

Length performance index was estimated from the equation (Pauly and Munro, 1984):

$$Ø = \text{Log } k + 2 \log l_\infty \qquad (4)$$

Where k and l_∞ are parameters of VBGR.

Growth performance index $Ø^1$ was estimated from the equation (Pauly and Manro, 1984):

$$Ø^1 = \text{Log } k + 0.67 \log W_\infty \qquad (5)$$

Where k is a parameter of VBGR and W_∞ is the mean weight of very old fish. The points at which the growth curve cuts the length axis on the sequentially arranged time scale gave the length at age counted from the origin. The estimation was derived from Pauly (1983).

The total mortality coefficient (Z) was estimated from the formular given by Ssentengo and Larkin in Pauly (1983).

$$Z = \frac{nk}{(n+1)(L_\infty - 1^1/L_\infty - I)} \qquad (6)$$

Where n = number of fish in computing the mean length T, 1' = smallest of fish that is fully represented in the catch. K and L∞ are parameters of the VBGF.

An independent estimate of Z was obtained from the Hoeing formular in Ehrhardt *et al.* (1983).

$$Z = 1.45 - 1.01\,T_{max} \qquad (7)$$

Where T_{max} = Longevity (years)

Table 1: Length – weight regression equation, correlation coefficient (r) and significance of correlation for *Sphyraena barracuda* from the fresh Water reaches of the lower Nun River

Fish species	Regression equation	Correlation coefficient	Significance of correlation
Sphyraena barracuda	LogW=0.0162+2.84logL	0.993	P<0.05,t=31.6,df=506

Table 2: Length-breath relationship of *Sphyraena barracuda* from the fresh water reaches of lower the Nun River

Fish species	Length-breath-equation	Correlation-coefficient	Significance of correlation
Sphyraena barracuda	$LogM = 0.73 \ Log \ T_L$	0.962	p<0.05 t =31.5, df = 549

Table 3: Length and weight at age of *Sphyraena barracuda* from the fresh water reaches of the lower Nun River

Fish species	Length-at-age (cm yr)					Weight-at-age (g yr)				
	1+	2 +	3+	4+	5+	1+	2+	3+	4+	5+
Sphyraena barracuda	22.5	25.5	28.0	29.5	30.4	85.5	173.4	212.8	241.9	249.3

Table 4: Growth increment with age at length and weight for *Sphyraena barracuda* from the fresh water reaches of the lower Nun River

Fish species	Length-at-age (cm)				Weight-at-age (g yr)			
	1-2	2-3	3-4	4-5	1-2	2-3	3-4	4-5
Sphyraena barracuda	7.5	3.0	2.5	1.5	61.5	87.9	39.4	29.1

Table 5: Growth parameters of *Sphyraena barracuda* from the fresh water reaches of the lower Nun River

Fish species	Growth parameters								
	L_{max} cm	W_{max} (g)	Lw (cm)	b	θ^1	Ø	K_{yr-1}	T_{oyz}-1	$T_{max\ yr}$
Sphyraena barracuda	34.1	349.3	40.4	2.84	3.17	2.26	0.55	-0.25	5

Table 6: Condition index values and factors of *Sphyraena barracuda* from the fresh water reaches of lower Nun River

Fish species	Condition index value	Condition factor
Gnathonemus tamandua	0.83-1.00	0.94

Table 7: Estimated mortality and exploitation values of *Sphyraena barracuda* from the fresh water reaches of the lower Nun River

Fish species	Total mortality Zyr^{-1}	Natural mortality Myr^{-1}	Fishing mortality Eyr-1	Exploitation rate	E%
Sphyraena barracuda	1.6	0.79	0.81	0.54	54

Natural mortality coefficient (M) was estimated from Taylor's formula in Ehrhardt *et al.* (1983).

$$M = 2.995T_o + 2.9975K \quad (8)$$

Fishing mortality coefficient (f) was estimated as:

$$E = Z - M \text{ (Gulland, 1971)} \quad (9)$$

The exploitation ratio was estimated using the formula:

$$E = F/Z \text{ (Gulland, 1971)} \quad (10)$$

The condition factor (CF) was calculated from the expression:

$$CF = \frac{100W}{L^3} \quad (11)$$

Where, W = the fresh body weight in (g), L = total length in cm.

RESULTS

The length-weight regression equation, correlation coefficient (r) and significance of correlation of *Sphyraena barracuda* from the lower Nun River is presented in Table 1. The regression equation was Log W = 0.0162+2.84logL and correlation coefficient of 0.993 at P<0.05. The length-breath regression equation, correlation coefficient (r) and significance of correlation of *Sphyraena barracuda* from the lower Nun River is presented in Table 2. The regression equation was LogM =0.73 Log T_L and correlation coefficient of 0.962 at P<0.05. Table 3 shows the length and weight at age of the fish species studied. The largest specimen *Sphyraena barracuda* measured 30.4 cm and weighed 249.3g at age 5^+.

Table 4 shows the growth increment with age at length and weight for *Sphyraena barracuda*. Growth increment in length was highest in 1-2 years; while growth in weight was highest in 2-3 years. Table 5 shows the growth parameters of ten fish species from the fresh water reaches of lower Nun River. The Maximum length at age attained L_{max} was 34.1 cm weighing 249.3 g. The length attained at infinity (L∞) was 40.4 cm. Growth exponent (b) was 2.84. Length performance index (θ^1) values ranged was 3.17. Weight performance index values (Ø) ranged was 2.26. Growth coefficient (K) value was 0.55. The hypothetical age at which length is zero (T_o) was –0.25 and the maximum age estimated was 5 years.

The condition index values and factor of *Sphyraena barracuda* from the lower Nun River are shown in Table 6. There was no temporal variation in the condition of the fish through out the year with condition index value ranging from 0.83 – 1.00 and condition factor value of 0.94. Table 7 Shows the estimated mortality and exploitation value, of *Sphyraena barracuda*. Total mortality (Z) value was $1.6yr^{-1}$. Natural Mortality (M) value was 0.79; fishing mortality (F) value was 0.81. Value for the rate of exploitation was 0.54 with corresponding percentage value of 54.

DISCUSSION

The length-breath relationship *Sphyraena barracuda* exhibited negative allometric growth (J<1.0). King (1991) also observed allometric length – breadth growth in Illisha

Africana in Qua Iboe estuary. The length breadth relationship being negative allometric means that growth rate was neither constant nor equal to the initial growth constant (J <1.0). However, the transformed length fitted over breath resulted to a three dimensional growth structure of most fish species (Lagler *et al*., 1977). Values of the length exponent in the length-breadth relationship of the species being negative allometric implied that the breadth of *Sphyraena barracuda* did not increase faster than the cube of its total length.

There is linear relationship between the fish body breadth and gill net mesh size selectivity. Ita and Madahili (1997) reported a linear relationship between body breath and gill net mesh size selectivity. Fish species with larger body-breadth were caught more in larger mesh sizes, while fish with small body breadth swim across nets with larger mesh size because of its small size (Ita and Madahili, 1997).

The L_{max} values of 34.1 cm, for *Sphyraena barracuda* varied for L_{max} values reported for the fish species studied by others. It had been reported that the barracuda grows beyond 1.8 m long (http://en.wikipedia.org/wiki/sphyraena_barracuda). Reed *et al*., 1967 recorded L_{max} values of 100 cm for *Clarotes laticeps*, from Northern Nigeria. It has however been shown that the maximum size attainable in fishes is generally location specific (King, 1991). King (1996) attributed the differences in maximum size attained by fish in different water bodies to noise from out board engines and industrial activities. Abowei and Hart (2007) attributed the differences in maximum size of *Chysichthys nigrodigitatus* in the lower river to high fishing pressure, environmental pollution and degradation. The fresh water reaches of the Nun River are often subjected to outboard engine operation. The SPDC Nun river flow station is also located along the river (Abowei and Hart, 2007).

Generally the estimated growth parameters in this study varied from those estimated for some fish species from some water bodies. Spare and Venema (1992) had already reported that growth parameters differ from species to species and also stock to stock even within the same species as a result of different environmental conditions. The hypothetical age at which length is zero (T_o) values was negative. This result compared favourably with the general observation made by Pauly (1983). King (1996) also estimated a negative T_o value for *Tilapia marie* from Cross river Niger. However, the results from this study varied from the report by Arawomo (1982), who reported positive "T_o" values for *Sarotherodon niloticus* in Opa reservoir. Valentine (1995), Abowei and Hart (2007) also reported positive "T_o" values for major cichlids and *Chrysichthys nigrodigitatus* from Umuoserche Lake and Nun river, respectively.

The growth performance index (Ø) of 2.26 was relatively high. Growth performance index compares the growth performance of different population of fish species. Faster growth rates are defensive mechanism against predators. The maximum age, (5) years estimated for this study compared favourably with the maximum age of 3 – 5 years estimate for some fish species in Nun river by Hart and Abowei, (1997).

The exploitation rate assesses if a stock is over fished or not, on the assumption that optimal value E (E_{opt}) is equal to 0.5. The use of E or 0.5 as optimal value for the exploitation rate is based on the assumption that the sustainable yield is optimized when F=M (Gulland, 1971). The result shows that *Sphyraena barracuda* with an exploitation rate of 0.54 is above the optimal value for sustainable yield, for the exploitation of the fishery. These populations therefore stand the risk of over exploitation if urgent measures are not taken to check the fishery.

REFERENCES

Abowei, J.F.N., 2000. Aspects of the fisheries of the lower Nun River. Ph. D Dessertation, University of Port Harcourt, Port Harcourt, pp: 248.

Abowei, J.F.N. and A. I. Hart, 2007. Size, Composition, age, growth, mortality and exploitation rate of *Chysichthys nigrodigitatus* from Nun River, Niger Delta, Nigeria. Afr. J. Applied Zool. Environ. Biol., (9):44–50. www.uniportjournal-com/ajazeb

Akari, E. J., 1982. Identification of common fresh water fishes of a stretch of Orashi River. HND Project, Rivers State University of Science and Technology, Port Harcourt. pp:45.

Alfred–Ockiya, J.F. and D.C. Njock, 1995. A comparative analysis of the length–weight relationship and condition factors of four species of grey mullet (Pisces / Mugilidae) from New Calabar River, Rivers state of Nigeria. Nigeria J. Tech. Edu., 2: 5-10.

Alfred–Ockiya, J.F., 2000. The length – weight relationship of snake head (*Chana chana*) from the fresh water swamps of Niger Delta, Nigeria. J. Aquatic Sci., 15: 12-14.

Ahmed, K.K. and S.B. Sahai, 1996. Length – weight relationship of major carp in Kaptai Lake. Bangladash, NAGA. The ICLARM quarterly, pp:28.

Arawomo, G.D., 1982. The Growth of *Sarotherodon Niloticus* in Opa, Reservoir. University of Ife, Nigeria. In: Proceedings of the 2nd Annual Conference of the Fisheries society of Nigeria (Fison) Held in Kainji Lake Resource, New Bussa on 24th-28th, November, 1982.

Bagenal, T.B. and F.W. Tesch, 1978. Methods for Assessment of Fish Production in Fresh Waters. 3rd Edn. London, Blackwell Scientific Publications Ltd., pp: 101-136.

Bakare, O., 1970. Bottom deposit as food of inland fresh water fish. Visser, S. Akainji. A Nigeria man made Lake. Kainji Lake Studies, : Ecology. NISER, Ibadan. 1: 52.

Beyer, J.E., 1987. On length – weight relationships computing the mean weight of the fish of a given length class. Fishbyte 5 (1): 11-13.

Bolger, T. and P.L. Connoly, 1989. The selection indices for the measurement and analysis of fish condition. J. Fish Biol., 30: 171-182.

Boverton, R.J.H. and S. J. Holt, 1957. On the dynamics of exploited fish populations. Fish Investment Ministry Agency. Food. 19: 533.

Bosseman, M., 1963. Annotated list of fisheries from the Niger Delta. Verh, Lerden. 61: 48.

Chapman, D.W. and P. Van Well, 1978. Growth and mortality of Stolothrissa tangenicae. Transaction of American fisheries of American fisheries society, 107(2): 26-35.

Chindah, A.C. and A. Osuamke, 1994. The fish assemblage of the lower Bonny River, Niger Delta, Nigeria. Afri. J. Ecol., 72: 58-65.

Coulter, G.W., 1970. Population changes within a group of fish species in Lake Tanganyuka, following their exploitation. J. Fish Biol., 2: 329-523.

Dadzie, S. and B.C.C. Wangila, 1980. Reproductive biology, length – weight relationship and condition factor of pond raised *Tilapia zilli* (Gervais), J. Fish Biol., 17: 243-253.

Dokubo, I.A.K., 1982. Longitudinal distribution of fishes in Sombrero river, Rivers State. B. Sc. Project, University of Port Harcourt, Choba, 140 . institute, New Bussa, Nigeria, pp: 221- 227.

Diri, M.S., 2002. Length-weight relationship of *Sarotherodon melanotheron* and *Tilapia guineensis* in Elechi Creek, Niger Delta, Nigeria. B. Sc. project. Rivers State University of Science and Technology, Port Harcourt, pp: 25.

Ezekiel, E.N., J.F.N. Abowei and A. I. Hart, 2002. The fish species assemblage of Odhiokwu Ekpeye flood plains. Niger Delta. Intl J. Sci. Tech., 1(1): 54-59.

Ehrhardt, N.M., P.S. Jacquemin, G.G. Francisco, G.D. German, M.L.B. Juan, O.O. Juan and S.N. Austin, 1983. On the fishery and biology of the grant squid. *Dosidicus sp.* was in the gulf of California, Mexica, Mexica In: J.R. Caddy, (Ed.). Advances in assessment of world cephalopod resources. FAO Fish Tech., 231:306-339.

Fagade, S.O., 1979. Observations on the biology of specie of Tilapia from the Lagos Lagoon, Bull. De l' I, F. A. N. 41, $A_{3:.}$.60-72.

Fagade, S.O., 1983. The biology of *Cromido tilapia* gunteri from a small Lake. Arch. Hydrobiol., 97: 60-72.

Gulland, J.A., 1969. Manual of Methods of Fish Stock Assessment Part 1. Fish Population Analysis. Fao Manual in Fisheries Science No. Rome, pp: 154.

Gulland, J.A., 1971. The Fish Resources of the Ocean West Polyfleet, Survey Fishing News (Books) Ltd. FAO Tech., pp. 97: 428.

Hart, S.A., 1997. The biology of *Mugil cephalus* (Linnaeus, 1758) Perciforms: (Mugilidae) in Bonny estuary. M.S.c. Thesis Department of Zoology University of Port Harcourt, Nigeria, pp: 102.

Hart, A.I. and J.F.N. Abowei, 2007. A study of the length – weight relationship, condition factor and age of ten fish species from the lower Nun river. Niger Delta. Afr. J. Applied Zool. Environ. Biol., 9:13-19. www.uniport. Journals.com/ajazeb.

Holden, M. and W. Reed, 1972. West African Fresh Water Fisher, Longmans Limited. London. pp: 53.

Ita, E.O. and Maelahili, (1997). The Current Status of Fish Stock and Fisheries in Kainji Lake; Consultancy Report on Fish Stock Assessment in Kainji Lake. The Nigerian-german (Gtz) Kainji Lake Fisheries Promotion Project, New Bussa. pp:128.

Jiri, C., 1976. A colour guide of familia fresh water fishes. Octopus Books Ltd. London, pp: 25.

King, R.P., 1991. Some aspects of the reproductive strategy of *Illisha Africana* (Block 1795) (Teleost, Clupudae) in Qua Iboe estuary, Nigeria. Cybium 15(3): 239-251.

King, R.P., 1996. Population dynamics of the Mud Skipper, *Penophthalinus Barbarus* (Gobidae) in the estuarine swamps of Cross River, Niger. J. Aquatic Sci., 11:31-34.

Lackey, R.T. and W.D. Hubert, 1978. Analysis of exploited fish populations sea grant Extension Division Virginia poly. Institute and State University, Blackberry Virginal, pp: 97.

Lagler, K. F., J. E. Bardach, R.R. Miller and D.R.M. Passion, 1977. Ichthydogy. 2nd Edn. John Wiley and Sons. pp:506.

Landau, R., 1979. Growth and population studies on *Tilapia galilae* in Lake inneret. Fresh Water Bol., 9: 23-32.

Longhurst, A. R., 1964. Bionomics of the Sclaenidae of Tropical West. Afr. J. Cons. Perm. Int. Exploi. Mer. 29(1): 83-114.

Loveque, C., O. Pyugy and G.G. Teugels, 1991. The fresh and brackish water fishes of West Africa, Musee Royale De. I. Afriqae Centrale, Tervurem, Belgique, Edition De. I. ORESTO, pp: 38.

Lowe–McConnel, R.H., 1987. Ecological studies in tropical fish Communities, Cambridge University Press, London. pp:73.

Nwandiaro, C.S., 1989. Icthyofauna of Lake Osuta, a Shallow Lake in Southern Nigeria, Arch, Hydrobiol., 115(3): 463-475.

Ogbo, E.A., 1982. Identification of Commonly Found Fresh Water Fishes of Otamiri River, Rivers State HND Project. Rivers State University of Science and Technology, Port Harcourt. pp:43.

Oni S.K., J.Y. Olayemi and J.D. Adegboye, 1983. The comparative physiology of three ecologically distinct freshwater fishes: *Alestes nurse* RUPEL, *Synodontis schall*. Block and Schneeide and *Tilapia zilli* Gervais J. Fish Biol., 22:105-109.

Orji, R.C. and O.E.A. Akobuchi, 1989. Studies on the icthyofauna of Otamiri River in Imo State, Nigeria. J. Aquatic Sci., 4:11-15.

Otobo, A.J.T., 1993. The ecology and fishery of the Pygmy Herring. *Sierrathensa Leonensis* (Thysvan Den Audenaerde, 1969) in the Nun River and Taylor Creek of the Niger Delta. Ph. D. Thesis. University of Port Harcourt, pp:298.

Pauly, D., 1980. On the interrelations between natural mortality, growth parameters and mean environmental temperature in 175 fish stock. J. Cons. 1. Int. Explor. Mer. 39(2): 175–192.

Pauly, D., 1983. Some Simple methods for the assessment of tropical fish Stock. FAO Fish. Tech., 52: 234.

Pauly, D. and J.L. Munro, 1984. Once more on growth Comparison in Fishes and Vertebrates. Fish byte, 2 (1): 21.

Poll, M., 1974. Synopsis and geographicaldistribution of the clupeidae, in fresh water. Description of three new species. Bull De. Ca. Clare. Deb. Sci. Sene–Tome (Lx(2):141-161.

Powell, C.B., S.A. Whyte, M. Isoun and F.U. Oteogbi, 1985. Oshika Oil Spillage Environmental Impact, Effect on Aquatic Biology. Paper Presented at the Nnpc/fmhc International Seminar on Petroleum Industry and the Nigerian Environment, 11-13 Nov. 1983, Kaduna, Nigeria, pp:168-178.

Reed, W., T. Burchad, A. J. Hopson, J. Jenness and I. Yaro, 1967. Fish and fisheries of Northern Nigeria. Ministry of Agriculture, Northern Nigeria. pp:226.

Ricker, W.E., 1975. Computer and interpretation of biological statistics of fish population. Bull. Res. Board-Cam.,pp:315-318.

Roff, D.A., 1986. Predicting body size with life history models. Biol. Sci., 36(5):316-232.

Schaefer, M.D., 1954. Some aspects of the dynamics of populations important to the management of the commercial marine fishes. Bull Intl. Am. Trop. Tuna. Comm., 1(2): 27-56.

Shenouda, T.S., F.A. Faten, M.R. Mahmoud and M.M. Rayzg, 1994. A detail study on age and growth for *Chrysichthys auratus* and *Chrysichthys rueppelli* from the southern most part of the River Nile (Egypt). J. Egypt Ger. Soc., 200 (1412). 73-101.

Siddique, A.Q., 1977. Reproductive biology, length-weight and relative condition of *Tilapia leucostica* (Trewaeva in lake Naivasha, Kenya). J. Fish Biol., 10:351-260.

Sikoki F.D., A.I. Hart and J.F. Abowei, 1998. Gull Net Selectively and Fish Abundance in the Lower Nun River, Nigeria. J. Applied Sci. Environ. Manage., 1:13-19.

Sikoki, F.D. and S.A. Hart, 1999. Studies on the fish and fisheries of the Brass river system and adjoining coastal waters in Bayelsa State Nigeria. J. Applied Sci. Environ. Manage., 2:63-67.

Sissenwine, M.P., B.E. Brown and Brenna-Hoskins, 1979. Brief history and the state of the arts of fish production models and some applications to fisheries of the North-Eastern United States In: Climate and fisheries workshop Centre for Ocean management Studies. University of Rhode Island, pp:25-28.

Spare, P., E. Ursin and S.C. Venema, 1992. Introduction to Tropical Fish Stock Assessment, Part 1 Manual. Fao Fisheries Technical, 306(1): 337.

Valentine, A.A., 1995. Studies on the major Cichilid fishes of Umuosericheh Lake, Oguta Imo State, Nigeria. Ph. D. Thesis Zoology, University of Port Harcourt, pp:170.

Welcomme, R.L. 1979. Fisheries Ecology of flood plain rivers London longman press, pp: 317.

Whitehead, P.J.P., 1984. Family Clupeidae. Daget J. Gosse, J. P. Thys. Van. Den. Audennered, D. F. S. (Eds.). Checklist of the freshwater fishes of Africa. ORSTOM, (1): 11-20.

Whyte, S.A., 1975. Distribution, tropic relationship and breeding habits of the fish population in a tropic lake basin, Lake Busumbwi, Ghana. J. Fool London., 177: 25-56.

Wikipedia, (free encyclopedia) 2009. Great barracuda. Retrieved on 25th March, 2009 from http://en.wikipedia.org/wiki/sphyraena_barracuda.