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Preliminary evaluation of by-catch, mortality and yield per recruit for the Sea bass, *Dicentrarchus labrax* in hand line fisheries, Bardawill Lagoon, North Sinai, Egypt

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ABSTRACT

Hand line gear is the main fishing method used that target sea bass in Bardawill lagoon. The present study was carried out in the lagoon from May to December, 2016 in order to evaluate the by-catch, mortality and yield per recruit. Samples were collected biweekly from three vessels equipped by three lines have live bait. Length at first maturity (L_{m50}) was estimated. Fish below L_{m50} was accounted as a by-catch. Adult and by-catch were recorded as numbers and biomass (kg) per units. By-catch was calculated monthly. Growth parameters, mortality and yield per recruit were determined. The length at first maturity (L_{m50}) was estimated as 32.5 cm (TL), which corresponding to the second year of life. 40.8% of the Sea bass catch per unit was recorded as a mature fish versus 59.2% as immature ones (by-catch). By-catches are predominant throughout the fishing season except from August to October. Growth parameters; $L\infty$ and K were estimated at 47.25 cm and 0.27 per year respectively. The current exploitation rate (E) was estimated at 0.68 and the total mortality (Z) was 0.83 yr^{-1}. The length at first capture (L_{c50}) was estimated at 24.5 cm. Relative yield per recruit was 0.68, 0.6 and 0.37 at the maximum (E_{max}), economic ($E_{0.1}$) and optimum exploitation ($E_{0.5}$) respectively. The study recommended that the hook sizes should be increased to capture the mature size ratio L_m/L_∞ = 0.65. Fishing from August to October is preferred by hand line gear and prevents at the rest of the fishing season. Exploitation rate should be reduced by 50%.

INTRODUCTION

FAO (2018) warns as by-catch represents a sustainable threat to marine fisheries by unwarranted mortality that threatens food security. Davies *et al.* (2009) decided that the by-catch constituted 40.4% of the global marine catches. Mainly, Sea bass are fished by fishers from moving or anchored boats, where they are caught with hooks and lines. By-catch and strategies of lines fishery have been studied in different areas as Erzini *et al.* (1996 & 1999) (southern Portugal), Zimmerhackle *et al.* (2015) in Ecuador and Salem (2018) in Bardawill lagoon. The handlines became widely used in Bardawill lagoon targeting Sea bass, *Dicentrarchus labrax* alongside fewer species. Despite of handline fishery of bass in lagoon is economically important; there is very little information on the Sea bass fish captured by the handline gear. By-catch is referred to the non-target species (discarded fish and non-marketable sizes or their lower value). This study aimed to evaluate the by-catch percentage, mortality

rates and yield per recruit with hand lines to regulate this fishery and minimize the fishing pressure on this important species.

MATERIALS AND METHODS

Bardawill lagoon (Fig.1) is the area of study. The lagoon is a shallow and saline bond bordered by the Mediterranean Sea; in the North Sinai Peninsula.

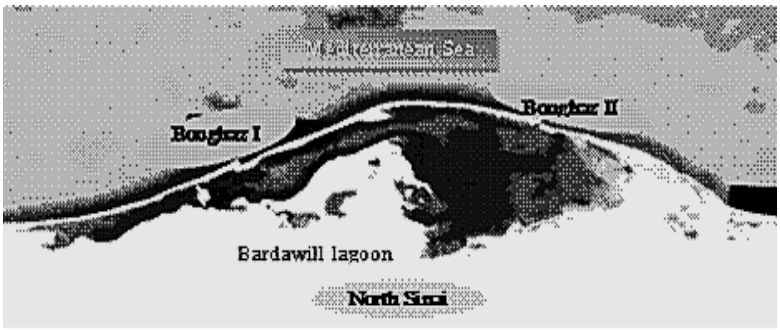

Fig. 1: Bardawill Lagoon

Hand lines gear usually targeted the Sea bass fish in the lagoon. The study was conducted from May to December 2016. After consultation of fishers, we used "J" style hooks with different shapes and dimensions (No. 17, 16, 15, 13 with a bends of ≈ 6.4, 7.2, 8.1, 9.9 mm respectively). These hooks are already used by the fishermen in the lagoon (Fig. 2).

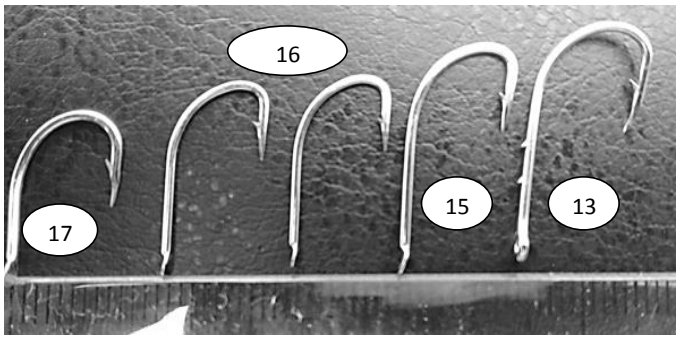

Fig. 2: "J" style hooks

Samples used in this study were collected from three vessels, each one equipped by three lines, each with one hook have live bait. Two fishers on each vessel were recorded. The lines made of monofilament 60 mm. The vessels worked in day and not anchored. Fishing was carried out in different areas at Boughaz I & II based on the recommendation from the fishers. These areas are characterized by sandy, gravel habitat having groove with depths ranging from 1.5 to 2.5 m. This study is based upon catch data obtained from 16 fishing trip (Two fishing trip per month), with an average of eight working hours per trip. Biological data (total length in cm and total weight in gm) of all Sea bass catch were recorded. Maturity stages of 189 individuals were examined and aged by otolith. The length at first maturity (L_{m50}) was calculated by fitting the maturation curve. Fish below L_{m50} was accounted as a by-catch where they were not allowed to be spawn at least once before they get caught to sustain their stock. Adult and by-catch were recorded as numbers and biomass (kg) per units. Also, by-catch was calculated monthly.

FiSAT II program was used to estimate the growth parameters ($L\infty$ and K) (Gayanilo *et al.,* 2003).

The instantaneous rate of total mortality (Z) was estimated by applying the length-converted catch curve method (Pauly, 1983). Natural mortality (M) was obtained by two method; Ursin (1967) as: $= (W)^{-1/3}$, where W is the mean total weight of all samples in gm and Hewitt and Hoenig (2005) as:$Ln(M) = 1.44 - 0.982 \times Ln(t_{max})$ and t_{max} was estimated by using the formula of Pauly and Munro (1984): $t_{max} = 3/K$

The relative yield-per-recruitment and the relative biomass per recruit were predicted by FiSAT program (Gayanilo *et al.*, 1997) as:

$$Y'/R = EU^{M/K}\left[1 - \frac{3U}{(1+m)} + \frac{3U^2}{(1+2m)} - \frac{U^3}{(1+3m)}\right]$$

$$Y'/R = EU^{\frac{M}{K}}\left[1 - \frac{3U}{(1+m)} + \frac{3U^2}{(1+2m)} - \frac{U^3}{(1+3m)}\right] Where U = 1 - (Lc/L\infty),$$

$m = (K/Z)$.L_{c50} is the length at first capture, M and Z are mortalities, K and L∞ growth parameters and E is the exploitation rate. The maximum yield was calculated from the yield-biomass-per-recruit model. Also, the exploitation rates at which the marginal increase ($E_{0.1}$) and reduces the biomass to 50% of its unexploited level ($E_{0.5}$) of Y′/R were estimated.

RESULTS AND DISCUSSION

This study provides the first attempt to determine by-catch of the Sea bass handline fishery. 189 individuals were examined (the length of the examined samples were ranged in length from 19.5 to 37.7 cm) and were aged from 0 to 3 years.The length at first maturity (L_{m50}) was estimated at 32.5 cm TL (Figure 3), which is corresponding to the second year of life. There were fewer mature female in sample, as males mature earlier than females. Maturity stage of bass was occurred at around 35 cm at 3 years of males in England water (Pawson & Pickett, 1996), while Sea bass in the Mediterranean matured earlier (Kara, 1997).

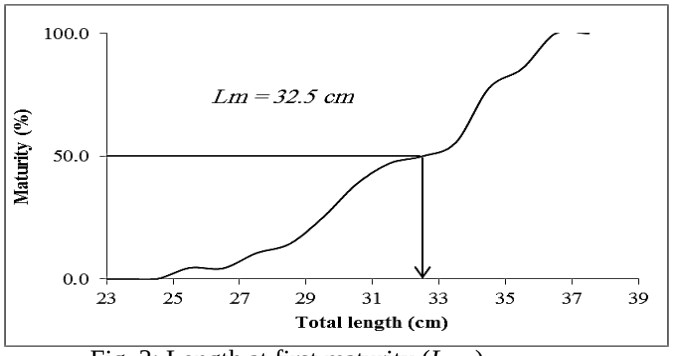

Fig. 3: Length at first maturity (L_{m50})

Length-frequency distributions of individuals were shown in (Figure 4). 1200 individuals of Sea bass fish were caught during the study period, 907 of them were under mature size with low economic value and 293 fish were over matured stage (TL = 32.5 cm), only one of them were more than one kg weight.

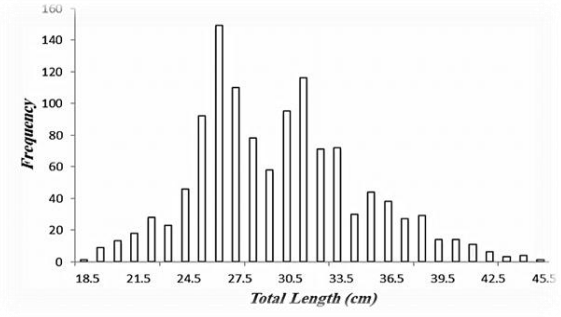

Fig. 4: Length frequency distributions of Sea bass caught with hook and hand line .

On average, 113.6 kg of bass per unit was recorded, of which only 46.3 kg were mature (40.8%), versus 67.3 kg immature (by-catch) representing 59.2% (Figure 5). Salem (2018) estimated the percent of by-catch ≈41% from total bass landings in longline fishery (At different sizes of "J" style hooks) in the same lagoon. The present study decided that hand line fisheries in Bardawill lagoon are not selective. In Ecuador, Zimmerhackel *et al.* (2015) recommended improving the selectivity of the hand lines fishery. By-catch consisted of small sized individuals which contributed to growth overfishing (Alverson *et al.*, 1994).Our results revealed that hand line fishery is not selective for size of sea bass fish, as the most individuals are under-marketable size. El-Aiatt *et al.* (2019) estimated the biomass losses of bass by 52.2 tons in all fishing gears in the same lagoon. To date there are no regulations for size or types of hooks in lagoon, our results demonstrate the need to regulate hand line fishery to minimize the fishing pressure on this important species.

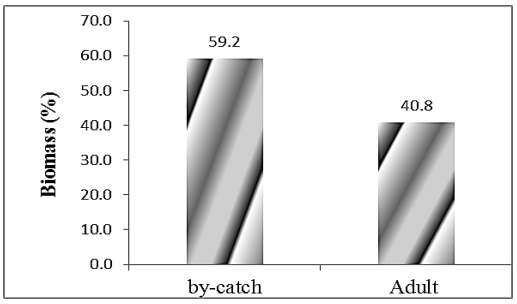

Fig. 5: By-catch and adult of bass in hook and hand line

The results showed that the beginning and the end of the fishing season were characterized by high percentage of by-catch, while the percentage of adult stages was higher in August, September and October (Fig. 6).

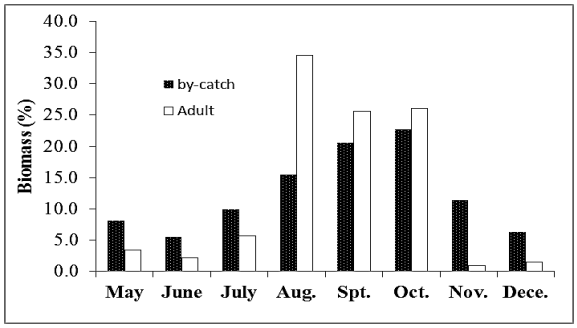

Fig. 6: Monthly percentage of by-catch and adult of bass in hook and hand line

This is may be due to that the most of stock at the beginning of the season did not reach the stage of sexual maturity (age 2 years or less) and the most of mature stages migrated from the lagoon during November and December.Adult fish may be move on their seasonal migrations to feeding or spawning grounds as mentioned by Pawson *et al.* (2007).

Growth parameters; $L\infty$ and K were estimated at 47.25 cm and 0.27 per year respectively (Fig. 7).The decreasing in $L\infty$ can be attributed to the fishing stress on the large fish sizes. Parsons (1982) found that the older year classes were related to the higher value of $L\infty$ for the same species.

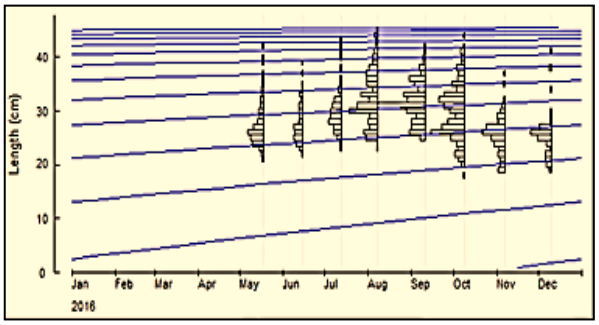

Fig. 7: Length frequency distribution of bass $L\infty$ estimated at 47.25 and K were 0.27 per year.

Total mortality (Z), natural mortality (M) and fishing mortality (F) for the Sea bass were estimated at 0.83, 0.27 and 0.56 year^{-1} respectively. The current exploitation rate (E) was estimated to be 0.68 (Fig. 8). This rate is considered to be higher and it should be reduced to 0.5 year^{-1} as recorded by Gulland (1971) (optimum exploitation rate).

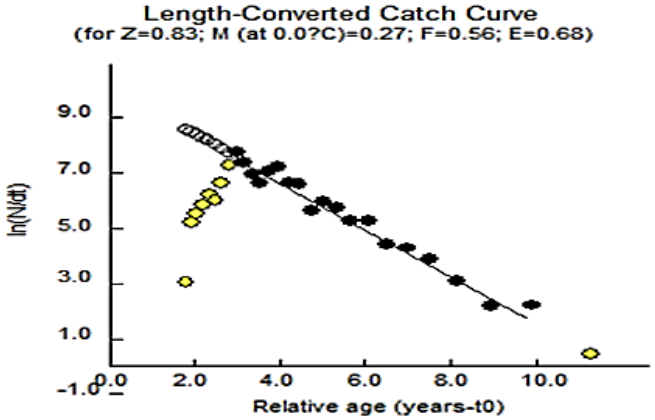

Fig. 8: Length-Converted Catch Curve of bass

The length at first capture (L_{c50}) was estimated at 24.5 cm (Fig. 9). L_{c50} corresponding to weight of 147.3 g. It is clear that the estimated length at the first capture (Lc) is smaller than the length at first maturity (Lm), which could deterioration the bass stock at the long run.

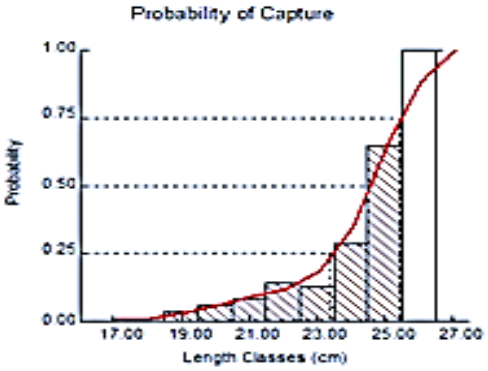

Fig. 9: Length at first capture (L_{c50})

Relative yield per recruit were 0.68, 0.6 and 0.37 at maximum (E_{max}), economic ($E_{0.1}$) and optimum exploitation ($E_{0.5}$) respectively (Fig. 10). At the present values of F= 0.56 yr^{-1}, M= 0.27 yr^{-1} and L_c= 24.5 cm, the exploitation rate was above the maximum, optimum and economic yield indices.

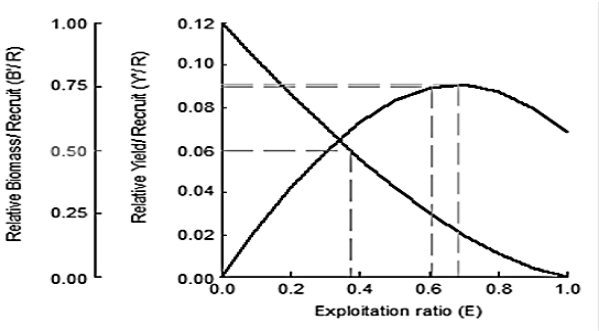

Fig. 10. The relative yield per-recruit and biomass per-recruitof bass at *Lc*=24.5 cm as *Lt.*

The results indicated that small fish sizes are more susceptible to capture by the current hooks andthe stock of bass is a heavily exploited.The current critical size ratio ($^{L_c}/_{L_\infty} = 0.52$) which is a proxy for hook size was indicated overfishing.

Increasing of $L_c$to the first sexual maturity (*32.5 cm as Lt*) would be associated with an increasing of economic relative yield from 0.6 to 0.7(17 %). This result was confirmed by Salem (2011).To decreases the overfishing; the size of hooks should be increased to capture the mature size ratio($^{L_m}/_{L_\infty} = 0.65$) (Fig. 11).

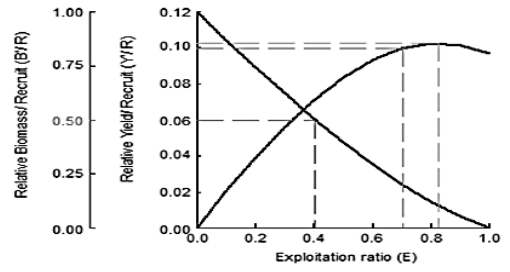

Fig. 11. The relative yield per-recruit and biomass per-recruitof bass at *Lm* =32.5 cm as *Lt.*

The present study concluded that, the current length at first mature of sea bass 32.5 cm (TL) and the length at first capture 24.5 cm (TL). This means that the hand line gear for bass in Bardawill lagoon allows the catch of immature individuals from the stock, reducing spawning stock biomass.By-catches are predominant throughout the fishing season except from August to October.The stock of bass was a heavily exploited by hand line gear (E=0.68).

Therefore, the study recommended that:

The size of hooks should be increased to capture the mature size ratio $L_m/L_\infty = 0.65$.

Fishing from August to October is preferred by hand linegear and prevents the rest of the fishing months.

Exploitation rate should be reduced by 50%.

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ARABIC SUMMARY

تقييم أولي للمصيد الجانبي، النفوق والانتاج النسبي لأسماك القاروص في مصايد السنار اليدوي بمنخفض البردويل ، شمال سيناء، مصر.

محمد سالم

كلية الاستزراع المائي والمصايد البحرية ، جامعه العريش، مصر.

الصيد بسنار الخيط اليدوي هي الطريقة الرئيسية المستخدمة لصيد أسماك القاروص في منخفض البردويل. أجريت الدراسة في المنخفض من مايو إلى ديسمبر ٢٠١٦ لتقييم المصيد العرضي والنفوق والانتاج النسبي لأسماك القاروص من حرفه السنار اليدوي. تم جمع العينات كل أسبوعين من ثلاث قوارب، كل قارب مجهز بثلاثة سنانير بطعم حي. قُدر الطول عند اول نضج جنسي (L_{m50}) بـــ ٣٢.٥ سم كطول كلي. تم حساب الأسماك تحت هذا الطول كمصيد جانبي عددياً ووزنياً (كجم) لكل وحدة صيد وكذلك المصيد الشهري. تم تسجيل ٤٠.٨ ٪ من المصيد لكل وحدة اسماك ناضجة مقابل ٥٩.٢ ٪ غير ناضجة (المصيد العرضي). تسود نسبة المصيد العرضي طوال موسم الصيد باستثناء الفترة من أغسطس إلى أكتوبر. تم تقدير معايير النمو، الطول عند اللانهاية بـــ ٤٧.٢٥ سم وسرعه النمو بـــ ٠.٢٧ سنويًا على التوالي. قُدر معدل الاستغلال الحالي (E) بـ ٦٨% عند معدل كلى للنفوق (Z) يساوي ٠.٨٣ في السنة. قُدر الطول عند اول صيد (L_{c50}) بـ ٢٤.٥ سم. العائد النسبي ٠.٦٨ ، ٠.٦ و ٠.٣٧ عند أقصى استغلال (E_{max})، والاستغلال الاقتصادي ($E_{0.1}$) والاستغلال الأمثل ($E_{0.5}$) على التوالي. أوصت الدراسة بضرورة تعديل حجم الخطافات وذلك للصيد عند الحجم الناضج. يفضل صيد الأسماك بهذه الحرفة في الفترة من أغسطس إلى أكتوبر ويمنع بقية موسم الصيد. يجب أن يخفض معدل الاستغلال الحالي بنسبه ٥٠٪.