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BIOLOGICAL PARAMETERS OF FALSE SCAD (*Decapterus rhonchus*) ENCOUNTERED IN THE COASTAL WATERS OF ELMINA, GHANA

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A B S T R A C T

The study evaluated some population parameters of *Decapterus rhonchus* in coastal waters of Elmina, Ghana. A total of 210 samples were collected from Elmina landing beach in the Central region of Ghana from July 2019 to December 2019. The total length of individual fish samples was measured and analyzed using TropFish R package. Von Bertalanffy parameters were estimated as asymptotic length ($L\infty$) = 40.6 cm, growth rate (K) = 0.14 per year, and growth performance index (Φ′) =2.367 per year. The length at first capture and maturity were 28.2 cm and 23.2 cm, respectively. Mortality parameters were calculated as total mortality rate (Z) = 1.09 per year, natural mortality rate (M) = 0.29 per year and fishing mortality rate (F) = 0.80 per year. The exploitation rate (E) was 0.73 which suggests that *Decapterus rhonchus* fishery in coast of Elmina, Ghana is highly overexploited. Reduction of fishing efforts through the removal of subsidies and the introduction of closed fishing season are some of the recommended management measures to sustain the *Decapterus rhonchus* fishery in Ghana.

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INTRODUCTION

The False scad (*Decapterus rhonchus*), also known as the spotfin scad, ten-finned horse mackerel and yellow horse mackerel, is a species of medium-sized marine fish classified in the jack family Carangidae. The False scad is distributed throughout the tropical and temperate waters of the eastern Atlantic Ocean from Namibia in the south to Spain and throughout most of the Mediterranean in the north (Fischer et al. 1981). The species has a typical body form compared to other species of *Decapterus*, and can be distinguished from these on its elongated 'scad-like' body shape alone. The False scad is known to grow to a length of 60 cm and a weight of 1 kg. Maximum size is at least 60 cm total length and it is common to 35 cm fork length (Edwards et al. 2001). The species lives both in pelagic and demersal areas of the continental shelf waters, ranging from depths of 15 m to 200 m (Sley et al. 2008). It is a predatory fish, taking small fishes, crustaceans including euphausiids and shrimps, and cephalopods as its main prey (Kompowski 1976, Wysokinski 1973). The False scad is a schooling species, forming large protective masses, often mingling with other semi-pelagic fishes (Ould-Mohamed 1999). It is of major importance to commercial fisheries throughout its range, including Ghana.

In Ghana, this species is mostly harvested or caught by fishermen using trawls, seine nets and gill nets (Ould-Mohamed 1999). Small sizes are also taken together with sardines using purse seines by commercial fishermen. It is also likely taken with small pelagic by industrial trawlers. This species provides nutritional benefit to marginalized fishing communities due to the low price. In terms of processing and marketing, the False scad is utilized fresh, frozen, smoked, dried-salted and for fishmeal and oil (Kwei and Ofori-Adu 2005). Despite its importance in Ghana, information on landings by countries in the region reported to FAO indicate fluctuations with a general decline from around 3,000 metric tons in the 1990s to around 2000 metric tons in 2010 (FAO 2009). It is furthermore anticipated that in the absence of proper management measures based on science, the stock size of these pelagic species in Ghana's coastal waters will collapse in the future. This event will not only have biological implication but also economic and nutritional implications to both the GDP of the country and the livelihood of consumers' especially vulnerable fishing households. Therefore, there is the need to sustainably manage this commercially important fish species based on inputs from stock assessment to avert possible collapse in the future. The primary aim of this study was to assess the population status of *Decapterus rhonchus* from the coastal waters of Elmina, Ghana.

METHODOLOGY

Study Area

This study focused on Elmina landing beach with geographical coordinates 5.0931°N, 1.3383°W (Figure 3.1). The Elmina landing beach is a major landing site in the Komenda - Edina-Eguafo-Abrem (KEEA) municipal in the Central Region of Ghana. It is the third largest landing site in Ghana after Tema and Sekondi harbors which is largely artisanal. Elmina contributes significantly not only to local livelihoods and economy of Elmina but also to the national fisheries by providing about 15% of the country's total fish output (KEEA 2003). In the KEEA municipality, there is a total population of 144,705 out of which 48.1 % are males and 51.9 % are females with the highest proportion of the population being those aged 0 - 4 years; within this age group, 50.9 % are males and 49.1% are females (GSS 2014). Elmina is a place that harbors a lot of migrants with the 2010 Census revealing a total of 42,192 migrants in the municipality out of which 28.7 % had lived for 1- 4 years and 16.2 % had lived for 5 - 9 years and 18.6 % of the migrants had lived there for more than 20 years (GSS 2014). Being a historic fishing community where fishing dates back to the 1400s, the Elmina fish landing center which was built along the bank of the Benya lagoon provides a very good landing site for all types of artisanal canoes and semi-industrial boats (Odotei 2002). These fishing vessels land variety of fish species like *Sardinella aurita, Sardinella maderensis, Thunnus albacares, Decapterus punctatus* and others. There are approximately about 2632 fishermen and 231 canoes operating at the Elmina fish landing beach excluding other semi-industrial vessels that also operate in the town (MoFAD 2004).

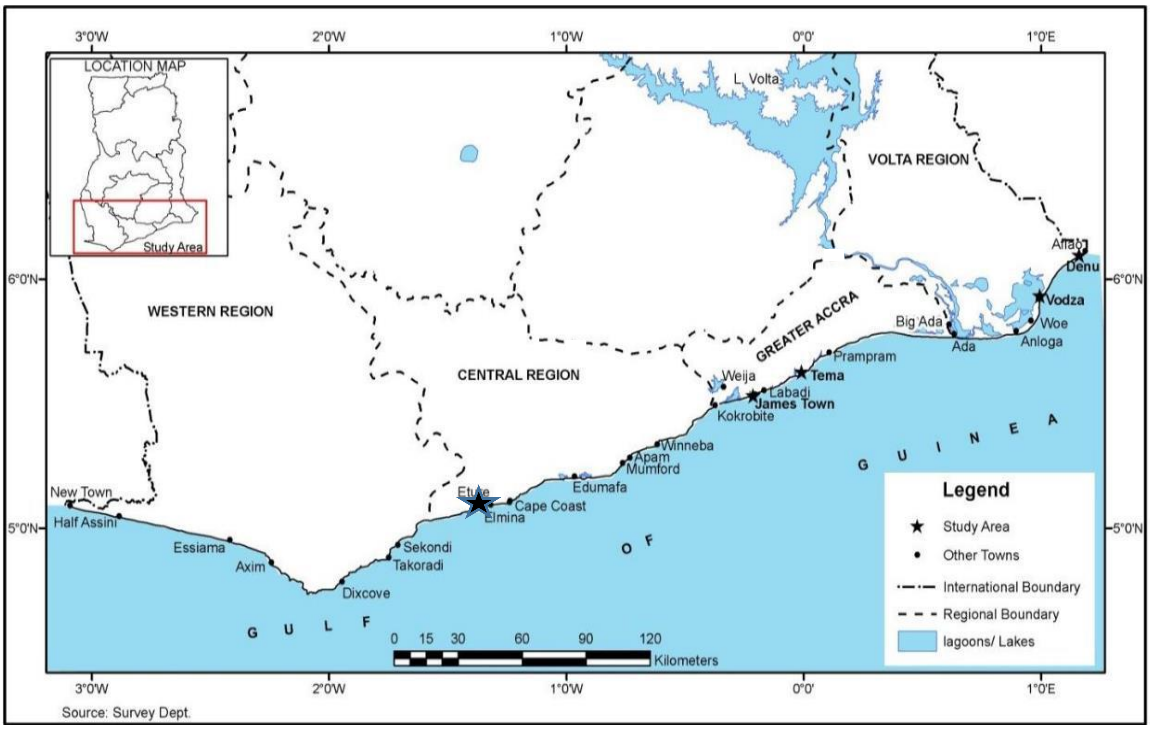

Figure 3.1 Map showing the study area (Source: Amponsah *et al*, 2017).

Data collection

Fish samples were purchased randomly from local fishermen at the Elmina landing site operating mostly multifilament fishing gears for seven months (once every month) from June, 2019 – December, 2019. Purchased specimen were preserved in ice blocks and analyzed on site. Identification of fish species was performed using keys by Fischer *et al.* (1981) and Kwei and Ofori-Adu (2005) to the species level. At the landing site, fish species were weighed to the nearest 0.01g using electronic scale while the total length was measured to the nearest 0.1cm using 100-cm measuring board. In all, a total of 210 specimen of *Decapterus rhonchus* were assessed.

METHODS

Growth Parameters

Parameters of which the fish growth follows Von Bertalanffy Growth Function (VBGF) including growth rate (K), asymptotic length (L_∞) and the growth performance index (Φ′) were estimated using the ELEFAN Simulating Annealing (ELEFAN_SA).

The Longevity (T_{max}) for the species was estimated as:

$$T_{max} = 3/K + to$$ (Anato 1999).

The growth performance index was calculated using the formula:

$$2\log L_\infty + \log K$$ (Munro and Pauly 1984).

The theoretical age at length zero (to) followed the equation:

$$\log_{10}(-t_0) = -0.3922 - 0.2752 \log_{10} L_\infty - 1.038 \log_{10} K$$ (Aleev 1952).

Mortality Parameters

Total mortality (Z) was computed using Linearized length converted catch curve (Spare and Venema 1992).

The natural mortality rate (M) was calculated using the procedure:

$M = 4.118K^{0.73}L\infty^{-0.333}$ (Then et al. 2015).

Fishing mortality (F) was calculated as

Z – M (Qamar et al. 2016).

The exploitation rate (E) was computed using

F/Z (Georgiev and Kolarov 1962)

Length at First Capture (Lc_{50})

The ascending left part of the length converted catch curve was used in estimating the probability of length at first capture (Lc_{50}), in addition to the length at both 75 and 95 percent capture which correlates with the cumulative probability at 75% and 95% respectively (Pauly 1984).

Length at first maturity

The length at first maturity (Lm_{50}) as

$Log_{10} Lm_{50} = 0.8979*Log_{10} (L\infty) - 0.0782$ (Froese and Binohlan 2000)

Data analysis

The TropFish R package in R programming was used in assessing the population parameters of the assessed fish species encountered during the study period (Taylor and Mildenberger 2017).

RESULTS

Growth parameters

Figure 4.1 shows the restructured length frequency with superimposed growth curves. From the Figure 4.1 below, the asymptotic length (L∞) and the growth rate of *Decapterus rhonchus* was 40.6 cm and 0.14 per year respectively. The growth performance index (Φ′) was calculated as 2.367 per year. The theoretical age at length zero (to) was estimated as -1.125 years. The longevity of the assessed fish species (T_{max}) was 22.6 years.

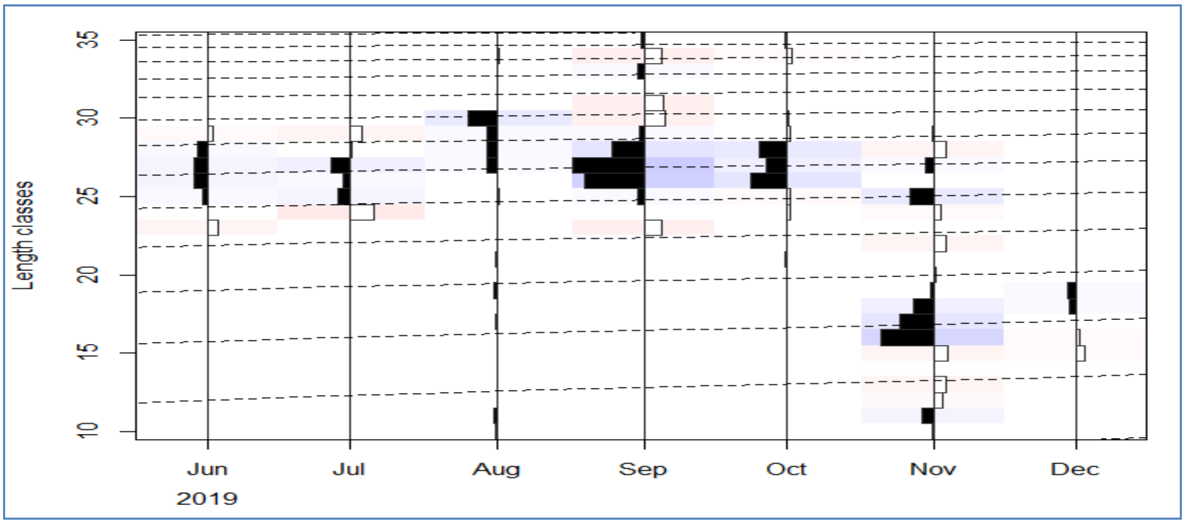

Figure 4.1 Restructured length distribution with growth curves for *Decapterus rhonchus*

Mortality parameters

From Figure 4.2, the total mortality rate (Z) was calculated as 1.09 $year^{-1}$. The natural mortality (M) and fishing mortality (F) rates were estimated at M = 0.29 $year^{-1}$ and F = 0.80 $year^{-1}$, respectively. The current exploitation rate (E) was obtained at 0.73.

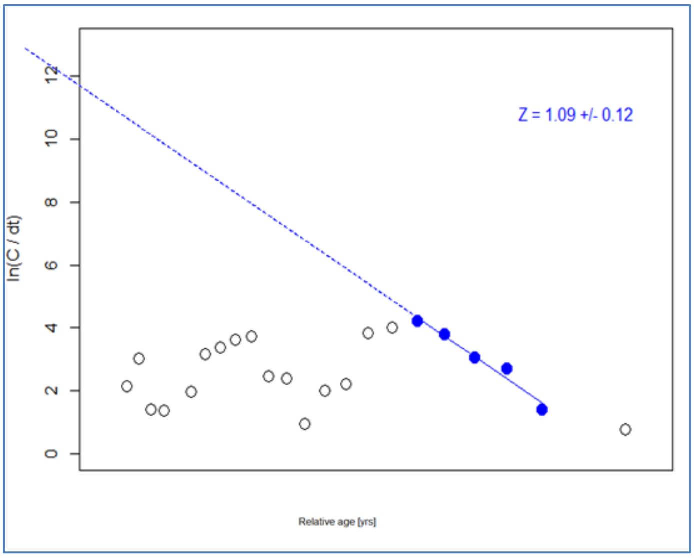

Figure 4.2 Length converted catch for *Decapterus rhonchus*

Length at first capture and maturity

Figure 4.3 shows the probability of capture of *Decapterus rhonchus*. From Figure 4.3, the probability of capture as an output from TropFish R package was estimated as: Lc_{50} = 28.2 cm, L_{75} = 29.6 cm and L_{95} = 31.5 cm (Figure 4.3). Therefore, the length at first capture (Lc_{50}) was 28.2 cm. The corresponding age at capture (t_{50}) was 8.49 years with tc_{75} and tc_{95} at 9.31 years and 10.7 years, respectively.

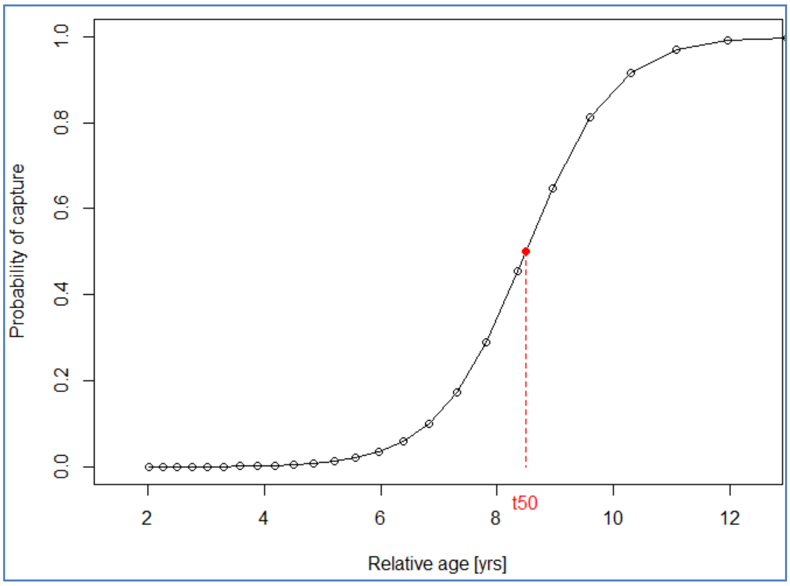

Figure 4.3 Age at first capture for *Decapterus rhonchus*

The length at first maturity (Lm_{50}) was estimated as 23.2 cm.

Recruitment pattern

Figure 4.4 shows the recruitment pattern of *Decapterus rhonchus*. From Figure 4.4, a continuous recruitment pattern was recorded with two recruitment peaks. The major recruitment peak occurred in September while the minor recruitment peak was in March. The percentage of recruits into the stock was 27.3 % in March and 29.3 % in September. The length at first recruitment (Lr_{50}) was 10.5 cm. Only July and December recorded no recruits.

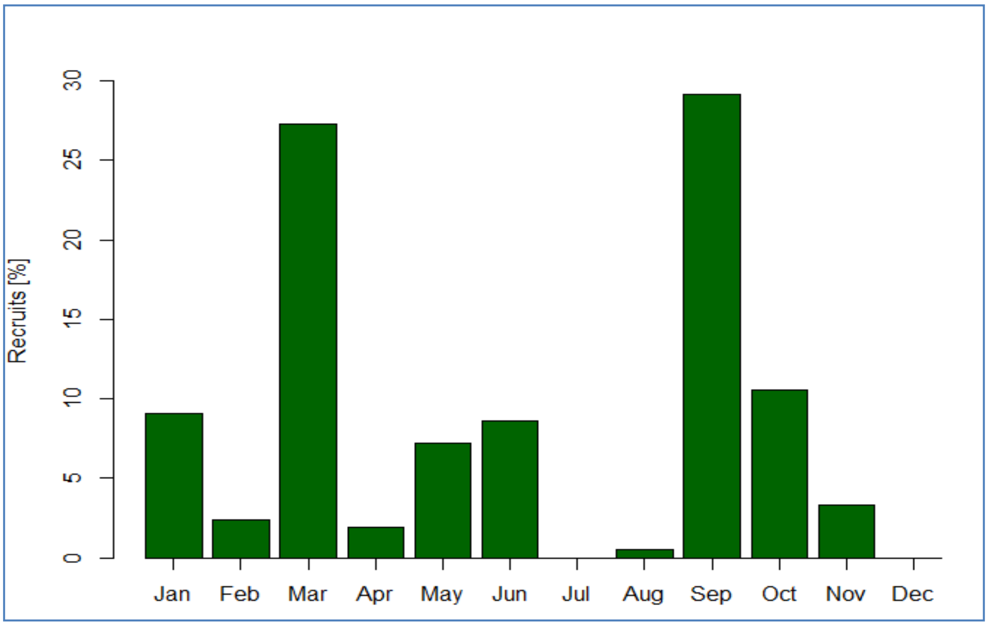

Figure 4.4 Recruitment pattern for *Decapterus rhonchus*

DISCUSSION

Growth parameters

The growth rate estimates from the coastal waters of Mauritania and Cape Verde were 0.30 per year and 0.16 per year (FAO 1979). The estimate of growth rate from the current study (K = 0.14 per year) was relatively lower than the estimates obtained from both Mauritania and Cape Verde coastal waters. The asymptotic length from the current study was 40.6 cm which was lower than the values obtained from Cape Verde and Mauritania coastal waters. According to FAO (1979), the asymptotic length of *D. rhonchus* from Mauritania and Cape Verde waters was 45.63 cm and 48.6 cm respectively. Similarly, the growth performance index of *D. rhonchus* from the study (i.e. 2.367 per year) was lower than the estimates obtained from Cape Verde and Mauritania coastal waters. According to FAO (1979), the growth performance index of *D. rhonchus* from Mauritania and Cape Verde waters was 2.79 per year and 2.58 per year respectively. The reasons for variation in the growth parameters could be due to geographical locations, the data analysis method used, the size classes obtained and the level of fishing activity (Amponsah *et al*. 2016, Kings 2005). The growth rate (K) obtained from the current study was 0.14 per year, an indication that this species is a slow growing fish species, signified by a longevity of approximately twenty-three (23) years (Kienzle, 2005). In terms of implications, in the wake of any heavy exploitation on this species, the outcome or consequences could be more of biological than economical because rebuilding of this species is likely to be at a slower rate (Rijavec 1973).

The ratio of the length at first capture and the asymptotic length which is known as the critical length at first capture (Lc) was 0.70. Pauly and Soriano (1986) documented that when Lc is less than 0.5, it implies the presence of more juveniles and when Lc is more than 0.5, it is suggestive of more matured individuals. From the study, the critical length at first capture was 0.70, relatively higher than 0.5 which indicates the presence of more matured individual within the samples used for the study. This finding also shows that growth overfishing which is mostly characterized by the presence of more juveniles does not exist within the fishery of the assessed fish species (Amponsah et al. 2016). The length at first maturity (Lm_{50} = 23.2 cm) was much lower than the Lc_{50} (i.e. 28.2 cm) which connotes that the species in the coastal waters of Elmina, Ghana gets at least an opportunity to spawn before becoming vulnerable to fishing gears. Consequentially, this finding proposes that recruitment overfishing is non-existent within the stock of *D. rhonchus* in Ghana's coastal waters. However, care should be taken not to intensify the exploitation of matured individuals as this could have future implications on recruitment of stocks.

From the present study, recruitment into the stock was found to be continuous throughout the year, except in July and December, buttressing that, the absence of recruitment overfishing from the coastal waters of Elmina, Ghana may be as a result of the continuous presence of matured female species (Amponsah et al. 2020). The existence of the two recruitment peaks exhibited by the species conformed to the findings by Pauly (1987) who reported that tropical fish species portray two recruitment peaks. The presence of the double peaks of recruitment could be adduced to the influence of environmental factors prevailing in the study area such as environmental variations, species interactions, and fishing. The length at first recruitment (Lr_{50} = 10.5 cm) was found to be lower than the length at first capture (Lc_{50} = 28.2 cm). The occurrence of such condition suggests that individuals of the assessed fish species get the chance to join the stock before becoming prone to capture by any available fishing gear. The absence of recruits during the months of July and December could be due to the fact that individuals during those periods invest more energy into building reproductive tissue and spawn during the succeeding months.

The natural mortality (M = 0.29 $year^{-1}$) was lower than the fishing mortality (F= 0.80 $year^{-1}$), this implies that the species in coastal waters of Elmina, Ghana are more vulnerable to fishing activities than to natural mortality induced conditions such as predation and changes in environmental conditions. In addition, it shows the high level of exploitation exerted by fishermen on fish species in coast of Elmina, Ghana. Pauly (1980) reported that the optimal exploitation level of fish species is mostly 0.5. From the study, the exploitation rate was estimated to be 0.73 which is relatively higher than the optimal level indicated by Pauly (1980). This infers that the species in the coast of Elmina, Ghana is over-exploited. As a management option, there is the urgent need to reduce fishing efforts through measures such as reducing the number of active canoes, removal of subsidies on fishing accessories like outboard motor and the introduction of closed fishing season.

CONCLUSION

Decapterus rhonchus from the coastal waters of Elmina, Ghana was found to be a slow-growing species with a high longevity of 23 years. The recruitment pattern was continuous with a high recruitment percentage in March and September. Based on the lengths at first recruitment, first maturity and first capture, incidence of recruitment and growth overfishing was absent. The exploitation rate estimated shows that this species is highly over-exploited in the coast of Elmina, Ghana. Fishing efforts should be reduced through the introduction of closed fishing seasons and the removal of subsidies to safeguard this commercial species from future collapse.

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CONFLICT OF INTEREST

The authors have no conflict of interest.

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