

## 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,  $L_{\infty} = 38.33\text{cm}$ ,  $k = 0.74/\text{yr}$ ,  $\phi^1 = 3.036/\text{yr}$  and  $T_{\text{max}} = 4.05\text{yrs}$ . 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  $0.649 \pm 0.046$  (March) and  $1.140 \pm 0.021$  (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°15'E – 4°30'E and 6°20'N – 6°45'N and bounded in the East by Lekki lagoon and South by Bight of Benin. The water

covers an area of 26 km<sup>2</sup> (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.

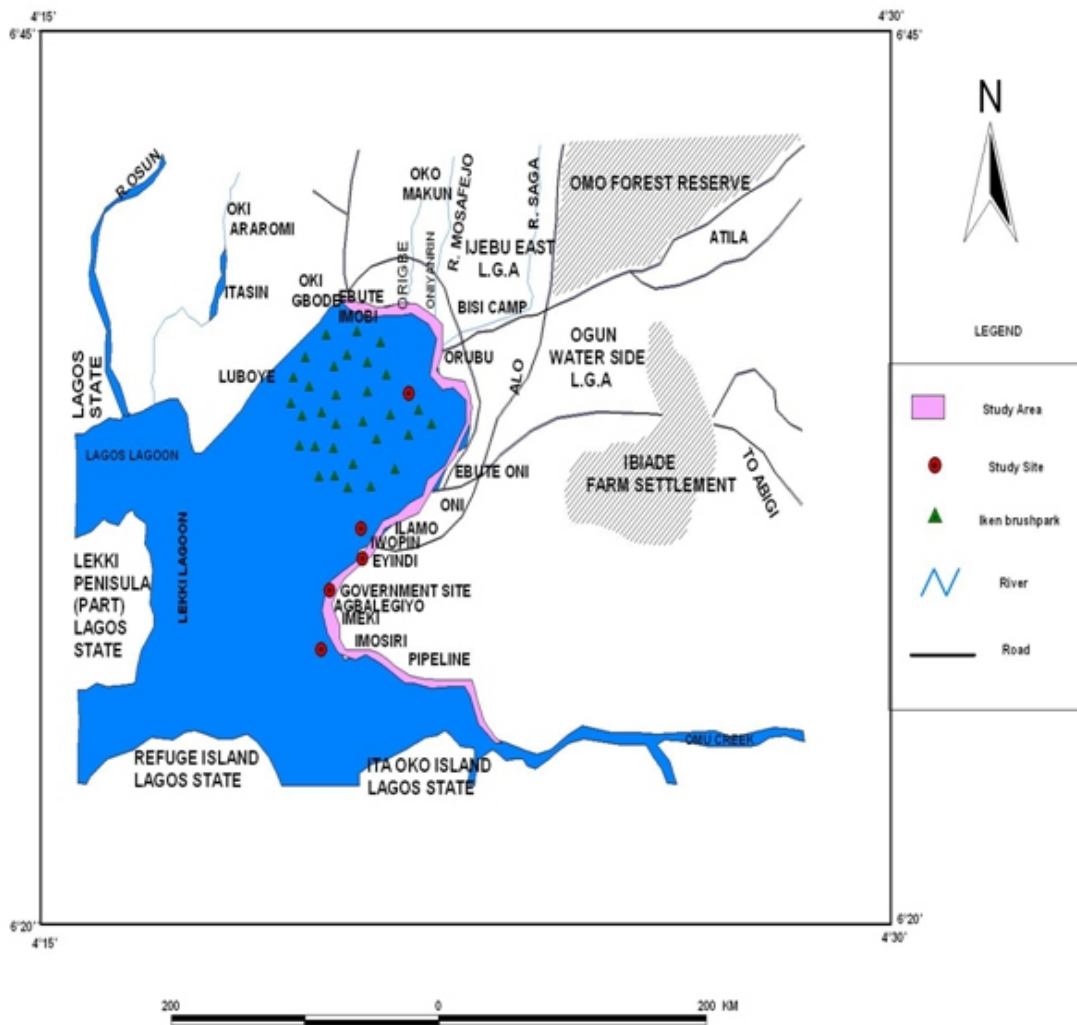


Figure 1. Map of Ogun State Coastal Estuary

### 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  $-2^{\circ}\text{C}$  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, (Gayaniilo. *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.

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

$$\phi^1(\text{phi prime}) = \ln K + 2 \ln L^{\infty} \quad (\text{Pauly and Munro,}$$

1984)

$$T_{\max} = 3/k$$

### Length-weight Relationship and Condition Factor

The LWR of fish was estimated by using the equation:  $W = aL^b$ , 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 February–July respectively. Size classes 13–14 to 26-27 cm were predominant (Figure 2). The respective monthly means of TL recorded were  $22.35 \pm 0.13$ ,  $22.84 \pm 0.11$ ,  $20.29 \pm 0.10$ ,  $21.73 \pm 0.11$ ,  $21.12 \pm 0.11$  and  $18.93 \pm 0.09$  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).

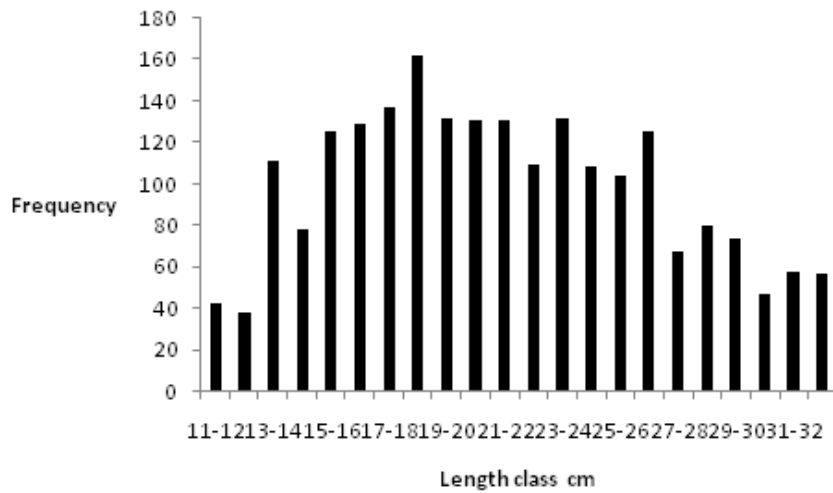


Figure 2: Length-frequency Distribution of *E. lacerta* in Ogun State Coastal Estuary

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
<b>Total</b>	<b>421</b>	<b>636</b>	<b>286</b>	<b>197</b>	<b>270</b>	<b>364</b>	<b>2174</b>	-
<b>Mean length(cm)</b>	-----	<b>22.83±0.40</b>	<b>20.29±2.11</b>	<b>21.73±3.51</b>	<b>21.12±2.29</b>	<b>18.93±1.44</b>	-	-
<b>Mean weight(g)</b>	<b>77.77±6.33</b>	<b>80.14±4.19</b>	<b>57.55±9.32</b>	<b>69.25±3.53</b>	<b>63.77±9.87</b>	<b>46.86±7.32</b>	-	<b>68.12±1.23</b>

### 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
<b>Total</b>	<b>120</b>	<b>16</b>	<b>28</b>	<b>26</b>	<b>12</b>	<b>18</b>	<b>20</b>

### 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 %
<b>BLUE-GREEN ALGAE</b>	68	12.83	41	12.17
<i>Anabaena</i>	11		9	
<i>Oscillatoria</i>	17		11	
<i>Phormidium</i>	27		13	
<i>Scenedesmus</i>	13		8	
<b>GREEN ALGAE</b>	93	17.55	63	18.69
<i>Ankistrodesmus</i>	21		15	
<i>Protococcus</i>	14		9	
<i>Mougeotia</i>	17		14	
<i>Cladophora</i>	26		15	
<i>Scenedesmus</i>	15		10	
<b>DIATOMS</b>	90	16.98	69	20.47
<i>Cyclotella</i>	15		11	
<i>Gyrosigma</i>	13		9	
<i>Navicula</i>	17		15	
<i>Ulothrix</i>	20		17	
<i>Tabellaria</i>	15		11	
<i>Nitzschia</i>	10		6	
<b>DESMIDS</b>	57	12.32	39	11.57
<i>Gonatozygon</i>	18		12	
<i>Penium</i>	15		10	
<i>Euastrum</i>	24		17	
<b>ROTIFER</b>	27	5.67	21	6.23
<i>Keratella</i>	11		9	
<i>Branchionus</i>	16		12	
<b>CRUSTECEANS</b>	48	9.89	32	9.50
<i>Eubbranchipus</i>	8		6	
<i>Cyclops</i>	6		5	
<i>Prawn</i>	34		21	
<b>FISH</b>	109	20.57	49	14.54
<i>Elops lacerta</i>	19		9	
<i>Sierrathrissa leonensis</i>	90		30	
<b>Unidentified Food Mass</b>	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,  $\phi^1$ , 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. lacerta* 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  $0.693 \pm 0.016$ ,  $0.649 \pm 0.046$ ,  $0.926 \pm 0.092$ ,  $0.754 \pm 0.011$ ,  $0.821 \pm 0.011$  and  $1.140 \pm 0.021$  respectively. The value was lowest in March and highest in July. Table 5 also shows the estimated mean condition factor to be  $0.830 \pm 0.090$ . 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	$22.35 \pm 1.110$	$0.693 \pm 0.016$
March	336	300	$22.84 \pm 0.400$	$0.649 \pm 0.046$
April	138	148	$20.29 \pm 2.110$	$0.926 \pm 0.092$
May	101	96	$21.73 \pm 3.510$	$0.754 \pm 0.011$
June	139	131	$21.12 \pm 2.290$	$0.821 \pm 0.011$
July	185	179	$18.93 \pm 1.440$	$1.140 \pm 0.021$
<b>Mean <math>\pm</math> SE</b>	<b>1108</b>	<b>1066</b>	<b><math>21.21 \pm 0.590</math></b>	<b><math>0.830 \pm 0.090</math></b>

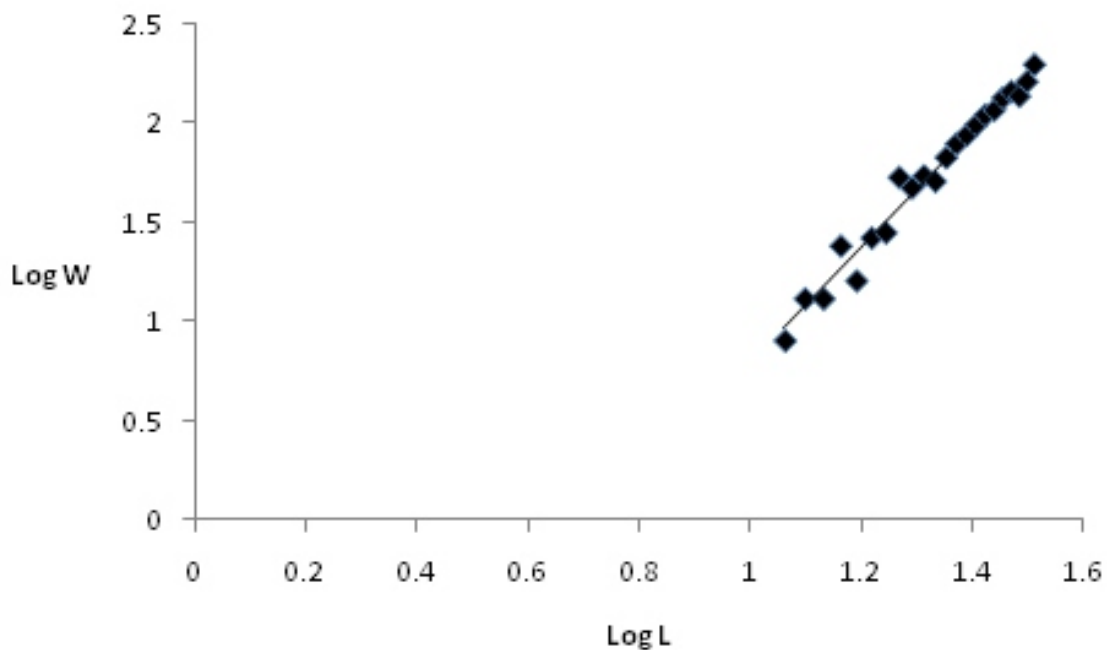


Figure 3: Length-Weight Relationship of *E. lacerta* in Ogun State Coastal Estuary

## 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 Elopidae 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,  $k = 0.74/\text{year}$ , phi prime ( $\phi^1$ ) = 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.

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