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# BIO-ECONOMIC ASSESSMENT IN AERIAL TRAPS (VERANDA NETS) FISHERY OF FLATHEAD GREY MULLET (*Mugil cephalus*) IN BARDAWILL LAGOON, NORTH SINAI, EGYPT

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ABSTRACT

Veranda nets are major technique in Bardawill lagoon, may be due to its ability to target different fish species and less effort required in operating it despite the majority of catching them in this study were non targeted (small size and immature). To manage marine fisheries effectively, we must assess and manage by catch. Data were collected monthly from three specified fishing vessels of Veranda nets of (*Mugil cephalus*) it operated in Bardawill lagoon for each fishing unit from May to November 2018-2019. Average catch of Flathead Grey Mullet (*Mugil cephalus*) from juvenile and adult was 513.6 kg (24.7% of total catch by veranda nets) and 620.3 kg (29.8% of total catch by veranda nets) in spring; 838.5 kg (19% of total catch by veranda nets) and 1363.8 kg (31% of total catch by veranda nets) in summer and 400.5kg (15.2% of total catch by veranda nets) and 832.3 kg (31.5% of total catch by veranda nets) in autumn, respectively. Our results indicated that, the landing of Flathead Grey Mullet juvenile leads to more losses of stock biomass which formed 76835.1 12544.3 and 59919.4 Kg for spring, summer and autumn, respectively and the ≈ 10.5 million LE losses in one fishing season 2018 and 2019.

## INTRODUCTION

Bardawill lagoon is one of the most important lagoons in Egypt as a source of good quality fish and a habitat for wildlife (**Touliabah *et al.*, 2002**). Lagoon is considered the main ecological and economic natural resource of North Sinai region (**GAFRD, 2001**).

Grey mullets (Family: *Mugilidea*) are extremely important fish, which are cultured in many countries due to their high-quality flesh, superior growth and wide rang of water salinity and temperature tolerance (**Mehanna *et al.*, 2019**). On this context, *Mugil cephalus* (**Linnaeus, 1758**) found in freshwater, brackish, hypo saline lagoons, and coastal marine areas (**FAO, 1990**). Mullet is the second; Nile Tilapia is the first; popular species for the Egyptian consumer and is considered the main species for the local population in the North Sinai region, due to its good price (**El-Aiatt *et al.*, 2022**).

**Sivasubramaniam (1990) and Sujatha (1996)** showed that overfishing occurs when the fisheries targets of a size was below the optimal harvestable size and before the fish has the opportunity to achieve its maximum biomass level, then the fisheries will lose much of the potential yield that could be achieved by catching them in the near future. So sustainable fisheries management generally requires fishing gears which retain large fish while allowing juveniles to escape (**Armstrong *et al.*, 1990**).

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**Greenstreet and Hall (1996)** reported that economic analysis can be used to predict the likely changes in returns, and this can be useful in making the right decision especially for countries facing declining fisheries. Though the intensive exploitation of fish communities is a main reason of substantial decrease in the abundance of target species changing the species composition.

The research aims to present a serious attempt to estimate the quantities of small fishes from Flathead Grey Mullet (*Mugil cephalus*) and estimate biological and economic losses due to small fish from Flathead Grey Mullet (*Mugil cephalus*) catches by the veranda units in Bardawill lagoon.

## MATERIALS AND METHODS

Bardawill lagoon Fig. 1 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**). It covers an estimated area of 136,318 Faddan with a maximum length of 95 Km and a maximum width of 22 Km, the water depth ranges from 0.5 m to 3 m (**GAFRD, 2015**). It is an important source for economical fish and salt production (**Abd Elrazek *et al*., 2006**).

The study began after the observation of illegal size landing of mullet in catch composition of veranda net fishing units. Data were collected monthly from three specified fishing vessels it operated in lagoon within one day for each fishing unit from May to November 2018 and May to November 2019). The fishing by this technique depends upon the aggregation of 4 vessels together; two of them motorized by 40 hp outboard and the other two are un-motorized and used for carrying nets.15 fishermen operate on each group of vessels (4 vessels). Bouss fishing nets consists of two parts, one horizontal and the other vertical. The vertical parts of one layer with 19 mm mesh size and mega 26. Its length is about 600 m with depth of 5 m. The net is kept vertically in water by floating parts or rubber of 50 cm distances between each other and loaded from the bottom by parts of lead in 75 g weight and 55 cm distance between each two successive parts.

The horizontal part is three layers net supported by units of Bamboo 40 cm distance between each two Bamboo parts to 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.

The total catches in general and grey mullet in particular were recorded as a quantity each fishing day. Total quantity of grey mullet landed were iced, labeled and transported to the laboratory in ice boxes. In the laboratory, Biometric data as total length ($L_T$) to the nearest 0.1 cm and weighted to one gram were measured. Length – weight relationship of the fish was represented by the equation $W=a\ L^b$, where 'W' and 'L' are the weight and length; 'a' and 'b' are constants (**Le Cren, 1951**).

Length at first capture ($Lc_{50}$) value was determined using the probability of capture was estimated from length-converted catch curve, using the running average technique to determine $Lc_{50}$ by using the FiSAT program. To determine the proportion of juveniles exploited. As, $Lm_{50}$ was determined length at first maturity from previous studies.

Accordingly, fish was classified into two groups: target (adult > $Lm_{50}$) and by-catch (Juvenile ≤ $Lm_{50}$) to assess bio-economic of grey mullet landings. Fish below $Lm_{50}$ was accounted as a by-catch (undersized individuals) where must be allowed to spawn

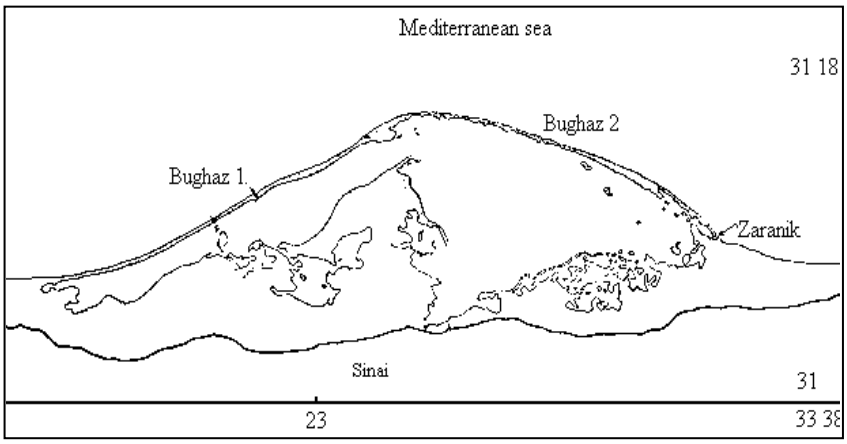


**Fig. 1. The map of Bardawill lagoon**

**Table 1. Length at first maturity of *Mugil cephalus* from previous studies**

| Fish species | Lm50 (cm) | Reference |
|---|---|---|
| **Flathead Grey-mullet** | 31.1 | **El-Aiatt *et al*. (2022)** |
| **(*Mugil cephalus*)** | 29.9 | **Omar (2013)** |
| **Average** | 30.5 | |

at least once before they get caught to sustain their stock. Average length (Lmean) cm of juvenile was taken as cut-off factor for estimating bio-economic losses for each month. The catch recorded from the observed three vessels on the day of observation was raised to total number of vessels, and then raised to the number of fishing days in fishing season. The proportion of juveniles and adults from observed length frequency data was determined. The Biological loss was estimated by considering the landings and loss in weights of juveniles if they were permitted to grow to $Lm5_0$. Economic loss due to the capture of juveniles was estimated by considering the price of adult and juvenile for that fishing season. Methods of **Najmudeen and Sathiadhas, (2008)** were used to estimate the bioeconomic losses as follows:

$$QA = ((1000/\omega)\ W/1000)\ (1\text{-}M)$$

Where:

QA: adult fish quantity corresponding to 1 kilogram of juvenile fish after a period of t year.

W: weight of the individual adult fish after a period of t years

ω: individual weight of juvenile in gram.

M: Natural mortality.

$$\mathbf{EL} = \left( \frac{\sum_{i=1}^{n} \frac{\mathbf{CiQi}}{(\mathbf{1}-\boldsymbol{\delta})^{t}}}{\boldsymbol{n}} \right) - \left( \frac{\sum_{i=1}^{n} \boldsymbol{ciqi}}{\boldsymbol{n}} \right)$$

Where:

EL: average economic loss for the quantity of Bream juveniles landed per unit per fishing trip.

Ci: average price of adult.

ci: average price of juvenile.

Qi: is the estimated virtual quantity of the adult fish corresponding to the quantity of juvenile landed (qi).

n: represents the total number of boats,

δ: is the standard discount rate (%),

t: age in year at minimum catching size.

Price of juveniles and adult was recorded by fishers, fisher's agents and fish retailers at the landing sites. During the study, 40 and 50 Egyptian pound (LE) was estimated as an average price for each kilogram of juvenile and adult Flathead Grey-mullet (*Mugil cephalus*), respectively.

# RESULTS AND DISCUSSION

## Catch Gear Composition of Veranda Net During Period Study

In the present study, total average production of three units of Veranda nets in the Bardawill lagoon during two fishing seasons 2018 and 2019 are shown in (Figs. 2 and 3). Fig. 4 show the average catch for the 2018 and 2019 fishing season.

## Seasonality Catches of Juvenile and Adult of Flathead Grey-Mullet (*Mugil cephalus*)

According to the size, Fig. 5 indicates estimated average catch of Flathead Grey Mullet (*Mugil cephalus*) from juvenile and adult of total catch of veranda net was 513.6 kg (24.7%) and 620.3 kg (29.8%) in spring; 838.5 kg (19%) and 1363.8 kg (31%) in summer and 400.5kg (15.2%) and 832.3 kg (31.5%) in autumn.

From our results, veranda net can have harmful biological effects among fishing nets, as juvenile of *M. cephalus fishing* accounted for (38.4% of total catches of grey mullet). This result agrees with **Salem *et al*. (2018), El-Aiatt *et al*. (2019) and Salem (2019)** they found that, the catch of juvenile catch was large when fishing with different fishing equipments in Bardawill lagoon.

## Biomass Loss of Flathead Grey Mullet (*Mugil cephalus*)

Results indicated that, weight of individuals at capture, average landing of juveniles and the increasing of weight at the length at first maturity as shown in Table 3 and Fig. 6. Adult fish quantity corresponding to 3.4 kilogram of juvenile of *Mugil cephalus*. The landing of juvenile leads to more losses of stock biomass. Biomass loss was found to be ~ 5981.5 kg for Flathead Grey Mullet.

The data on the actual of fishing losses by veranda nets is not available, but it was found that many other fishing gears have a major role in the loss of Biomass, based on many previous studies as in **Salem *et al*. (2018)** study where resulted that, gill net have harmful biological effects where the higher proportion of juveniles (41.7% of total catches) in Bardawill lagoon. As they found that, the landing of small fish in Bardawill lagoon has led to more losses of stock biomass, which formed about 345 tons. Also our results agree with **Jomaa (2018), Salem (2019) and El-Aiatt *et al*. (2019)** who reported that there is a lot of biological loss due to juvenile fishing.

Therefore, the mesh size of nets must be reconsidered to mitigate the juvenile catches as indicated by **Hovgård and Lassen (2000)** that, catching undersized fish is the result of a mismatch between the selectivity of the gear and can occur even in highly species-selective fishing activities.

## Economic Loss of Flathead Grey Mullet (*Mugil cephalus*)

Results indicated that, the landing of Flathead Grey Mullet juvenile leads to more losses of stock biomass which formed 76835.1 12544.3 and 59919.4 Kg for spring, summer and autumn respectively and the ≈ 10.5 million LE losses in one fishing season 2018 and 2019 (Table 3 and Fig. 7).

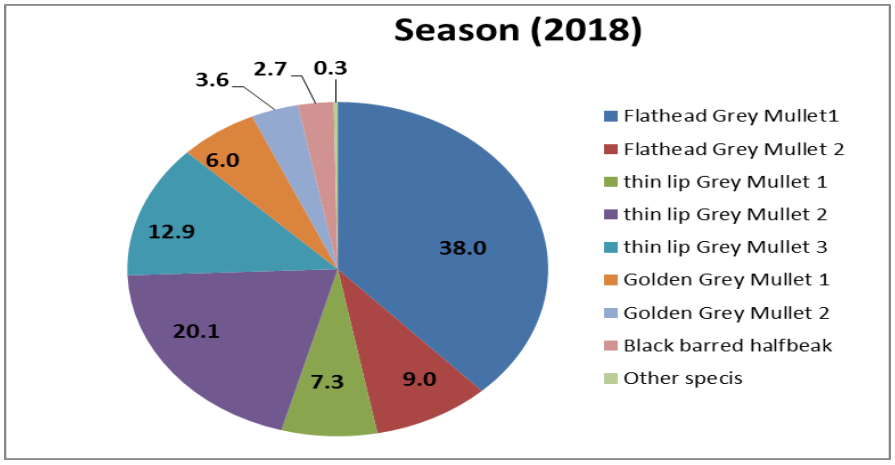


**Fig. 2. Percentage catches composition of Veranda nets in the Bardawill lagoon during fishing seasons 2018**

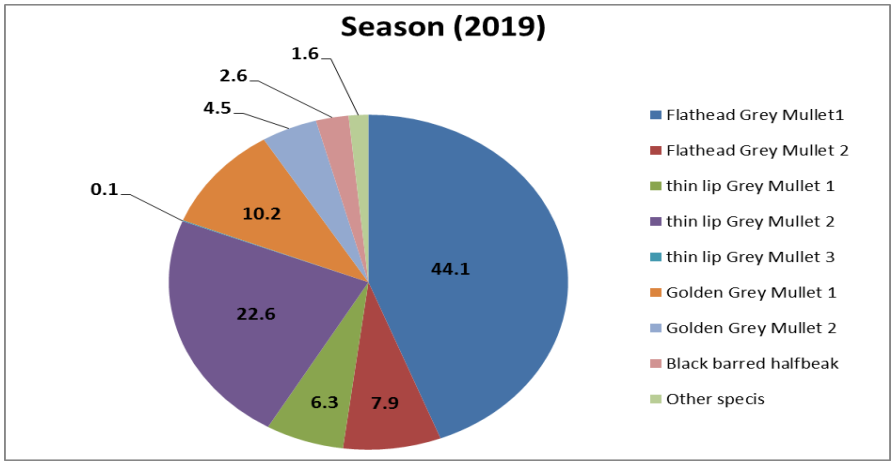


**Fig. 3. Percentage catches composition of Veranda nets in the Bardawill lagoon during fishing seasons 2019**

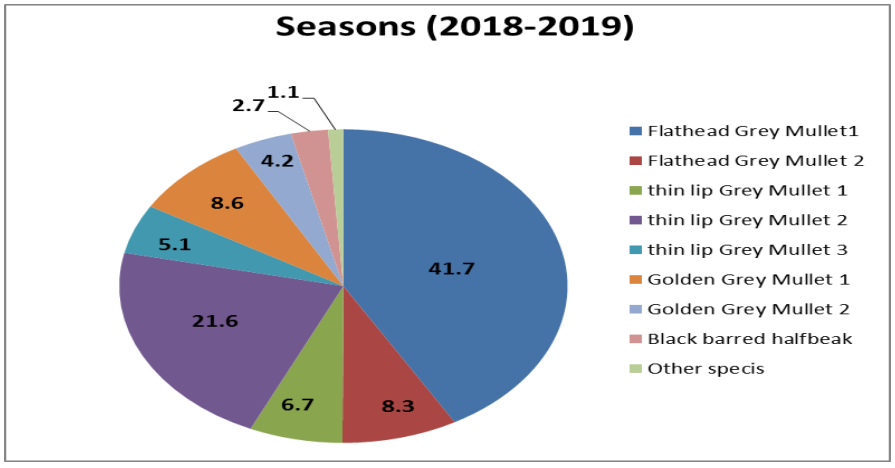


**Fig. 4. Percentage catches composition of veranda nets in Bardawill lagoon during fishing seasons 2018 and 2019 from May to November 2018 and May to November 2019**

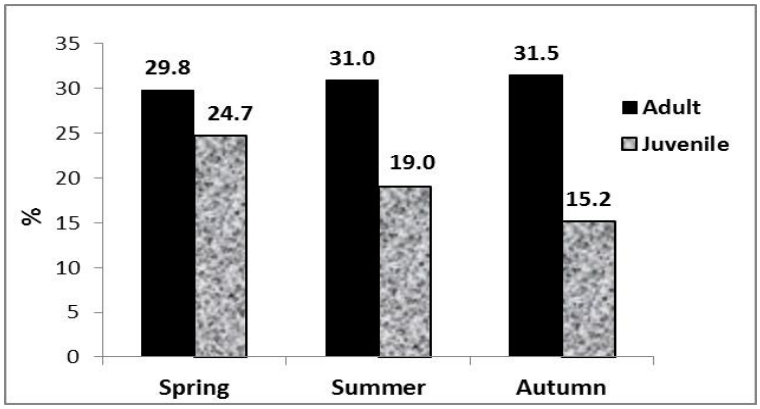


**Fig. 5. Percentage of juvenile and adult of Flathead Grey Mullet (*Mugil cephalus*) during two fishing seasons 2018 and 2019 from May to November 2018 and May to November 2019**

**Table 2. Biomass loss (kg) of Flathead Grey Mullet (*Mugil cephalus*)**

| | | Adult | Juvenile |
|---|---|---|---|
| | **Total** | 1133.8 | |
| | **quantity** | 620.3 | 513.6 |
| **Spring** | **(%)** | 54.7 | 45.3 |
| | **QA** | - | 3.4 |
| | **Biomass loss** | - | 1752.8 |
| | **Total** | 2202.3 | |
| | **quantity** | 1363.8 | 838.5 |
| **Summer** | **(%)** | 61.9 | 38.1 |
| | **QA** | - | 3.4 |
| | **Biomass loss** | - | 2861.7 |
| | **Total** | 1232.8 | |
| | **quantity** | 832.3 | 400.5 |
| **Autumn** | **(%)** | 67.5 | 32.5 |
| | **QA** | - | 3.4 |
| | **Biomass loss** | - | 1366.9 |
| **Total quantity of juvenile** | | - | **1752.6** |
| **Total Biomass loss** | | - | **5981.5** |

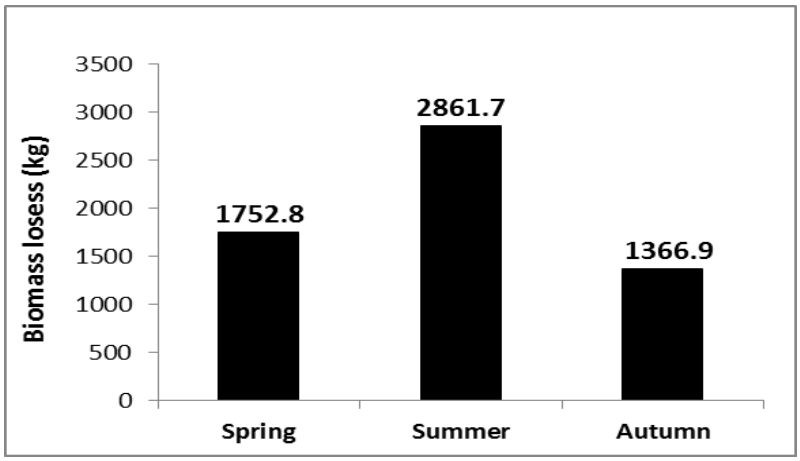


**Fig. 6. Biomass loss of juvenile of Flathead Grey Mullet, *Mugil cephalus* during two fishing seasons 2018 and 2019 from May to November 2018 and May to November 2019**

**Table 3. Total economic loss (million LE) of Flathead Grey Mullet (*Mugil cephalus*) during period study in Bardawill lagoon, (2018 and 2019):**

| | Spring | Summer | Autumn |
|---|---|---|---|
| Juvenile landing quantity (qi), kg / unit / season | 513.6 | 838.5 | 400.5 |
| Adult quantity (QA) to1 kg of juvenile | 3.4 | 3.4 | 3.4 |
| Biomass quantity losses (Qi) kg / unit / season | 1752.8 | 2861.7 | 1366.9 |
| Av. number of fishing units in Bardawill lagoon | 20 | 20 | 20 |
| Activity fishing days / year | 120 | 120 | 120 |
| Av. Economic loss for the quantity of Flathead Grey Mullet juvenile, EL/ unit/ season | 76835.1 | 125445.3 | 59919.4 |
| Av. Economic loss for the quantity of Flathead Grey Mullet juvenile, EL/ unit/ day | 3841.8 | 6272.3 | 2996.0 |
| Av. daily Economic loss for three seasons | | 4370.0 | |
| Total economic loss during Activity fishing days / year | | 524399.7 | |
| Total economic loss (million LE) for total unit in lagoon / fishing season | | 10,487,993.63 | |

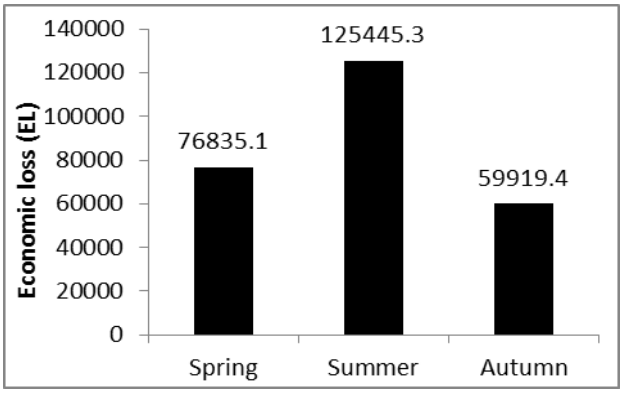


**Fig. 7. Economic loss of juvenile of Flathead Grey Mullet (*Mugil cephalus*) during two fishing seasons 2018 and 2019 from May to November 2018 and May to November 2019**

Our results agree with **Mehanna *et al.* (2011), Gaihiamngam *et al.* (2013), Salem (2019) and El-Aiatt *et al.* (2019)** there is a lot of economic loss due to juvenile fishing.

The present findings indicate that, even though the fishermen in lagoon have succeeded in improving the fishing efficiency with the help of technological advancements, they failed to achieve economic efficiency, since huge amount of future income in the form of large quantity of juveniles are being destroyed every year.

Long term benefits of mesh size shifts to larger sizes are very difficult for fishers to comprehend and accept. Indeed, even demonstrating the long-term benefits and short-term losses doesn't make fishers convinced of the need for conservation and change (**Mohamed *et al.*, 2008**) as the field level extension work is poor and considerable awareness needs to be developed among fishers to move towards sustainable marine fisheries.

## Recommendation

Good fisheries management requires the fishing gears to retain large fish while allowing juveniles to escape. so, must be reduced the current exploitation rate including reduction of the present level of fishing effort and an increase in the length at first capture should be increased to reach length at first mature (Lm) by regulate mesh sizes of the nets used In order to reduce the loss of biomass and economic.

Long term benefits of mesh size shifts to larger sizes are very difficult for fishers to comprehend and accept. Indeed, even demonstrating the long term benefits and short-term losses doesn't make fishers convinced of the need for conservation and change. So, must as the field level extension work and considerable awareness needs to be developed among fishers to move towards sustainable marine fisheries.

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## الملخص العربي

# التقييم البيولوجي والاقتصادي للمصايد الهوائية (شباك البوص) لمصايد أسماك البوري بمنخفض البردويل - شمال سيناء، مصر

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تعتبر شبكات الشرفة من التقنيات الرئيسية في بحيرة البردويل، وقد يرجع ذلك إلى قدرتها على استهداف أنواع مختلفة من الأسماك وقلة الجهد المطلوب لتشغيلها على الرغم من أن غالبية عمليات صيدها في هذه الدراسة لم تكن مستهدفة (صغيرة الحجم وغير ناضجة). من أجل إدارة مصايد الأسماك البحرية بشكل فعال، يجب علينا تقييم وإدارة المصيد عن طريق الصيد. تم جمع البيانات شهريًا لأسماك البوري من ثلاث سفن صيد محددة من شباك البوص كانت تعمل في بحيرة بردويل لكل وحدة صيد من مايو إلى نوفمبر 2018-2019. بلغ متوسط صيد البوري من اليوافع والبالغين 513.6 كجم (24.7% من إجمالي المصيد بواسطة شباك البوص) و620.3 كجم (29.8% من إجمالي المصيد بواسطة شباك البوص) في الربيع. 838.5 كجم (19% من إجمالي المصيد بواسطة شباك البوص) و1363.8 كجم (31% من إجمالي المصيد بواسطة شباك البوص) في الصيف و400.5 كجم (15.2% من إجمالي المصيد بواسطة شباك البوص) و832.3 كجم (31.5% من إجمالي المصيد بواسطة شباك البوص) في الخريف على التوالي، وقد أشارت نتائجنا إلى أن هبوط اليوافع من البوري يؤدي إلى مزيد من الخسائر في الكتلة الحيوية للمخزون والتي شكلت 76835.1، 12544.3 و59919.4 كجم للربيع والصيف والخريف على التوالي وخسائر 10.5 مليون جنيه مصري في موسم صيد واحد 2018 و2019.

**الكلمات الاسترشادية:** منخفض البردويل، شباك البوص، البوري، الخسارة البيولوجية والخسارة الاقتصادية.

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