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EVALUATION OF DIFFERENT SIZE "WEAK HOOK" C- STYLE HOOK IN BARDAWIL LAGOON FISHERS TO REDUCE NON-TARGET SPECIES, NORTH SINAI, EGYPT

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ABSTRACT

This study is based upon comparative catch data obtained from three fishing sets of different hook sizes carried out in the demersal longlines fishery in Bardawill lagoon. After consultation of fishers, were used three C-style hooks for this study: Nos. hooks size no. 0/3 (with a bend width of 9.9 mm), 0/2 (with a bend width of 7.1 mm) and 0/4 (with a bend width of 11 mm). The demersal longlines used in this study consisted of monofilament mainline 60 mm and 30 mm leaders. The space between leaders was approximately 3 m. Each longline consisted of hooks. To reduce capture of "c" style catch rates a decrease in catch rate with increasing hook size. Mean total length (TL) of eel were significantly different among the three hooks. Eels caught on small hooks no. 0/2 had a significantly smaller mean TL (mean TL 43.9 cm) compared to eel caught on large hooks (No. 0/3 mean TL 61.5 cm). Catch rates of small eel (mean TL 39.1 cm) was highest in December followed by October and November. The highest Catch Per Unit Effort (CPUE) was achieved when large hooks (No. 0/3) were used compared to small hooks (No. 0/2). fishermen in the demersal longline fishery in Bardawil Lagoon are encouraged to use large hooks (No.0/3). Furthermore, future management measures should introduce minimum landing sizes for European eel to avoid capture of small eel (mean TL 45.1) and thereby reduce fishing mortality preventing stock degradation of these economic valuable species. Eels (mean TL 61.5 cm) to reduce capture of small eels (mean TL 45.1 cm) fishermen in the demersal longline fishery in Bardawil Lagoon are encouraged to use large hooks (No. 0/3) with a band width ≥12.7 mm. thereby reduce fishing mortality preventing stock degradation of these economic valuable species.

INTRODUCTION

During the last years, many illegal fishing gears appeared, which led to the deterioration of the fish stock, long line one of these gears, which caused the depletion of the fish stock in the Bardawil lagoon, especially the important economic species. Where the best fisheries management requires that fishing gears should catch the large adult fish while small juveniles are allowed to escape **(Armstrong *et al.*, 1990).** The capture efficiency is defined as the proportion of fish encountering the gear which are retained in the catch. In fisheries management, one of the most widely used technical measures to achieve different managerial objectives is the implementation of more selective fishing gears **(Graham *et al.*, 2007; Eveny *et al.*, 2009; Condie *et al.*, 2014).** Size selectivity by larger hooks was clearly demonstrated for some fisheries **(Cortez-Zaragoza *et al.*, 1989; Otway and Craig, 1993),** but in other cases, catch size distributions seemed to be nearly independent of hook size **(Erzini *et al.*, 1996, 1998,1999; Halliday, 2002; Stergiou and Erzini, 2002; Cooke *et al.*, 2005).** The

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percent of juveniles were dominated in the catch competition of longline fishing in Bardawil lagoon. Hand line gear is the main fishing method used, that target sea bass and European eels in Bardawill lagoon. **(Salem, 2018 and 2019).** Knowledge of how gear selectivity influences the catch of managed species is important for improving catch efficiency in directed fisheries, providing guidance to management on regulatory actions, and informing the assessment process **(McAuley *et al.*, 2007)**. Thus, the current study aimed to provide a basis for determining the most suitable hooks size to reduce the capture of undersized species in Bardawil lagoon to using c-style hook sizes.

MATERIALS AND METHODS

Study Area

The study was carried out in Bardawill lagoon (Fig. 1). The lagoon is a natural depression and covers an area of ≈ 650 km2 with a depth of 0.3 to 3 m **(EEAA, 2008).** It is one of the largest saltwater lagoons in the northern coast of Sinai province of Egypt. It is one of the most important fishing grounds in Egypt, since it is the largest and almost free of pollution lagoon **(El-Bokhty and El-Aiatt, 2014).**

Gear Design

Demersal longlines operations targeting some species in the lagoon. This study is based upon comparative catch data obtained from three fishing sets of different hook sizes carried out in the demersal longlines fishery in Bardawill lagoon. The study was conducted in period From October to November During 2019 and repeated in 2020.After consultation of fishers, were used three C-style hooks for this study: Nos. hooks size No. 0/3 (with a bend width of 9.9 mm), 0/2 (with a bend width of 7.1 mm) and 0/4 (with a bend width of 11 mm) as shown in Fig. 2. The demersal longlines used in this study consisted of monofilament mainline 60 mm and 30 mm leaders. The space between leaders was approximately 3 m. (Fig. 2).

Fishing Experiment and Sampling

The fishing area was based on recommendation from fishers. These were characterized by sandy-mud habitat and depths ranging from 1.5 to 2.5 m. The demersal longlines used in this study consisted of monofilament mainline 60 mm and 30 mm leaders. The space between leaders was approximately 3 m. Hooks were baited with small shrimp. Within each fishing trip, six longlines, two per treatment, were deployed. Fishing time was kept the same for all treatments. During the study period, nine fishing trips (one fishing trip equaled one day) were carried out; three fishing trips per month. Longlines were set during the nights only and retrieved after approximately one hour. Catches were iced, labeled and transported to the laboratory for processing. In the laboratory, catches were sorted by species and total length (TL) measured to the nearest 0.1 cm and weighed. Some species were classified into two groups: target (adult) and non-target (juvenile). The species were divided as follows: eels (adult, ≥ 50 cm TL) and undersized (juvenile < 50 cm TL), sea bass adult, ≥ 30.0 cm TL) and undersized (juvenile < 30.0 cm TL), sea bream adult, ≥ 24.5 cm TL) and undersized (juvenile < 24.5 cm TL) to examine differences in catch rates by hook size. Length at first capture and minimum legal size were determined according to FAO database, annual reports of ICES and previous results (e.g). The catch data were standardized pooling all monthly fishing trips (900 hooks). The mean Catch Per Unit Effort (CPUE) was calculated dividing the total weight (kg) by the pooled monthly fishing trips (900 hooks). Differences in catch rates, sizes and mean CPUE of eel caught on different hook sizes (Each one No. = 2100 hooks) were assessed using ANOVA.

Fig. 1. Map of Bardawill lagoon

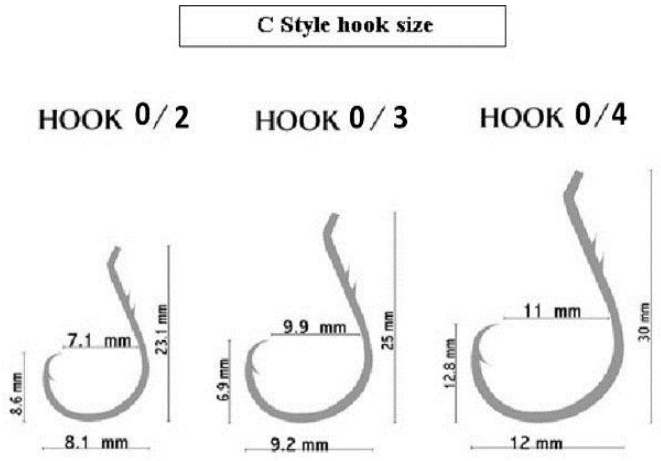

Fig. 2. Shapes and dimensions of hooks

Photo. 1. Some species of catch

RESULTS

This study provides the first attempt to determine different hook sizes in C-style. The catch rates in "c" style hooks decreased with increasing hook size. Results indicated that, four fish species were caught, weigh a total of 28.963 kg. Decreasing hook size led to increase fish catches; 12.22, 11.999, and 4.75 Kg with hooks size No. 0/2, 0/3 and 0/4, respectively. Catches were dominated by eels accounting for 55.8% by number and 64.3% by weight, followed by a few species as seabream (*Sparus aurata*) and seabass (*Dicentrarchus labrax*). C-style catch is composed of different fish species, but the most frequent one is the European eel, *Anguilla anguilla* forming 18.37 kg, followed *by Sparus aurata* (4.92 kg), the *Dicentrarchus labrax* (2.37 kg) and *Platycephalus indicus* (3.33 kg).

There were significant differences ($p < 0.05$) in numbers of eel caught by different hook sizes. Average total landing for eel caught on hook size No. 0/3 was significantly different from those caught by hooks No. 0/4 and 0/2. Also, there were significant differences ($p < 0.05$) in mean TL for eel between hook size No. 0/3 and the other two sizes No. 0/4 and 0/2. Mean TL was estimated as 43.9, 61.5 and 39.1 cm for hook sizes No. 0/2, 0/3 and 0/4, respectively. Mean TL of eel were significantly different among the three hook sizes. Eels caught on small hooks (No. 0/2) had a significantly smaller mean TL (39.1 cm) compared to eel caught on large hooks (61.5 cm for hook No. 0/3). Catch rates of small eel was the highest in December followed by October and November. The highest CPUE was achieved when small hooks (No. 0/2) were used compared to large hooks (No. 0/3). To reduce capture of small eels of mean TL equal 43.9 cm, fishermen in the demersal longline fishery in Bardawil lagoon are encouraged to use large hooks (No. 0/3 for C-style) with a band width ≥12.7 mm. Furthermore, future management measures should introduce minimum landing sizes for European eel to avoid capture of small eel (mean TL 45.1) and thereby reduce fishing mortality preventing stock degradation of these economic valuable species (Fig. 3).

Four main species were recorded as a composition of longline catches, European eels constituted the most dominant fish species by weight (18.37 Kg) followed by Sea bream (4.52kg) Sea bass (2.37Kg) and sandflatfish (3.33 kg). Also, observed total length of 76 European eels follow of 39 to 71 cm, Sparus aurata ranged from 15.2 to 23 cm and the weight from 47 to 132 g. Size-structure of fish were grouped. Midlength of 15.5 cm showed the highest frequency distribution (0-age group) and the highest length recorded during the study period was 73.1 cm in the European eels (Fig. 4).

In respect to the monthly catch of both adult and juveniles that recorded in different hook sizes of C-style, hook No. 0/4 recorded the highest production of adults during all months of the experiment. Juveniles were appeared in considerable amount in November, at a rate of 47.84% (Fig. 5). While in hook No.0/3 the highest production of juveniles was noticed in October, at a rate of 47.33%. While, the highest production was of the adult stages in was of December by 100% (Fig.6). The results also indicated that for hook No. 0/2, the highest production of the juvenile was in October at a rate of 100%. While, the highest production of the adult stage was in December forming 50.30% (Fig.7). The highest CPUE (0.68 Kg/boat/ fishing day) was achieved by hook size No. 0/2, while the lowest CPUE (0.04 Kg/boat/ fishing day) was achieved by hook size No. 0/4 and CPUE of the hook size No. 0/3 was 0.67 Kg/boat/fishing day (Fig. 8).

On the other hand, the length-frequency distribution of eel for each hook size of C-style. The distributions are overlapping and significantly different among the different hook sizes (No. 0/4, 0/3 and 0/2). Length range recorded by different hook sizes of eel was 30.6 – 56, 35.2 - 87.1 and 39.2 - 63.7 cm for hook sizes No. 0/4, 0/3 and 0/2, respectively. Fig. 9 presents the average total length of eel caught by different hook sizes where it estimated as 43.69, 62.26 and 46.79 cm of hook No. 0/2, 0/3 and 0/4, respectively.

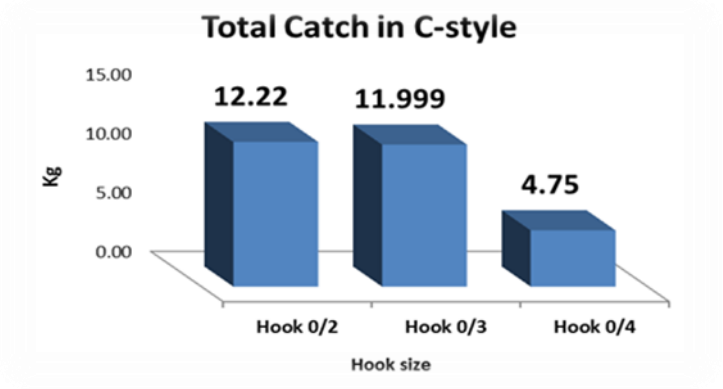

Fig. 3. Total catch of different hook sizes in C- style

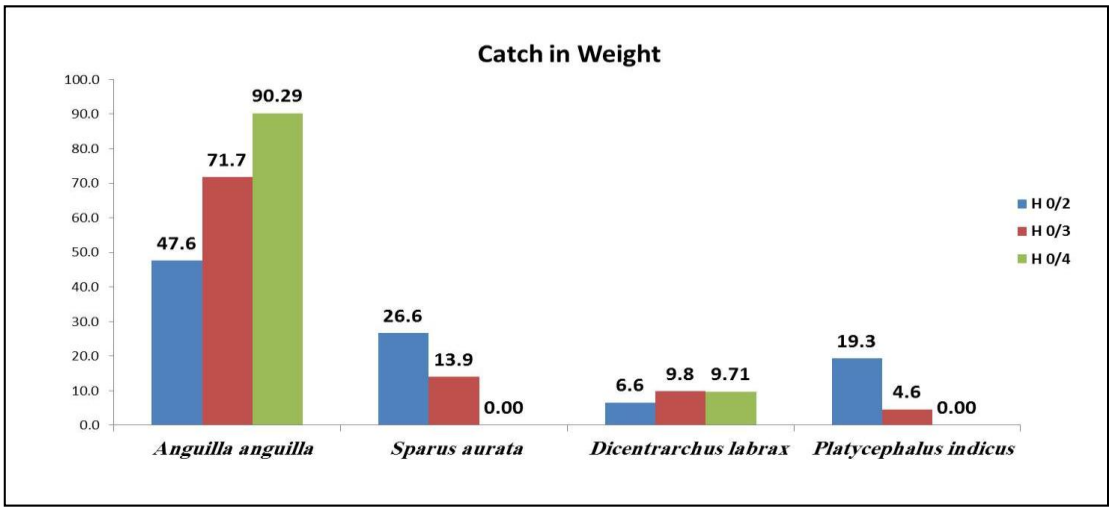

Fig. 4. Catch composition from different hook sizes of C-style

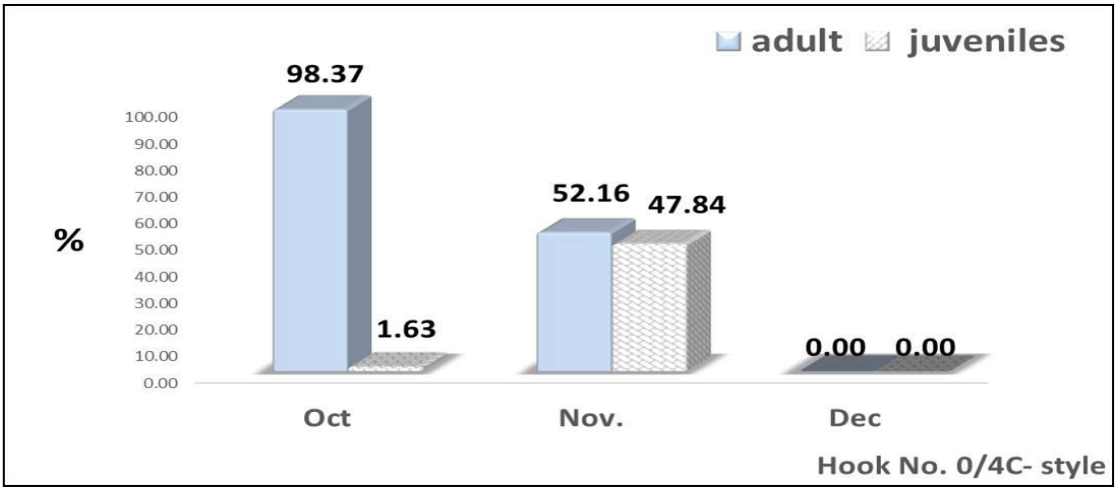

Fig. 5. Monthly, Total catch (adult and juveniles) in hook No. 0/4 C-style

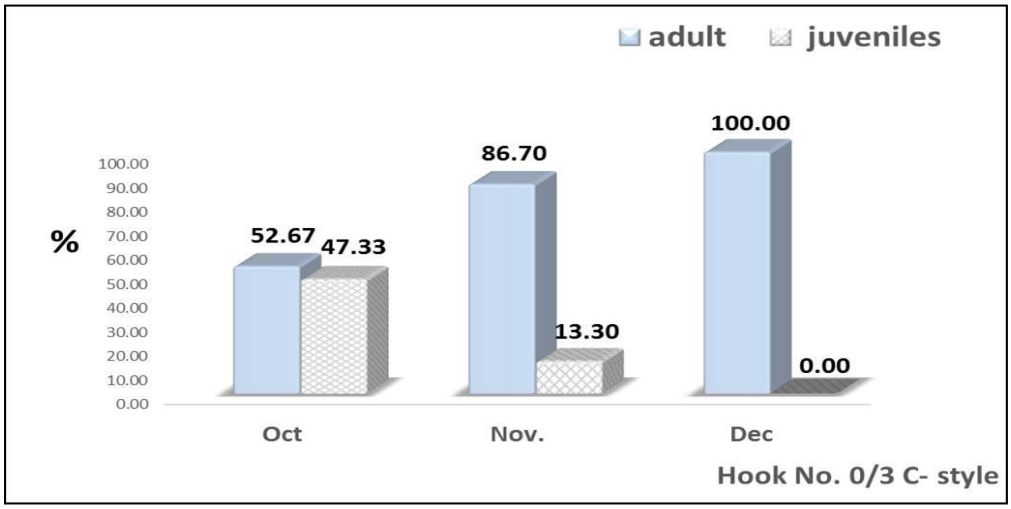

Fig. 6. Monthly, Total catch (adult and juveniles) in hook No. 0/3 C-style

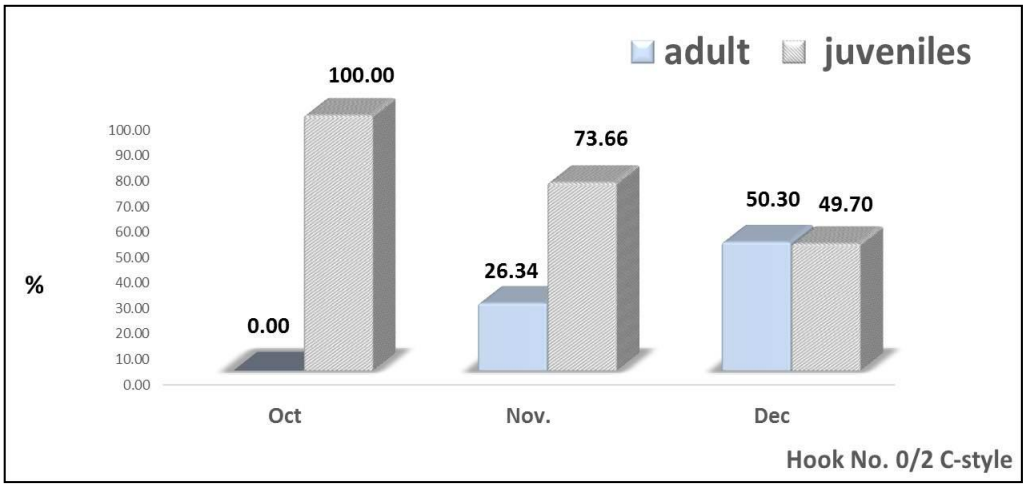

Fig. 7. Monthly, Total catch (adult and juveniles) in hook No. 02 C-style

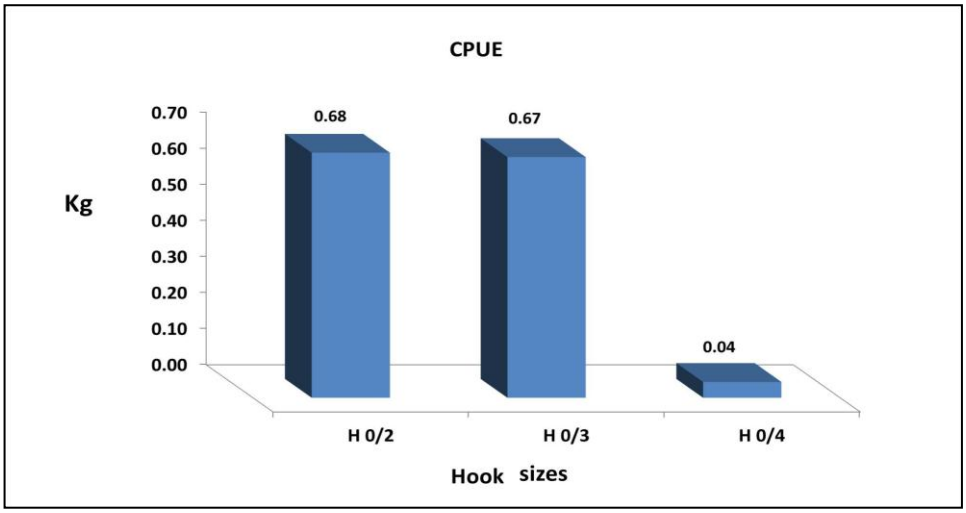

Fig. 8. Catch per unit effort using different hook sizes of C-style

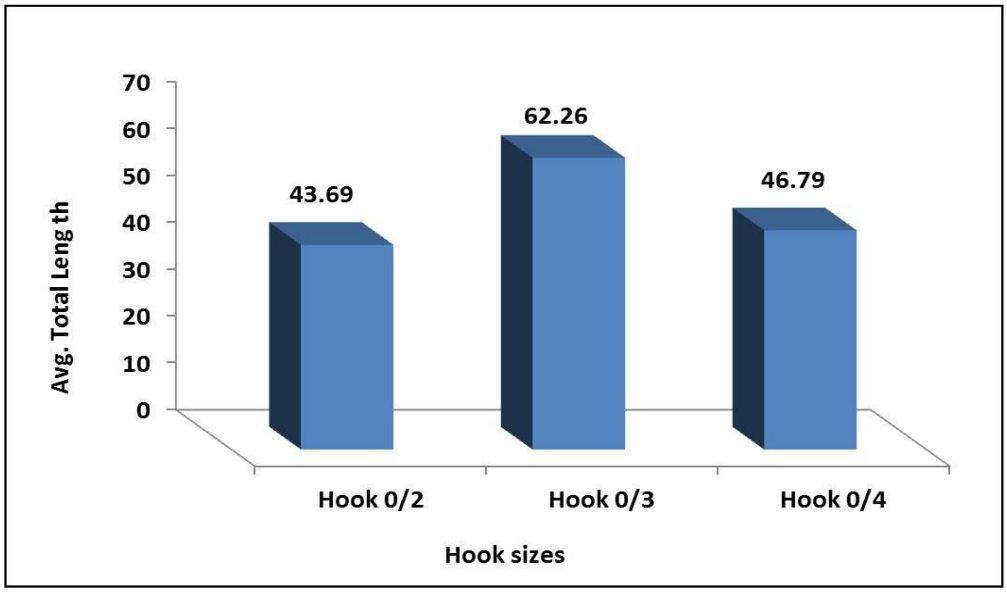

Fig. 9. Average Total length in different hook sizes for C-style

DISCUSSION

In our experiment, preliminary assessment of the impact of different hook sizes on the catch of some species, since there is no legislation limiting hook and line gear, which needs to be taken into account for future fishing operations in Bardawill lagoon. There is a lack of information online gear, catch composition; catch rates and factors which affect them. The total weight of eel in the use of small hooks was significantly higher compared to large hooks. Hook size affected only the numbers and weights of individuals caught, but also the diversity of the catch as a whole. Bream fishes were captured with hooks. The numbers and species composition of fish caught can be influenced by a number of variables such as hook size and design **(Erzini *et al.*, 1998)** where they found that, smaller hooks (No. 0/2 and 0/4) caught more breams (Sparidae) than larger hooks (No. 0/3). Landings in weight and the diversity of species caught were lower with large hooks (No. 0/3). Decreasing the hook size led to higher catch rates of most species. Results indicated significant differences in target eel size and catch rate (number and weight) between the commonly used hook size (No. 0/3) and the other two hook sizes (Nos. 0/2 and 0/4) used in this study. This result was confirmed by previous studies as **Otway and Craig (1993)**, **Alos *et al.* (2008) and Mongeon *et al.* (2013)** . authors found an inverse relationship between catch rates and hook size where generally smaller hooks gave higher catch rates than larger ones. In a study conducted by **Patterson *et al.* (2012)** on the size of circle hooks, they found that, increasing hook size led to increased capture size and greatly diminished the diversity of the catch. This result differed from **Ralston (1982); Bertrand, (1988)**, **Fernö and Olsen (1994)** which noted that different hook sizes did not notably modify catches. Results showed apparent lack of differences in size distribution between small hooks and little evidence with the large hook while there were negatively relation among hooks size and the catch rates as the greater proportion of catch was achieved smaller hooks. Therefore, the hooks size could impact fishing effort and change the dynamics of

eel. These results are confirmed by **Erzini *et al.* (1999)** in a study on different hook sizes, where they found the highest catch rate was obtained with the smallest hook. Catch rates are influenced by a number of variables in fisheries as hook size **(Piovano *et al.*, 2010).** Decline in catch rate with increasing hook size for all fishes was observed by **Garner *et al.* (2014).** However, the increasing of hook size led to catch large fishes, it also reducing the number of smaller one. Though the general overlapping of length frequency curves of different hook sizes, a size 0/3 hook offers the best result to reduce the young eels in fishery. The size of the hook affects the structure of the size and distribution of the length of the catch **(Punt *et al.*, 1996; Bayse and Kerstetter, 2010).** It is not surprising that the catch size-frequency distributions of the different-sized hooks were often overlapping **(Erzini *et al.*, 1996; 1997 and 1999).** By-catch is critical component of fisheries management, as catch of undersized fishes and non-targeted species represented a global fisheries problem **(Davies *et al.*, 2009)**. The present work revealed that landings of by-catch species were much higher for the small size hooks than for the large size hook. By-catch is high (>100% of targeted landings), moderate and low with hooks size No. 0/2, 0/3 and 0/4, respectively. This result that is consistent with previous research as Bacheler and **Buchel, (2004)**. Hooks size was effective strategy to mitigate by-catch in demersal longline fishery especially of the European eels. Selectivity of the hooks is due to the choice of the hook itself in relation to the size of the fish. Small-sized fish can swallow a hook no bigger than a certain size. While large fish escape from the small size hooks where the small hooks cannot hook the large fishes. Portion loss has already been observed of the large fishes during the fishing operation by the small hooks. Therefore, by changing the size of the hook can control the side catch of small-sized fish satisfactorily. Although Large hook No. 0/4 may be the most appropriate hook to use. Increasing the hook size used in a fishery can exclude undersized fish **(Alos *et al.* 2008; Campbell *et al.*, 2014)**. The results showed a significant increase in CPUE using the small hook. Similar results were obtained by **Halliday, 2002**. Circle hooks have been proposed as a conservation measure to reduce mortality for vulnerable by catch species that have high rates of interaction with longline gear.

Conclusion

Study suggests that hooks size No. 0/4 and 0/2 in C- style regulations in adult fish do not efficiently target sizes to achieve reductions in by-catch. While the by-catch and juveniles were negligible in the catches of hook No. 0/3. In the case of hooks No. 0/4 and 0/2 by-catch and juveniles accounted dangerous numbers. Also, Fishing should be prevented by this gear during October of each year due to the high by-catches in this period, especially the fish juveniles. Finally results revealed that the C-style hooks No. 0/3 is the most preferable hook choice, it must be done evaluation of all fishing gears in Bardawil lagoon. also, these are important recommendations for sustainable development of demersal longline fisheries in Bardawil lagoon.

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الملخص العربي

تقييم للإحجام المختلفة "الخطاف الضعيف" للنمط الخطاف C في مصيد منخفض البردويل لتقليل الأنواع غير المستهدفة، شمال سيناء، مصر

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قامت الدراسة بالمقارنة بين أنواع الخطاف المختلفة للمصيد التي تم الحصول عليها من ثلاث مجموعات صيد، ولقد تم إجراؤها بمصايد الخيوط الطويلة القاعية بمنخفض البردويل. بعد استشارة الصيادين، استخدمنا ثلاثة انواع مختلفة من الخطاف من النمط C في هذه الدراسة: في الخطاف رقم ٣/٠ (بعرض انحناء 9.9 مم)، 2/٠ (بعرض انحناء 7.1 مم) و4/0 (بعرض انحناء 11 مم). الخطوط الطويلة المستخدمة في هذا الدراسة من خيوط رئيسية أحادية 60 مم و30 مم. كانت المسافة بين القادة حوالي 3 م. كل خط طويل يتكون من مجموعه من الخطاطيف. لتقليل معدلات الالتقاط لنمط "c"، يتم تقليل معدل الصيد مع زيادة حجم الخطاف. كان متوسط الطول الكلى من ثعبان البحر مختلفًا بشكل كبير بين الخطافات الثلاثة. صيد الثعابين على خطافات صغيرة رقم 2/0 كان متوسط الطول الكلي أصغر بكثير (متوسط 43.9 سم) مقارنة بثعبان السمك الذي يتم صيده على خطافات كبيرة (رقم 3/0 يعني 61.5 سم). كانت معدلات صيد ثعبان السمك الصغير (متوسط طول 39.1 سم) حيث كان أعلى معدلاتها في شهر ديسمبر تليها أكتوبر ونوفمبر. تم تحقيق أعلى CPUE عند استخدام خطافات كبيرة (رقم 3/0) مقارنة بالخطافات الصغيرة (رقم 2/0). يتم تشجيع الصيادين في مصايد الخيوط الطويلة في منخفض البردويل على استخدام خطاطيف كبيرة (رقم ٠ /٣). علاوة على ذلك، يجب أن تقوم الادارة في المصيد بتعديل الخطاف المستخدم للحد من أحجام إنزال ثعبان السمك الأوروبي لتجنب صيد ثعبان السمك الصغير (متوسط 45.1) وبالتالي تقليل معدل وفيات الصيد مما يمنع تدهور مخزون هذه الأنواع ذات القيمة الاقتصادية. ثعابين السمك (متوسط 61.5 سم) لتقليل صيد ثعابين السمك الصغيرة (متوسط 45.1 سم) يتم تشجيع الصيادين على استخدام مصايد الخيوط الطويلة في منخفض البردويل على استخدام الخطاف الاكبر (رقم 3/0) بعرض نطاق ≤12.7 ملم. وبالتالي تقليل معدل وفيات الصيد مما يحول دون تدهور مخزون هذه الأنواع الاقتصادية القيمة.

الكلمات الاسترشادية: مصايد الخيوط الطويلة، حجم الخطاف، منخفض بردويل، النمط c، سمك ثعبان البحر، القاروص، الدنيس.

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