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The Estimation of Fishing Effort of the Most Important Fish Species Caught From the Egyptian Marine Fisheries

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Abstract: The research aimed to estimate the Maximum Sustainable Yield (MSY) and the level of Fishing effort (F_{MSY}) that attainable for the sustainability of the most important fish species caught from the Egyptian marine fisheries (Mediterranean and Red sea), this can be achieved through the following sub-objectives: (1) A study of evolution of fish catch from the Egyptian marine fisheries during the period (2005-2020), (2) A study of evolution of the most important fish species with the highest catches from the Egyptian marine fisheries during the research period, (3) A study of evolution of standard boats for catching fish species in question, (4) Estimating of the Maximum Sustainable Yield (MSY) and the Fishing effort (F_{MSY}) that attainable for the sustainability of the fish species in question. The research relied on the use of some descriptive and quantitative economic analysis methods in analyzing the published secondary data during the period (2005-2020) which is represented in the annual fishing, and the effort as a number of fishing boats in question (purse seine, Trawling and Trammel net), using surplus production models (SPM_S) for Schaeffer and Fox, and the data was analyzed on the computer using program $SPSS_{V.16}$.
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Key words: Fishing effort, Maximum Sustainable Yield, Schaefer model, Fox model, Marine fisheries and Egypt.

Introduction:

Since the beginning of 2020, the world economy faced with two major crises, The first was Corona Virus (Covid-19) pandemic, which caused a severe recession as a result of closing the main markets, restaurants and hotels(1), The second was the Russian invasion of Ukraine in February 2022, which led to an enormously increase in inflation throughout the world and a tremendous rise in the prices of all commodities, especially of the necessities commodity for the day life such as energy and foods in the third world countries, where the monthly food price index, which tracks the prices of globally traded food commodities, increased by about 12.6% between February and March 2022(2). In order to contain this inflation, countries had to adopt policies of support for food commodities and focuses on achieving sustainable development, especially for commodities that have the highest level of physical characteristics of production factor intensities, which is in Egypt, for example, is fish producing from marine fisheries, where these fisheries are characterized by basic components of fish production with all its productive resources (Vast fisheries with a surface area of about 11.2 million feddan, including the Mediterranean fisheries with an area of 6.8 million feddan and the Red Sea fisheries with an area of 4.4 million feddan- fishing fleet- productive, marketing and manufacturing labor-fish management – society's pool fish knowledge), The reason which increase the importance of the marine fisheries area is the exploitation of fisheries based on the volume of water not on the basis of the surface area(3).

Egyptian fish economy in general is considered an important sector of the Egyptian national economy, due to its basic role in producing animal protein for food security, In addition fish considerer as the alternative to livestock and chicken meat due to its highly nutrition value, cheap prices, variety of consumption purposes and lastly faster production. It is also characterized by being an important source of omega-3 acids and macro and micro nutrients such as vitamins and minerals(4), and contributes by about 42.63% of the animal protein consumed in Egypt during the year 2020(5).

Fish catching considered as one of the important factors affecting fisheries resources and fish production, because the sustainability of fisheries is essential in providing the fish resource for the next generations, so catching should be done in a balance form with regaining the fish resources (Growth and production) to ensure the minimum of fish stock which allows getting non-decreasing fish production for next generations in the long run[6]. Therefore, estimating the fish stock is of great importance of enhancement and development a strategy based on a scientific basis to preserve the fish mass from deterioration [7].

Context of the problem:

Although Egypt has a vast water area from marine fisheries which is about 11.2 million feddan, representing about 83% of the total water area in Egypt amounting to about 13.5 million feddan[8], the fish production from the marine fisheries amounted to about 113.47 thousand tons only, representing only about 8% of the total fish production in Egypt which estimating about 1.44 million tons during the period (2005-2020)[9], This situation reflects the need to regulate the exploitation of fish aquatic resources in the Egyptian marine fisheries, by estimating the optimal Fishing effort (F_{MSY}) needed to achieve Maximum Sustainable Yield (MSY) to achieve a balance between increasing production and fish stocks to the extent that protects them from decreasing and extinction in the long term.

Research objectives:

The research mainly aimed to estimate the Fishing effort of the most important fish species caught from the Egyptian marine fisheries, this can be achieved through the following sub-objectives: (1) A study of evolution of fish catch from the Egyptian marine fisheries during the period (2005-2020), (2) A study of evolution of the most important fish species with the highest catches from the Egyptian marine fisheries during the research period, (3) A study of evolution of standard boats for catching fish species in question, (4) Estimating of the Maximum Sustainable Yield (MSY) and the Fishing effort (F_{MSY}) that attainable for the sustainability of the fish species in question.

Research method:

In achieving its objectives, the research relied on the use of some descriptive and quantitative economic analysis methods in analyzing data related to the subject of the research, and specifically the following economic methods and models were used: (1) Some statistical methods such as arithmetic averages, percentages, standard deviation and coefficient of variation, (2) The annual changes rates for economic variables using the growth function, (3) Surplus production models for Schaefer and Fox to estimate the maximum sustainable yield for the most important fish species with the highest yield caught from marine fisheries in Egypt and the fishing effort that attainable for sustainable fish yield.

Data sources:

The research is based on published secondary data for the period from 2005 to 2020 were collected from Bulletin of food balance sheet, Fish statistics year book, Annual Bulletin of statistics fish production & food and Agricultural organization of United Nation by http://www.fao.org; while the data was analyzed on the computer using $SPSS_{V.16}$ Program.

Previous studies and theoretical and analytical framework:

Previous studies:

The Study (El-Kholei, 2008)[10] aimed to estimate the maximum sustainable yield (MSY) and the corresponding fishing effort (F_{MSY}) for Sardine, Mullet and Sole catch in the Egyptian Mediterranean by using Schaefer and Fox models during (1995-2006).The study Results indicated that the average (MSY) values for Previous fish species are about 19.4 and 1.6 thousand tons, and their corresponding (F_{MSY}) average about 123.83 and 174 standard boats respectively. The results indicated that the rational exploitation for Sardine, Mullet and Sole (Catch purse seine, trammel and trawl respectively) required a reduction.

The study (Wally et al., 2008)[11] aimed to estimate the economic efficiency of the use of the Egyptian marine fishing fleet. The study relied on the use of the quantitative analysis method, especially the Schaefer model, to estimate the maximum allowed fishing rate in 2006, by dividing the categories of fishing boats according to the horsepower of the boat is divided into 15 categories. The results indicated that the value of the idle investments, which represent fishing boats in excess of the need for fish resources in the Mediterranean and Red Sea, is estimated at about 324.4 million LE, The study recommended the necessity of adopting scientific methods to preserve the Egyptian marine fish resources in order to reduce the fishing effort to achieve the appropriate bio-economic exploitation of those resources, and the necessity of providing alternative opportunities for the excess investments represented in the fishing boats that exceed the needs of the fleet.

The study (Mazrou and El-Adawi, 2015)[12] aimed to identify the reasons for the observed fluctuation in the fish production of Burullus Lake and to present some proposals to rationalize the use of natural resources in the lake. The study relied on the application of a surplus production model (SPM) by Schaefer (1954) and Fox (1970) to estimate the optimal level of fishing effort (F_{MSY}) and the maximum sustainable yield (MSY) for the period from 1994 to 2013, The results indicated that the average of actual yield of the total fish production and tilapia production in the lake was lower than the maximum sustainable yield estimated by the two models. The results also showed a decrease in the actual fishing effort compared to its estimated counterparts of the two models, which indicates that there is no excessive fishing in the lake and that the observed fluctuation in production is a result of the pollution of the lake, where the percentage of catfish production to the total lake production and tilapia production increased during the study period, and the study recommended the necessity of continuous follow-up in the treatment of agricultural drainage water incoming to the lake and continuous disinfection and guarding of the Burullus gas inlet.

The study (Maiyza, et al., 2020)(7)aimed to estimate (MSY) and the corresponding level of (F_{MSY}) for both the Med. and Red Sea, Egypt. With analyzing annual catch and effort data, The Schaefer model results indicated that, the value of MSY was estimated $730*10^3$ tons for Mediterranean Sea fisheries and at $63.1*10^3$ tons for Red Sea fisheries and these values of MSY were obtained at fishing effort of $3.5*10^3$ and $1.6*10^3$ standard boats in Med. and Red Sea respectively. The results indicated that the optimum exploitation in Egyptian Marine fisheries required an Urgent reduction in fishing effort and this confirmed the overexploitation situation of the Marine fish stocks in Egypt.

The study (El-Zohery et al., 2020)(13) aimed to identify the reasons for the observed fluctuation in fish production from Manzala Lake. The study depended on the use of quantitative analysis through the application of Schaefer and Fox surplus production models to estimate the level of fishing effort to achieve the Maximum Sustainable Yield, and the results indicated an increase in the pollution of Al-Manzala Lake during the period (1995-2017), which is due to the lack of non-resistance of fish species inside the lake to Noilacihporta E, which results from increased pollutants, high sedimentation and plankton rot, which led to a change in the crop composition, especially for the main production. The study recommended supporting the lake with an amphibious excavator to get rid of the density of aquatic plants, with the need to stop the policy of drying, backfilling and dredging in the lake's fisheries.

The study (Karim et al.,, 2020)(14) aimed to estimate Maximum Sustainable Yield (MSY) Marine captured shrimp fishery of the bay of Bengal, Bangladesh by using surplus production models (SPM_S) from (1991-2014). The results indicated that the maximum catch was found 4188 Mt in 1992 and the minimum was 2175 Mt in 2006. In CEDA, The MSY was estimated by using the initial proportion (IP) value of 0.7 because the starting catch was approximately 70% of the max. catch the estimated MSY values of Fox and Schaefer from CEDA with two error assumptions were 2527 MT and 2584 MT, 2794 Mt and 2655 Mt, respectively.

The study (Rouf et al., 2020)(15) aimed to estimate (MSY), (F_{MSY}) and total allowable catch of major fishery in the in the Passur river, Bangladesh using (SPM_S) with observation – error estimate based on 4 years (2011-2014) catch and effort data. The results indicated that Fox model was especially highlighted in the study, the estimated value of (MSY) was 4.6 kg with corresponding F_{MSY} of 13.5 units (200 m^2SBN/day). The results provide clear evidence that the fishery of the Passur River is being overexploited in the months from December to March. The study results indicated that sustainable exploitation of the stock can be assured through reducing present fishing effort. In addition, TAC might be incorporated along with several existing fisheries management measures to ensure the compensation of the stock towards long-term sustainability.

-Theoretical framework:

The theoretical framework includes identifying some concepts related to the subject of the research, which are represented in the fish stock, fishing effort, the maximum sustainable output that achieves biological balance, and overfishing, in addition to identifying the types of fishing gear, as follows:

1. Fish stock: It is a group of fish of one species that ensures the repetition and continuity of fish production located at the same place(16).
2. Fishing effort: It is a measure of the effect for the fishing means used by fishermen to exploit the fish stock. The fishing effort may be represented by the fishing boat, the crew working on the fishing boat, or the equipment and tools used by the fishing boat during the real fishing period(3).
3. Maximum Sustainable Yield (MSY): It is the maximum amount of fish production that can be caught during a period of time (a year) from the fish stock under the prevailing environmental conditions, which in turn maintains the ability of the fish stock to reproduce and survive, and it is also called the potential energy of fish stock to achieve biological balance, and it is estimated at (25-30%) of the fish stock in the case of fisheries that were not exposed to overfishing, while in the case of over-fishing, this percentage is much reduced(16).
4. Overfishing: It is the limit that exceeds the critical level of the maximum sustainable yield, and thus the minimum stock of fish decreases, which leads to a decrease in the ability to develop it(6).
5. Types of fishing gear: The fishing boats where used in catching the fish from Egyptian marine fisheries varies according to the type of fish species(3). The fishing methods such as Trawling, Purse seine, Long liner, and Trammel net. While the mechanical power boats searching for fish to catch the light of Purse seine will attracts Sardinellas nei, Anchovy and small Sardine, while Shrimp are caught by Trawling and Trammel net from Mediterranean fisheries. Regarding, the Red Sea there is a fishing methods such as Trawling, purse seine, long liner, Trammel net and karakba & crab net, The light will be shed in the

research on the machinery boats of the purse seine and Trawling, due to their specialization in catching the fish in question from the Red Sea fisheries, where the purse seine nets work on catching Blue runner and Sardinellas nei, and the Trawling nets work on catching Brushtooth lizardfish[9].

The fishing fleet consists of fishing boats that form different groups in their engine horse power, and because fishing boats are not homogeneous, it was necessary to unify the power of the machinery boats in question with an average engine 175 H.P. for each standard boat, as follows:

Number of standard boats converted from machinery boats =

(num. of operating machinery boats) × (Engine in H.P.) / (175 H.P.).

Methodology:

Estimating the fish stock to determining the level of its exploitation is important to preserve the fish mass in a sustainable manner. The following methods of estimating fish stock are:

(1) Direct methods (surveys): A method for estimating fish production by measuring live fish from stock surveys.

(2) Indirect methods (Surplus production models): As known Biomass dynamics models (BDM_S) It is considered one of the fastest methods and gives an estimate of the Maximum Sustainable Yield and the corresponding fishing effort level. The research relied on estimating the models of surplus production models for Schaefer and Fox, as follows:

Surplus production models for Schaefer and Fox:

The Surplus production models for Schaefer (1954) and Fox (1970) are used to estimate the maximum sustainable yield (MSY) and their corresponding fishing effort level (F_{MSY}), as follows:

(1) Schaefer model [17]:

Surplus production model for Schaefer excess the yield (Catch in weight) per unit of fishing effort (Y/F) as a function of fishing effort (F) as follows:

$Y_i/F_i = a + b\, F_i \quad \text{if,} \; F_i \leq - a/b$

Where:

Y_i: Yield in year i (catch in weight).

F_i: Fishing effort in year i, where i= 1, 2, 3 …. n.

a, b: Parameters.

Estimating the previous equation by the method of ordinary least squares (OLS), a, b parameters were obtained, which are used in estimating F_{MSY} and then MSY, where it is noted that the slope b must be negative because Y/F decreases for each increase of (F), and the constant (a) is the value of (Y/F) and we get it only after the first catch on the stock first, so (a) must be positive.

The function can be written as:

$Y = a\,F \pm b\,F^2$

By differentiating the previous function with respect to the fishing effort to get the marginal product and equal it to zero to find the maximum point, which is (F_{MSY}), as shown in Table (1) as follows:

$F_{MSY} = - a/2b$

Substituting the value of (F_{MSY}) into the production function, (MSY) was obtained, and it can be calculated as follows:

$MSY = - a^2 / 4b$

2. Fox model [18]:

Fox model express the log of yield per unit of fishing effort as a function of effort as follows:

$Y_i/F_i = \exp^{c + d F}$

The previous function can also be written in semi-logarithmic form as follows:

$\text{In}\,(Y_i / F_i) = c + d\,F$

Where:

Y_i: Yield in year i (catch in weight).

F_i: Fishing effort in year i, where i= 1, 2, 3, …., n.

c, d: Parameters.

By performing differentiation with respect to (F_i), it is possible to obtain the marginal product equation and set it equal to zero to find the value of (F_{MSY}) that achieves MSY, as shown in Table (1):

$F_{MSY} = - 1/d$

Substituting the value of F_{MSY} into the production function, we get MSY, and it can also be calculated as follows:

$MSY = - 1/d \,.\, \exp^{(c-1)}$

Table (1): Fishing effort and Maximum Sustainable Yield using surplus production models for Schaefer and Fox.

Schaefer model	F_{MSY}	$- a/2b$
	MSY	$- a^2 / 4b$
Fox model	F_{MSY}	$- 1/d$
	MSY	$- 1/d \,.\, \exp^{(c-1)}$

Source: - Schaefer, M. B. (1954), Some Aspects of the Dynamics of population Important to the management of the Commercial Marine Fishers, Bulletin of the Inter- American tropical Tuna Commission, 1(2) pp: 27-56.

-William W., Fox Jr. (1970), An Exponential Surplus -Yield Model for Optimizing Exploited Fish Populations, American Fishers Society Journal, Vol. 99 (1), pp: 80-88.

Both models share their hypothesis that there is an inverse relationship between the productivity of a unit of effort and the amount of the fishing effort used, and in the absence of fishing effort, the fish production is called unexploited biomass as indicated by point (a), while they differ in that Schaefer model assumes the existence of a level for fishing, all the fish stocks are depleted, which is the point (-a/b), so the fishing effort must always be less than this point, while the Fox model does not assume this - Figure (1).

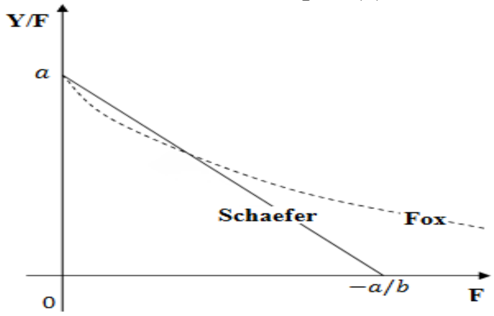

Figure (1): Illustration of the different assumptions behind Schaefer and Fox models.
Source: Defeo, O. and Caddy, J., (2001), Evaluation a Dynamic Approach to Yield- Mortality Models, ICES Journal of Marine Science, Vol. 58 (6), PP: 1253–1260.

Results and Discussion:

First: Evolution of fish catches from the Egyptian marine fisheries during the period (2005-2020):

The fish catch from the Egyptian marine fisheries includes both the catch of the Mediterranean and Red Sea fisheries, and it is clear from the data in tables (2, 3) that:

The average year catch from the Egyptian marine fisheries was about 113.47 thousand tons represents about 7.88% of the total Egyptian fish catch, during the period (2005-2020), also fish catch from Med. and Red Sea was about 58.18% and 41.83%, respectively- Table (2), Figure (2).

The total fish catch in Egypt during the research period ranged between a minimum of about 889.30 thousand tons in 2005, and a maximum of about 2.04 million tons in 2019, and it increased at a statistically significant growth rate of about 5.6% of the average during the period of the research, and by an annual increase of about 80.63 thousand tons.

The catch of marine fisheries in Egypt ranged between a minimum of about 98.95 thousand tons in 2019 and a maximum of about 136.24 thousand tons in 2008, and decreased at a statistically significant rate of decrease that amounted to about 1.5% of the average during the research period, and by an annual decrease of about 1.70 thousand tons.

The fish catch from the Mediterranean fisheries ranged between a minimum of about 48.02 thousand tons in 2019 and a maximum of about 88.88 thousand tons in 2008, and decreased by a statistically significant decrease rate of about 3% from the average during the research period of about 66.02 thousand tons, and by an annual decrease of about 1.98 thousand tons.

Table (2): The relative importance of catch from the Egyptian marine fisheries during the period (2005-2020). (Thousand tons)

Years	Catch						
	Total	Marine fisheries		Med. Sea		Red sea	
		Qty.	(%)	Qty.	(%)	Qty.	(%)
2005	889.30	107.45	12.08	56.72	52.79	50.73	47.21
2006	970.92	119.61	12.32	72.67	60.76	46.94	39.24
2007	1008.01	130.75	12.97	83.76	64.06	46.99	35.94
2008	1067.63	136.24	12.76	88.88	65.24	47.36	34.76
2009	1092.89	127.82	11.70	78.79	61.64	49.03	38.36
2010	1304.79	121.36	9.30	77.39	63.77	43.97	36.23
2011	1362.17	122.30	8.98	77.80	63.61	44.50	36.39
2012	1371.98	114.20	8.32	69.33	60.71	44.87	39.29
2013	1454.40	106.66	7.33	63.03	59.09	43.63	40.91
2014	1481.88	107.80	7.27	62.75	58.21	45.05	41.79
2015	1518.94	102.93	6.78	57.60	55.96	45.33	44.04
2016	1706.27	103.65	6.07	53.96	52.06	49.69	47.94
2017	1822.80	109.76	6.02	58.93	53.69	50.84	46.32
2018	1934.74	104.70	5.41	56.73	54.18	47.96	45.81
2019	2038.99	98.953	4.85	48.02	48.53	50.94	51.48
2020	2010.57	101.38	5.04	49.89	49.21	51.49	50.78
Mean	1439.77	113.47	7.88	66.02	58.18	47.46	41.83

Source: Compiled and calculated from: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007-2022), Cairo, Egypt.

Figure (2): The relative importance of catch from the Egyptian marine fisheries during the period (2005-2020).
Source: Table (2).

Table (3): The most important descriptive statistical indicators of catches fish from the Egyptian marine fisheries during the period (2005-2020).

Variable	Unit	Catch			
		Total	Marine fisheries	Med.	Red Sea
Min	1000 Ton	889.30	98.95	48.02	43.63
Max	1000 Ton	2038.99	136.24	88.88	51.49
St. Dev	-	378.84	11.46	12.56	2.72
C.V(1)	(%)	26.31	10.10	19.02	5.73
Change Rate	(%)	5.6**	-1.5**	-3.00**	0. 4n.s
Trend Value	1000 Ton	80.63	-1.70	-1.98	-

(1) Coefficient of Variation = Stander deviation/ Mean*100
(**) indicates statistical significant at the 0.01 level. (n.s) non-sign.
Source: The results of analyzing the data contained in Table (2) on computer using $SPSS_{V.16}$ Program.

The fish catch from the Red Sea fisheries ranged between a minimum of about 43.63 thousand tons in 2013 and a maximum of about 51.49 thousand tons in 2020, with an average of about 47.46 thousand tons, while the statistical significance of the rate of change has not been established, which indicates the fluctuation of fish production about the average during the research period.

It is clear from the above that the statistical significant increase in the total fish catch is not due to production of marine fisheries, as the fish production in the Med. decreased at a statistically sign. rate of decreasing, and the significance of the fish production from the Red Sea was not proven, and therefore the increase is due to the output from the rest of the fisheries, whether natural or aquaculture, which requires a great need to pay attention to directing the economic exploitation of marine fisheries.

Second: Evolution of the most important fish species with the highest catches from Egyptian marine fisheries during the period (2005-2020):

(A) Evolution of the most important fish species with the highest catches from Med. in Egypt:

It is clear from the data in Tables (4, 5) that:

The average fish catch of the most important fish species with the highest catches (Sardinellas nei, Anchovy & small Sardine and Shrimp) from the Med. was about 22 thousand tons, represent about 33.32% of the total fish production from the Med. fisheries, which amounts to about 66.02 thousand tons, which represented by the sardinellas nei, which ranked first with a rate about 16.75% of the total, followed by Shrimp with a rate of about 10.63% of the total, followed by Anchovy & small Sardine at a rate about 5.92% of the total, and the fish production of Sardinellas nei, Anchovy & small Sardine was combined for their catch with the same type of nets (purse seine boats)- Table (4).

It was found that the fish catch of Sardinellas nei, Anchovy & small Sardine from the Med. ranged between a min. of about 9.88 thousand tons in 2011, and a max. of about 25.45 thousand tons in 2007, and by an annual decrease of about 4.2% from the average about 11.06 thousand tons, and by decrease about 630 tons during the research period.

The fish catch of Shrimp from the Med. ranged between min. of about 2.95 thousand tons in 2005, and max. of about 10.80 thousand tons in 2011, with an average about 7.02 thousand tons, the statistical significance of Shrimp production has not been proven, which means that its production fluctuated around the average during the period search.

Table (4): The relative importance of the most important fish species with the highest catch of fish from the Med. in Egypt during the period (2005-2020). (Thousand tons)

Statement / Year	Catch									
	Marine Med.	the most important fish species with the highest catch of Med.						Sardinellas nei, Anchovy & small Sardine(1)	Total species	
		Sardinellas nei		Shrimp		Anchovy & small Sardine				
		Qty.	(%)	Qty.	(%)	Qty.	(%)	Quantity	Qty.	(%)
2005	56.72	14.98	26.41	2.95	5.20	5.06	8.91	20.04	22.98	40.52
2006	72.67	14.76	20.32	3.27	4.50	5.78	7.95	20.54	23.81	32.77
2007	83.76	20.19	24.11	4.81	5.74	5.26	6.27	25.45	30.25	36.12
2008	88.88	17.39	19.56	10.75	12.09	4.86	5.47	22.25	33.00	37.13
2009	78.79	11.92	15.13	10.63	13.49	3.17	4.02	15.09	25.72	32.64
2010	77.39	8.97	11.59	10.56	13.65	2.99	3.86	11.96	22.52	29.10
2011	77.80	7.88	10.13	10.80	13.88	2.00	2.57	9.88	20.68	26.58
2012	69.33	10.63	15.34	6.64	9.57	2.90	4.19	13.53	20.17	29.09
2013	63.03	10.24	16.25	5.95	9.45	3.60	5.72	13.84	19.80	31.42
2014	62.75	10.10	16.10	8.06	12.85	3.64	5.8	13.74	21.81	34.75
2015	57.60	9.94	17.26	7.07	12.28	3.24	5.63	13.18	20.26	35.17
2016	53.96	9.15	16.95	6.43	11.92	2.66	4.92	11.81	18.24	33.79
2017	58.93	8.58	14.56	8.07	13.69	3.45	5.85	12.03	20.10	34.11
2018	56.73	8.90	15.69	5.61	9.89	4.57	8.06	13.47	19.08	33.64
2019	48.02	6.56	13.66	4.67	9.72	4.49	9.35	11.05	15.71	32.73
2020	49.89	6.80	13.62	6.06	12.14	4.96	9.94	11.76	17.82	35.71
Mean	66.02	11.06	16.75	7.02	10.63	3.91	5.92	14.98	22.00	33.32

(1) The fish catch of Sardinellas nei, Anchovy & small Sardine were collected for fishing with the same type of nets (purse seine boats).
Source: Compiled and calculated from: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007-2022), Cairo, Egypt.

Table (5): The most important descriptive statistical indicators of the fish species in question caught from the Med. in Egypt during the period (2005-2020).

Statement	Unit	Catch	
		Sardinellas nei, Anchovy & small Sardine	Shrimp
Min	1000 Ton	9.88	2.95
Max	1000 Ton	25.45	10.80
St. Dev	-	4.54	2.60
C.V	(%)	30.31	37.04
Change Rate	(%)	-4.2**	1.2n.s
Trend Value	1000 Ton	-0.63	-

(**) indicates statistical significant. at the 0.01 level. (n.s) non-sign.
Source: The results of analyzing the data contained in Table (4).

(B) Evolution of the most important fish species with the highest catches from Red Sea fisheries in Egypt:

It is clear from the data in tables (6, 7) that:

The average fish catch of the most important fish species catches (Blue runner, Sardinellas nei and Brushtooth lizardfish) from the Red Sea fisheries was about 16.93 thousand tons, represent about 35.67% of the total fish production in the Red Sea, which amounted to about 47.46 thousand tons during the research period, by represented by the Blue runner, which ranked first with a rate about 16.60% of the total, followed by Sardinellas nei with a percentage of about 11.34% of the total, followed by Brushtooth lizardfish with a percentage of about 7.73% of the total, and the fish product of Blue runner and sardinellas nei was combined to catch them with the same type of nets purse seine boats- Table (6).

It was found that the fish catch of Blue runner and Sardinellas nei from the Red sea fisheries ranged between a minimum of about 8.19 thousand tons in 2008, and a maximum of about 18.75 thousand tons in 2019, and increased at a statistically significant annual growth rate about 5.2% of the average of about 13.26 thousand tons, and an increase of about 690 tons during the research period.

The fish catch of Brushtooth lizardfish fish from the Red sea fisheries ranged between a minimum of about 2.19 thousand tons in 2005 and a maximum of about 4.50 thousand tons in 2016 with an average about 3.67 thousand tons, while the statistical significance of the Brushtooth lizardfish yield was not proven, which means that its output fluctuated around average over the research period.

Table (6): The relative importance of the most important fish species with the highest catches from the Egyptian Red Sea fisheries during the period (2005-2020). (Thousand tons)

Statement / Year	Catch									
	Marine Red Sea	the most important fish species with the highest catches of Red sea						Blue runner and Sardinellas nei	Total	
		Blue runner		Sardinellas nei		Brushtooth Lizardfish				
		Qty.	(%)	Qty.	(%)	Qty.	(%)	Qty.	Qty.	(%)
2005	50.73	7.94	15.64	2.89	5.69	2.19	4.31	10.83	13.01	25.64
2006	46.94	5.94	12.65	2.37	5.04	4.16	8.87	8.31	12.47	26.56
2007	46.99	6.52	13.88	2.19	4.67	3.15	6.71	8.71	11.87	25.25
2008	47.36	4.91	10.37	3.28	6.93	4.12	8.69	8.19	12.31	25.98
2009	49.03	7.93	16.18	7.30	14.88	4.38	8.94	15.23	19.61	39.99
2010	43.97	6.15	13.99	4.70	10.69	3.92	8.92	10.85	14.77	33.58
2011	44.50	5.91	13.29	4.84	10.88	3.88	8.73	10.75	14.64	32.89
2012	44.87	8.06	17.96	5.33	11.88	3.88	8.64	13.39	17.26	38.47
2013	43.63	7.09	16.25	4.15	9.51	3.60	8.26	11.24	14.84	34.02
2014	45.05	7.83	17.37	4.59	10.18	3.90	8.66	12.42	16.31	36.21
2015	45.33	7.20	15.87	5.09	11.23	3.68	8.12	12.29	15.97	35.22
2016	49.69	9.80	19.73	6.89	13.86	4.50	9.06	16.69	21.20	42.66
2017	50.84	9.61	18.91	7.92	15.58	4.08	8.04	17.53	21.62	42.53
2018	47.96	9.15	19.08	9.50	19.81	3.29	6.87	18.65	21.94	45.75
2019	50.94	10.78	21.17	7.97	15.65	3.27	6.43	18.75	22.03	43.24
2020	51.49	11.18	21.71	7.10	13.78	2.72	5.28	18.28	21.00	40.78
Mean	47.46	7.88	16.60	5.38	11.34	3.67	7.73	13.26	16.93	35.67

(1) The fish catch of Sardinellas nei and Blue runner were collected to catch them with the same type of nets (purse seine boats).

Source: Compiled and calculated from: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007-2022), Cairo, Egypt.

Table (7): The most important descriptive statistical indicators of the fish species in question catches from the Egyptian Red sea fisheries during the period (2005-2020).

Statement	Unit	Catch	
		Blue runner and Sardinellas nei	Brushtooth lizardfish
Min	1000 Ton	8.19	2.19
Max	1000 Ton	18.75	4.50
St. Dev	-	3.77	0.62
C.V	(%)	28.43	16.89
Change Rate	(%)	5.2**	0.01n.s
Trend Value	1000 Ton	0.69	-

(**) indicate statistical significant. at the 0.01 level. (n.s) non-sign.
Source: The results of analyzing the data contained in Table (6).

Third: Evolution of fishing standard boats related to the corresponding fish species caught from the Egyptian marine fisheries during the period (2005-2020):

It is clear from the data in tables (8, 9) that:

The number of purse seine boats in the Med. ranged between a minimum of about 195 standard boats in 2005, and a maximum of about 420 standard boats in 2019, and increased at a statistically significant annual growth rate of about 5.5% of the average of about 302 standard boats, and an increase of about 17 standard boats.

The number of trawling and trammel nets in the Med. fisheries ranged between a min. of about 1231 standard boats in 2009 and a max. of about 1745 standard boats in 2018, and increased at a statistically significant annual growth rate of about 2.3% of the average of about 1476 standard boats, and an increase of about 34 standard boats.

Table (8): Standard boats for fishing the fish species in question caught from the Egyptian marine fisheries during the period (2005-2020). (Engine in = 175 H.P.)

Statement / Year	Fishing effort			
	Med. Sea		Red sea	
	Purse seine	Trawling and Trammel net	Purse seine	Trawling
	(to catch Sardinellas nei, Anchovy & small Sardine)	(to catch Shrimp)	(to catch Blue runner and Sardinellas nei)	(to catch Brushtooth lizardfish)
2005	195	1238	194	740
2006	200	1289	176	190
2007	209	1256	325	635
2008	230	1271	594	594
2009	238	1231	268	514
2010	247	1540	298	508
2011	250	1329	337	482
2012	266	1406	397	569
2013	305	1531	380	459
2014	354	1529	371	460
2015	374	1670	372	453
2016	409	1701	348	395
2017	383	1651	337	408
2018	391	1745	376	401
2019	420	1733	383	405
2020	359	1492	377	361
Mean	302	1476	346	473

Source: Compiled and calculated from tables (1, 2, 3, 4, 5) of Appendixes.

The number of purse seine boats in the Red Sea ranged between a minimum of about 176 standard boats in 2006, and a maximum of about 594 standard boats in 2008, and increased at a statistically significant annual growth rate of about 2.9% from the average of about 346 standard boats, with an increase of about 10 standard boats, while the number of trawling boats in the Red Sea fisheries ranged between a minimum of about 190 standard boats in 2006, and a maximum of about 740 standard boats in 2005, with an average of about 473 standard boats, and the statistical significance of them was not established, which indicates that their numbers fluctuated around the average during the research period.

Table (9): The most important descriptive statistical indicators of standard boats for fishing the fish species in question caught from the Egyptian marine fisheries during the period (2005-2020).

Statement	**Unit**	**Fishing effort**			
		Med. Sea		**Red Sea**	
		Purse seine	**Trawling and Trammel net**	**Purse seine**	**Trawling**
		(to catch Sardinellas nei, Anchovy & small Sardine)	**(to catch Shrimp)**	**(to catch Blue runner and Sardinellas nei)**	**(to catch Brushtooth lizardfish)**
Min	boat	195	1231	176	190
Max	boat	420	1745	594	740
St. Dev	-	80.75	189.04	93.38	125.93
C.V	(%)	26.74	12.81	26.99	26.62
Change Rate	(%)	5.5**	2.3**	2.9*	-1.8n.s
Trend Value	boat	17	34	10	-

(*) indicates statistical significant. at the 0.05 level.
(**) indicates statistical sign. at the 0.01 level. (n.s) non-sign.
Source: The results of analyzing the data contained in Table (8).

From the above it is clear that there is a significant increase in the purse seine boats designated for fishing for Sardinellas nei, Anchovy & small Sardine in the Med. fisheries, amounting to about 5.5%, accompanied by a significant decrease in the production of Sardinellas nei, Anchovy and small Sardine by about 4.2%, which indicates that the production of these fish species is facing a danger as a result of the increase in the fishing units for their catch in a ratio more than its decreasing yield and it is clear that, despite the insignificance of Shrimp production in the Mediterranean Sea fisheries, the trawling and trammel net boats designated for fishing increased at a statistically significant growth rate of about 2.3%, which requires the need to monitor the increase of boats that may negatively affect the long-term Shrimp production and then stock.

Fourth: Maximum Sustainable yield and the fishing effort that attainable for the sustainability of the fish species in question caught from the Egyptian marine fisheries during the period (2005-2020):

Given the importance of sustainable fisheries in providing the fish resource for future generations, it was necessary to strike a balance between the maximum sustainable yield that we can obtain (Critical exploitation level) and the optimal fishing effort attainable for sustainability, whereas if the production amounts of any species or a group of them increased of this level, it consider as an indicator of the beginning of decreasing amounts resulting from it in the next years, especially with the continuation of the fishing effort, which is considered over fishing. The following is an estimate of the maximum sustainable yield and the fishing effort attainable for it, as follows:

(A) Maximum sustainable yield and the fishing effort achieved sustainability of the fish species in question caught from the Med. fisheries:

It is clear from the estimated data in Table (10) that the statistical significance of each of Schaefer and Fox models at the 0.01 probability level for Sardinellas nei, Anchovy & small Sardine (purse seine boats), while the statistical significance of Shrimp (Trawling and trammel net boats) was not proven, which indicates the absence of the over-fishing phenomenon.

It was found from the results of surplus production models for Schaefer and Fox that the value of (MSY) of Sardinellas nei, Anchovy and small Sardine from the Med. that can be caught without disturbing the biological balance was estimated at about 18.34 and 16.60 thousand tons, respectively, at the level of the optimal fishing effort that achieves the (MSY), which was estimated at about 237 and 167 standard boats, respectively.

Table (10): Estimation of maximum sustainable yield and the fishing effort attainable for the sustainability of the fish species in question caught from the Egyptian Med. fisheries using Schaefer and Fox models during the period (2005-2020).

Species	Statement	Schaefer model	Fox model
Sardinellas nei, Anchovy and small Sardine (Purse seine)	Equation	Y/F = 154.65 – 0.326 F (8.72)** (-5.73)**	Ln (Y/F) = 5.601 – 0.006 F (24.79)** (-7.77)**
	F test	32.87**	60.41**
	R^{-2}	0.680	0.798
	F_{MSY}(boat)	237	167
	MSY(Ton)	18341	16597.31
Shrimp (Trawling and Trammel net)	Equation	Y/F = 10.79 – 0.004 F (2.64)* (-1.47)n.s	Ln (Y/F) = 2.374 – 0.001 F (2.83)* (-1.05)n.s
	F test	2.15n.s	1.107n.s
	R^2	0.071	0.007

(**) indicates statistical sign. at the 0.01 level. (n.s) non-significant.
Source: The results of data analysis contained in Table (4, 8) using $SPSS_{V.16}$ Program.

By comparing the results of Table (10) with the data contained in Table (4) regarding the fish catch of Sardinellas nei, Anchovy and small Sardine, it was found that the actual production exceeded the maximum allowable production during the period (2005-2008) by about 3.73 and 5.47 thousand tons respectively, according to Schaefer and Fox models, which indicates on over-fishing, and this led to a decrease in their production from the maximum allowable production during the period (2009-2020) by about 5.73 and 3.99 thousand tons, according to Schaefer and Fox models, respectively.

It was also clear from comparing the results of Table (10) with the data in Table (8) regarding the fishing effort for production of Sardinellas nei, Anchovy & small Sardine from the Mediterranean sea fisheries represented in the number of purse seine boats for their catch, that it exceeded the estimated fishing effort and attainable for the maximum sustainable yield by about 135 standard boats during the research period according to Fox model, while the actual fishing effort exceeded the estimated fishing effort during the period (2009-2020) by about 96 standard boats according to Schaefer model, which indicates the presence of idle energies and wasted investments, and this may be attributes to the lower of the efficiency of the management resource with the fish management component in its regulatory and supervisory parts, which allows the depletion of the stock fish or fish mass(*).

It is clear from the above that the relative importance fish species varies in the long run unless the fish stocks of these species are preserved. It was mentioned (El-Kholei, 2008)[10] in a research paper dealing with the period (1991-2006) in the Med. fisheries, the fish catches of Sardinellas nei ranked first in the most important fish caught, followed by Mullets and Sole and the results of Schaefer and Fox models shows that there is over-fishing for these species, especially for Mullets which its wildfry uses in aquaculture fish, which lead to decrease its production by the time, which the research attained, where it was found that the fish production of Sardinellas nei remained the first in the important fish species catch from the Med. fisheries during the research period, followed by the Anchovy and small Sardine, then Shrimp, while the fish catch of Mullet and Sole diminished so much that he could not compete in relative importance

(B) Maximum sustainable yield and the fishing effort that attainable of the sustainability of the fish

(*) Fish stock of a water resource estimates with doing a fishing experiment to get the following data: (1) The area of water which is used to estimate the fish stock, (2) The water area which is used to do the experiment on, (3) The efficient productivity of the fishing unit, (4) The time of doing experiment, (5) The fish production by use the law of fish stock which is used to systemize the relations among the pervious variables, it can get the fish stock.

species in question caught from the Red Sea fisheries:

It is evident from the data estimated in Table (11) that the statistical significance of each of Schaefer and Fox models at the probability level of 0.01 for Blue runner, Sardinellas nei (purse seine boats) and Brushtooth lizardfish (trawling boats), and the following is an estimate of (MSY) and (F_{MSY}) that achieves the sustainability of the Blue runner, Sardinellas nei and Brushtooth lizardfish on the as follows:

The results of the surplus production models for Schaefer and Fox show that the maximum sustainable yield of Blue runner and Sardinellas nei from the Red sea fisheries caught without disturbing the biological balance was estimated at about 14.34 and 12.35 thousand tons at the level of the fishing effort that achieved the maximum sustainable yield was estimated at about 411 and 333 boats, respectively.

Table (11): Estimation of Maximum Sustainable Yield and the Fishing effort that attainable for the sustainability of the fish species in question caught from the Egyptian Red Sea fisheries using Schaefer and Fox models during the period (2005-2020).

Species	Statement	Schaefer model	Fox model
Blue runner and Sardinellas nei (Purse seine)	Equation	Y/F = 69.83 – 0.085 F (7.44)** (-3.24)**	Ln (Y/F) = 4.612 – 0.003 F (17.69)** (-3.84)**
	F test	10.53**	14.72**
	R^{-2}	0.388	0.478
	F_{MSY}(boat)	411	333
	MSY(Ton)	14341.85	12346.69
Brushtooth Lizasrdfish (Trawling net)	Equation	Y/F = 21.28 – 0.027 F (9.48) ** (-5.83) **	Ln (Y/F) = 3.460 – 0.003 F (19.97)** (-8.27)**
	F test	34.02**	68.46**
	R^2	0.688	0.818
	F_{MSY}(boat)	394	333
	MSY(Ton)	4192.95	3901.60

(**) indicates statistical sign. at the 0.01 level. (n.s) non-sign.

Source: The results of data analysis contained in Table (4, 8) using $SPSS_{V.16}$ Program.

By comparing the results of Table (11) with the data in Table (6) related to the fish catch of Blue runner and sardinellas nei from the Red Sea fisheries, it was found that the actual production exceeded the max. allowable production in 2009 by an increase of about 890 tons and 2.88 thousand tons, according to Schaefer and Fox models, respectively, and it also exceeded by about 3.64 and 5.63 thousand tons during the period (2016-2020) according to Schaeffer and Fox models, respectively, which indicates over-fishing, which in turn will affect the reduction of fish stock and thus production of Blue runner and Sardinellas nei in the next years.

It was also clear from comparing the results of Table (11) with the data contained in Table (8) related to the fishing effort of the production of Blue runner and Sardinellas nei from the Red Sea fisheries, represented in the number of purse seine boats for their catch, that it exceeded the estimated (F_{MSY}) that attainable for the maximum sustainable yield by about 183 and 261 standard boats in 2008 according to Schaefer and Fox models, respectively, it also exceeded by about 35 standard boats as an average for the period (2011-2020) according to the Fox model only.

The results of Schaefer and Fox models show that (MSY) of Brushtooth lizardfish from the Red Sea fisheries, caught without disturbing the biological balance, was estimated at about 4.19 and 3.90 thousand tons, respectively, at the optimum fishing effort level that achieved the maximum sustainable yield, estimated at 394 and 333 standard boats, respectively.

By comparing the results of Table (11) with the data in Table (6) related to the fish catches of Brushtooth lizardfish during the research period shows that the actual production exceeded the maximum allowable production in 2009 by about 190 and 480 tons, and it also in 2016 by about 310 and 600 tons, according to Schaefer and Fox models, respectively, while it exceeded the max. allowable production during 2006, 2008, 2010 and 2017 by about 260, 220, 20 and 180 tons, respectively, according to Fox model only.

It was also clear from comparing the results of Table (11) with the data contained in Table (8) related to the fishing effort for the Brushtooth lizardfish product from the Red Sea fisheries represented by the number of trawling boats for its fishing that it exceeded the estimated fishing effort that attainable for the maximum sustainable yield by about 108 and 169 standard boats as an average of the research period according to Schaefer and Fox models, with the exception of 2006 in which the number of actual boats decreased from the fishing effort attainable for the sustainability by about 204 and 143 standard boats according to Schaefer and Fox models, as well as in 2020, in which the actual boats decreased from the sustainable Fishing effort that attainable for the sustainability by about 33 standard boats according to Schaefer model only.

Conclusion:

The research had come to some important results can be summarized a; (1) The actual catch of Sardinellas nei, Anchovy and small Sardine exceeded the maximum allowable production during the period (2005-2008) by about 3.73 and 5.47 thousand tons according to Schaefer and Fox models, respectively, this led to a decrease in their production from the max. allowable production during the period (2009-2020) by about 5.73 and 3.99 thousand tons according to Schaefer and Fox models, respectively, (2) The actual Fishing effort represented in the number of Purse seine boats for catching Sardinellas nei, Anchovy & small Sardinellas from the Mediterranean fisheries increased from the estimated fishing effort, which attainable for the Maximum Sustainable Yield by about 135 standard boats during the period (2005-2020) according to Fox model, while it increased by about 96 boats during the period (2009-2020) according to Schaeffer model, (3) The actual catch of Blue runner and Sardinellas nei from the Red sea fisheries exceeded the max. allowable production in 2009 by about 890 tons and 2.88 thousand tons according to Schaefer and Fox models, respectively, and it also exceeded by about 3.64 and 5.63 thousand tons during the period (2016-2020) according to Schaefer and Fox models, respectively, (4) The actual Fishing effort represented in the number of purse seine boats for catching Blue runner and Sardinellas nei from the Red sea fisheries increased from the estimated fishing effort by about 183 and 261 standard boats in 2008 according to Schaffer and Fox models respectively, while it increased by about 35 standard boats as an average for the period (2011-2020) according to Fox model only, (5) The actual catch of Brushtooth lizardfish from the Red sea fisheries exceeded the maximum allowable production in 2009 by about 190 and 480 tons, and it also exceeded by about 310 and 600 tons in 2016 according to Schaefer and Fox models, respectively, while it exceeded the max. allowable production during 2006, 2008, 2010 and 2017 by about 260, 220, 20 and 180 tons, respectively, according to Fox model only, (6) Increasing the actual Fishing effort represented in the number of Trawling boats for catching Brushtooth lizardfish from the Red sea fisheries than the estimated Fishing effort, which attainable for (MSY) by about 108 and 169 standard boats as an average for the period (2005-2020) according to Schaefer and Fox models, respectively, excluding each of the following: In 2006, in which the number of actual boats decreased from the sustainable fishing effort by about 204 and 143 standard boats, according to Schaeffer and Fox models, and in 2020, which decreased by 33 standard boats, according to Schaffer model only.

In light of the findings of the research, it recommended the following should be necessary: (1) Reducing the number of purse seine boats in the Mediterranean fisheries by about 135 boats with a horsepower (hp) of 175, and purse seine boats and trawling boats in the Red Sea fisheries by about 35, 138 boats, respectively, with a horsepower (hp)of 175, (2) Strict execute of the implementation of the fishing law to preserve the stock of fish species, (3) Heading to economically exploiting the marine water space by encouraging fishing with remote marine fisheries, and marine aquaculture fish, especially in the Red sea fisheries, which are characterized by bays and lagoons.

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Appendixes

Table (1) in the appendix: Distribution of motorized fishing units for Purse seine boats operating in the Mediterranean waters according to horse power.

Engine in H.P.	10-20	20-30	30-50	50-100	100-150	150-200	200-250	250-300	300-400	400-500	500-600	600-700	700-800	More than 800
2005	0	0	2	33	91	53	27	7	3	4	0	0	0	0
2006	0	1	5	37	83	55	26	.07	3	7	0	0	0	0
2007	0	0	1	35	96	60	23	5	1	10	0	0	0	0
2008	0	0	0	26	83	78	30	6	9	6	0	0	0	0
2009	0	0	0	22	76	68	34	15	9	7	1	0	0	0
2010	0	0	0	19	84	77	27	8	13	11	0	0	0	0
2011	0	0	0	20	94	68	28	8	7	17	0	0	0	0
2012	0	0	0	18	77	72	25	13	11	20	0	0	0	1
2013	0	0	0	13	73	75	31	4	18	28	3	0	2	0
2014	0	0	0	14	69	62	32	10	21	35	6	2	4	1
2015	0	0	0	17	62	55	27	8	24	43	6	2	6	2
2016	0	0	2	11	59	50	26	7	24	54	6	2	8	4
2017	0	0	1	21	40	47	23	8	19	53	8	3	5	5
2018	0	0	0	18	38	56	25	11	25	50	5	2	7	4
2019	1	0	0	18	45	50	22	11	27	39	23	8	2	4
2020	0	0	0	11	41	35	25	10	29	44	7	2	4	5

Source: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007- 2022), Cairo, Egypt.

Table (2) in the appendix: Distribution of motorized fishing units for Trawl boats operating in the Mediterranean waters according to the engine HP for the fishing boat

Engine in H.P.	10-20	20-30	30-50	50-100	100-150	150-200	200-250	250-300	300-400	400-500	500-600	600-700	700-800	More than 800
2005	0	0	1	74	345	399	226	16	21	29	2	0	0	8
2006	0	0	0	78	349	397	225	25	17	36	7	0	0	7
2007	0	0	1	85	334	389	223	17	16	51	2	0	0	3
2008	0	0	0	64	303	379	256	18	19	44	8	0	0	4
2009	0	0	0	67	290	369	233	27	22	38	12	2	0	1
2010	0	0	0	24	205	325	270	144	63	83	9	2	0	3
2011	1	0	0	41	302	373	232	20	37	78	5	1	0	1
2012	0	0	1	36	295	359	245	17	30	93	11	0	2	9
2013	0	0	1	32	231	373	257	16	33	100	18	6	7	10
2014	0	0	2	27	198	365	255	10	22	96	37	18	10	11
2015	0	0	1	25	172	352	259	11	25	99	51	30	16	16
2016	0	0	0	26	158	358	249	12	16	108	65	27	18	12
2017	0	0	0	27	142	355	243	12	16	92	57	26	19	15
2018	0	0	0	23	138	311	245	15	23	123	64	22	20	22
2019	1	0	2	32	132	306	228	13	21	110	65	22	25	27
2020	1	1	1	26	113	267	200	13	14	104	55	16	24	20

Source: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007- 2022), Cairo, Egypt.

Table (3) in the appendix: Distribution of automatic fishing units for Trammel boats operating in the Mediterranean waters according to the engine HP for the fishing boat

Engine in H.P.	Up to 10	10-20	20-30	30-50	50-100	100-150	150-200	More than 800
2005	41	72	59	96	102	3	0	0
2006	176	71	93	117	103	4	0	0
2007	172	76	89	107	99	5	0	0
2008	154	63	89	124	94	5	0	0
2009	141	56	77	126	93	5	0	0
2010	135	50	84	180	75	2	0	0
2011	104	61	78	188	68	3	0	0
2012	95	54	55	204	67	3	0	0
2013	80	39	47	221	181	3	0	0
2014	71	52	51	235	57	6	0	0
2015	72	54	54	317	48	4	1	0
2016	69	63	52	374	59	5	1	0
2017	69	51	69	418	85	7	0	0
2018	57	96	36	426	84	1	0	0
2019	55	107	35	460	79	2	0	0
2020	59	63	144	335	41	1	0	1

Source: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007- 2022), Cairo, Egypt.

Table (4) in the appendix: Distribution of automatic fishing units for Purse seine boats operating in the waters of the Red sea, according to the engine HP for the fishing boat

Engine in H.P.	50-100	100-150	150-200	200-250	250-300	300-400	400-500	500-600	600-700	700-800	More than 800
2005	0	0	1	11	3	3	63	2	0	0	0
2006	0	0	4	16	7	11	41	4	0	0	0
2007	0	2	0	4	18	7	13	49	20	0	3
2008	0	0	7	13	2	4	66	15	1	2	68
2009	1	1	4	18	7	11	49	18	0	0	5
2010	2	0	1	6	2	7	74	18	0	0	5
2011	1	0	1	6	1	6	74	21	0	1	11
2012	1	1	0	5	0	1	81	31	0	1	16
2013	0	0	0	4	1	4	74	22	0	1	21
2014	0	0	1	2	0	5	75	20	0	1	20
2015	0	0	2	2	0	4	75	17	2	2	20
2016	0	0	2	1	0	4	74	16	0	1	19
2017	0	0	1	1	0	4	73	15	0	1	18
2018	0	0	0	2	0	1	79	15	0	1	24
2019	0	0	1	3	0	5	74	12	0	1	28
2020	1	0	1	2	0	5	73	11	0	1	28

Source: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007- 2022), Cairo, Egypt.

Table (5): in the appendix: Distribution of motorized fishing units for Trawl boats operating in the waters of the Red sea, according to the engine HP of the fishing boat

Engine in H.P.	**50-100**	**100-150**	**150-200**	**200-250**	**250-300**	**300-400**	**400-500**	**500-600**	**600-700**	**700-800**	**More than 800**
2005	5	0	5	17	1	5	86	39	5	5	65
2006	0	0	3	5	1	4	58	7	0	0	0
2007	0	0	3	18	4	4	66	23	1	2	70
2008	0	0	7	13	2	4	66	15	1	2	68
2009	0	1	9	15	3	4	66	18	1	1	49
2010	0	0	4	14	2	4	72	14	1	2	48
2011	0	0	4	12	1	4	74	13	1	1	44
2012	0	0	2	17	1	3	73	13	1	1	62
2013	0	1	4	15	0	3	76	11	0	0	41
2014	0	0	5	13	0	1	78	10	0	0	42
2015	0	0	3	14	0	0	79	11	0	0	40
2016	0	0	2	6	0	0	74	11	0	0	33
2017	0	0	2	5	0	0	76	11	0	0	35
2018	0	0	2	5	0	0	77	14	0	0	31
2019	0	0	2	4	0	0	78	12	0	1	32
2020	0	0	0	4	0	0	78	14	0	0	23

Source: Ministry of Agriculture and land reclamation, General Authority for Fish Resources Development (GAFRD), Fish Statistics Year Book (2007- 2022), Cairo, Egypt.