



## Fishing gears, catch composition and length at first capture of the common fish species in Bardawil lagoon, Egypt

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### ARTICLE INFO

#### Article History:

Received: July 30, 2020

Accepted: Aug. 19, 2020

Online: Aug. 22, 2020

#### Keywords:

Bardawil lagoon,  
fishing gears,  
catch composition,  
catch trend,  
management

### ABSTRACT

Bardawil Lagoon is one of the northern lakes in Egypt and it is a part of the Mediterranean coastal lands of Sinai. It plays an essential role in fish production in Egypt, where it produces very economically important fish species such as seabass, seabream, sole, grey mullet, and white grouper. Bardawil lagoon is the least polluted wetland in Egypt and represents one of the least polluted in the entire Mediterranean region with an average area of about 650 Km<sup>2</sup> and employing up to 3,000 fishermen. The fishery in Bardawil lagoon is seasonal generally from early April to the end of December. This measure was taken to protect the seabream and seabass leaving the lagoon for the spawning migration. In Bardawil lagoon, total annual commercial landings varied between 2226 and 5410 tons during the last 20 years (Annual statistical report 2018). In 2018, only 2610 tons were landed corresponded to a value of almost 130 million LE. A number of fishing methods are used in the lagoon including Dabba or trammel nets, El-Bouss or veranda, Kalsa or trawl nets and Lines or sinner. The present work investigated the fishing methods used in Bardawil lagoon, its characteristics, the catch composition, catch trend, and the length at first capture of the most common fish species in the lagoon.

### INTRODUCTION

Egyptian Fisheries (which includes the management, catching, processing, marketing of fish stocks) and aquaculture (the farming of fish) provide an important source of food, employment, income and recreation for Egyptian people and Millions of Egyptian depend upon fish and fisheries for their livelihoods (Mehanna, 2020).

Bardawil lagoon (Fig. 1) is one of the northern lakes in Egypt and it is a part of the Mediterranean coastal lands of Sinai. It is an important source of local and economic fishes in North Sinai, and it plays an essential role in the fish production in Egypt, where it produces very economically important species of fishes such as seabass, seabream, sole, grey mullet, eel, meager and white grouper. Bardawil lagoon is a shallow hyper-saline lagoon, that extends to about 85 km length with a maximum width of 22 km, and

range in depth from 0.3 to 3 m. It is occupying much of the Mediterranean coast of Sinai and separated from the sea by a sandbar that varies in width between 100 m and 1 km. Bardawil lagoon is the least polluted wetland in Egypt and represents one of the least polluted in the entire Mediterranean region with an average area of about 650 Km<sup>2</sup> and employing some of 3,000 fishermen. The fishery in Bardawil lagoon is seasonal generally from early April to the end of December; all fishing activities are prohibited in winter, from January to the end of March. These measures were taken to protect the seabream and seabass leaving the lagoon for spawning migration. A number of fishing methods are used in the lagoon including Dabba or trammel nets, El-Bouss or veranda, Kalsa or trawl nets, Lines or sinnar, El-Dahbana nets and El-Tair nets (Mehanna, 2006a&b; Mehanna, 2013; Mehanna *et al.*, 2013; Farouk, 2014; Salman 2014; Mehanna *et al.*, 2019).

One of the main challenges that facing the lagoon development is the fishing gears used. Although Egypt took some regulations for the conservation of the lagoon fisheries, unfortunately these regulations couldn't ensure the sustainability of the lagoon and the conservation of commercial fish stocks. So, the present study will focus on the fishing gears characteristics used in the Bardawil lagoon and their impacts on the lagoon production.



Fig. 1. Bardawil Lagoon

## MATERIALS AND METHODS

### 1. Collection of Fishery Statistics

Data concerning the monthly and annual catch of different fish species and fishing effort of Bardawil lagoon were obtained from the General authority for Fish Resources Development annual statistical book (GAFRD, 2018).

### 2. Sampling and catch composition

Monthly random samples of different fish species were collected from the landing sites along Bardawil lagoon during the fishing seasons 2017/2018 and 2018/2019 from

May to December to investigate the length frequency distribution of the commercial species. While the catch composition of the different fishing gears was recorded during the monthly field trips to the lagoon fishery (Fig. 2).



**Fig. 2. Sampling procedure in Bardawil Lagoon**

### ***3. Biological measurements***

Length measurements made on total body length for each specimen to nearest millimeter and sorted afterwards in sequential length groups of one centimeter interval.

### ***4. Length frequency distribution***

Length frequency distribution for the common species in Bardawil lagoon was determined and the percentage of occurrence of each length class was obtained according to **Gayanilo *et al.* (1997&2003)**.

### ***5. Length at first capture ( $L_c$ )***

The length at first capture ( $L_c$ ); the length at which 50% of the fish species retained in the gear for the most common fish species in Bardawil lagoon was estimated from the length frequency distribution as described in **Sparre and Venema (1998)**.

## RESULTS AND DISCUSSION

### 1. Fishing gears and catch composition

#### 1.1 The Dabba fishing technique (Trammel nets)

Dabba (Fig. 3) is the main fishing method in Bardawil lagoon and constituting about 92% of the fishing fleet in the lagoon. Dabba fishing vessels contributed by 1144 and 1120 fishing vessels. Each fishing vessel reaches about 6-7 m in length and 1.8 m average width, motorized by outboards of 8 to 10 hp; two or three fishermen are working on each vessel.

The fishing gear is trammel nets of Italian type; each unit has 30 m average length. The two external layers of the net have 120 mm mesh size and 2 m depth, while the middle layer has smaller mesh size of about 33 mm and about 3 m depth. The fishing gear includes 30 fishing units of trammel net and reached 900 m in length. Each fishing gear is supported by an upper rope that has floating units, separated from each other by about 80 cm, and has a lower rope loaded by parts of lead with an average weight of 50 g and separated from each other by about 40 cm.

Fishermen spread the net in water daily with the sun set and collected it at early morning of the next day. Catch of Dabba is composed of gilthead sea bream *Sparus aurata*, Sea basses *Dicentrarchus labrax* and *D. punctatus*, soles *Solea solea* and *S. aegyptiaca*, grey mullets, *Mugil cephalus*, crabs *Portunus pelagicus* and *Callinectes sapidus* and shrimps *Penaeus japonicus*, *P. semisulcatus*, *P. kerathurus* and *Metapenaeus* spp.



**Fig. 3. Dabba fishing gear in Bardawil Lagoon**

#### 1.2 The veranda fishing gear or "Bouss "

This method (Fig. 4) constituting about 7% of the fishing fleet in Bardawil lagoon. The number of fishing vessels of veranda type working in Bardawil lagoon during 2010 and 2011 were 84 and 108, respectively. The fishing by this technique depends upon the aggregation of 4 vessels together; two of them motorized by 15-30 hp outboard and the other two are un-motorized and used for carrying nets. 14-20 fishermen operate on each group of vessels (4 vessels). Bouss fishing nets consists of two parts, one horizontal and the other vertical. The vertical part of one layer with 18-26 mm mesh size. Its length is about 600 m with depth of 5 m. The net is kept vertically in water by floating

parts or rubber of 40 cm distances between each other and loaded from the bottom by parts of lead in 50 cm distance between each two successive parts. The horizontal part is three layers net supported by units of Bamboo make it spread in water. Its length is about 600 m with width of 4 m, while the mesh size is 120 mm for the external two layers and 20 mm for the middle one. This fishing gear is used only for catching grey mullets. Each fishing operation takes about 2 hour and repeated for 4-5 times per day.



**Fig. 4. Veranda fishing gear in Bardawil lagoon**

### 1.3 Line fishing technique (Sinnar)

The lines gears operating in the Bardawil lagoon are long and hand lines. In the long-line method, the mainline is of 300 to 450 m length to which 250 to 300 branch lines are attached. Each branch line has a hook of about 50 to 60 cm length. The baits used in this method are the small shrimps and grey mullets and the main catch is eels and groupers. In the hand-line, hooks are used individually to catch single fish, while light are used to attract fishes. This method of fishing operated only to catch the nocturnal fishes and its main catch is *Dicentrarchus labrax*, *D. punctatus* and eel which appeared in the lagoon recently.

### 1.4 Dahbana fishing technique (purse seine)

The dahbana gear (chancholla) is working at night for catching *Liza ramada* and *L. aurata* but it is a destructive gear for the sea bream juveniles. It is a trammel net used by Dabba fishing boats to catch mullets.

### 1.5 Isfinkes fishing technique

The sphinx nets are of three layers with 28-30 mm mesh size. Its height is less than 1 m. The net is kept vertically in water by floating parts or rubber and loaded from the bottom by parts of lead. Isfinkes nets are very cheap and not need boats to use. This type of nets not allowed to use in the lagoon but the fishermen used it for catching the soles fingerlings.

Besides these methods, there are some illegal fishing gears operating in the lagoon in the different months according to the appearance and abundance of the different

species (Bardawil book, 2008), for example the Madad gear for catching the groupers and meagers and the crab nets.

## 2. Catch composition

Most of fish species inhabiting Bardawil lagoon and in particular all commercial fish species do not reproduce in the lagoon (catadromous species). The most important commercially exploited fish species in the lagoon are gilthead seabream, seabass, grey mullets and soles. *Mugil cephalus* constitutes the bulk of the catch among the grey mullets. Whereas, *Liza ramada*, *L. aurata*, *L. saliens*, *L. carinata* and *Chelon labrosus* are caught in some numbers. Both of *Dicentrarchus labrax* and *D. punctatus* are common, but the former is more numerous and attains large sizes. *Argyrosomus regius* and *Epinephalus aeneus* are caught in small quantities. *Crenidens crenidens*, a Red sea immigrant fish, can occasionally be found in the commercial catch. Fish species which reproducing in the lagoon are *Atherina boyeri*, *Aphanius dispar*, *A. fasciatus*, *Pomatoschistus marmoratus* and *Syngnathus abaster*. **Ben-Tuvia (1979)** listed over 60 species of fishes collected from the lagoon. The species found are by nature eurytopic, especially in their tolerance to both low and high salinity. Surprisingly, *Tilapia zillii* fishes in the lagoon have been reported during 1971 (Chervinski 1972). The lagoon serves as a nursery ground for juvenile shrimps; *Metapenaeus stebbingi*, *M. monoceros* and *Penaeus semisulcatus* (**Tandler, 1972; Ben-Tuvia & Gilboa, 1975; Tom, 1979**). **Levinsohn (1980)** pointed out to the importance of sea grass which gives the shelter to *M. stebbingi*, the most abundant shrimp in the lagoon. Whereas, young *P. semisulcatus* and *M. monoceros* were found only near the inlets. These species along with swimming crab (*Portunus pelagicus*, *Charybdis* spp. and *Callinectes* spp.) are abundant on muddy bottoms in the Mediterranean off Bardawil.

By 1990, the catch composition of the lagoon was greatly changed, crustaceans (shrimp and crab) landings have greatly increased annually in Bardawil lagoon, reaching about 50 percent of the total catch, affecting the catch of other economic fish species like seabream and seabass (**Mehanna, 2006a, b & c; Khalil and Shaltut, 2006**). Many driving factors which alter the ecological condition of the lagoon as well as biological balance were responsible for this dramatic change. The serious decline of seabass and seabream stocks, the common predators for shrimp and crab and prohibition of Cioncholla fishing gear in 1993 leads to restoration of sea grass beds in the lagoon, which represent a suitable ecological niche for shrimps (**Tom *et al.*, 1984**),

The appearance of crustacea motivates fishermen to adopt the kalsa fishing technique (trawl nets) to catch crustacea. This fishing method was destructive contributed in catching fish fry, especially bottom feeder like seabream and seabass, and progressive decline and collapse of their stocks (**Mehanna, 2006**).

The Mugilid species such as *Mugil cephalus*, *Liza ramada*, and *L. aurata* in Bardawil lagoon contributed about 26% of the total catch during the period from 2005 to

2018 (Fig. 5) followed by *Sparus aurata* (Sparidae) which constituted about 6.7%; *Solea solea* and *S. aegyptiaca* (Soleidae) forming about 4.5%. Seabass such as *Dicentrarchus labrax* and *D. punctatus* (Moronidae) constituting about 1.7%, while *Argyrosomus regius* (Sciaenidae) along with *Epinephelus aenus* (Serranidae) are forming up to 0.5%. Crustaceans in the lagoon are represented in the catch by shrimp mainly *Metapenaeus stebbingi* (21.5%) and crabs mainly *Portunus pelagicus* (31.3%) (Fig. 5). In addition, the “others” group that contains the unsorted species or those of lesser importance. This group contains *Anguilla anguilla* (Anguillidae); *Terapon puta* (Terapontidae); *Siganus* spp. (Siganidae); *Hemiramphus far* (Hemiramphidae); *Tylosurus* spp. (Belonidae) and *Tilapia zillii* (Cichlidae).

Moreover, water salinity decrease gave the chance to several fish species inhabiting Mediterranean coast off Bardawil lagoon to find a save shelter and rich grazing area in the lagoon. In addition, those species find their ways to unoccupied trophic levels in the lagoon in favour of the declined eurhaline native species.

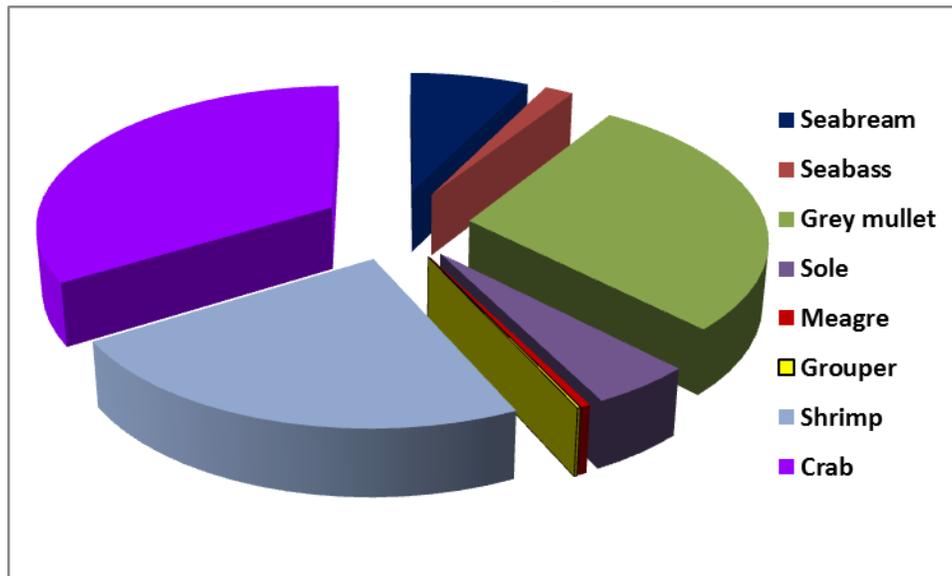


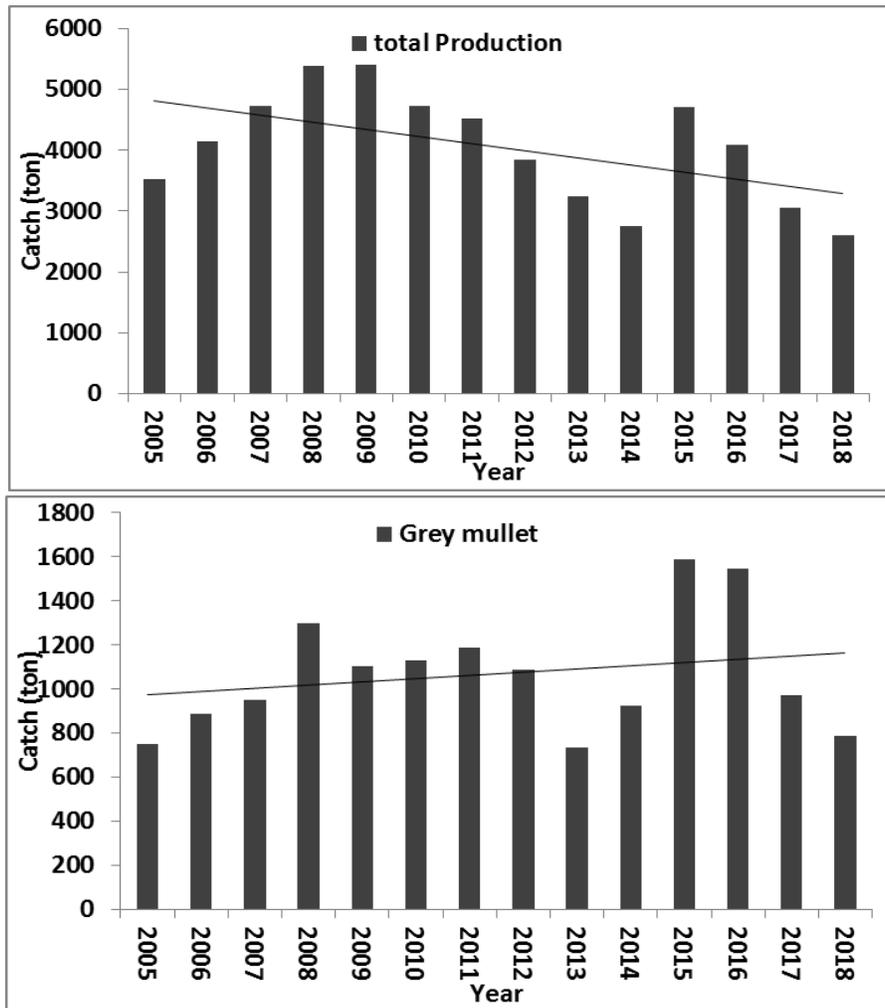
Fig. 5. Catch composition in Bardawil lagoon during 2005-2018

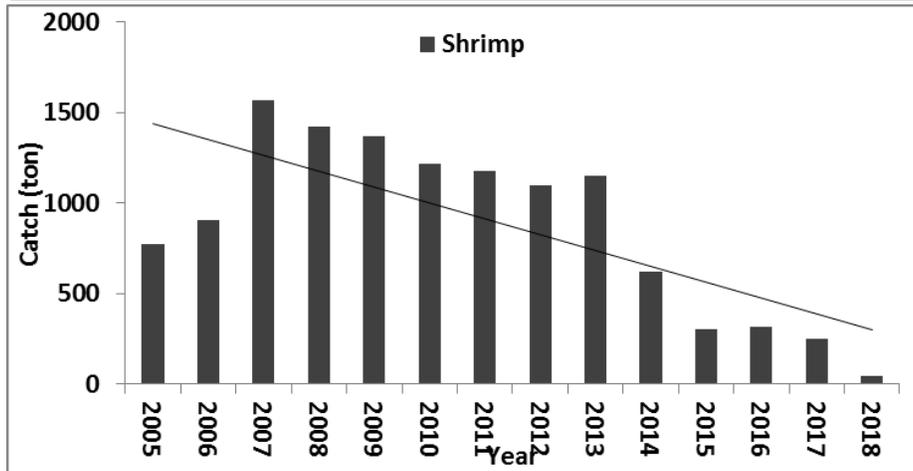
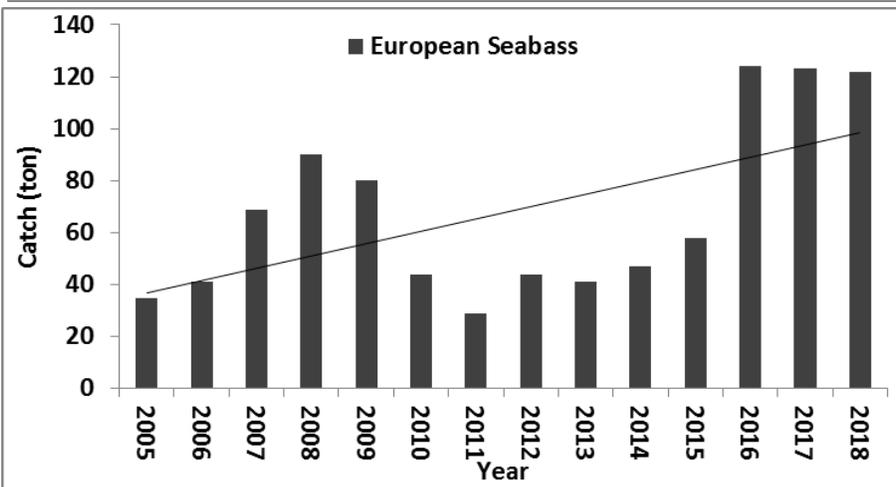
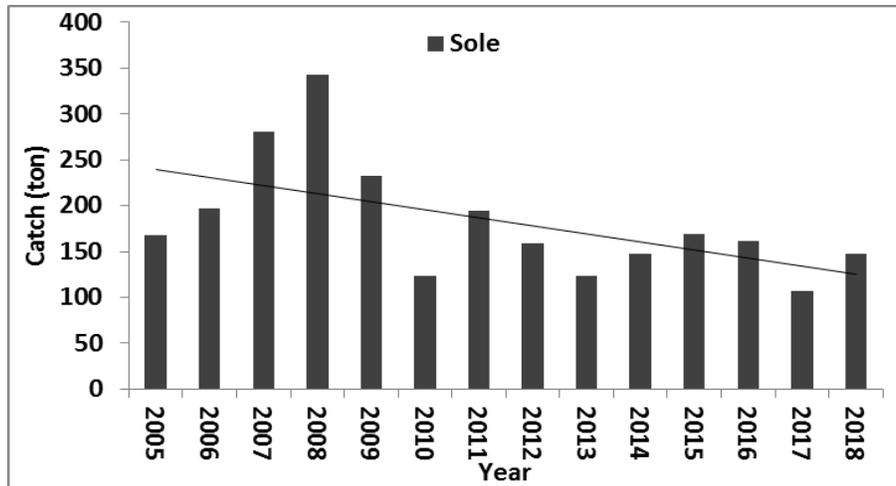
### 3. Catch trend

The annual total fish production from Bardawil lagoon during the period from 2005 to 2018 (Fig. 6) fluctuated between a minimum of 2610 ton during 2018 and a maximum value of 5410 ton during 2009 with an average of 4055 ton. The catch of seabream varied from a minimum of 208 ton during 2017 to a maximum of 336 ton during 2008 with a mean of 278 ton. Grey mullet species were fluctuated between a minimum of 733 ton (2013) and a maximum of 1590 ton (2015) with a mean of 1069 ton. Seabass species contributed to a minimum of 29 ton (2011) and a maximum of 124 ton (2016) with a mean of 68 ton during all investigated seasons. The flatfishes catch (*Solea* spp.) varied between a minimum of 107 ton (2017) and a maximum of 343 ton (2008) with a mean of 182 ton. The shrimp catch varied between a minimum of 43 ton (2018)

and a maximum of 1569 ton (2007) with a mean value of 873 ton. The crab catch fluctuated between a minimum of 519 ton during 2014 and a maximum of 2071 ton during 2009 with a mean value of 1268 ton during the period from 2005 to 2018.

Generally, the fish production in Bardawil lagoon shows a decreasing trend during the period of study and the same trend is noticed for all the commercial species except for European seabass and grey mullet. For shrimp, a sharp decreasing was observed since 2015 this coincide with banning the kalsa fishing gear (bottom trawl net).





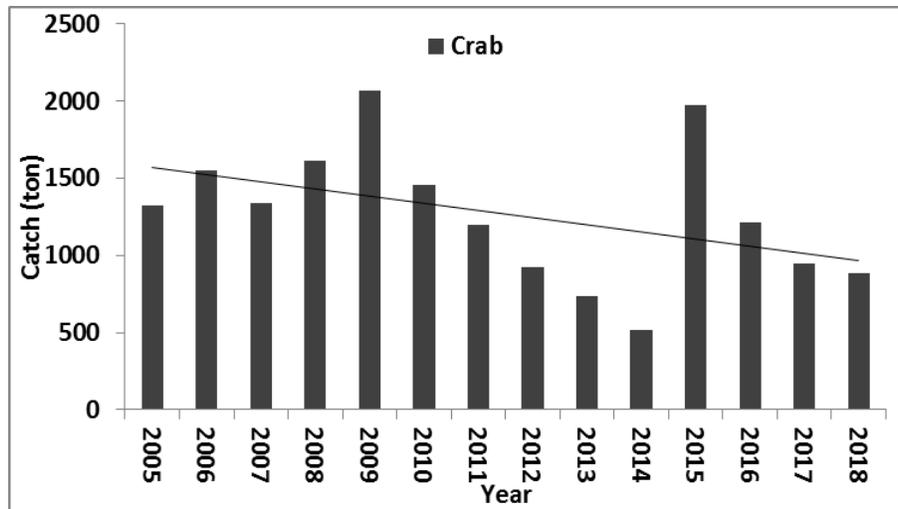


Fig. 6. Catch trend for total and commercial species in Bardawil Lagoon

#### 4. Length frequency distribution for the common species

Length frequency data have a practical application in the field of fisheries science. The analysis of length-frequency data can be used for the estimation of age, growth, survival and mortality rates (Pauly, 1980, 1983, 1984 & 1987). Also, in fishes, size is generally more biologically relevant than age, mainly because several ecological and physiological factors are more size-dependent than age-dependent. Consequently, variability in size has important implications for diverse aspects of fisheries science and population dynamics (Erzini *et al.*, 1999). The length frequency distribution also is applied in some analytical yield models such as the yield per recruit models of Beverton & Holt (1957).

##### 4.1 Grey mullet

The grey mullets are the most abundant fish species inhabiting Bardawil lagoon. They form about 26% of the total lagoon production. In 2018, 789 ton of grey mullets were landed forming a net profit of about 40 million Egyptian pounds. Mullet's catch is composed mainly from *Mugil cephalus*, *Liza ramada* and *L. aurata*, while both *Chelon labrosus* and *L. saliens* are found in very small amounts and recorded under the “others” group.

The length frequency for 320 *L. ramada*, 280 *M. cephalus*, 150 *L. aurata* and 200 specimens of *Chelon labrosus* was grouped in 1 cm length groups to construct the length frequency distribution (Fig. 7). The total length was ranged from 12 to 44 cm TL for *L. ramada*, from 14.0 cm to 59 cm for *M. cephalus*, from 13 to 30 cm for *L. aurata* and from 15.0 cm to 35 cm for *Chelon labrosus*. The most frequent lengths in the sample were from 19 to 28 cm for *L. ramada*, from 24 cm to 40 cm for *M. cephalus*, from 16 to 20 cm for *L. aurata* and from 19 to 25 cm for *C. labrosus*.

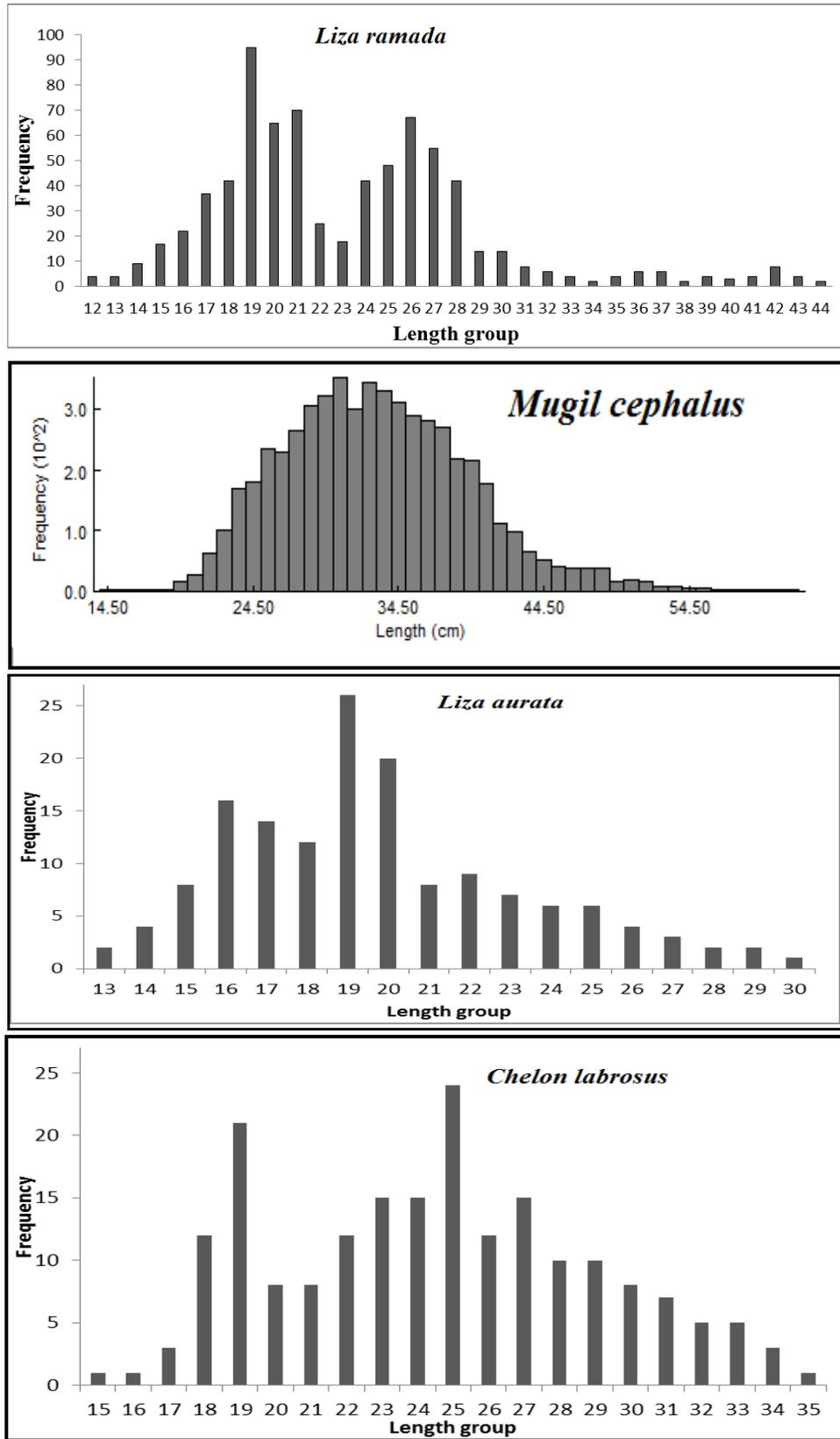


Fig. 7. Length frequency distribution of Grey mullet in Bardawil Lagoon

#### 4.2 Seabream *Sparus aurata*

A total of 345 seabream were measured. The lengths of the fish caught varied from 13.0 cm to 33.0 cm and the great majority of the annual catch was composed of the individuals from 17 cm to 21 cm (Fig. 8).

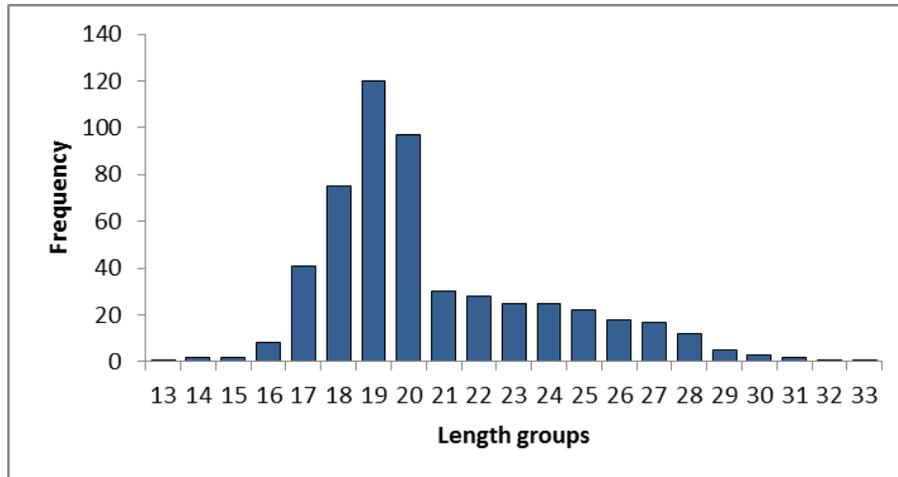


Fig. 8. Length frequency distribution of *Sparus aurata* in Bardawil lagoon

#### 4.3 European seabass

A total of 159 individuals of *Dicentrarchus labrax* were examined and the length of the examined samples were ranged in length from 20.0 to 55.7 cm total length. Length-frequency distributions of individuals were shown in (Fig. 9).

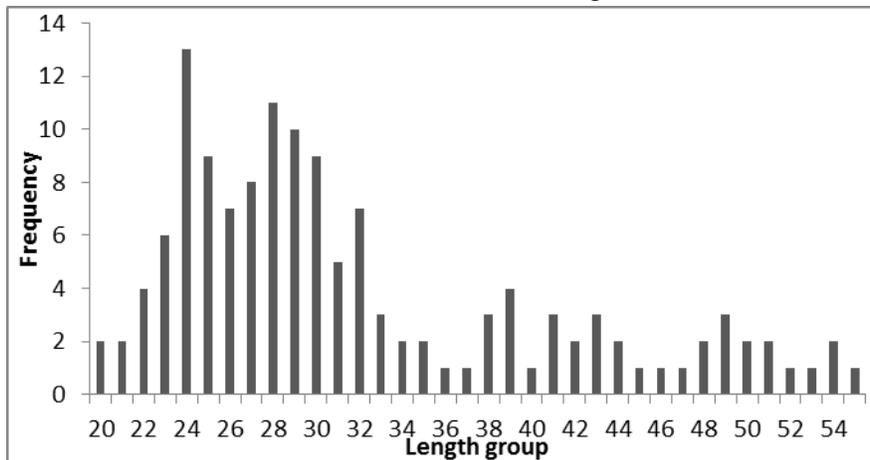


Fig. 9. Length frequency distribution of *Dicentrarchus labrax* in Bardawil lagoon

Mehanna (2006) mentioned that seabasses are exploited by two fishing methods in the Bardawil lagoon; trammel nets and lines. The length frequency of seabass caught by trammel nets was smaller than that by lines, where the length of seabasses fished by trammel nets ranged between 16 and 30 cm TL for *D. labrax* and that fished by hook and lines ranged between 26 and 71 cm TL for *D. labrax*. She concluded that the fishes of lengths greater than 60 cm for *D. labrax* were rarely reported in the catch.

#### 4.4 Soles

The soles catch in Bardawil lagoon composed of two species, the common sole, *Solea solea* and the Egyptian sole *S. aegyptiaca*. They are exploiting by trammel nets (locally known as Dabba) and earning up to 10 million LE annually. A total of 2000 individuals were measured (1200 *S. aegyptiaca* and 800 *S. solea*). The total length was varied between 9.0 and 34.8 cm for *S. solea* and between 11.0 and 30.5 cm for *S. aegyptiaca* (Fig.10).

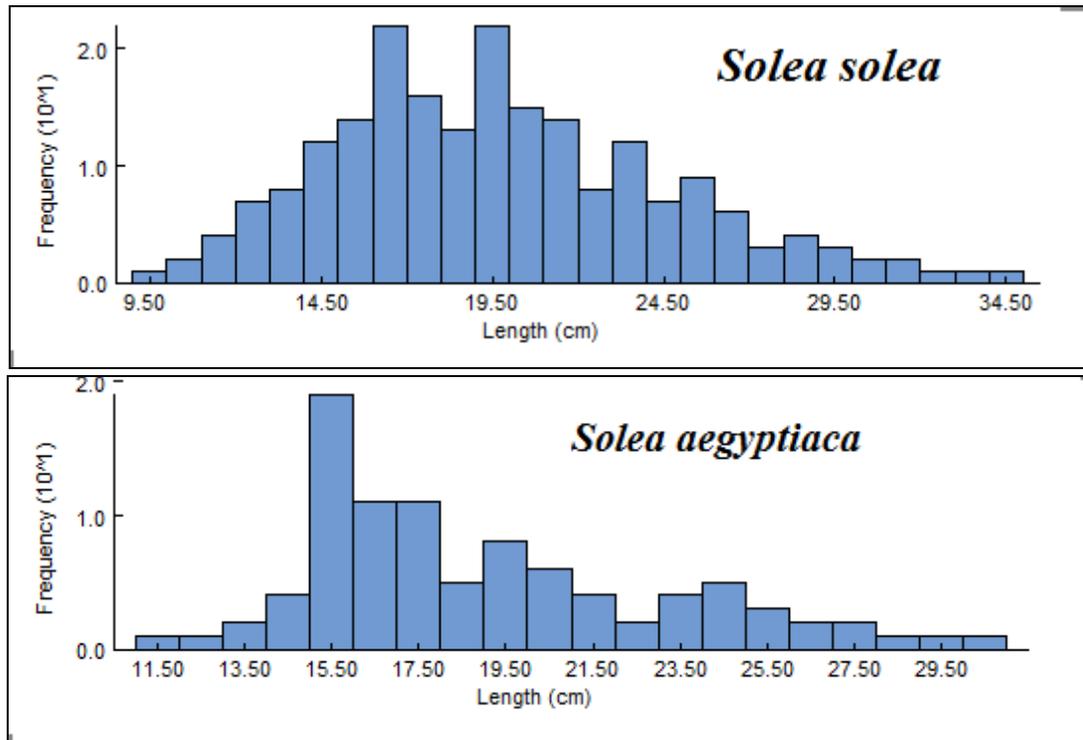


Fig. 10. Length frequency distribution of Sole species in Bardawil lagoon

#### 5. Length at first capture for the important species

Length at first capture (Lc) has a great importance in the fisheries management as it is an indication for the suitability of mesh size. The length at first capture at which 50% of the fish are vulnerable to capture for the most important species in Bardawil lagoon was given as 19.1 cm for *Sparus aurata*, 27.9 cm for *Mugil cephalus*, 18.8 cm for *Liza ramada*, 15.9 cm for *Solea solea*, 24.5 cm for *Dicentrarchus labrax*. It is obvious that, the length at first capture is smaller than the length at first sexual maturity reported for these species in the previous studies indicating the overexploitation situation due to the small mesh sizes used in Bardawil lagoon (Khalifa, 2005; Mehanna and Khalil, 2006; Mehanna, 2007a&b; Mehanna *et al.*, 2010; Mehanna *et al.*, 2011; Mehanna *et al.*, 2013; Mehanna *et al.*, 2014; Salem and El-Aiatt, 2012; Mehanna and Hegazi, 2013; Salman, 2014; Mahmoud, 2019).

## CONCLUSION

In conclusion, fisheries management includes different management measures. Among these are technical regulations on fishing gears in order to obtain the overall goal of high sustainable yield in the fisheries. These regulations for example, the urgent increase of mesh size to improve the selective properties of a fishing gear so that by-catches of juvenile fish are reduced. This action will safeguard recruitment to the larger size groups of a fish stock including the spawning stock. Also, the mitigation of the negative impact of fishing gears on the ecosystem and the biodiversity through the prohibition of the destructive ones is another example. From this work, the fishing gears used in Bardawil lagoon need to improve their selectivity and increase their mesh sizes.

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