Improvement of Trammel Net Landing and Reduction of Fishing for Gilthead Seabream (*Sparus aurata*) Juveniles in Bardawil Lagoon, North Sinai, Egypt.

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Abstract: Four types of trammel nets A & B & C and D as mesh sizes of 30, 32, 34 and 36 mm were used to assess the efficacy of various trammel nets modification to select and reduce the small seabream, Sparus aurata. After twenty-eight hauls, average yield of bream was calculated per haul as follows: 2.01, 1.83, 1.37 and 0.48 kg for 30, 32, 34 and 36-mesh sizes, respectively. Also, average weights of untargeted catch species were calculated per haul as follows: 2.86, 1.89, 0.84 and 0.37 kg for the same models, respectively. The sizes of fish were affected by different meshes, where the length at first capture increased with meshes from 15.2 cm in the 30-mesh size (smallest mesh size) to about 24 cm for the 36-mesh size (largest mesh size). Results indicate that substantial improvement in size-fish for these commercially important species is achieved by switching from the conventional 30 and 32 mm-mesh sizes to a 34 mm-mesh size. The minimum mesh size of the trammel nets especially used in seabream fishery must be 34 mm in order to protect fish stocks and optimum catch efficiency for the future. On the economic level, the study showed that the use of C model will slightly decrease the total income on a short term but will protect fish stock and secure a profitable on long term. Hence, there is a need to identify the potential long and short-term benefits by lagoon management.

Keywords: Trammel net, *Sparus aurata*, by-catch, Bardawil lagoon, Egypt.

INTRODUCTION

Trammel net is a passive gear widely used in Bardawil lagoon fishery. Seabream, *Sparus aurata* is a main target species of catches in trammel fishing. Trammel net which work in Bardawil fishery is illegal net where it bring in large quantities of by-catch which it often includes juveniles of economic fishes, small individual of target species and crabs. Machias *et al.* (2001) mentioned that the main problem in the Mediterranean is the absence of monitoring of the discarded fraction of the catches. The selectivity studies and the effects of mesh size changes are considered of great importance for the management of fisheries (Pestana and Riberio-Cascalho, 1991; Sobrino *et al.*, 2000 and Campos *et al.*, 2002). Poor data on by-catch and discarding rates can lead to biased estimates of fishing effort and mortalities. In order to manage marine fisheries effectively, we must assess and manage by-catch (Alverson *et al.*, 1994). By-catches impact on the ecosystem by increasing the mortality of the incidentally captured species and have an economic impact when consisting the juveniles of commercially valuable species and food fish and hence constitute a threat to food security and sustainable fisheries (FAO, 2006). The present worke assessed the efficacy of various different mesh sizes of trammel net aimed to reduce sea bream fish discarding. This study, which is among the first ones related to sea bream as the target species caught by trammel net in Bardawil lagoon, aiming to fill the gap in this field.

MATERIALS AND METHODS

Study area:

The study was carried out in the Bardawil lagoon (Fig. 1).The lagoon covers an area of 693 km^2, in an arid area in the northern part of Sinai Peninsula, Egypt. It separated from the Mediterranean Sea by along narrow sandbar that varies in width between 100 m and 1 km. The lagoon is connected with the Mediterranean Sea by two artificial and one natural narrow channels. The lagoon is considered as a natural depression with a depth of 0.5-3 m.

Nets design:

Four models of trammel nets namely A, B, C and D (The model is 500 m long and 1.5 m depth of trammel net) differ only in inner mesh size were used in this experiment. Trammel nets consist of three panels: the inner panel has a small mesh size (which was measured using ruler) and light hand force to stretch the mesh [mesh sizes of 30 mm (this size is the same type of that used by fishermen in Bardawil lagoon), 32, 34 and 36 mm]. The inner panel sandwiched between two outer layers of larger mesh size (12.5 mm) and stretched. Nets color was transparent and used to catch the bream fish.

Fishing experiment and sampling collection:

The study is conducted between May and November 2010 using small boat (which length of 6 m and was powered by 9.9 horsepower outboard engine) and equipped with four models of mesh sizes. Nets were set to touch the bottom by weights and held vertically in the water by floats on the top. Twenty-eight hauls for each mesh size were randomly sampled (nets were set one hour before sunset and hauled one hour after sunrise). Trammel nets entangle fish in bags or pockets of netting, when fish were attempt to pass the outer panels, pushed the inner panel, and are carried through to the other outer panel, which creates a bag or pocket, thereby trapping the fish.

Catch recording and data analysis:

The bream fish of each model were washed and sorted after measuring the total length (Lt) to the nearest centimeter and weighed to the nearest gram. Other catch were sorted, identified and weighed. Using the plot of

the probability of capture against lengths for each mesh size to determine the L_{50} (length at which 50% of the fish is retained).

Economic analysis:

The catch was sorted in grades. For each one, average prices per kg were determined. Income differences between the models were calculated.

Statistical analysis:

Analysis of variance (ANOVA) was used to test differences of the catches among net mesh sizes. F-test was applied for comparison of pairs of the mean catch and income of mesh sizes models (SAS Institute, Cary, NC, USA, 1997).

RESULTS AND DISCUSSION

The samples of experiment:

Seabream, *Sparus aurata* stock in the Bardawil lagoon is heavily exploited (Khalifa, 2005 and Mehanna, 2006) and their catches showed a serious decline. This study confirms previous studies, where the samples of seabream, *S. aurata* (target catch) was sorted to three grades, bream no. 1 (200 g per fish and more), bream no.2 (100 -200 g per fish) and bream no.3 (100 g per fish and less). The grade no. 3 is the dominated fish of samples, corresponding with the landing of bream by fishermen in Bardawil lagoon (Fig. 2). Untargeted catch species, *Solea sp., Mugil cephalus, Liza ramada* and other species weighs (kg) are illustrated in Table 1. The most of untargeted catch species were small fish; indicating that illegal mesh sizes and rising of by-catch. By-catch reduction studies mostly concerned on the trawl fisheries (Graham, 2003 and Fonseca *et al.,* 2005), where trammel net is more selective than trawl nets, while it is less selective than a gill net, in terms of the size and species caught (FAO, 2006).

Yield and mesh sizes:

After twenty-eight hauls, average yield of bream was calculated per haul for all tested models as follows: 2.01, 1.83, 1.37 and 0.48 kg for A, B, C and D, respectively (Fig. 3). The A model is the highest yield but the most of catch is a juvenile fish (17 fish / kg) followed by model of B (10 fish / kg). Models of C and D gave the lowest yield and largest fish (7 and 4 fish / kg, respectively). Also, average weights of untargeted catch species were calculated per haul as follows: 2.86, 1.89, 0.84 and 0.37 kg for A, B, C and D models, respectively (Table 1). It was clear that the models of A and B were the highest in the fishing and fish is juvenile stage. Many studies have documented that, larger fish are more vulnerable to fishing than smaller fish but the trammel catch in Bardawill lagoon is not consistent with that where the most of trammel nets are illegal mesh sizes (30-mesh size) and the stock under-growth overfishing as a mentioned by Mehanna *et al.* (2010) and Salem (2011). Bream fish were allowed to be caught with a minimum weight of 100 g per fish (10 fish / kg) according to Bardawil fishing regulations. Mehanna *et al.* (2011) mentioned that, the minimum market size for seabream is 300 g.

Length at first capture and mesh sizes:

Four tested models of trammel nets A, B, C and D differ only in inner mesh size, where the catches and the size selectivity of trammel nets depends on the mesh size of the inner net (Koike and Takeuchi, 1985, Purbayanto *et al.,* 2000 and Erzini *et al.,* 2006). The length at first capture (L_{50}) is proxy of mesh size and use to compare the effectiveness of capture. This study indicated that, the sizes of catch were affected by different meshes, where L_{50} increased with meshes from 15.2 cm in model A (smallest mesh size) to about 24 cm for model D (largest mesh size). Our results indicated that, L_{50} was about 15.2 cm an average weight of 60 g and 17.4 cm an average weight of 99 g caught with A and B models, respectively. The catches of A and B models are illegal lengths according to fishing regulation of Bardawil management where catch is 0-group and immature fish while the good fisheries management require that fishing gears should catch the large adult fish and juveniles were allowed to escape (Cetinic´ *et al.,* 2002). L_{50} of C and D models are 19.5 and 23.7 cm, respectively (Fig. 4). The L_{50} which caught by A model was close to that of Salem (2011) in Bardawil lagoon, who estimated the length at first capture as 15.54 cm, which shows that the main trammel net in the lagoon is 30-mesh size. Also, who recorded that, the raised L_{50} from 15.54 to 24.5 cm would be associated with an increase of yield by 38 %. As a result that, most of bream catch in Bardawil lagoon was below the length at first sexual maturity (length at first maturity as 20.5, Salem, 2011) which must have a chance to spawn 2–3 times before capture (Grandcourt *et al*, 2005).

Income and economic losses:

Of the dominant average prices, average income of bream catch was calculated for each test model per haul. It was found that, B type is the highest in average cash income 109 LE followed by A type with an average 104.4 LE then C type averaging 98.9 LE and D type in the rear an average of 52.8 LE.

From view economic level, marketable bream fish of Bardawil lagoon had the highest price (average: 9-10 $ per kg), where the general market size for sea bream is 200 g with prices 9 $. Our results indicated that, 68% of bream sizes were less than 100 g with prices reach 4 $. Incomes showed in Figure 5, where the income of B model was slightly higher than of A model and followed by C and D models, respectively. On a long run, a huge economic losses will occur with two mesh sizes (A and B models) where the most of catch at 0-group. Mehanna (2007) and Salem (2010) mentioned that, the bream attained to 1st year at 21.26 and 21.22 cm in Bardawil and Port Said, respectively. The losses were estimated at least 68% (36% A and 32% B models) of total bream catch (juveniles) annually with illegal trammel gear (Fig.6), where that fish become marketable size after one year from current catch. This means that, we waste more than half of our resources of bream fish annually, which can be caught after one year only. Generally, the fishing activity addressed to the catch of certain sizes uneconomic. The mesh size currently used in the trammel 30 and 32 mm (global legal mesh size was 36

mm, which have a very low probability of retention for small-sized individuals). Inverse proportionality between total income and mesh sizes (Fig. 7) was found. Model A is the highest total income followed by B, C and D models, respectively. The study showed that the use of C model will slightly decrease the income on a short term but will protect fish stock which would have a chance to spawn one time at least before reaching the mean size at first capture. Hence, there is a need to identify the potential long and short-term benefits by lagoon management.

Statistical analysis:

Analysis of variance (ANOVA) was used to examine the differences of yield, the length at first capture (L_{50}) and income with mesh sizes as:

1. For the weight of yield: types A & B are the highest in weight and there are no significant differences between them. D is the least in weight and there were significant differences evident with the other three types. There were no significant differences evident between B & C.
2. For the length at first capture (L_{50}) of bream: L_{50} was significantly different among the four nets. L_{50} increased significantly with the mesh sizes increases.
3. For the total income: Despite the high weight with less mesh sizes, there were slightly significant differences among incomes of nets, except 36-mesh size. No significant differences evident between A & B models.

Table (1): Weight (kg) of untargeted catch species for different models.

Species	Mesh sizes			
	30	32	34	36
	Kg			
Solea sp.	1.15	0.57	0.26	0.08
Mugil cephalus	0.43	0.50	0.37	0.17
Liza ramada	0.55	0.36	0.10	0.05
Other species	0.74	0.47	0.12	0.08
Total	2.86	1.89	0.84	0.37

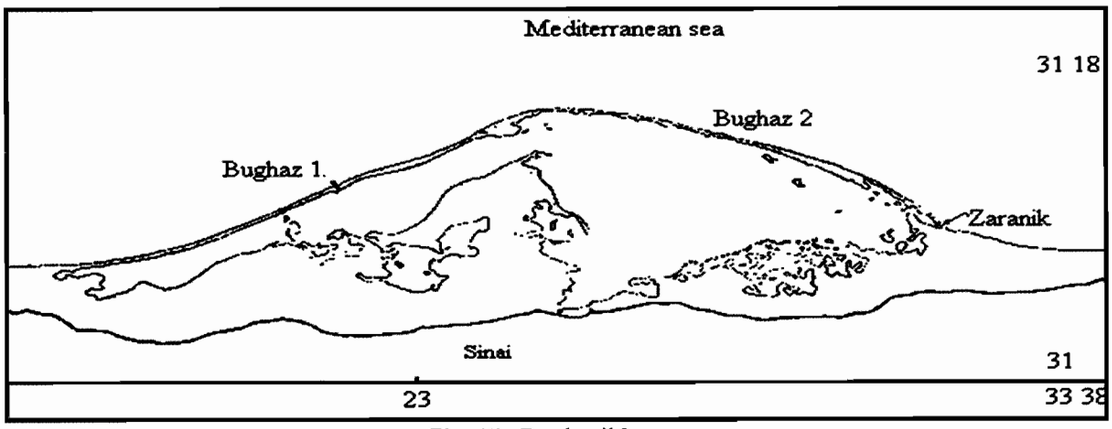

Fig. (1): Bardawil lagoon

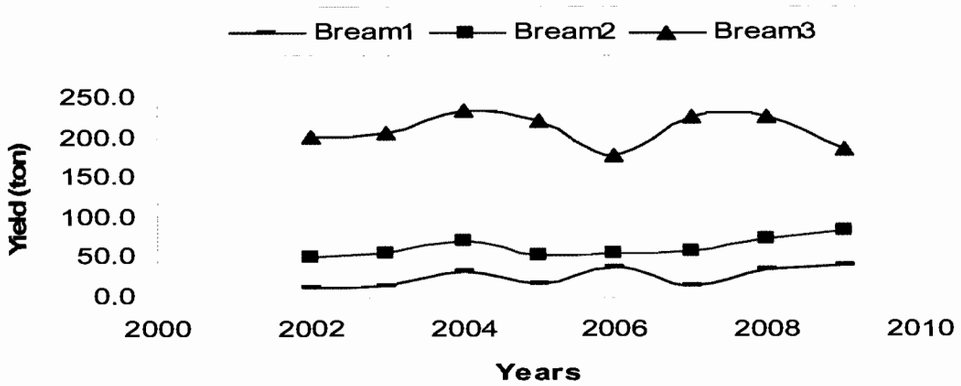

Fig. (2): Yield Seabrean, *S. aurata* sorted into grades from landing in Bardawil lagoon (2009)

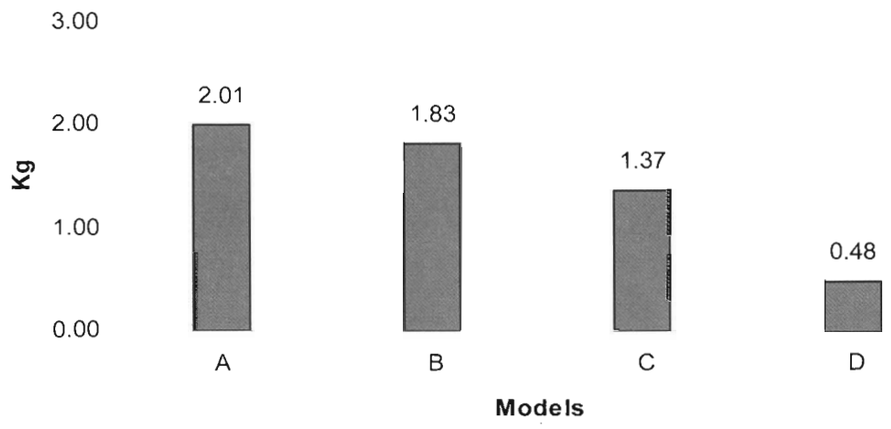

Fig. (3): Average yield (Bream) per haul for different models

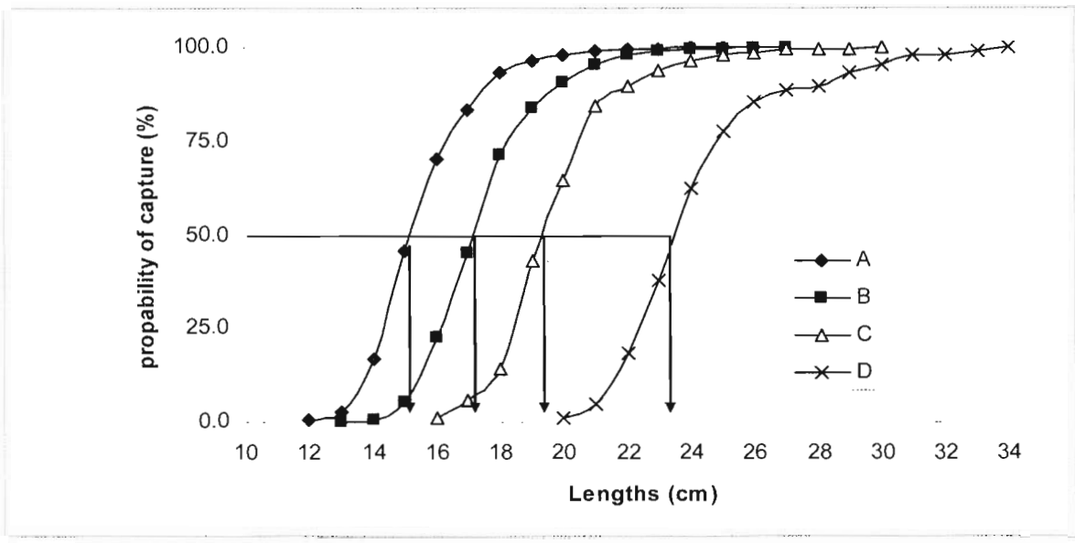

Fig. (4): The length at first capture (L_{50}) of bream for different models

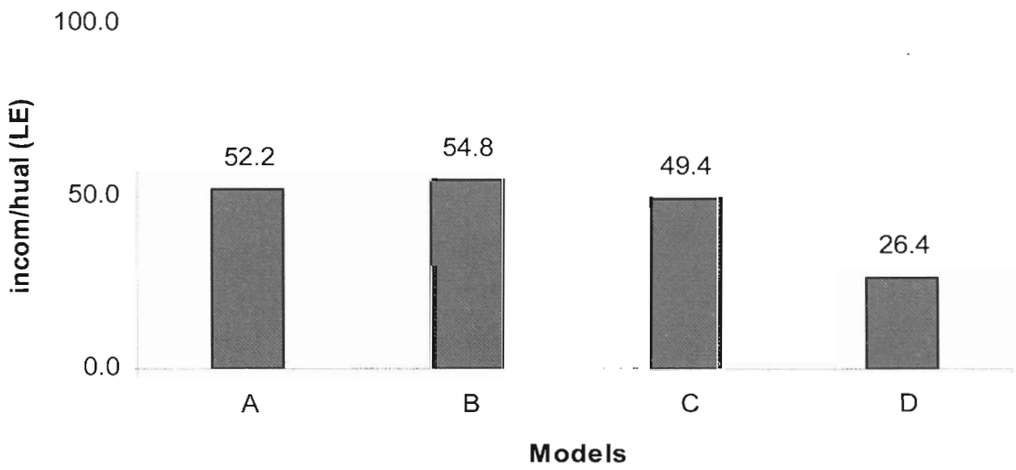

Fig. (5): Income (LE) per haul of bream for different models

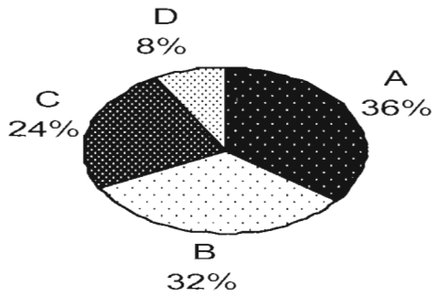

Fig. (6): Percentage of seabrean, *S. aurata* catch from experimental models.

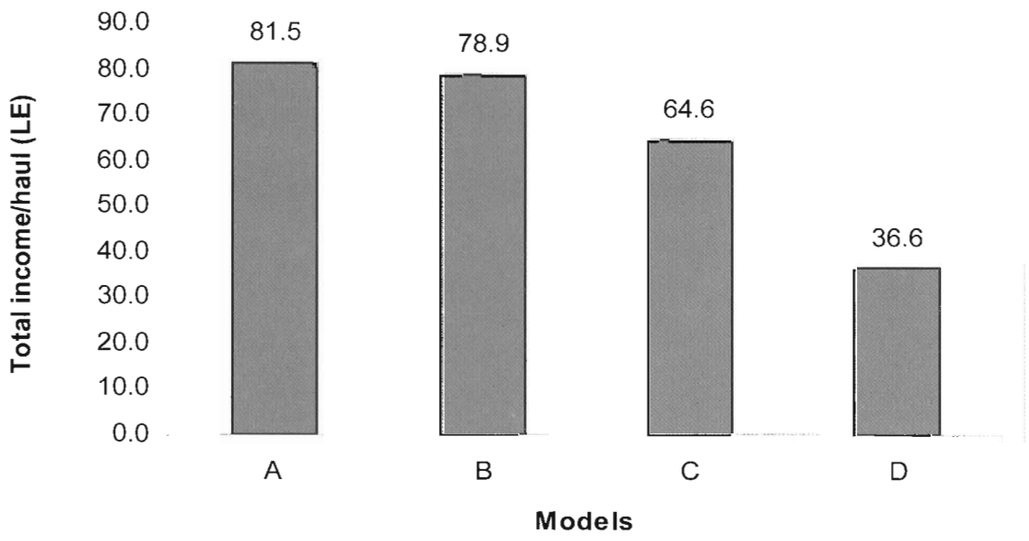

Fig. (7): Total income (LE) per haul for different models

CONCLUSION

This study concluded that, it is possible to release a substantial percentage (68%) of juvenile using technical modification for the existing mesh size designs, where significantly reduced juvenile with C model (34 mm-mesh size) was obtained. In addition, the use of C model will protect the fish stock and would have a chance for bream fish to spawn one time at least before reaching the mean size at first capture.

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تحسين المصيد والحد من صيد زريعة أسماك الدنيس بشباك الدبة فى منخفض البردويل، شمال سيناء، مصر.

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استُخدمت أربعة نماذج من شبكة الدبة A & B & C & D مختلفة في سعة الماجا فقط على النحو التالى: ٣٠، ٣٢ ، ٣٤ ، ٣٦ مليمتر لتقييم فعالية الماجات المختلفة في تقييم المصيد والحد من صيد زريعة أسماك الدنيس. بعد ثمانية وعشرين سرحة (رمية)، تم حساب متوسط المصيد لكل سرحة من الدنيس على النحو التالي ٢,٠١, ١,٨٣, ١,٣٧, ٠,٤٨ كجم للنماذج ٣٠, ٣٤ , ٣٢ و ٣٦ مم على التوالي . أيضا، تم حساب متوسط وزن المصيد من الأنواع غير المستهدفة على النحو التالي: ٢,٨٦, ١,٨٩, ٠,٨٤, ٠,٣٧ كجم لنفس النماذج على التوالي .تأثرت أحجام الأسماك بالماجات المختلفة، حيث تدرج الطول عند بداية الصيد من ١٥,٢ سم لنموذج ٣٠ لحوالي ٢٤ سم لنموذج ٣٦. تُشير النتائج إلى تحسن كبير في حجم الأسماك ذات الأنواع الهامة تجاريا عن طريق التحول من النماذج التقليدية العاملة بالمنخفض (٣٠, ٣٢ مم) إلى النموذج ٣٤ مم وهو النموذج الأدنى المناسب في صيد الأسماك وخاصة الدنيس من أجل حماية الثروة السمكية واستمرارية الصيد الأمثل في المستقبل .على الصعيد الاقتصادي، أظهرت الدراسة أن استخدام نموذج C (٣٤ مم) سيخفض قليلا من إجمالي الدخل على المدى القصير ولكن من شأنه حماية المخزون السمكي وتأمين ربحية جيدة على المدى الطويل وهذا ماتوصى به الدراسة. بالتالي، هناك حاجة إلى تحديد الفوائد المحتملة طويلة وقصيرة الأجل من قبل إدارة المنخفض لضمان استمرارية الإنتاج والحفاظ على المخزون السمكي.