SOME STOCK PARAMETERS OF *ELOPS LACERTA* DURING ESTUARINE PHASE OF LIFE HISTORY

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ABSTRACT

Some stock parameters of *Elops lacerta* in Ogun State coastal estuary, Nigeria were carried out between February and July, 2014. Data were collected on length–weight distribution, sexes, stages of gonad development, food and feeding habits, growth parameters, length-weight relationship (LWR) and condition factor for 6 months. Data were analysed using descriptive, parametric test and FiSAT II for fish stock assessment. Results showed that species length class ranged from 11-12 cm to 32-33 cm, sex ratio, 1.04:1 (male:female), was not significantly ($p>0.05$) different from the expected 1:1 for natural population. Gonadal examination indicated that the fish stock did not mature in the habitat. *E. lacerta* was found to forage mostly on diatoms and unidentified fish specimen. Estimates of growth parameters, $L\infty$ = 38.33cm, k = 0.74/yr, ϕ^1= 3.036/yr and Tmax = 4.05yrs. Parameters of LWR, a = 0.00746 and b = 2.917 (r^2 = 0.950) were estimated. b was not significantly ($p>0.05$) different from 3.0 depicting isometric growth pattern. The condition factor ranged between 0.649±0.046 (March) and 1.140±0.021 (July). The study revealed that the habitat provided a good ecosystem to support the fish population. Regulatory policy should therefore be available to ensuring its sustainability and continuous onward recruitment into the marine environment.

Keywords: *Elops Lacerta*, life history, Ogun State coastal estuary, condition factor, growth parameters

INTRODUCTION

West African ladyfish, *Elops lacerta,* is widely distributed in tropical waters and sometimes foray into temperate zones (Adams *et al.,* 2013). The fish spawns in marine environment and the larvae disperse into estuarine habitats, which according to Adams *et al.* (2013) are declining and degrading in quality. Most Ladyfish is now faced with significant challenges from anthropogenically mediated habitat loss and alterations, making it vulnerable to both habitat degradation and overfishing (Adams *et al.*, 2013). Despite recent call for its conservation, biological information on the fish in estuarine habitats is lacking. According to Adams *et al.* (2013), little is known about this species and the habitats upon which the fisheries it supports depends. Also, ladyfish is an example of fish species that has globally received little research attention because of their lower economic status (Levesque, 2010).

E. lacerta species is sympatric with *E. senegalensis* in tropical and subtropical marine and estuarine habitats and are often mistaken for one another in the West African estuaries of Benin and Nigeria (Agboola and Anetekhai, 2008; Abowei, 2010; Adams *et al.,* 2013). Offshore spawning of *Elops* species has been reported (Ugwumba, 1989; Aceves – Medina *et al.*, 2003; Tzeng *et al.,* 2005). According to Beckley (1984) and McBride *et al.* (2001), Age-0 stage of the fish settles in low salinity areas in the estuaries without entering freshwater but juveniles are capable of surviving hypersaline conditions.

West African ladyfish juveniles have been reported off Lagos coast and Lekki lagoon in Nigeria. The juveniles are typically found in moderate salinities of 23 – 25 ppt (Lawson and Aguda, 2010), also in broad salinity range of 0 – 45 ppt (Govoni and Merriner, 1978). Time series data between 2003 and 2012 show that its production in Nigerian coastal waters increased from 787 mt tonnes to 1,192 mt tonnes, while between 2003 and 2007, the production fell by 44% and increased by 170% between 2007 and 2012 (FDF, 2013). Despite the significance of this fishery in Nigeria, there is dearth of information on the species' biology in the estuaries where they spend a phase of their life. Hence, this study provides baseline information on some stock

parameters of *E. lacerta* stock in an estuarine water in Nigeria.

MATERIALS AND METHODS

Description of the Study Area

The study was carried-out in Ogun State coastal estuary, Ogun Waterside and Ijebu-East Local Government Areas of Ogun State, Nigeria (Figure 1). It is situated between $4^{0}15^{1}$E – $4^{0}30^{1}$E and $6^{0}20^{1}$N – $6^{0}45^{1}$N and bounded in the East by Lekki lagoon and South by Bight of Benin. The water covers an area of 26 km^{2} (Ssentongo *et al*., 1983). It empties into the Atlantic Ocean via the Lagos Harbour. The water does not have direct access to the marine condition but it is linked to Lekki and Lagos lagoons. The lack of direct access to the Atlantic Ocean coupled with the influx of Rivers Osun, Mosafejo and Oni into the water makes it essentially freshwater. Trewavas (1983) and Abdul *et al*. (2010) described the water including the Lekki lagoon as an estuary having the characteristics of freshwater all year round.

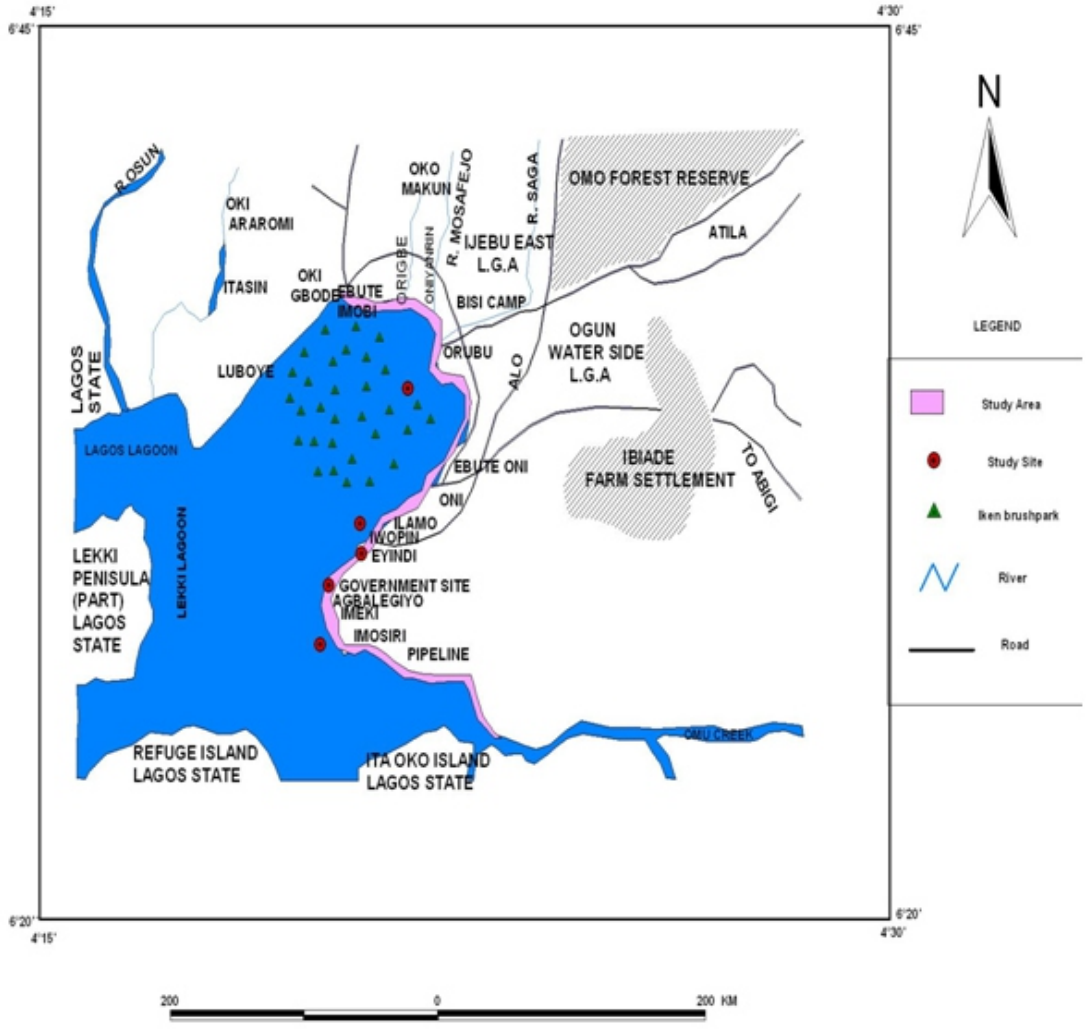

Figure 1. Map of Ogun State Coastal Estuary

Sampling and Laboratory Procedures

Specimens of *E. lacerta* were collected from the sampling sites (Figure 1) from commercial landings of fishermen between February and July 2014. Biometric data such as body weight (BW to the nearest 1 gramme) and total length (TL to the nearest 0.1 centimetre) were collected. The total length was taken as the distance from the snout, with the mouth closed, to the tip of the tail fin. 20 specimens from each sex and 10 others were also randomly selected each month, preserved in an ice chest and rapidly transported to the laboratory where they were kept in the freezer at -2°C for gonad and stomach analyses. The specimens for gonad analysis were later thawed, wiped and dissected dry before the stage of gonad development was classified following the macroscopic method described by Nikolsky (1963) and Bucholtz *et al.* (2008) as shown in Table 1. Specimens for stomach content analysis were dissected to remove the guts and the contents analysed using numerical and frequency of occurrence methods (Hyslop, 1980).

Table 1. Stages of gonad development classified by Nikolsky (1963) and Bucholtz et al. (2008)

Variables	Stages	Gonad Development
Immaturity	I	Young individuals which have not yet engaged in reproduction. Gonads are of very small size.
Resting Stage	II	Sexual products have not yet begun to develop. Gonads of very small eggs not distinguished to the naked eyes.
Maturation	III	Eggs distinguishable to the naked eyes. A very rapid increase in weight of the gonad in progress, testes changes from transparent to a pale rose colour.
Maturity	IV	Sexual product, ripe gonads have achieved their maximum weights but the sexual products are not still extruded when light pressure is applied.
Reproduction	V	Sexual products are extruded in responses to very light pressure on the belly. Weight of the gonads decreases rapidly from the start of spawning to its completion.
Spent	VI	The sexual products have been discharged, genital aperture is inflamed, gonads have appearance of a deflated sac and ovaries usually containing a few left over eggs and the testes contain residual sperm.

Growth Parameters

Length-frequency polygon was plotted from the data obtained from TL measurements of the fish and the modes or peaks were used in the determination of age groups of the fish species following the method of Petersen (1981). This was checked with integrated methods of Pauly (1980). The length-frequency data were analysed using FiSAT II computer programme, Version 1.2.1, (Gayanilo. *et al.*, 2002). The stepwise procedure was adopted for correction of length-frequency data for mesh selection, and non-seasonalised equation of von Bertalanffy was used to estimate growth parameters in ELEFAN 0-I sub-routines of FiSAT II.

$L(t) = L\infty(1 - \exp(-k(t - t_0)))$

ϕ^1 (phi prime) $= \ln K + 2\ln L\infty$ (Pauly and Munro, 1984)

$T_{max} = 3/k$

Length-weight Relationship and Condition Factor

The LWR of fish was estimated by using the equation: $W = a L^b$, where a is the intercept and b is the allometry coefficient. After logarithmic transformation of this relation ($\log W = \log a + b \log L$), parameters a and b were determined via least–square linear regression method (Zar, 1999). In order to check if the value of b was significantly different from 3, the method described Sparre and Venema (1992) was used. The value of b gives information on the kind of growth pattern of fish: the growth is isometric if $b = 3$ and the growth is allometric if $b \neq 3$ (negative allometric if $b < 3$ and positive

allometric if $b > 3$). Condition factor CF was estimated as:

$CF = 100W/L^b$

Where W = weight in grammes, L = total length in centimetres and b = exponent of LWR

RESULTS

Length - Frequency and Mean Weight Distribution in *E. lacerta* in Ogun State Coastal Estuary

Table 2 shows the length-frequency distribution of *E. lacerta* in Ogun State coastal estuary. The range of Total length (TL) was between 11-12 cm and 32-33 cm. 421, 636, 286, 197, 270 and 364 fish specimens recorded in Febuary–July respectively. Size classes 13 – 14 to 26-27 cm were predominant (Figure 2). The respective monthly means of TL recorded were 22.35± 0.13, 22.84± 0.11, 20.29± 0.10, 21.73± 0.11, 21.12± 0.11 and18.93± 0.09 cm (Table 3). The average weight of each total length class was calculated and presented in Table 2. Modal progression analysis shows that there were several age groups in the population of *E. lacerta* in the estuary (Figure 2).

Figure 2: Length-frequency Distribution of *E. lacerta* in Ogun State Coastal Estuary

Table 2: Length Frequency and Mean Weight Distribution of *E. lacerta* in Ogun State Coastal

Length (cm)	February	March	April	May	June	July	Total	Mean weight(g)
11-12	21					21	42	8
12-13	19					19	38	13
13-14	31	30	29			21	111	13
14-15		41	15		22		78	24
15-16	14	32	31	17		35	129	16
16-17		26	21	6	43	29	125	26.3
17-18	32	25		21	31	28	137	28
18-19	11	34	19	25	32	41	162	53
19-20	17	27	21	17	21	29	132	47
20-21	22	30	42	18		19	131	54
21-22	-	35	30	31	21	14	131	50.6
22-23	25	29	12	11		32	109	66.8
23-24	37	44	9		9	33	132	78.3
24-25	29	45			12	22	108	86.8
25-26	17	39	12	18	18		104	97.7
26-27	38	41	13		22	11	125	109.4
27-28	22	23			12	10	67	116
28-29	37	19	13		11		80	133.3
29-30	24	30		19			73	143.3
30-31		31			16		47	136
31-32	14	24	19				57	161
32-33	11	31		14			56	196
Total	**421**	**636**	**286**	**197**	**270**	**364**	**2174**	-
Mean length(cm)		**22.83±0.40**	**20.29±2.11**	**21.73±3.51**	**21.12±2.29**	**18.93±1.44**	**-**	**-**
Mean weight(g)	**77.77±6.33**	**80.14±4.19**	**57.55±9.32**	**69.25±3.53**	**63.77±9.87**	**46.86±7.32**	**-**	**68.12±1.23**

Gonadal Stages

From gonad macroscopic examination (Table 3), it was observed that all fish specimens were immature during the period of study. The fish specimens' gonads were all in stages I, II and III (Immature, resting and maturation respectively). This implies that none of the fish specimens was mature during the study period.

Table 3: Variations in Sex Ratio and Gonad Stages of *E. lacerta* in Ogun State Coastal Estuary

Month	**Stage of gonads Number**	**I**		II		III	
		M	**F**	**M**	**F**	**M**	**F**
Feb	20	2	2	8	4	2	2
Mar	20	2	8	4	2	0	4
Apr	20	2	6	0	4	6	2
May	20	8	6	4	0	2	0
Jun	20	2	0	6	0	0	12
Jul	20	2	6	6	2	4	0
Total	**120**	**16**	**28**	**26**	**12**	**18**	**20**

Food and Feeding Habit

The stomach contents analysis of the fish gut (Table 4), using frequency of occurrence method, revealed that blue-green algae, green algae and diatoms constituted 12.17%, 18.69% and 20.47% respectively. Desmids constituted 11.57%, rotifers, crustaceans and fish were 6.23%, 9.50% and 14.54% respectively. Unidentified food mass was 6.83%. Meanwhile, numerical method showed that the respective food items were 12.83%, 17.55%, 16.98%, 12.32%, 5.67%, 9.89%, 20.57% and 7.17% of the whole stomach contents.

Table 4: Stomach Contents Analysis of *Elops lacerta* in Ogun State Coastal Lagoon

Food Items	**Numerical method**		**Frequency method**	
	No	**Percentage %**	**No**	**Percentage %**
BLUE-GREEN ALGAE	68	12.83	41	12.17
Anabaena	11		9	
Oscillatoria	17		11	
Phormidium	27		13	
Scenedesmus	13		8	
GREEN ALGAE	93	17.55	63	18.69
Ankistrodesmus	21		15	
Protococcus	14		9	
Mougeotia	17		14	
Cladophora	26		15	
Scenedesmus	15		10	
DIATOMS	90	16.98	69	20.47
Cyclotella	15		11	
Gyrosigma	13		9	
Navicula	17		15	
Ulothrix	20		17	
Tabellaria	15		11	
Nitzschia	10		6	
DESMIDS	57	12.32	39	11.57
Gonatozygon	18		12	
Penium	15		10	
Euastrum	24		17	
ROTIFER	27	5.67	21	6.23
Keratella	11		9	
Branchionus	16		12	
CRUSTECEANS	48	9.89	32	9.50
Eubranchipus	8		6	
Cyclops	6		5	
Prawn	34		21	
FISH	109	20.57	49	14.54
Elops lacerta	19		9	
Sierrathrissa leonensis	90		30	
Unidentified Food Mass	38	7.17	23	6.83

Growth Parameters

Results show that maximum age, longevity $t_{max,}$ of this stock was estimated to be approximately 4.05 years and growth performance index, ϕ^1, was 3.036/year. Estimates of growth parameters, the asymptotic length, $L\infty$, growth curvature, k, were 38.33 cm and 0.74/year respectively

LWR Parameters and Condition Factor of *E. lacerta* **in Ogun State Coastal Estuary**

The LWR parameters, *b* and *a*, estimates were 2.917 and 0.00746 (r^2 = 0.950). Estimated *b* was not significantly ($p > 0.05$) different from 3.0 indicating isometric growth pattern of *E. larceta* in the estuary. Mean monthly condition factors of the fish are presented in Table 3. The condition factors of *E. lacerta* in Ogun State coastal estuary from February – July were 0.693± 0.016, 0.649± 0.046, 0.926± 0.092, 0.754± 0.011, 0.821± 0.011 and 1.140± 0.021 respectively. The value was lowest in March and highest in July. Table 5 also shows the estimated mean condition factor to be 0.830± 0.090. The condition factor was inversely related to size in this study.

Table 5: Mean Monthly Condition Factor of *E. lacerta* in Ogun State Coastal Estuary

Month	No		Size (cm)	Condition Factor
	M	F		
February	209	212	22.35±1.110	0.693±0.016
March	336	300	22.84±0.400	0.649±0.046
April	138	148	20.29±2.110	0.926±0.092
May	101	96	21.73±3.510	0.754±0.011
June	139	131	21.12±2.290	0.821+0.011
July	185	179	18.93±1.440	1.140±0.021
Mean±SE	**1108**	**1066**	**21.21±0.590**	**0.830±0.090**

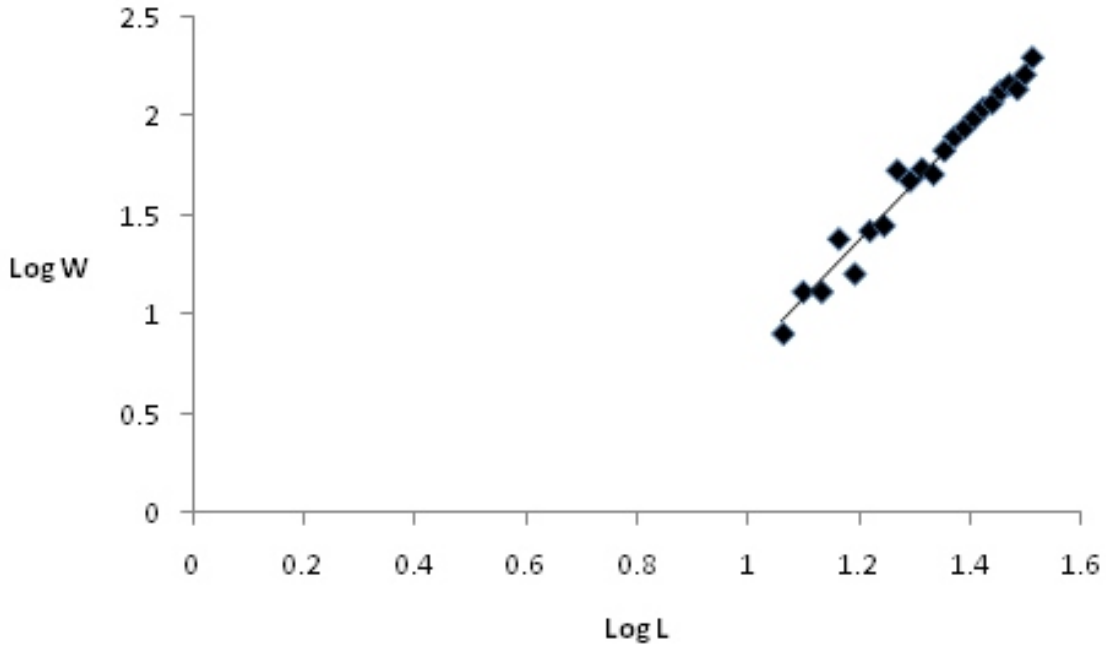

Figure 3: Length-Weight Relationship of *E. lacerta* in Ogun State Coastal Estuary

DISCUSSION

The preponderance of sub-adult *E. lacerta,* 13-27 cm, was similar to the observation of Lawson and Aguda (2010) in Ologe lagoon, Lagos State, Nigeria. It was reported that fish of about 90-169 mm TL and 170-269 mm TL constituted 36.305 and 49.5% of the entire population of *E. lacerta* in Ologe lagoon mostly between February and July. Between August and January there was no evidence of the presence of *E. lacerta* in Ologe lagoon but this was not confirmed in Ogun State coastal estuary in the present study. Presence of few adults during the study might be as a result of migratory nature of the fish as adult fish mature and spawn in the sea. Lawson and Aguda (2010) reported the movement of *E. lacerta* from Ologe lagoon to Lagos coast through the Badagry creek and back to the sea because of the inter connectivity of the water bodies. Ugwumba (1989) had earlier reported the preponderance of adult *E. lacerta* in the marine environment of Nigeria. Conversely, Nelson (1984) observed the presence of all life history stages in both the marine and brackish waters. More or less absence of larger size groups in the population confirms the assertion of McBride *et al.* (2001) who reported that the family Elopiadae are offshore spawners. Several age groups of *E. lacerta* population were reported in this study unlike in the Lawson and Aguda (2010) study that reported two age groups dominated by the smaller size groups.

Lawson and Aguda (2010) reported consistent preponderance of male *E. lacerta* in Ologe lagoon. This is corroborated by the observation of Ugwumba (1989) on the stock in the Lekki lagoon. However, in this study, the sex ratio, 1.04:1 (male: female), was not significantly different from expected 1:1 of natural population. This confirms the normality of the sampled population used for this study (Bhujel, 2008). Information on sex ratio is important for understanding the relationship between individuals, the environment and the state of the population (Vicentini and Araujo, 2003). Sex ratio may vary from the expected 1:1 from species to species, or even in the same population at different times, being influenced by several factors such as adaptation of the population, reproductive behaviour, food availability and environmental conditions (Nikolsky, 1963; Vandeputt *et al.,* 2012). As illustrated by Oliveira *et al.* (2012), the reproductive success of the female is usually related to access to resources and environmental conditions, and not to the number of mating partners as in the case of males. Meanwhile, lifetime reproductive success of male however has been reported to be limited by access to females.

Age, growth and reproductive characterization in *Elops* species are poorly documented. No validated method to determine its growth has been reported, but the length-frequency analyses by various authors (Ugwumba, 1989; McBride *et al.*, 2001; McBride and Horodysky, 2004; Lawson and Aguda, 2010) suggested that only three-year classes of the fish were reported occupying estuaries and near shore habitats. Ageing from hard parts, scales and otoliths, reported by the authors indicated that *Elops* species have maximum life span between 4-6 years which was in-line with the value of 4.05 years, estimated in this study. Attempt to use length-frequency data (length-based stock assessment) in this study showed that the growth rate, k = 0.74/year, phi prime (ϕ^1) = 3.06/year, are typical of tropical and *r*-selected fish species. With Petersen method, the fish growth rate has been determined in the past to be high, 1.2-2.0 cm per month but the determination by classical methods (scales, otoliths) was unsuccessful.

From the study, the fish species spends 18 months in the lagoon where it gets to leptocephali stage (Dare, 1982). According to Dare (1982), *Elops* does not mature in the lagoon. This was similar to the observation made from this present study as no gonad of the samples of fish specimens was found to be mature. This also affirmed the observation of Ugwumba (1989) that the fish matures in the marine environment. According to Zale and Merifield (1989), spawning locations of ladyfish are unknown, but have been inferred to be offshore judging from the locations of capture of early larvae. Moreso, sexual maturity was attained at a total length of about 120 cm which was higher than the size found in Ogun State coastal estuary during the period of study.

According to Haimovici and Velasco (2000), da Costa and Araujo (2003), and Abdul *et al.* (2010),

LWR is of great importance to fishery assessment and it is widely used in fish biology particularly to determine the structure and function of fish population (Anderson and Neumann, 1996) and to predict weight from length measured in yield assessment (Ecoutin and Albaret, 2003). It is also used to calculate the standing stock biomass, evaluate the index of well-being of fish population (Safran, 1992), assess growth rates and age structure of fish population (Kolher *et al.,* 1995), and to make morphometric comparisons between species and populations (King, 1996). LWR is also used in life history comparisons between regions (Konan *et al.,* 2007).This measurement in conjunction with age data can provide information about stock composition, age-at-maturity, life-span and reproduction.

The validity of the results collected in this study was confirmed by the results of Martin-Smith (1996) and Pauly and Gayanilo (1997) who suggested that *b* values may range from 2.5-4.0 and 2.5-3.5 respectively. Allen (1951) opined that the value of *b* exponent remains constant at 3.0 for ideal fish growth. The value of '*b*' remains unchanged during a given life phase but '*b*' varies with environmental factors (Tesch, 1971). *E. lacerta* exhibited allometric growth pattern (*b* ranged between 2.27 and 2.75) in Ologe lagoon, and in Coastal Rivers of South-eastern of Ivory Coast, *b* was estimated to be 2.968 for the species (Konan *et al*., 2007). This is an indication that *b* is related to the habitat. Other factors reported to be influencing the value of *b* which might also have affected the value obtained during the study include: sexual dimorphism (Artigues *et al*., 2003), period of the year and stage of maturity (Weatherly and Gill, 1987), water quality or food availability for fish growth (Mommsen, 1998) and sampling procedure (Ecoutin and Abaret, 2003).

The monthly and average condition factors recorded in this study, 0.649-1.14, was less than the range, 1.00 – 2.00, estimated given by Lawson and Aguda (2010) from brackish water fish species in Nigeria. The variation in condition factors in a population may be attributed to sexual maturation and active spawning of the larger fish (El-Agami, 1988). According to Le Cren (1951), the larger the condition factor, the better the condition of fish. Saliu (2001) noted that condition factor is not constant for species or population over time interval and might be influenced by both biotic and abiotic factors such as feeding regime and stage of gonad development. In some cases, low condition factors are attributed to energy transfer to the gonads during maturation in the life history of a fish (Lizama *et al*., 2002). Condition factor may, therefore, vary due to growth, maturity, stomach fullness and other environmental factors (Khan *et al*., 1991). In the present study, the relatively low condition factor in *E. lacerta* could be attributed to environmental factors as the fish samples were better during rainy season (April – July) than dry season (February and March).

CONCLUSION

From the study, it is shown that Ogun State coastal estuary offers a suitable ecosystem for sub-adult population of *E. lacerta* in terms of growth and food availability. Therefore, to ensure sustainable growth and onward recruitment into the marine environment, regulatory policy should be put in-place in the estuary to control its exploitation.

REFERENCES

Abdul, W. O. Omoniyi, I. T., Akegbejo-Samsons, Y., Agbon, A. O., and Idowu, A. A. 2010. Length-weight relationship and condition factor of cichlid tilapia, *Sarotherodon galilaeus* in the freshwater ecotype of Ogun State coastal estuary, Ogun State, Nigeria. *International Journal of Biol. & Chemical Sciences* 4(4), 1153-1162.

Abowei, J.F.N. 2010. The condition factor, length-weight relationship and abundance of *Elops seneganensis* (Regan, 1909) from Nkoro River, Niger Delta, Nigeria. *Advance Journal of Food Science and Technology* 2, 16–21.

Aceves-Medina, G. Jim Enez-Rosenberg, S.P.A., Hinojosa- Medina, A. 2003. Fish larvae from the Gulf of California. *Scientia Marina* 67, 1–11.

Adams, A.J. Horodysky, A.Z., McBride, R.S., Guindon, K., Shenker, J., MacDonald, T.C., Harwell, H.D., Ward, R. and Carpenter, K. 2013. Global conservation status and research needs for tarpons (Megalopidae), ladyfish (Elopidae) and

bonefishes (Albulidae). *Fish and Fisheries DOI:10.11 11/faf.12017*, 1-32

Agboola, J. I. and Anetekhai, M. A. 2008. Length–weight relationships of some fresh and brackish water fishes in Badagry creek, Nigeria. *Journal of Applied Ichthyology* 24, 623–625.

Allen, K.R. 1951. The Horokiwi Stream: A case study of a front population. *New Zealand Marine Department Fisheries Bulletin* 10, 238pp

Anderson, O. R. Neumann, R. M. 1996. Length, weight and associated structural indices. *In* Nielsen, L. A., Johnson, D. L. (Eds.) *Fisheries Techniques*. Bethesda, Amer. Fish. Soc., pp447–482.

Andrade, H. A., Campos, R. O. 2002: Allometry coefficient variations of the Length–weight relationship of skipjack tuna (Katsuwonus pelamis) caught in the southwest South Atlantic. *Fish Res.* 55, 307–312.

Artigues, B. Morales–Nin, B., and Balguerias E. 2003: Fish length–weight relationships in the Weddell Sea and Bransfield Strait. *Polar Biol.*, 26, 463–467.

Beckley, L.E. 1984.The ichthyofauna of the Sundays Estuary, South Africa, with particular reference to the juvenile marine component. *Estuaries* 7, 248–258.

Bhujel, R.C. 2008. Data Accuracy and Exploratory Analysis. *Statistics for Aquaculture*. Wiley – Blackwell publ. USA First ed, pp42 – 49

Bucholtz, R. H, Tomkieewicz, J., and Dalskov, J. 2008. Manual to determine gonadal maturity of herring (*Clupea harengus*). *L.D - DTU Aqua-report,* 197-08, Charlottenlund: National Institute of Aquatic Resources. 45pp.

da Costa, M.R. and Araujo, F. G. 2003. Length–weight relationship and condition factor of *Micropogonias furnieri* (Desmarest) (Perciformes, Sciaenidae) in the Sepetiba Bay, Rio de Janeiro State, Brazil. *Revista Brasileira de Zoologia* 20 (4), 685–690.

Dare, J. H. 1982. The estuarine stage growth of *Elops lacerta* (C and V 1846). *Doc. Sci. Cent. Rech. Oceanogr.*, Abidjan. 13 (1), 53-72

Ecoutin, J. M., and Albaret, J. J., 2003. Rélation longueur–poids pour 52 esp~ces de poissons des estuaires et lagunes de l'Afrique de l'Ouest. *Cybium* 27 (1), 3–9.

El- Agami, A.E. 1988. Age determination and growth studies of *Gerves oyena* (Forskhall 775) in Arabian Gulf waters. Mahasagar 21 (1), 23 – 24

FDF (Federal Department of Fisheries) 2013: Fisheries Statistics of Nigeria, Projected human population; fish demand and supply in Nigeria, 2005-2020, 56pp

Gayanilo, F.C. Sparre, P., Pauly, D. 2002. FAO-ICLARM Stock Assessment Tools II, Users guide. FAO, Rome. 81pp.

Govoni, J.J. and Merriner, J.V. 1978. The occurrence of ladyfish, *Elops saurus* larvae in low salinity water and another record for Chesapeake Bay. *Estuaries* 1, 205- 206

Hyslop, E.J. 1980. Stomach content analysis: A review of methods and their application. *Journal of Fish Biology* 17, 411 - 429

Haimovici, M. and Velasco, G. 2000. Length-weight relationship of marine fishes from Southern Brazil. *The ICLARM Quarterly* 23 (1), 14-16.

Khan, M.S. M.A. Ambak, K.J. Ang and Moshin, A.K.M. 1991. Length-weight relationship and relative condition of Malaysian freshwater catfish, *Mystus nemurus* Cuvier and Valenciennes, in Chenderoh Reservoir. *Aquacul. & Fish Mgt.* 22, 373 – 376

King, R.P. 1996. Length-weight relationships of Nigerian freshwater fishes. *NAGA, The ICLARM Quarterly* 19, 49-52.

Kolher, N. Casey, J. and Turner, P. 1995, Length–weight relationships for 13 species of sharks from the western North Atlantic. *Fish. Bull.* 93,412–418.

Konan, K.F. Quattara, A., Quattara, G. and Gourcne, G. 2007. Weight – length relationship of 57 fish species of the coastal rivers in South-eastern of Ivory Coast. *Ribarstro* 65 (2), 49-60

Lawson, E.O. and Aguda, A.F. 2010. Growth patterns, diet composition and reproduction in the ten pounder, *Elops lacerta* from Ologe lagoon, Lagos, Nigeria. *Agriculture and Biology Journal of North America* 1, 974–984.

Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and more precise results.

condition in the perch (*Perca fluviatilis*). *J. Anim Ecol.* 20, 201-219.

Levesque, J. 2010. Habitat use patterns of juvenile Ladyfish (*Elops saurus*) in Florida (USA) Estuaries. *Wildl. Biol. Pract.* 6(2), 39-56

Lizama, M., De Los, A.P. and Ambrose A.A. 2002. Condition factor in nine species of fish of the Characnidae family in the upper Parana river flood plain, Brazil. *Braz. J. Biol.* 62(1), 121 – 124

Martin–Smith, K. H. 1996. Length/weight relationships of fishes in a diverse tropical freshwater community, Sabah, Malaysia. *J. Fish Biol.* 49, 731–734.

McBride, R.S. and Horodysky, A. Z. 2004. Mechanisms maintaining sympatric distributions of two ladyfish (Elopidae: *Elops*) morphs in the Gulf of Mexico and western North Atlantic Ocean. *Limnology and Oceanography* 49, 1173–1181.

McBride, R.S. MacDonald, T.C., Matheson, R.E., Rydene, D.A. and Hood, P.B. 2001. Nursery habitats for ladyfish, *Elops saurus*, along salinity gradients in two Florida estuaries. *Fishery Bulletin* U.S. 99, 443–458

Mommsen, T. P. 1998. Growth and metabolism. *In* Evans, D. H. (Ed.) *The Physiology of Fishes.* CRC Press, New York pp65–97.

Nelson, J.S. 1984. *Fishes of the World.* John Wiley and Sons, NY. 523p.

Nikolsky, C.V. 1963. *The Ecology of Fishes.* Academic press, London and New York. pp. 187-230.

Oliveira, M. R. Costa, E. F. S, Araújo, A. S., Pessoa1, E. K. R., Carvalho, M. M., Cavalcante, L. F. M. and Chellappa, S 201₂ Sex Ratio and Length-Weight Relationship for Five Marine Fish Species from Brazil. *J. Mar. Biol. Oceanogr.* 1:2., http://dx.doi.org/10.4172/2324-8661.1000103

Pauly, D. 1980. A selection of simple methods for the assessment of tropical fish stocks. *FAO Fish. Circ.*, (729): Issued also in French. Superseded by FAO Fish. Tech. Paper. 234: 54p

Pauly, D. and Gayanilo, J. F. C. 1997. A bee: An alternative approach to estimating the parameters of a length-weight relationship from length frequencies samples and their bulk weights. *NAGA ICLARM*, Manila Phillipines.

Pauly, D. and Munro, J. L. 1984. Once more on the comparison of growth in fish and invertebrates. *ICLARM Fishbyte* 2(1), 21

Petersen, C.G.I. 1981. Eine method zur Bestimmug de Alters und.des wuches des Fische. Mitt. Dtsch. See. Fischerei Ver II: 226 - 235

Safran, P. 1992. Theoretical analysis of the weight–length relationships in the juveniles. *Mar. Biol.* 112, 545–551.

Saliu, J. K. 2001. Observation on the condition factor of *Byrinus nurse* (Pisces: Cypriniformes, Characidae) from Asa reservoir, Ilorin, Nigeria. *Trop. Freshwater Biol.* 10, 9 – 17

Sparre, P. and Venema, S.C. 1992. Introduction to tropical fish stock assessment. Part 1 Manual. *FAO Fisheries Tech. Paper* No 306 (1), Rev. 1. Rome, FAO, 376pp.

Ssentongo, G. W., Ajayi, T. O. and Ukpe, E. T. 1983. Report on a resource appraisal of the artisanal and inshore fisheries of Nigeria. *FAO, Rome FI: DP/NIR/77/001*, p. 43.

Tesch, F.W. 1971: *Age and Growth. Fish production in freshwaters.* Blackwell, Oxford. I.: W.E. Rickers (ed). pp 98 -130

Trewavas, E. 1983. *Tilapine Fishes of the Genera Sarotherodon, Oreochromis and Danakilia.* London British Museum (Natural History), 583p.

Tzeng, W.N., Chen, H.L. and Teng, H.Y. 2005. The recruitment dynamic of *Elops hawaiensis leptocephalus* in Gongshytyan Creek estuary of Northern Taiwan. *Journal of the Fisheries Society of Taiwan* 32, 129–130.

Ugwumba, O.A. 1989. Distribution and growth pattern of the ten-pounder (Val.) in the freshwater, estuarine and marine environments of Lagos, Nigeria. *Archiv Fur Hydrobiologie* 115, 451–462.

Vandeputte, M. Quillet, E. and Chatain, B. 2012. Are sex ratios in wild European sea bass (*Dicentrarchus labrax*) populations biased?. *Aquat. Living Resour.* 25, 77-81.

Vicentini R. N. and Araújo F. G. 2003. Sex ratio and size structure of *Micropogonias furnieri* (Desmarest, 1823) (Perciformes, Sciaenidae) in Sepetiba Bay, Rio de

Janeiro, Brazil. *Braz. J. Biol.* 63, 559-566.

Weatherley, A. H. and Gill, H. S. 1987. *The Biology of Fish Growth*. Academic Press, London, 325p.

Zale, A.V. and Merrifield, S.G. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Florida) – Ladyfish and Tarpon. *U.S. Fish and Wildlife Service Biological Report* 82(11.04) Tr EL – 82 – 4: 13 pp.

Zar, J. H., 1999. *Biostatistical Analysis*. 4th Edition. Prentice–Hall, Englewood Cliffs, New Jersey, 662p.