JOURNAL OF THE
ARABIAN AQUACULTURE SOCIETY
Vol. 9 No 1 Arabian Aquaculture Conference May 2014

Techno- Economic study of fishing methods in Bardawil Lagoon

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ABSTRACT

Bardawil Lagoon is a large, very saline lake in Egypt on the north cast of the Sinai Peninsula.). The lagoon is nearly clear and it is least polluted in the entire Mediterranean region. The study refer to light on the catch composition of Bardawil Lagoon during the period (2001 – 2012) and illustrate the fishing methods in the lagoon (Trammel net, Veranda, Trawl net, long line and hand lining). Efficiency of Fishery Exploitation (E.F.E): it is a measure, which relate obtained economic surplus as percentage to total costs. It is referred to the effectiveness of elements of fishery exploitation (natural, human and capital resources). It varied from maximum of (252%) in Mechana followed by kalsa (226.89 %), Vernado (Bouss) (105.86 %), trammel net (Dabba) (66.45%) and Sinnar (-79 %) respectively. Consequently, fishery management should be aimed at maximizing of the efficiency of fishery exploitation. This can be achieved by improving environmental condition, utilization of more effective fishing gears, with improved construction and higher quality materials, improving fishing techniques, and it is necessary to re-calculate fishing effort of particular types of boats, so as to express it in comparable units.

Keywords: Bardawil Lagoon, fishing methods, efficiency of fishery exploitation.

INTRODUCTION

However, since fisheries resources are renewable, appropriate management strategies must be adopted to ensure their sustainability if fisheries must continue to play its triple role of a food supplier, employment provider and foreign exchange earner, in Egypt economy

Bardawil Lagoon plays an important role in lakes' fisheries of Egypt since it is the least polluted wetland in Egypt and most of its catch is exported. Bardawil Lagoon total annual commercial landings varied between 2801.3 and 3844ton (2001-2012) About 5000 local fishermen are working in the lagoon using different kinds of fishing methods some of them are very harmful to the lagoon ecosystem. Eight species (seabream, seabass, grey mullet, common sole, Egyptian sole, thinlip grey mullet, crab and shrimp) are targeted in the lagoon while more than 20 species and two threatened ones (turtle and seahorse) are caught as bycatch .

During the last ten years, crustacea (shrimp and crab) landings have greatly increased annually in Bardawil Lagoon, reaching about 52.7 % of the total catch, affecting the catch of other economic fish species like sea bream and sea bass. Mullets (family: Mugilidae), are the most important fish resources in Lake Bardawil, where they contributed about 28.3% of the total fish

production in the lagoon (GAFR 2012). Three species namely: *Mugil cephalus, Liza ramada* and *L. auraia* are the main constituents of the commercial catch of mullets in the lake. Mullets are exploited by veranda or bouss fishing method in the Lake. Because of the economic importance of mullets, their biology in different Egyptian water bodies has been extensively studied (RafaiL 1968; El-Sedafy? 1971; Fayek, 1973; El-Maghraby *et aL* 1973; Hashem *et al,* 1973; Hashem *el aL,* 1977; Salem and Mohammed, 1982; Hosny and Hashem, 1995). On the other hand, very limited studies were done about their dynamics and management (Mehanna, 2004; El-Gammal and Mehanna, 2004; Mehanna and Amin, 2005 and Al-Ziftawy,2013).

The Gilthead sea bream, *Sparus aurata* is an important species in the Egyptian coasts ofMediterranean Sea and the Bardawil lagoon fisheries. It was found in a wide variety of marine habitats, from rocky to sandy bottoms, at depths between 0 to 500 m, although it is usually more common at less than 150m deep (Abecasis *et al.*, 2008). In Bardawil lagoon, *Sparus aurata* is mainly exploited by two fishing techniques; trammel nets and hand line. This species is common as a discard and by-catch of trawl and gill-nets fisheries operating in the lagoon. All previous studies agreed that during the last twenty years, the stock of sea bream shows a serious decline in Bardawil lagoon (Bebars *et al.*,1986&1992; Khalifa, 1995; Khalil and Sheltout, 2006; Mehanna, 2006; Salem *etal.*, 2008).

Aim of study

The present investigation aimed to threw light on Bardawil Lagoon fisheries during the period (2001-2012). and evaluate the economic efficiency of fishery exploitation for different fishing methods in the lagoon.

Study area

The study was carried out in the Bardawil Lagoon (Figure 1).

Figure (1): ***Map of Bardawill Lagoon indicating two Boughazes***

The lagoon covers an area of 693 km2, in an arid area in the northern part of Sinai Peninsula, Egypt. It is separated from the Mediterranean Sea by a long narrow sandbar that varies in width between 100 m and 1 km. The lagoon communicates with the Mediterranean Sea water by two artificial and one natural narrow channel. The lagoon is considered as a natural depression with a depth of 0.5-3 m. The lagoon is of tectonic origin compared to the other Mediterranean Egyptian lagoons,for example, Idku, Burullus, and Manzala, which are of deltaic origin (the Nile River Delta) (El-Bana, et al., 2002). Bardawil Lagoon is the largest and least polluted lagoon in Egypt (Fanos, et al., 1994) (Mehanna,et al.,2011)

MATERIALS AND METHODS

The fisheries in the Bardawil Lagoon are seasonal and extend from April to December of each year. The exact date of opening and closing of the fishing season is decided by the General Authority of Fish Resources Development. The numbers of boats which work in the lagoon in these seasons were supplied from the report of the Administration of Bardawil Lagoon. Also, by recording the catch for each species or the species category for the different fishing gears by month, and the fishing season separately, the catch is weighed for each fishing technique and sorted into its different species. The catch estimate of each technique is weighed for each species.

Sampling data sheet was designed to collect the information about the catch and the effort, A sample of 600 fishermen and their families had been randomly selected from the fish landing centers Teloul and Eghziwan between April, 2010 and December, 2012. making interview with the skippers and the fishermen which were analyzed statistically after that.

RESULTS

I-Catch composition of the Bardawil Lagoon fisheries

Catch composition (ton) of the different species of the Bardawil Lagoon during the period 2001-2012 was shown in Table (1).

It clears that crabs *Epinephelus reguim* constituted the first major component of the catch forms 38% of the total catch, (2053.2 ton) in 2009. While, the shrimps represented the second major fish group which reached its maximum production 33% (1565.8 ton) in 2007 and representing about 25 % (1354.9 ton) of the catch in 2009. The catch of shrimp was represented in the lagoon by *Penaeus japonicus*, *P. semisulcatus* and Metapenaeus spp. Then followed by mullets which represented the third major fish group as it gives rise to 37.3% from the total catch in 2006 but it decreased to form 28.3% (1087ton) in 2012 .It was contributed in the catch by grey mullet *M. cephalus*, thicklip mullet *Liza ramada* and goldenhead mullet *Liza aurata* .

However, sea bream *Sparus aurata* attained 223.1 tons in 2001 constituting about 8% of the total catch, while it increased to 336.2 in 2008 and representing about 15 % of the total catch of the Bardawil lagoon, then it suddenly dropped to the level of 5.8% (212 ton) in 2011 of the Bardawil catch .Meanwhile, soles *Solea vulgaris* was reached to the maximum production 7% (292.3) in 2006 then dropped to 4.3 % (123 ton) in 2010. This is beside other species which range between7%in 2001 to 1% in 2012. Lastly, the

Table (1): Catch composition (ton) of the different species in the Bardawil Lagoon during the period 2001-2012.

Species	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sea Bream	223.1	266.4	279.1	338.7	293.3	274.0	303.1	336.2	314.6	304	212	256
Sea Bass	57.1	24.7	40.1	26.9	35.0	43.7	68.9	90.3	80.6	44	29	44
Sole	141.7	139.8	158.7	126.7	167.9	292.3	281.3	342.5	231.6	123	194	159
Groupers	11.2	11.9	8.4	12.5	16.0	26.9	16.2	32.6	31.8	30	7	14
Grey mullet	577.7	651.3	599.8	366.2	404.7	479.7	575.6	851.3	747.8	—	—	—
Thicklip mullet	330.1	349.9	318.1	258.1	268.9	268.3	301.4	347.1	307.8	—	—	—
Goldenheadmullet	80.6	81.5	81.9	79.0	78.7	76.1	74.2	99.5	76.1	—	—	—
Mugillidae sp.	**988.4**	**1082.7**	**999.8**	**703.3**	**752.3**	**824.1**	**951.2**	**1297.9**	**1131.7**	**1133**	**1190**	**1087**
Crabs	520.4	608.8	953.5	569.7	1321.9	1184.1	1342.8	1610.7	2053.2	1456	1202	926
Shrimps	595.2	813.7	808.1	329.4	775.0	1264.2	1565.8	1424.6	1354.9	1220	1176	1101
Others	264.3	134.0	77.9	119.7	173.2	232.9	199.6	258.2	211.8	421	519	257
Total	**2801.3**	**3082.0**	**3325.7**	**2226.9**	**3534.4**	**4142.1**	**4728.8**	**5393.0**	**5410.1**	**4731**	**4529**	**3844**

Source: ***GAFRD, El – Arish branch of General Authority for fish resources Development (2001-2012).***

Sea bass *Dicentrarchus labrax*, reaches about1.5% (80.6 ton) in 2009 then decreased to 29 tons in 2011. Then followed by Groupers Epinephelus spp, has the least species production of the total catch in the lagoon about (7 ton) in 2011.

From Table (1) it can be seen that, the crustacean constitutes 52.7% of the total catch of the lake in 2012.While Mullet constitute 28.3% of the total catch.

Also, from the table, it can be seen that the crustacean dominate the catch along the period of the study. Flourishing of crustacean may be resulted from dredging of the inlets; which provide suitable environmental condition, or decline of their common predators, which influence the suitability of the ecological niche. Also , forbidden of Cioncholla fishing units to work in the lagoon since 1993 contribute to the restoration of sea grass in the lagoon. Sea grass beds represent a suitable ecological niche for shrimps (Tom, et al. 1984). So, the fishermen adapted new fishing techniques suitable to catch crustacean (Kalsa fishing gear.) .The introduction of the trawl nets (kalsa) may be the cause of decline of must species especially bottom feeder like sea bream and sea bass.

II-Fishing methods in Bardawil Lagoon

1. Trammel net (Dabba)

Small boats with an overall length of 6 m and 9.9 Horse power outboard engine which worked with trammel nets and hand lines .The boats were equipped with 500 – 1000 m trammel net (mesh size 3.5 cm) or 2 to 4 hand line. The line is often 5-10 m long and containing one hook. The hooks are often 2-3 cm long containing life bait. (1-3) fishermen worked on each boat. The fishing boats work in night .Dabba represents about 93% from the total boats in the lake, worked upon it 2-3 fishermen and it fishing nightly.

Catch composition

The catch of the lake is composed mostly of: Fig. (2) Trammel net

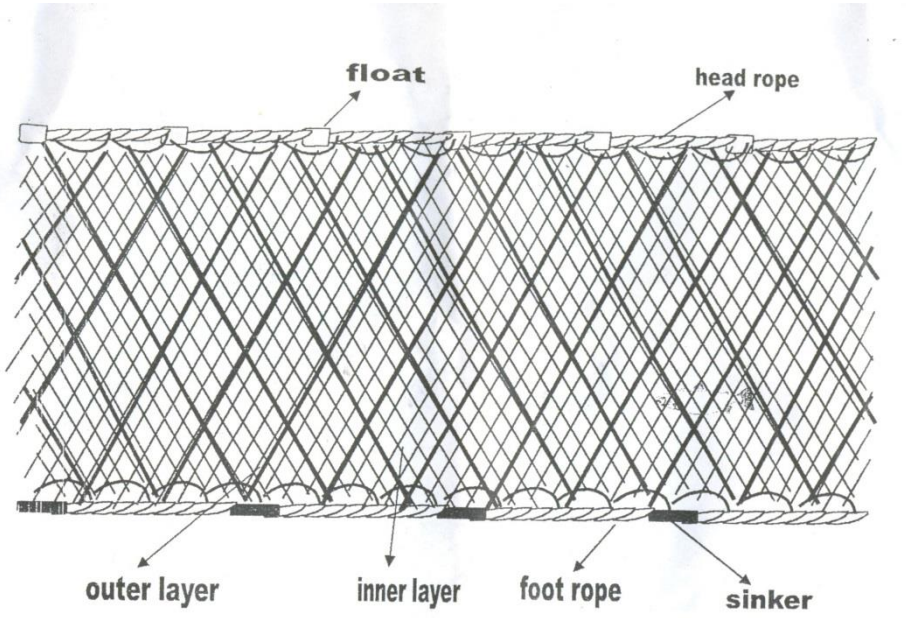


Figure (2) Trammel net (Dabba)

Catch of these gears is composed of gilthead sea bream *Sparus aurata*, seabass *Dicentrarchus labrax*, *D. punctata*, soles *Solea solea*, groupers Epinephelus regium, Grey mullet *M. cephalus*, Thick lip mullet *Liza ramada*, Golden head mullet *Liza saliens*.

2-The veranda fishing gear (Locally named Bouss)

88 fishing vessels of veranda type are present in the lagoon. The fishing by this technique depends upon the aggregation of 4 vessels together; two of them are motorized by 15-30 HP outboard engines and the other two are un-motorized and are used for carrying net. 15 fishermen operate on each group of vessels (4 vessels). The veranda fishing gear has two parts, one horizontal, and the other is vertical. The vertical part is 500 m in length and 5 m in depth and with mesh size of 20-24 mm. It is a single layered net which is kept vertically in water by a head rope and foot rope. The head rope is provided by floating buoys of 40 cm distances between each other and the foot rope is kept on bottom by parts of lead; separated from each other by average distances of about 55 cm. The horizontal part is a trammel net, with 500 m in length and 2.5m in width, with mesh size of 120 mm for the two outer layers and 26 mm for the inner one. The horizontal layer is supported by rods of Bamboo on which the net is supported on the water surface. Each group of vessels has two sets of the fishing gear reaching 1000 m in length (Al-Ziftawy,M.M.(2013).

This type of fishing gears is used to catch only grey mullets. According to the

behavior of the grey mullets, they jump over the net when they are trapped. The fishing method depends on encircling the mullets which try to escape by jumping over the vertical net; they fall over the horizontal net and get entangled. Each fishing operation takes about 2 hours and repeated for 3-4 times per day (Ameran.2004).

This fishing technique is specific for grey mullet capture, and as expected, the catch of the Bouss net is composed of 100 % mullets. About 3-4 shots per day are carried out, each having duration of two hours.

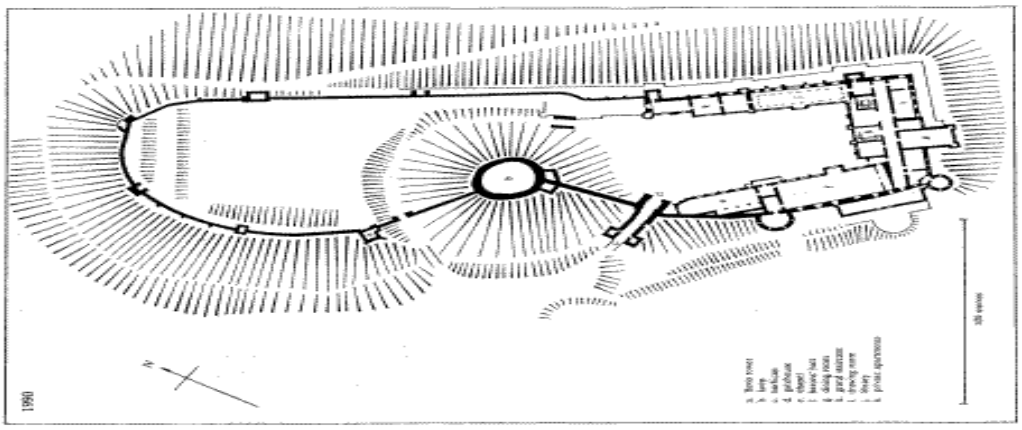
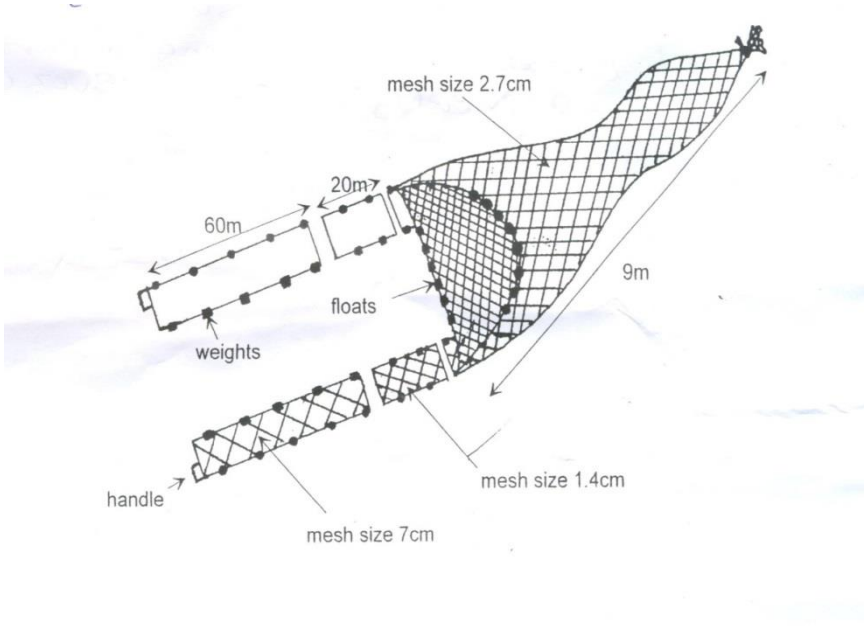


Figure (3): Veranda net

3-Trawl net of shrimp (Kalsa)

It is used mainly for fishing only crustacea. The trawl net (Kalsa) consists of two wings and bag, wing on each side of the bag net. The length of each wing is about 7.5 meters and the height is about 2 meters. The head rope of the wing is fitted with floats; the distance between each is about 25 cm. while the foot rope of the wing is fitted with sinkers "weights", also 25 cm. apart. The stretched mesh size of the wing is about 0.8 cm. The bag net is about 7 meters in length and its stretched mesh size is 0.6 cm. The mouth of the bag net has a radius 5 meters with a size of 0.7 cm and the head rope has some floats to keep the bag open, while the foot line of the bag mouth is fitted with weights which keep the bag creeping on the sandy floor of the lake. The fishermen throw the net in the water, and then the boats move to deeper water where the bag is dragged. Finally, the two wings and bag are then pulled to one of the boats to collect the catch. (Ameran.2004). Catch of these gears is composed of Crabs *Portonus pelagicus* and Shrimps as *Penaeus*

japonicus, *P. semisulcatus* and *Metapenaeus spp*.



Figure(4) Trawl net of shrimp (Kalsa)

4-Long line with hooks and baits (Locally named Sinnar)

The lines gear operating in the Bardawil Lagoon is both long line and hooks and line methods. In the first method, the mainline is 300 to450 m in length. Each branch with the hook is about 50 to 60 cm length. There are 250: 300 branch lines attached to the mainline. The types of baits used are the small shrimp and grey mullets. The main catch of this method are Eels and Grouper. In the hand –line, hooks are seated individually to catch single fish, while light are used to attract fishes. The main catch of this method is the sea bass species. The boats used in the two methods have three fishermen. This method of fishing operated only to catch nocturnal fishes (Ameran.2004).

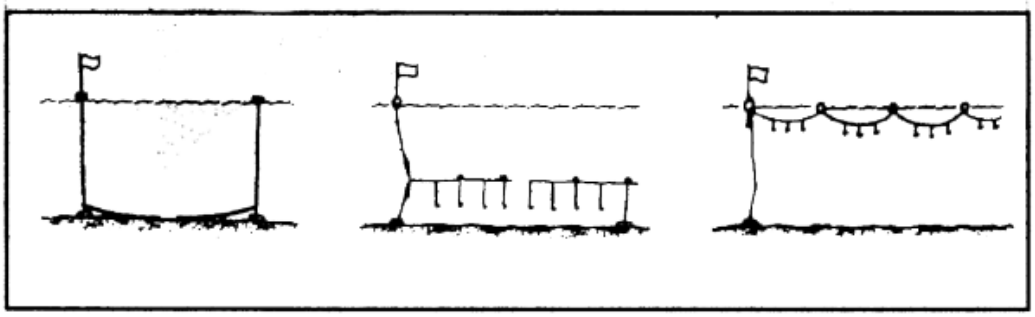


Figure (5): Long line with hooks and baits

5-Hand lining

Hand lining is employed in winter, mostly near the openings, to catch the migrating seabass (*Dicentrarchus labrax*). Its catch, which constituted a small fraction of the total, was recorded under the three other fishing methods (Ameran.2004).

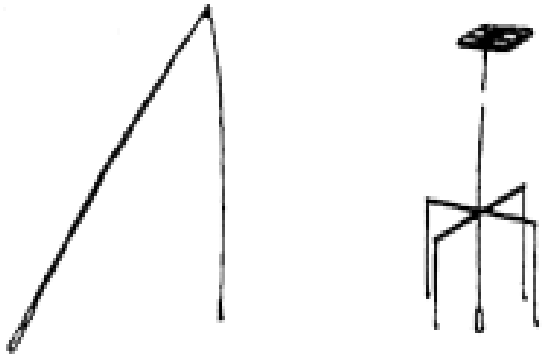


Figure (6): Hand Line with hook

III-Economic evaluation of fishing methods in Bardawil Lagoon

The information on fishing operations has been collected in 2008 and 2009 on a questionnaire basis, where the author has interviewed boats ' owners, fishermen, and other related persons.

To evaluate the existing fishing operations of the fishing methods used in lake Bardawil during 2010 and 2012, and as seen from Table (2).

Table (2): ***Economic evaluation of fishing methods in Bardawil Lagoon During 2010-2012.***

Item (per ton)	Dabba*	Boussa*	Meshna	Kalsa	Sinnar
1-Variable costs (L.E)	365	1365	668	834	412
2- Fixed costs (L.E)	10734	11500	12816	11480	11593
3-Total costs (L.E)	11099	12865	13483	12314	12005
4-Total income (L.E)	18475	26484	47455	40255	2409
5-Net income(L.E)	7376	13619	33972	27941	-9597
6-Economic Efficiency (E.E., %)	60.08	48.58	28	30.6	476
7- Technological Efficiency T.E.,(%)	39.92	51.42	72	69.4	-376
8-Economic Efficiency of fishery Explotation (%)	66.45	105.86	252	226.89	-79

AL-Ziftawy, M.M.(2013)

The following economic indices have been calculated :-

$$* \text{Economic Efficiency (E.E)} = \frac{\text{total costs} \times 100}{\text{total income}}$$

(Shafei, 1987).

The lower the calculated value, the higher economic surplus.

** Technological Efficiency (T.E.): It is a measure of the ability of economic unit to withstand price and quantity risks. It is equal to:

$$\text{T. E.} = \frac{\text{net income} \times 100}{\text{total income}}$$

(Shafei, 1987).

***Efficiency of Fishery Exploitation (E.F.E.): It is a measure, which relate obtained economic surplus as percentage to total costs. It is referred to the effectiveness of elements of fishery exploitation (natural, human and capital resources). It is equal to:

$$\text{E. F. E.} = \frac{\text{net income} \times 100}{\text{total costs}}$$

(Leopold, 1975).

It varied from maximum of (252 %) in Meshana followed by kalsa (226.89%), Vernada (Bouss) (105.86%), trammel net (Dabba) (66.45%) and Sinnar (-79%) ,respectively.

Consequently, fishery management should be aimed at maximizing of the efficiency of fishery exploitation. This can be achieved by improving environmental conditions , utilization of more effective fishing gears , with improved construction and higher quality materials , improving fishing techniques, and it is necessary to re –calculate fishing effort of particular types of boats , so as to express it in comparable units

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دراسة تكنو– إقتصادية لطرق الصيد في بحيرة البردويل

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تعد بحيرة البردويل واحدة من أكبر بحيرات المياة المالحة في الساحل الشمالي بمحافظة شمال شيناء بمصر. وتعتبر البحيرة صافية تقريبا وأقل البحيرات تلوثا في منطقة البحر المتوسط.

وتهدف الدراسة إلي إلقاء الضوء علي التركيب الصنفي لبحيرة البردويل خلال الفترة (٢٠٠١–٢٠١٢)، وتوضيح طرق الصيد المستخدمة في البحيرة (الدابة– البوص– المشنة– الكلسة–السنار).

وتعتبر كثافة الاستغلال السمكية Efficiency of FisheryExploitationمقياسايعبر عن العوائد الاقتصادية (EFE) كنسبة مئوية من التكاليف الكلية، وهي تشير إلي كفاءة الاستغلال السمكي (الطبيعية ، البشرية ، الرأسمالية)، وقد تراوحت كفاءة الاستغلال السمكية أقصي قيمة لها (٢٥٢.٠٠%) في حرفة المشنة تليها حرفة الكلسة (٢٢٦.٨٩%) ثم حرفة البوص (١٠٥.٨٦%)، ثم حرفة الدابة (٦٦.٤٥%) ثم حرفة السنار (–٧٩.٠%) علي التوالي.

وبالتالي فإن تنظيم المصايد في بحيرة البردويل لابد وأن يهدف إلي زيادة كفاءة الاستغلال السمكية، وهذا يمكن تحقيقه عن طريق تحسين الظروف البيئية واستخدام شباك صيد أكثر تأثيرا، وتطوير أدوات الصيد واستخدام مواد ذات كفاءة عالية، ومن الضرورى لإعادة حساب مجهود الصيد لأنواع محددة من المراكب لكي يمكن التعبير عنها أو وضعها في وحدات قابلة للمقارنة.