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An economic study of human and capital resources in Egyptian Natural Fisheries

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Abstract: Fish wealth in Egypt is one of the most important sources of national income; Natural fisheries are considered one of the main sources of fish wealth besides Aquaculture which was contributed about 32.5% of total Egyptian fish production during the period (2000-2018). Natural fisheries in Egypt suffer from a low relative contribution of their production of total Egyptian fish production compared with Aquaculture according to the statistics of General Authority for Fish Resources Development (GAFRD) in 2018, the natural fisheries (marine, lakes, Nile River and its branches) contributed about 19.29% of total Egyptian fish production, whereas the total actual area of Natural fisheries is estimated about 13.79 million acres which contributed about 92.2% of total actual area of several fish production in Egypt (Natural fisheries and Aquaculture) which are estimated at 14.96 million acres. While the exploited area of natural fisheries is estimated about 6.36 million acres, which contributes about 88.2% of the total exploited area of the various sources of fish production in Egypt, which is estimated about 7.22 million acres, which may reflect the misuse of natural fisheries in Egypt. So this study aims to identify the impact of human and capital resources on fish production in the Natural fisheries in Egypt during the study period (2000-2018). It was shown from results that: (1) the achieved fish income from these fisheries was increasing with annual growth rate which was estimated about 13.17% because of steady increase of the sale price of fish despite of decreasing of fish production from natural fisheries about 4.01%. (2) Fish production from lake fisheries (45.6%) is exceeded over fish production from marine fisheries (31.3%) of the total fish production from natural fisheries is due to the percentage of actual exploited area in lake fisheries (82.1%) is more than marine fisheries (37.5%). because of current strategies towards Egyptian lakes development since 2014 which are included Bardawil, Manzala, Qarun, Burullus and Mariout. (3)The stability of the number of boats is related to the number of fishermen in the Egyptian natural fisheries are related to the exceeded decreasing annual rate of the number of boats than the number of fishermen in those fisheries. (4) There is a misuse of the Egyptian marine fisheries, where the actual exploitation exceeds the optimal exploitation of these fisheries in all years of study, which requires the necessity to reduce the fishing effort in these fisheries. As for lakes fisheries, they are characterized by a marked improvement in the level of exploitation of these fisheries as a result of the current state plans to develop some lakes with these. (5) it was found the number of sailboats is the most important economic determinants affecting fish production from total Egyptian natural fisheries and Egyptian fresh water fisheries. While it was also found the number of fishermen and average price per ton of marine fish are the most factors affecting the quantity of fish production from marine fisheries. (6) It was no significant of economic factors affecting fish production from lakes fisheries due to the number of lakes and their overlapping production, whereas each lake is considered a single economic unit that differs in its production and characteristics, and no statistical results were reached. due to the number of lakes and their overlapping production, whereas each lake is considered a single economic unit that differs in its production and characteristics, so no statistical results were reached.(7) both of two variables the average individual consumption and the number of fishermen (as human labor) are the most important economic factors affecting Egyptian fish income in Egyptian natural fisheries in general and each type of these natural fisheries. (8) The number of fishermen (human labour) contributes to the instability of the natural fisheries to a greater degree than the number of boats. And the number of fishermen in lakes fisheries and the number of boats in the freshwater fisheries are the most contributing to the instability of the natural fisheries.
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Keywords: economic; study; human; capital; resource; Egyptian Natural Fisheries

1. Introduction

Fish wealth in Egypt is one of the most important sources of national income, as well as a source of safe protein which provides food needs internally and develops other industries beside it. Natural fisheries are considered one of the main sources of fish wealth besides fish farming which was contributed about 32.5% of total Egyptian fish production during the period (2000-2018). Natural fisheries resources occupy large areas of more than 13 million acres which was estimated about 15% of the agricultural land area, and these resources vary according to its nature, like Red and Mediterranean seas, lakes, which include Manzala lakes, Burullus and Bardawil, Idko, Qarun, Bitter Lakes, and Port Fouad Saltern, and fresh water resources which include the River Nile with its main two branches, canals and drains .

In order to achieve fish economic development - as it is an integral part of achieving the objectives of agricultural development, it is necessary to care of fisherman (the human labor element), the fisherman is the basic and main human element in the process of fish production from natural fisheries who makes physical and mental effort to achieve this process, bearing all obstacles and difficulties during the fishing process. The human element has a dual role in the development process, as he is the target of the development process and the beneficiary of its positive effects. On the other hand, he is the main resource for production - and it is necessary to focus on the all kinds of fishing boats which are used in the fishing process because of its importance in fish production in natural fisheries, so human resources (numbers of fishermen) and the capital resources (numbers of boats) must be studied in the Egyptian natural fisheries, to identify their impact on production and income and actual exploitation of those fisheries according to the current fishing effort, and to identify which of those resources has a greater impact on fish production than those fisheries.

Key Words: fish production - natural fisheries - fish stock - Schaefer model - human resources.

- ***Problem of the study***

Natural fisheries in Egypt suffer from a low relative contribution of their production of total Egyptian fish production compared to Aquaculture. According to the statistics of General Authority for Fish Resources Development in 2018, the natural fisheries (marine, lakes, Nile River and its branches) contribute about 19.29% of total Egyptian fish production, while Aquaculture contributes about 80.71%, although natural fisheries area is more than aquaculture area. The actual area of natural fisheries is estimated about 13.79 million acres which contributed about 92.2% of total actual area of several fish production in Egypt (the natural fisheries and aquaculture area) which are estimated at 14.96 million acres. While the exploited area of natural fisheries is estimated about 6.36 million acres, which contributes about 88.2% of the total exploited area of the various sources of fish production in Egypt, which is estimated about 7.22 million acres, which may reflect the misuse of natural fisheries in Egypt.

Study Objectives:

The study aims to identify the impact of human and capital resources in Egyptian natural fisheries during the study period (2000-2018) by studying the following topics:

1- The current status of fish production in Egyptian natural fisheries and the achieved income from it.
2- The current status of fish production resources (water, Humanity and capitalism resources).
3- Estimating the optimal production and effort in Egyptian natural fisheries which preserves the resources or fish stock from depletion.
4- Estimating the most important economic factors affecting natural fisheries fish Production in Egypt.
5- Estimating the most important economic factors affecting fish income from total natural fisheries in Egypt.
6- Estimating all instability and weighted instability coefficients for numbers of fishermen (human labor), numbers of boats (automated work), fish production and fish income in Egyptian natural fisheries.

Study methodology:

The study is based on two main methods: - descriptive economic analysis and quantitative economic analysis of the variables studied by using some statistical and economic standard models including time trend models, estimating annual growth rates of economic variables by using the following growth function:

$$\mathbf{Ln\ y = a + bt \quad or \quad y = e^{(a+bt)}}$$

And also it was estimated the optimum fish production in Egyptian natural fisheries (marine, lakes, water fresh fisheries) using Surplus production models (Schaefer) which used to determine the optimum level of effort F_{max} which produces the maximum sustainable yield (MSY) to preserve the resource or fish stock from depletion.

-Descriptive Schaefer model:

Schaefer model is one of Surplus production models, which can be used to estimate the maximum biological sustainable yield (MSY) and the corresponding fishing effort (F_{max}) in easily way, expresses the catch per unit effort (CPUE) or catch effort as a function of effort as follows:

$$\mathbf{Y_i / F_i = a + b\,F_i \qquad if\ (F_i \leq -a/b)}$$

Where,

Y_i: yield in year i (catch in weight)

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

Yi /Fi: yield (weighted catch) per unit of effort or catch effort in year i, it can be derived from the yield Yi of the year i for the entire fishery and the corresponding effort Fi. So by estimating this equation via ordinary least square method (OLS), the obtained parameters a and b used to estimate the MSY and Fmax using the following formulas:

$$\mathbf{MSY = -\,0.25 \times a^2/b \quad or \quad -\,a^2 / 4b}$$

$$\mathbf{F_{max} = -\,0.5 \times a/b \quad or \quad -\,a / 2b}$$

The slope (b) must be negative if the catch per unit effort or catch effort (Y_i /F_i) decrease with increasing effort (F_i) - fig.1.

The intercept (a) is the (Y_i /F_i) value obtained just after the first vessel fishes on the stock for the first time; therefore the intercept (a) must be positive. Thus -a/b is positive and (Y_i /F_i) is zero for F_i = -a/b. since a negative value of catch per unit effort (Y_i /F_i) is absurd, the model applies to F_i value lower than (-a/b), **(Schaefer1954), (El–Kholei, 2008)**.

Fig.1. Illustration for assumption for the Schaefer model.

The intercept (a) is the (Y_i /F_i) value obtained just after the first vessel fishes on the stock for the first time; therefore the intercept (a) must be positive. Thus -a/b is positive and (Y_i /F_i) is zero for F_i = -a/b. since a negative value of catch per unit effort (Y_i /F_i) is absurd, the model applies to F_i value lower than (-a/b), **(Schaefer1954), (El–Kholei, 2008)**.

It was also estimated the most important economic factors affecting Egyptian natural fisheries production and income during period (2000-2018) using multiple regression model by using backward method to reach the best models that are consistent with the economic and statistical logic.

It was calculated instability coefficients by creating an index that measures annual which is based on the Average Percentage deviation methods that measures oscillations by means of the time direction correction factor, and these coefficients are calculated as the following:

$$IY_t = Y_t - Y_t / Y_t$$

Where, IY_t is instability index, y_t is the actual value of variable at time t, Y_t is the estimated Y. T= 1

1- Estimating the time trend equation.
2- Calculating the estimated values of the dependent variable.
3- Estimating the absolute values of the annual deviations of the estimated values (y) which are calculated from the actual values and then they are calculated as percentages of the estimated values
4- Adding these percentages and dividing them by the number of years to
   Obtain the instability coefficients during the estimated period.

The optimal state: It is a state where the instability coefficient is equal zero, which means that there is no instability, and the higher value of coefficient, the greater in instability.

Data sources:

This study is depend on secondary statistical data published in government agencies such as the General Authority for Fish Resources Development (GAFRD) , the Central Agency for Public Mobilization and Statistics (CAPMAS), and the National Institute of Oceanography and Fisheries (NIOF), in addition to references and research related to the study.

***Research results*:**

The following result explains the indicators of fish production in Egyptian natural fisheries during (2000-2018) because of the importance of fish sector in national agricultural income, fish sector in Egypt (From natural fisheries & Aquaculture) contributes about 9.64% of agricultural income value, 2.15% of agricultural production tools value and 13.68% of agricultural net income value in 2018, (GAFRD,2019). So it is important to study the development of fish production, fish income, and the fishery economic resources in Egyptian natural fisheries and also in their three types (marine, lakes, Nile River and its branches) to find out the most important economic determinants affecting fish production and fish income, and estimating instability coefficients for them.

First: The current status of fish production and achieved income in Egyptian natural fisheries during (2000-2018):

- **The current status of fish production in Egyptian natural fisheries during (2000-2018)**

Table (1) shows that:

- The total fish production from marine fisheries which include Mediterranean Sea and Red Sea decreased from 130.9 thousand tons in 2000 to 104.7 thousand tons in 2018 with annual decline rate about 3.88% annually, and the significance of this estimate has been proven at the level of probability 1% according to (F-Test), the total annual average of the Egyptian fisheries production about 117.92 thousand tons during (2000-2018).
- The average fish production from lakes fisheries which include in the northern delta (Mariout, Idko, Manzala, and Burullus) and the production of coastal lagoons (Bardawil, Port Fouad Saltern) and the production of inland lakes (Bitter, Temsah & the Suez Canal, Qarun and Al-Rayan and the water bodies in the New Valley, Lake Nasser, Toshka Spillway) is estimated about 171.83 thousand tons, between a minimum about 144.03 thousand tons in 2007, and a maximum about 195.44 thousand tons in 2003, also it was shown the presence of a statistically insignificant increase in production

due to the overlap between the nature of production of each Egyptian lake.

- The average fish production in fresh water fisheries and its branches is estimated about 87.22 thousand tons, between a minimum about 66.6 thousand tons in 2012, and a maximum about 120.85 thousand tons in 2002, with annual decreasing rate which is significant statistically estimated about 4.72% at the level of probability 1% according to (F-Test).
- The average fish production in natural fisheries is estimated about 736.98 thousand tons, between a minimum about 335.61 thousand tons in 2016, and a maximum about 431.12 thousand tons in 2003, with annual decreasing rate which is significant statistically estimated about 4.01% at the level of probability 1% according to (F-Test).
- The total Egyptian fish production increased from 724.40 thousand tons in 2000 to 1.82 million tons, with an annual average about 1.21 million tons, with annual increasing rate which is significant statistically estimated about 34.54% at the level of probability 1% according to (F-Test).
- There is relative stability in marine, lake and freshwater fisheries, where the instability coefficient was estimated about 3.77, 3.84, and 6.66 respectively, due to decreasing of instability coefficient of fish production in these fisheries.

So, It was found from Current status of fish production in Egyptian natural fisheries that relative importance of fish production was decline from 2003 to 2018 during study period, and the annual fish production from Egyptian natural fisheries decreases about 4.01 % which is significant statistically at the level of probability 1% according to (F-Test), this annual decreasing is due to annual decreasing of fish production from marine and fresh water fisheries which are estimated about 3.88%, 4.72% at the level of probability 1% ,where both of marine and fresh water fisheries contribute about 54.4% of average Egyptian fish production from Egyptian natural fisheries ,while fish production of lake fisheries is statistically insignificant increase due to the overlap between the nature of production of each Egyptian lake. Fish production in Egyptian natural fisheries is relatively stable (3.42) due to decreasing instability coefficient in marine, lake and freshwater fisheries which was estimated about 3.77, 3.84, and 6.66 respectively.

Table (1): The Current status of fish production in Egyptian natural fisheries during (2000-2018) (Tons)

Years	Total fish production from marine fisheries	Total fish production from lakes fisheries	Total fish production from fresh water fisheries	Total fish production from natural fisheries	Total fish production	Total fish production from natural fisheries / Total Egyptian fish production (%)
2000	130844	173149	80321	384314	724407	53.05
2001	133173	185591	109887	428651	771515	55.56
2002	132508	172040	120852	425400	801466	53.08
2003	117381	195442	118300	431123	875990	49.22
2004	111395	177099	105000	393494	865029	45.49
2005	107453	158297	83803	349553	889300	39.31
2006	119606	151312	104976	375894	970923	38.72
2007	130748	144033	97710	372491	1008007	36.95
2008	136243	157884	79688	373815	1067630	35.01
2009	127821	172242	87335	387398	1092888	35.45
2010	121362	179199	84648	385209	1304794	29.52
2011	122303	163339	89712	375354	1362174	27.56
2012	114198	173416	66623	354237	1371975	25.82
2013	106661	182525	67671	356857	1454401	24.54
2014	107799	170932	66060	344791	1481882	23.27
2015	102933	171475	69704	344112	1518943	22.65
2016	103654	158475	73484	335613	1706273	19.67
2017	109764	183463	77732	370959	1822800	20.35
2018	104695	194851	73739	373285	1934742	19.29
Average	117923.2	171829.7	87223.42	376976.3	1205958	32.54*
(%) of natural fisheries	31.3	45.6	23.1	100.0	-	-
Rate Of Change (%)	(3.88)**	0.38ns	(4.72)**	(4.01)**	34.54**	-
Instability coefficient	3.77	3.84	6.66	3.42	-	-

*** geometric mean ** significant at the level of 1% ( ): Values in parentheses refers to negative values**

Source: Collected and counted from: Ministry of Agriculture and Land Reclamation- **General Authority for Fish Resources Development (GAFRD)** – Yearbook of Fishery statistics- (2000-2018), Cairo, Egypt, 2021.

- **The current status of fish income in Egyptian natural fisheries during (2000-2018)**

It is shown from Table (2) that

- Total fish income from marine fisheries had increased from about 985.47 thousand pounds in 2001 to about 4.12 million pounds in 2018, with an annual average of 1.91 million pounds, with a statistically significant annual increasing rate at the 1% level, it reached about 10.81%.
- Total fish income from lakes fisheries had estimated about 1.32 million pounds as a minimum in 2000 and about 4.92 million pounds as maximum in 2018, with an annual average of 2.28 million pounds, with a statistically significant annual increasing rate at the 1% level reached about 10.81%.
- Total fish income from fresh water fisheries had estimated about 483.37 thousand pounds as a minimum in 2000 and about 1.62 million pounds as maximum in 2017, with an annual average of 901.73 thousand pounds, with a statistically significant annual increasing rate at the 1% level reached about 6.46%.
- Total fish income from natural fisheries had estimated about 2.89 million pounds as a minimum in 2000 and about 10.65 million pounds as maximum in 2018, with an annual average of 5.09 million pounds, with a statistically significant annual increasing rate at the 1% level reached about 13.17%.
- Total Egyptian fish income had increased from 5.69 million pounds in 2000 to 48.25 million pounds in 2018, with an annual average of 16.91 million pounds, and a statistically significant annual increasing rate at the 1% level reached about 23.17%.
- Percentage of the contribution of fish income from Egyptian natural fisheries to the total Egyptian fish income during the study period had estimated about 22.07% as a minimum in 2018 and 54.14% as a maximum in 2001 with an annual average about 35%.
- It was found from instability coefficient of fish income from marine, lakes, fresh water fisheries that lakes fisheries is the most instability fisheries in fish income whish was estimated about 13.68 then fresh water fisheries then marine fisheries which instability coefficient were estimated about 9.85 , 11.90 respectively in these fisheries.
- **So, it was found from current status of fish income in Egyptian natural fisheries**, the decreasing of relative importance of fish income in natural fisheries from total fish income, where fish income from natural fisheries has increased with a statistically significant annual increasing rate at the 1% level reached about 23.17%. The relative stability of fish income in Egyptian natural fisheries (12.24) according to the instability coefficient, is due to the relative stability of fish income which achieved from marine (9.58) and freshwater fisheries (11.90), where the ratio contribution of Both marine and freshwater fisheries was estimated about 37.5% and 17.7% of the average total fish income from Egyptian natural fisheries respectively. The stability of fish income from marine fisheries compared to other natural fisheries income is due to the greater diversity of fish species in marine fisheries compared to other natural fisheries - Table No. (2).

It is clear from studying the current status of fish production and income during study period that, despite of decreasing in annual fish production from natural fisheries about 4.01% and with a statistically significant at the 1% level, the achieved fish income from these fisheries was increasing with annual growth rate which was estimated about 13.17% with a statistically significant at the 1% level because of steady increase of the sale price of fish.

Table (2): The Current Status of Egyptian natural Fish Income during (2000-2018) (Thousand pounds)

Years	Total fish income from marine fisheries	Total fish income from lakes fisheries	Total fish income from fresh water fisheries	Total fish income from natural fisheries	Total Egyptian fish income	Natural Fisheries of Egyptian fish income (%)
2000	1085701	1319992	483365	2889058	5685993	50.81
2001	985469	1554508	704796	3244773	5993476	54.14
2002	1188898	1389006	734484	3312388	6188328	53.53
2003	995942	1513379	735005	3244326	6710027	48.35
2004	1171864	1685540	781766	3639170	7428870	48.99
2005	1116801	1561847	559728	3238376	7814098	41.44
2006	1423643	1713096	799878	3936617	9305446	42.30
2007	1617458	1802359	847666	4267483	10830839	39.40
2008	1877852	1773727	654219	4305798	11030752	39.03
2009	1659639	1827538	655296	4142473	11660761	35.52
2010	1909992	1950183	829019	4689194	14494759	32.35
2011	2146638	1972139	1051494	5170271	16819074	30.74
2012	1938605	2696631	820935	5456171	17641947	30.93
2013	1783707	2633533	865938	5283178	19629036	26.92
2014	2323022	2688454	966602	5978078	22280419	26.83
2015	2482239	2723841	1062674	6268755	23408881	26.78
2016	2728622	3074865	1350622	7154109	32307727	22.14
2017	3679672	4457266	1620264	9757201	43810786	22.27
2018	4116183	4925386	1609110	10650680	48251163	22.07
Average	**1906944.6**	**2277015.3**	**901729.5**	**5085689.4**	**16910125.4**	**35.00**
(%) of natural fisheries	**37.5**	**44.8**	**17.7**	**100.0**	**-**	
Rate Of Change (%)	**13.00****	**10.81****	**6.46****	**13.17****	**23.17****	
Instability coefficient	**9.85**	**13.68**	**11.90**	**12.24**	**-**	

**** Significant at the level of 1%**

Source: Collected and counted from: Ministry of Agriculture and Land Reclamation- **General Authority for Fish Resources Development (GAFRD)** – Yearbook of Fishery statistics- (2000-2018), Cairo, Egypt, 2021.

Second: The current status of fish production resources (water, human and capital resources) during period (2000-2018):

1- Egyptian fish water resources during (2000-2018):

The Egyptian fish water resources are divided into two main types: **(a) natural fisheries** represented in marine, lakes and freshwater fisheries, whose exploited area is estimated at about 6.36 million acres, which represents about 46.12% of its actual area (13.79 million acres , **(b) Lands**

and farms designated for Aquaculture, whose exploited area is estimated About 0.86 million acres, which represents about 73.50% of its actual area (1.17 million acres). So according to the exploited area used in fish production from its various sources, the natural fisheries exploited area represent about 88.0% of the total exploited area for fish production from varios Egyptian fish water resources, which is estimated at about 7.22 million acres.

Marine, lakes and freshwater fisheries contribute about 66.1%, 31.1% and 2.8% of the total exploited area to fish production from the Egyptian natural fisheries. The exploited area of marine fisheries, lake fisheries and freshwater fisheries represents about 37.5%, 82.1% and 100% of their total actual area respectively, in 2018, Table No. (3).

So it was shown from the previous results that, fish production from lake fisheries (45.6%) is exceeded over fish production from marine fisheries (31.3%) of the total fish production from natural fisheries is due to the percentage of the actual exploited area in lake fisheries (82.1%) is greater than that of marine fisheries (37.5%) as a result of current strategies towards Egyptian lakes development since 2014 which are included Bardawil, Manzala, Qarun, Burullus and Mariout.

Table (3): The area of Egyptian fish resources from its various sources and their relative importance in 2018

Water body	**Actual area (million acres)**	**Exploited area (million acres)**	**Exploited area of actual area (%)**
A. Marine Fisheries	*11.20*	4.20	37.5
B. lakes Fisheries	*2.41*	1.98	82.1
C. Fresh Water Fisheries(Nile River and its branches)	*0.18*	0.18	100
Total area of Natural Fisheries	*13.79*	6.36	46.12
Total area of aquaculture	*1.17*	0.86	73.5
Total	***14.96***	***7.22***	***48.26***

Source: collected and counted from:

- Ministry of Agriculture and Land Reclamation- **General Authority for Fish Resources Development (GAFRD)** – Yearbook of Fishery statistics- (2018), Cairo, Egypt, 2021.
- Maiyza, shimaa Ibrahim (2015), **An Economic Study on Fish Production in the Mediterranean fisheries in Alexandria**, Ph.D. thesis, Faculty of Agriculture, Alexandria University.

2- Human resources (fishermen numbers) and capital resources (boats) during (2000-2018)

Human resources represented in fishermen numbers and capital resources represented in boats numbers, therefore it was shown from Table (4):

(a) **Total of fishermen numbers in marine fisheries** was estimated about 17.30 thousand fishermen in 2013 as a minimum and about 46.91 thousand fishermen in 2009 as a maximum, with an annual average about 2.70 thousand fishermen, the significance was not statistically proven. Also it was found that **Total of boats numbers in marine fisheries** was estimated about 6.08 thousand boats as a minimum in 2018 and about 7.89 thousand boats in 2006 as a maximum, with an annual average about 6.52 thousand boats with a statistically significant annual decrease at the level of 5% which estimated about 1.98%.

(b) **Total of fishermen numbers in lakes fisheries** was estimated about 6.08 thousand **fishermen** in 2013 as a minimum and about 24.92 thousand **fishermen** in 2017 as a maximum, with an annual average about 13.37 thousand **fishermen** , the significance was not statistically proven. Also it was shown that **Total of boats numbers in lakes fisheries** was estimated about 12.14 thousand boats as a minimum in 2008 and about 21.48 thousand boats in 2003 as a maximum, with an annual average about 16.21 thousand boats with a statistically significant annual decrease at the level of 1% which was estimated about 5.73%.

(c) **Total of fishermen numbers in fresh water fisheries** was estimated about 5.29 thousand **fishermen** in 2013 as a minimum and about

12.78 thousand **fishermen** in 2003 as a maximum, with an annual average about 10.52 thousand **fishermen**, with a statistically significant annual decrease at the level of 5% which was estimated about 2.08%. Also it was shown that **Total of boats numbers in fresh water fisheries** was estimated about 9.49 thousand boats as a minimum in 2013 and about 18.36 thousand boats in 2003 as a maximum, with an annual average about 12.69 thousand boats with a statistically significant annual decrease at the level of 1% which was estimated about 9.23%.

(d) **Total of fishermen numbers in Egyptian natural fisheries** was estimated about 65.55 thousand **fishermen** in 2009 as a minimum and about 28.67 thousand **fishermen** in 2013 as a maximum, with an annual average about 50.84 thousand **fishermen** , with a statistically significant annual decrease at the level of 5% which was estimated about 1.08%. and it was shown that **Total of boats numbers in natural fisheries** was estimated about 28.40 thousand boats as a minimum in 2001 and about 44.90 thousand boats in 2001 as a maximum, with an annual average about 35.42 thousand boats with a statistically significant annual decrease at the level of 5% which was estimated about 8.58%.

Table (4): Human resources (fishermen numbers) and capital resources (boats numbers) during (2000-2018)

years	Marine fisheries		Lakes fisheries		Freshwater fisheries		Total natural fisheries	
	Total fishermen numbers	Total boats numbers	Total fishermen numbers	Total boats numbers	Total fishermen numbers	Total boats numbers	Total fishermen numbers	Total boats number
2000	26915	6356	18670	20147	17287	16757	62872	43260
2001	27534	6388	20905	20147	16492	18360	64931	44895
2002	27969	6548	14169	19604	11748	18039	53886	44191
2003	25672	6468	12809	21479	14182	18360	52663	46307
2004	27885	6596	11221	18261	10382	14725	49488	39582
2005	25545	6750	13976	16221	10333	12399	49854	35370
2006	25024	7888	15392	18843	10617	13914	51033	40645
2007	27511	6745	14739	20502	12777	11806	55027	39053
2008	37786	6534	12273	12142	7950	11773	58009	30449
2009	46909	6848	11563	16320	7076	11811	65548	34979
2010	21804	6566	11881	16468	9279	12040	42964	35074
2011	25885	6486	12051	12376	5538	10681	43474	29543
2012	23987	6504	7003	14341	7068	9983	38058	30828
2013	17299	6177	6077	13479	5293	9488	28669	29144
2014	21267	6212	7621	13121	8437	10646	37325	29979
2015	29265	6302	10767	14199	11200	10341	51232	30842
2016	27251	6179	9770	12944	11278	10213	48299	29336
2017	24539	6204	24918	14502	12409	10299	61866	31005
2018	22028	6075	18219	12836	10499	9491	50746	28402
Average period	**26951.3**	**6517.2**	**13369.7**	**16207**	**10518.2**	**12690.8**	**50839.2**	**35415**
% of fishermen numbers	**53.0**	**-**	**26.3**	**-**	**20.7**	**-**	**100.0**	**-**
% of boat numbers	**-**	**18.4**	**-**	**45.8**	**-**	**35.8**	**-**	**100.0**
Rate of change (%)	**(1.18)^{ns}**	**(1.98)***	**(1.24)^{ns}**	**(5.73)****	**(2.08)***	**(9.23)****	**(1. 80)***	**(8.58)****
Instability coefficient	**7.29**	**2.02**	**15.27**	**4.20**	**20.24**	**7.33**	**11.21**	**4.73**

* Significant at the level of 5% ** significant at the level of 1%

ns: refers to no significant ( ): Values in parentheses refers to negative values

Source: collected and counted from: Ministry of Agriculture and Land Reclamation- General Authority for Fish Resources Development (GAFRD) – Yearbook of Fishery statistics- (2000-2018), Cairo, Egypt, 2021.

It was clear from studying human resources in Egyptian natural fisheries during study period that marine fisheries have the largest fishing effort in the number of fishermen and the least fishing effort in the number of boats, As the number of fishermen in marine fisheries contributes a greater percentage to the total number of fishermen in natural fisheries (53.0%), followed by the number of fishermen in lakes fisheries and freshwater fisheries with rates estimated at 26.3% and 20.7 % of the total number of fishermen in natural fisheries respectively. The exceed of the number of fishermen in marine fisheries compared to other natural fisheries is mainly due to the variety of automatic fishing trades working in marine fisheries (Trawling, Purse Seine, Long liner, Trammel net, Karkaba and Crab net) and the ability of these crafts to accommodate an increasing number of fishermen depending on the size of the boat, its motor power and the kind of fishing craft, In addition to, fishermen who work on the sailing fishing boats of its various degrees (1st. Class, 2nd. Class, 3rd. Class) - depending on the boat length- which are 3 fishermen / sailboat. Whereas fishermen in both lakes fisheries and freshwater fisheries are licensed working on third degree of sailboats only, (Maiyza, 2019).

While It was clear from studying capital resources in Egyptian natural fisheries during study period that lakes fisheries have the largest fishing effort in the number of boats, As the number of boats in lakes fisheries contributes a greater percentage to the total number of boats in natural fisheries (45.8%), followed by the number of boats in fresh water fisheries and marine fisheries with rates estimated at 35.8% and 18.4 % of the total number of boats in natural fisheries respectively- Table No.(4). **The exceed of fishing boats numbers of in lakes fisheries** is due to the variety of Egyptian lakes as productive economic units have fishing centers and ports and boats licensed to work in them.

According to the value of the instability coefficient, the total number of boats licensed in Egyptian natural fisheries in general and each type of natural fisheries (marine, lake, freshwater fisheries) is more stable than the total number of fishermen working in these fisheries during the study period, Table No. (4), as the boat is considered a single economic unit with its fishermen on it. Also, marine fisheries are the most stable among other Egyptian natural fisheries, followed by lakes fisheries and then freshwater fisheries. **Therefore, the number of boats stability in Egyptian natural fisheries in general and each type of natural fisheries- as previously mentioned- is related to the annual decrease in the number of boats exceeds the annual decrease in the number of fishermen.**

Third: Estimating the Optimum production and effort values in the Egyptian Natura fisheries that preserve the resource or fish stock from depletion:

Fish wealth is considered one of the renewable natural resources that have the ability to regenerate through the processes of natural reproduction. So it is necessary to assess Fish stock and estimate their exploitation and production capacity in Egyptian natural fisheries as one of the sources of fish wealth in Egypt.

Fish stock assessment is essential and indispensable to protect Egyptian Natural fisheries and their fish wealth, to exploit it in a way that ensures its regeneration. Fish stock is affected by a set of factors, as natural factors (water characteristics, temperature, salinity ... etc.), anthropogenic factors by misusing fishing efforts for fish stocks (number of fishing boats, fishing equipment, fishing periods ... etc.). So fishing effort is the most influencing factor on fish stocks, because of increasing fishing effort in an unorganized manner that was not commensurate with the stock's capacity and its production capacity, which leads to deteriorate the stock.

Fish stock assessment is very important process because it determines: (1) fisheries productivity, (2) the impact of fishing process on fisheries, (3) the effect of changing fishing rates. So it is essential to ensure the fisheries management and optimal exploitation by **(John Musick, Ramón Bonfil, 2005)**:

- Identify the level of exploitation that gives maximum weighted production in the long term from under study fisheries.
- Fish stocks assessment studies must be direct to fishermen and decision-makers in fisheries management, because these studies answer to number of questions: when and where? What catch? , as well as what is size supposed to catch? And how to fish (fishing methods and tools).

Fish stocks are characterized by continuous change from one region to another and from one period of time to another, so estimating it is a very complex and expensive process, Therefore, surplus production models deal with the entire stock, the entire fishing effort and the total yield obtained from the stock, without details about growth and mortality parameters or the effect of mesh size on the age of fish capture **(Maiyza et al., 2020).**

"Surplus production models" are used to determine the optimum level of effort F_{max} which produces the maximum yield that can be sustained without affecting the long-term productivity of the stock, the so-called maximum biological sustainable yield (MSY). The main reason for the relative popularity of surplus production models in tropical fish stock assessment, which is can be applied when data are available on the yield and the effort expend over a certain number of years. The fishing effort must have undergone substantial changes over the period study, **(FAO, FTP, 1998).**

Schaefer (1954) model is considered one of the most common surplus production models for estimating fish stocks, by expressing the fish stock by the fish density index, i.e. unit effort productivity, which is expressed by the productivity of the boat - considering the boat as one economic unit with its fishermen on it, **(Maiyza, 2015).**

So it is important to estimate the maximum biological sustainable yield (MSY) and the corresponding fishing effort (Fmax) as an index to study the fish stock that maintains the resource or fish stock from being depleted, Where it is known, that the increase in fish production beyond the permitted level of fishing in the catch leads to a decrease in the quantity caught in the following seasons even with the stability level of fishing effort (number of boats, number of fishermen).

Using the data available for production and the number of fishing units operating in natural fisheries of all kinds, marine, lake, and freshwater for the time period (2000-2018)- Table No.(5), Schaefer model (1954) has been applied as a relationship between boat productivity after standardization of fishing effort by converting every 10 sailboats into one motor boat according to average productivity indicator in marine fisheries; while in the case of lake and freshwater fisheries, the numbers of boats used are sailboats as the dominant fishing effort in those fisheries - Table No. (5).

Table.5. Evolution of fish production and the total number of boats used in Egyptian Natural fisheries during the period (2000-2018).

year	Marine Fisheries		Lake Fisheries		Fresh water fisheries	
	Production (ton)	Number * of boats (boat)	Production (ton)	Number of boats (boat)	Production (ton)	Number of boats (boat)
2000	130844	4938	173149	20147	80321	16757
2001	133173	4765	185591	20147	109887	18360
2002	132508	4724	172040	19604	120852	18039
2003	117381	4882	195442	21479	118300	18360
2004	111395	5033	177099	18261	105000	14725
2005	107453	5172	158297	16221	83803	12399
2006	119606	6289	151312	18843	104976	13914
2007	130748	5277	144033	20502	97710	11806
2008	136243	5384	157884	12142	79688	11773
2009	127821	5421	172242	16320	87335	11811
2010	121362	5406	179199	16468	84648	12040
2011	122303	5397	163339	12376	89712	10681
2012	114198	5441	173416	14341	66623	9983
2013	106661	5302	182525	13479	67671	9488
2014	107799	5290	170932	13121	66060	10646
2015	102933	5380	171475	14199	69704	10341
2016	103654	5363	158475	12944	73484	10213
2017	109764	5437	183463	14502	77732	10299
2018	104695	5392	194851	12836	73739	9491
Average	117923	5279	171830	16207	87223	12691

* The number of sailboats was transferred to the equivalent power boats according to average productivity indicator.

Collected and counted from; Ministry of Agriculture and Land Reclamation- General Authority for Fish Resources Development (GAFRD) – Yearbook of Fishery statistics- (2000-2018), Cairo, Egypt, 2021.

Where the results showed the spread of the phenomenon of overfishing in marine and lake fisheries, in years in which the actual or real values of total production and the fishing effort exceeded the estimated values of the maximum production (MSY) and the maximum effort (F max), which were estimated by statistical coefficients of the model Schaefer (1954) for fish production - Table No. (6).

The results showed that the phenomenon of overfishing prevails in all years of the study period in marine fisheries, while in lake fisheries it prevails during the years 2000, 2001, 2002, 2003, 2004, 2006, 2007; while this phenomenon is not existed in freshwater fisheries. This indicates that the marine fisheries are the most Egyptian natural capture fisheries that was misused its exploited, followed by lake fisheries, whereas Freshwater fisheries have not yet reached their optimal use.

Table.6. MSY and Fmax estimated via Schaefer model of Fish catch In Egyptian Natural fisheries during (2000-2018).

Items	Marine Fisheries	Lake Fisheries	Fresh water fisheries
Schaefer Model	**Y/f =53.615 - 0.0059 f**	**Y/f =21.448 - 0.0006 f**	**Y/f =8.7608 - 0.0001 f**
Production equation	**$Y = 53.615 f - 0.0059 f^2$**	**$Y = 21.448 f - 0.0006 f^2$**	**$Y = 8.7608 f - 0.0001 f^2$**
MSY * (tons*103)	**121.8**	**191.7**	**191.9**
Fmax ** (boats)	**4544**	**17873**	**43804**
Overfishing situation	**It prevails during the whole study period**	**Prevails in some years of the study period (2000, 2001, 2002, 2003, 2004, 2006, 2007)**	**There is no overfishing during the study period**

* $MSY = a^2 / 4b$ ** $F_{max} = a/2b$ Collected and counted from ; ; Figures No. (1), (2), (3), (4), (5), (6).

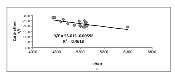

Fig.1. Relationship between catch effort and effort in Marine fisheries during the period (2000-2018).

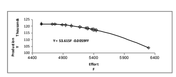

Fig.2. Yield Curve according to Schaefer Model of fish catches in Marine fisheries during the period (2000-2018).

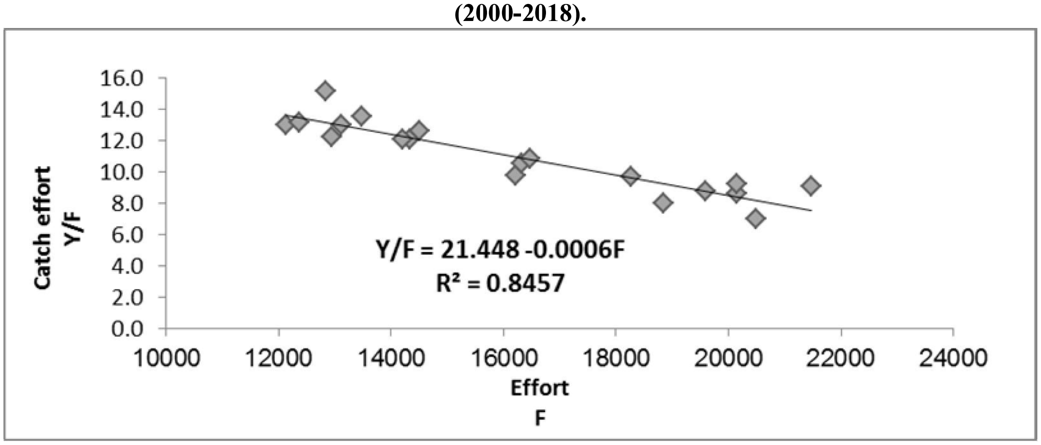

Fig.3. Relationship between catch effort and effort in Lake Fisheries during the period (2000-2018).

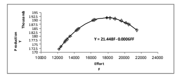

Fig.4. Yield Curve according to Schaefer Model of fish catches in lake fisheries during the period (2000-2018).

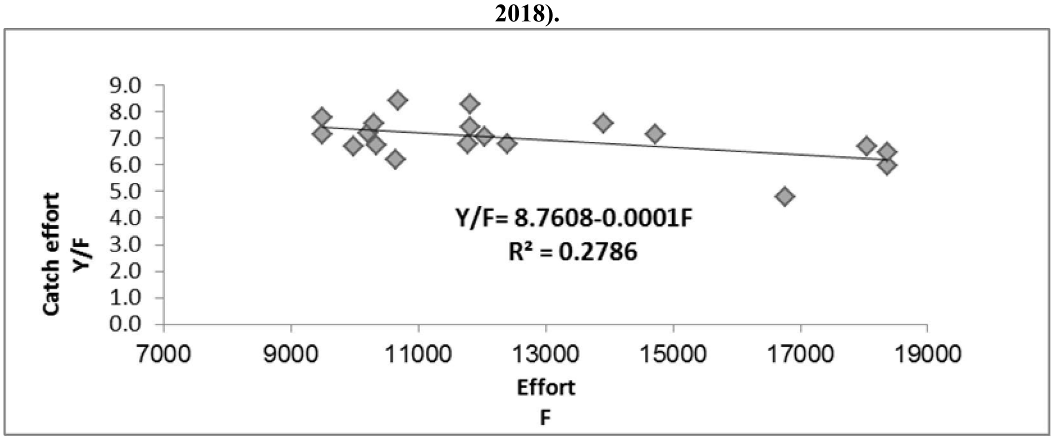

Fig.5. Relationship between catch effort and effort in Fresh water fisheries during the period (2000-2018).

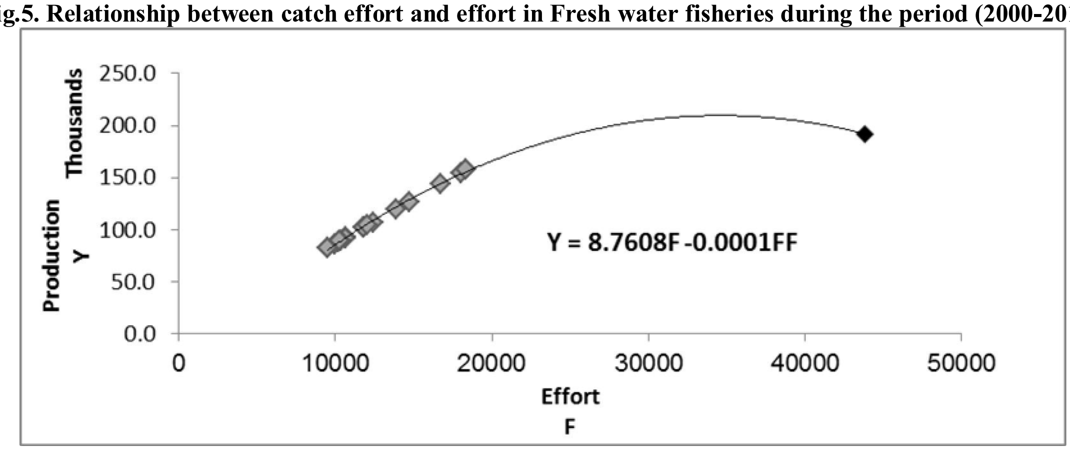

Fig.6. Yield Curve according to Schaefer Model of fish catches in Fresh water fisheries during the period (2000-2018).

Therefore, to achieve the optimum utilization of these fisheries, the actual fishing effort in these fisheries must be reduced to reach the optimum effort (F_{max}), which is estimated at about 4544, 17873 boats respectively, whereas it must be increased the actual fishing effort to about 43804 boats to reach optimal exploitation in Freshwater fisheries- Table No. (6).

It can be concluded from previous results, there is a misuse of the Egyptian marine fisheries, where the actual exploitation exceeds the optimal exploitation of these fisheries in all years of study, which requires the necessity to reduce the fishing effort in these fisheries. As for lake fisheries, they are characterized by a marked improvement in the level of exploitation of these fisheries as a result of the current state plans to develop some lakes.

When comparing the previous results with the percentage of the utilized area of the actual area in the different natural fisheries (marine, lakes and freshwater)- as previously mentioned that the area utilized for each of the marine and lake fisheries and freshwater fisheries is about 37.5%, 82.1%, 100% of their total actual area respectively in 2018. So when the percentage of the exploited area of the actual area of natural fisheries increases, the overfishing phenomenon decreases in natural fisheries. And therefore, increasing the area exploited for fishing effort lead to reduce the fish density or productivity of the fishing (productivity of the boat) of the natural fisheries by imposing the stability of the fishing effort. Therefore, the fish stock can be preserved by increasing the exploited area while maintaining the stability of the fishing effort to reduce the density of fish.

FORTH: The Most Important Economic Factors Affecting Natural Fisheries fish Production in Egypt:

To study the most important economic factors or determinants affecting fish production from Egyptian natural fisheries in general and each type of these natural fisheries, The study assumed a set of explanatory or independent variables, which are: **(A)**The number of fishermen (X1), **(B)** the number of motor boats (X2), which are found in marine fisheries only, **(C)** the number of sailboats (X3) which are found in all types of natural fisheries, **(D)** the average price per ton of produced fish(L.E / Ton) (EGP) (X4), which are found in each fisheries in study, by using the multiple regression model to identify the most important independent variables affecting fish production as a dependent variable (Y) (in thousand tons) from the Egyptian natural fisheries during the study period to reach the best models that are consistent with the economic and statistical logic – through Table No. (7).

1- The Most Important Economic Factors Affecting Egyptian Natural Fisheries fish Production

It was shown from Equation (1) that the number of sailboats (X3) is the most important economic determinants affecting Egyptian fish production from natural fisheries according to the following logarithmic model

$$\text{Ln } Y = 3.037 + 0.280 \ln(X3)$$
$$(5.522)^{**} \quad (5.261)^{**}$$
$$R^2 = 0.62 \quad R^{-2} = 0.60 \quad F = 27.68^{**} \quad D.W = 1.2$$

It was clear from Equation (1) that, There is a statistically significant positive relationship between the quantity of Egyptian fish production from natural fisheries (thousand tons) as a dependent variable Y and the number of sailboats (X3) as an independent variable, that means increasing the number of sailboats by 10% leads to increasing the total amount of fish production by 2,8%. and as well as coefficient of adjusted determination is estimated at about 0,60, which means that the variable of the number of sailboats explain about 60% of the changes that occurred in the fish production of fisheries during the study period. The significance of this estimate has been proven at the level of probability 1% according to (F-Test) which estimated about 27.68. Also it was shown that the model was free of first order autocorrelation between residuals in time series by using Durbin Watson test. The previous results are supported by the fact that sailboats are licensed to work in natural fisheries which accounts for 86.8% of the total average of the number of boats during the study period (2000-2018).

2- The Most Important Economic Factors Affecting Egyptian Marine Fisheries Production

It from showed Equation (2) that, the number of fishermen (X1) and the average price per ton of produced fish (X4) are the most important economic determinants affecting Egyptian marine fisheries fish production according to following double logarithmic regression model

$$\text{Ln } Y = 3.444 + 0.160 \ln(X1) - 0.114 \ln(X4)$$
$$(4.149)^{**} \quad (2.037)^{*} \quad (-3.304)^{**}$$
$$R^2 = 0.557 \quad R^{-2} = 0.502 \quad F = 10.069^{**} \quad D.W = 1.09$$

It was found from Equation (2) that, There is a statistically significant positive relationship between the quantity of Egyptian fish production from marine fisheries (thousand tons) as a dependent variable Y and the number of fishermen (X1) as an independent variables, that means increasing the number of fishermen by 10% leads to increasing the total amount of fish production from marine fisheries by 1.6%. Also it was found There is a statistically significant inverse relationship between the quantity of Egyptian fish production from marine fisheries (thousand tons) as a dependent variable Y and the average price per ton of produced fish (X4) as an independent variables, that means decreasing the price of the produced fish (X4) by 10% leads to increasing the total amount of fish production by 1.1%. and as well as coefficient of determination is estimated at about 0.50, which means that the variable of fishermen numbers and the average price per ton of produced fish explain about 50% of the changes that occurred in the fish production of marine fisheries during the study period. The significance of this estimate has been proven at the level of probability 1% according to (F-Test) which estimated about 10.07. Also it was shown that the model was free of first order autocorrelation between residuals in time series by using Durbin Watson test.

The previous results are consistent with the economic logic where the number of fishermen working in the Egyptian marine fisheries represents about 53% of the average total number of fishermen in natural fisheries through period (2000-2018), and reducing the production price of the commodity will encourage the producer to increase his production of it to increase its economic return and cover his production costs.

3- The Most Important Economic Factors Affecting Egyptian fresh water fish Production

While as it was found from equation (3), the number of sailboats (X3) is the most important economic factors affecting Egyptian fresh water fisheries fish production from the double logarithmic regression model which is the best regression model explain the following equation:

Ln Y= -2.278 + 0.714 ln(X3)

(-2.115)* (6.247)**

R^2= 0.697 R^{-2}= 0.679 F=39.023** D.W= 1.298

Equation (3) explained showed that, There is a statistically significant positive relationship between the quantity of Egyptian fish production from fresh water fisheries (thousand tons) as a dependent variable Y and the number of sailboats (X3) as an independent variables, which means increasing the number of sailboats by 10% leads to increasing the total amount of fish production by 7.1%. Also coefficient of determination is estimated at about 0.68, which means that the variable of the number of sailboats explains about 68% of the changes that occurred in the fish production of fresh water fisheries during the study period. The significance of this estimate has been proven at the level of probability 1% according to (F-Test) which estimated about 39.02. Also it was shown that the model was free of first order autocorrelation between residuals in time series by using Durbin Watson test.

It is shown from previous results that the number of sailboats is the most important economic determinants affecting fish production from total Egyptian natural fisheries and Egyptian fresh water fisheries. While it was also found the number of fishermen and average price per ton of marine fish are the most factors affecting the fish production from marine fisheries, and there is no statistically significant factors affecting fish production from lakes in Egypt, due to the number of lakes and their overlapping production, whereas each lake is considered a single economic unit that differs in its production and characteristics, and no statistical results were reached.

Table (7): The main economic factors of Total Egyptian fish production in natural fisheries from (2000-2018).

	Items	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total natural fisheries	Fish Production (thousand ton)	384.3	428.6	425.4	344.1	393.5	349.6	375.9	372.5	373.8	387.4	385.2	375.3	354.2	356.9	344.8	344.1	335.6	371.0	373.2
	Number of fishermen (fisherman)	62872	64931	53886	52663	49488	49854	51033	55027	58009	65548	42964	43474	38058	28669	37325	51232	48299	61866	50746
	Number of motorized boats (boat)	4229	3954	3812	4089	4252	4383	5490	4543	4809	4708	4826	4852	4909	4864	4829	4919	4955	5053	5051
	Number of Sailing boats (boat)	39031	40941	40379	42218	35330	30987	35155	34510	25640	30271	30248	24691	25919	24280	25150	25923	24381	25952	23351
	average price per ton (pound)	7.52	7.57	7.79	7.53	9.25	9.26	10.47	11.46	11.52	10.69	12.17	13.77	15.40	14.80	17.34	18.22	21.32	26.30	28.53
Total marine fisheries	Fish Production (thousand ton)	130.9	133.2	132.5	117.4	111.4	107.5	119.6	130.8	136.2	127.8	121.4	122.3	114.2	106.7	107.8	102.9	103.6	109.8	104.7
	Number of fishermen fisherman)	26915	27534	27969	25672	27885	25545	25024	27511	37786	46909	21804	25885	23987	17299	21267	29265	27251	24539	22028
	Number of motorized boats (boat)	4229	3954	3812	4089	4252	4383	5490	4543	4809	4708	4826	4852	4909	4864	4829	4919	4955	5053	5051
	Number of Sailing boats (boat)	2127	2434	2736	2379	2344	2367	2398	2202	1725	2140	1740	1634	1595	1313	1383	1383	1224	1151	1024
	price average per ton (pound)	8.30	7.40	8.97	8.48	10.52	10.39	11.90	12.37	13.78	12.98	15.74	17.55	16.98	16.72	21.55	24.12	26.32	33.52	39.32
Total lakes fisheries	Fish Production (thousand ton)	173.1	185.5	172.0	195.4	177.1	158.3	151.3	144.0	157.9	172.2	179.2	163.3	173.4	182.5	170.9	171.5	158.5	183.5	194.8
	Number of fishermen (fisherman)	18670	20905	14169	12809	11221	13976	15392	14739	12273	11563	11881	12051	7003	6077	7621	10767	9770	24918	18219
	Number of Sailing boats (boat)	20147	20147	19604	21479	18261	16221	18843	20502	12142	16320	16468	12376	14341	13479	13121	14199	12944	14502	12836
	price average per ton (pound)	7.62	8.38	8.07	7.74	9.52	9.87	11.32	12.51	11.23	10.61	10.88	12.07	15.55	14.43	15.73	15.88	19.40	24.30	25.28
Total fresh water fisheries	Fish Production (thousand ton)	80.3	109.9	120.9	118.3	105.0	83.8	105.0	97.7	79.7	87.4	84.6	89.7	66.6	67.7	66.1	69.7	73.5	77.7	73.7
	Number of fishermen (fisherman)	17287	16492	11748	14182	10382	10333	10617	12777	7950	7076	9279	5538	7068	5293	8437	11200	11278	12409	10499
	Number of Sailing boats (boat)	16757	18360	18039	18360	14725	12399	13914	11806	11773	11811	12040	10681	9983	9488	10646	10341	10213	10299	9491
	price average per ton (pound)	6.02	6.41	6.08	6.21	7.45	6.68	7.62	8.68	8.21	7.50	9.79	11.72	12.32	12.80	14.63	15.25	18.38	20.84	21.82

Source: collected and calculated from ; Ministry of Agriculture and Land Reclamation**- General Authority for Fish Resources Development (GAFRD)** – Yearbook of Fishery statistics- (2000-2018), Cairo, Egypt, 2021.

Fifth: ***The Most Important Economic Factors Affecting fish income from Total Natural Fisheries in Egypt:***

To study the most important economic factors or determinants affecting fish income from Egyptian natural fisheries in general and each type of these natural fisheries, The study assumed a set of explanatory or independent variables, which are: **(A)** The number of fishermen (X1), **(B)** the number of motor boats (X2), which are found in marine fisheries only, **(C)** the number of sailboats (X3) which are found in all types of natural fisheries, **(D)** average individual consumption (kg / capita)(X4) , by using the multiple regression model to identify the most important independent variables affecting fish income from the Egyptian natural fisheries (Y) (in million pound) during (2000-2018) to reach the best models that are consistent with the economic and statistical logic – through Table No. (8).

1- The Most Important Economic Factors Affecting Fish Income from Egyptian Natural Fisheries:

It was shown from Equation (4) that average individual consumption (kg / capita) (X4) and The number of fishermen (X1) are the most important economic factors affecting Egyptian fish income from natural fisheries according to the following logarithmic model**.**

Ln Y= -2.924 + 2.453 ln(X4) + 0.399 ln(X1)

(-1.67) (13.67)** (2.97)****

R^2= 0.93 R^{-2}= 0.92 F=99.73 D.W= 1.91**

It was clear from Equation (4), **that, There is a statistically significant positive relationship between fish income in natural fisheries (million pounds) as a dependent variable Y and both independent variables, the average individual consumption (X4) and The number of fishermen (X1)**, that means increasing average individual consumption (kg / capita) and the number of fishermen by 10% leads to increasing the fish income by 24.5%, 3.9% respectively. And as well as coefficient of adjusted determination is estimated at about 0,92, which means these variables explain about 92% of the changes that occurred in the fish income from natural fisheries during the study period. The significance of this estimate has been proven at the level of probability 1% according to (F-Test) which estimated about 99.73. Also it was appeared that the model was free of first order autocorrelation between residuals in time series by using Durbin Watson test.

2- The Most Important Economic Factors Affecting fish income from Egyptian Marine Fisheries

It was shown from Equation (5) that average individual consumption (kg / capita) (X4) and The number of fishermen (X1) are the most important economic factors affecting Egyptian fish income from marine fisheries according to the following logarithmic model

Ln y= -6.841 + 2.818 ln(X4) + 0.607 ln(X1)

(-3.076) (11.81) ** (3.40) ****

R2= 0.90 R^{-2}= 0.89 F=72.69 D.W= 2.21**

Equation (5) showed that, There is a statistically significant positive relationship between fish income in *Egyptian Marine Fisheries* (million pounds) as a dependent variable Y and both independent variables, the average individual consumption (X4) and The number of fishermen (X1), which means increasing average individual consumption and the number of fishermen by 10% leads to increasing the fish income by 28.18%, 6.07% respectively. And as well as coefficient of adjusted determination is estimated at about 0.89, which means these variables explain about 89% of the changes that occurred in the fish income from fisheries during the study period. The significance of this estimate has been proven at the level of probability 1% according to (F-Test) which estimated about 72, 69. Also it was appeared that the model was free of first order autocorrelation between residuals in time series by using Durbin Watson test.

3- The Most Important Economic Factors Affecting fish income from Egyptian Lakes Fisheries:

It was shown from Equation (6) that average individual consumption (kg / capita) (X4) and The number of fishermen (X1) are the most important economic factors affecting Egyptian fish income from lakes fisheries according to the following linear regression model

Y= -4237.34 + 318.20 (X4) + 0.057 (X1)

(-6.56) (10.129)** (2.99)****

R^2= 0.87 R^{-2}= 0.85 F=53.69 D.W= 1.43**

Equation (6) showed, that, There is a statistically significant positive relationship between fish income in *Egyptian lakes Fisheries* (million pounds) as a dependent variable Y and both independent variables, the average individual consumption (X4) and The number of fishermen (X1), which means increasing average individual consumption (kg / capita) and The number of fishermen by one unit leads to increasing the fish income by 318.2 & 0.057 million pound respectively. And as well as coefficient of adjusted determination is estimated at about 0.85, which means these variables explain about 85% of the changes that occurred in the fish income from fisheries during the study period. The significance of this estimate has been proven at the level of probability 1% according to (F-Test) which estimated about 53.69. Also it was noticed that the model was free of first order autocorrelation between residuals in time series by using Durbin Watson test.

Table (8): The main economic factors of Total Egyptian fish income in natural fisheries from (2000-2018).

	Items	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total natural fisheries	Fish income (Million pound)	2889.06	3244.77	3312.39	3244.33	3639.17	3238.38	3936.62	4267.48	4305.80	4142.47	4689.19	5170.27	5456.17	5283.18	5978.08	6268.75	7154.11	9757.20	10650.6
	Number of fishermen (fisherman)	62872	64931	53886	52663	49488	49854	51033	55027	58009	65548	42964	43474	38058	28669	37325	51232	48299	61866	50746
	Number of motorized boats (boat)	4229	3954	3812	4089	4252	4383	5490	4543	4809	4708	4826	4852	4909	4864	4829	4919	4955	5053	4229
	Number of Sailing boats (boat)	39031	40941	40379	42218	35330	30987	35155	34510	25640	30271	30248	24691	25919	24280	25150	25923	24381	25952	23351
	Consumption per capita (kg/year)	14.65	15.79	14.3	15.24	15.63	15.32	16.62	16.98	15.95	15.89	19.7	19.08	20.55	19.73	20.84	20.18	21.64	22.72	22.98
Total marine fisheries	Fish income (Million pound)	1085.70	985.47	1188.90	995.94	1171.86	1116.80	1423.64	1617.46	1877.85	1659.64	1909.99	2146.64	1938.65	1783.71	2323.02	2482.23	2728.62	3679.67	4116.18
	Number of fishermen fisherman)	26915	27534	27969	25672	27885	25545	25024	27511	37786	46909	21804	25885	23987	17299	21267	29265	27251	24539	22028
	Number of motorized boats (boat)	4229	3954	3812	4089	4252	4383	5490	4543	4809	4708	4826	4852	4909	4864	4829	4919	4955	5053	4229
	Number of Sailing boats (boat)	2127	2434	2736	2379	2344	2367	2398	2202	1725	2140	1740	1634	1595	1313	1383	1383	1224	1151	1024
	Consumption per capita (kg/year)	14.65	15.79	14.3	15.24	15.63	15.32	16.62	16.98	15.95	15.89	19.7	19.08	20.55	19.73	20.84	20.18	21.64	22.72	22.98
Total lakes fisheries	Fish income (Million pound)	1319.99	1554.51	1389.01	1513.31	1685.54	1561.85	1713.09	1802.35	1773.7	1827.54	1950.18	1972.14	2696.63	2633.53	2688.45	2723.84	3074.87	4457.26	4925.39
	Number of fishermen (fisherman)	18670	20905	14169	12809	11221	13976	15392	14739	12273	11563	11881	12051	7003	6077	7621	10767	9770	24918	18219
	Number of Sailing boats (boat)	20147	20147	19604	21479	18261	16221	18843	20502	12142	16320	16468	12376	14341	13479	13121	14199	12944	14502	12836
	Consumption per capita (kg/year)	14.65	15.79	14.3	15.24	15.63	15.32	16.62	16.98	15.95	15.89	19.7	19.08	20.55	19.73	20.84	20.18	21.64	22.72	22.98
Total fresh water fisheries	Fish income (Million pound)	483.365	704.796	734.484	735.005	781.766	559.73	799.88	847.67	654.22	655.30	829.02	1051.49	820.935	865.94	966.60	1062.67	1350.62	1620.26	1609.11
	Number of fishermen (fisherman)	17287	16492	11748	14182	10382	10333	10617	12777	7950	7076	9279	5538	7068	5293	8437	11200	11278	12409	10499
	Number of Sailing boats (boat)	16757	18360	18039	18360	14725	12399	13914	11806	11773	11811	12040	10681	9983	9488	10646	10341	10213	10299	9491
	Consumption per capita (kg/year)	14.65	15.79	14.3	15.24	15.63	15.32	16.62	16.98	15.95	15.89	19.7	19.08	20.55	19.73	20.84	20.18	21.64	22.72	22.98

Source: collected and calculated from ; Ministry of Agriculture and Land Reclamation**- General Authority for Fish Resources Development (GAFRD)** – Yearbook of Fishery statistics- (2000-2018), Cairo, Egypt

4- The Most Important Economic Factors Affecting fish income from Egyptian fresh water Fisheries:

It was shown from Equation (7) that average individual consumption (kg / capita) (X4) and The number of fishermen (X1) are the most important economic factors affecting Egyptian fish income from fresh water fisheries according to the following semi-logarithmic regression model

Y= - 7640.32 + 1881.12 ln (X4)+ 330.20 ln(X1)
(-6.84) ** (9.31) ** (3.75) **
R^2= 0.85 R^{-2}= 0.83 F= 44.76 D.W= 1.69**

Equation (7) showed, that, There is a statistically significant positive relationship between fish income in *Egyptian freshwater Fisheries* (million pounds) as a dependent variable Y and both independent variables, the average individual consumption (X4) and The number of fishermen (X1), which means *increasing average individual consumption and the number of fishermen by 10% leads to increasing the fish income by 20.86%, 3.66% respectively.* And as well as coefficient of adjusted determination is estimated at about 0.85, which means these variables explain about 85% of the changes that occurred in the fish income from fisheries during the study period. The significance of this estimate has been proven at the level of probability 1% according to (F-Test) which estimated about 44, 76. Also it was noticed that the model was free of first order autocorrelation between residuals in time series by using Durbin Watson test.

So through the previous results in this study it was found that, the both variables the average individual consumption and the number of fishermen (as human labor) are the most important economic factors affecting Egyptian fish income in Egyptian natural fisheries in general and each type of these natural fisheries.

Sixth: Estimating weighted instability coefficient of number of fishermen (human labor) and number of sailboats (automatic labor) in several kinds of Egyptian capture fisheries:

Weighted instability coefficients are calculated so that it can find out which production resource is the most responsible of the instability in natural fisheries, So *it was* found from the following table (9) and figure (7), The number of fishermen (human labour) contributes to the instability of the natural fisheries to a greater degree than the number of boats.. And the number of fishermen in lakes fisheries and the number of boats in the freshwater fisheries are the most contributing to the instability of the natural fisheries.

Table (9): Weighted instability coefficients of number of fishermen (human labor) and number of boats (automatic labor) in Egyptian natural fisheries during (2000-2018)

Fisheries	*weighted instability coefficients*	
	Number of Fishermen	*Number of boats*
Sea fisheries	196.53	13.15
lakes fisheries	411.62	68.01
fresh water fisheries	212.87	93.08

Source: **collected and calculated from data in table (4).**

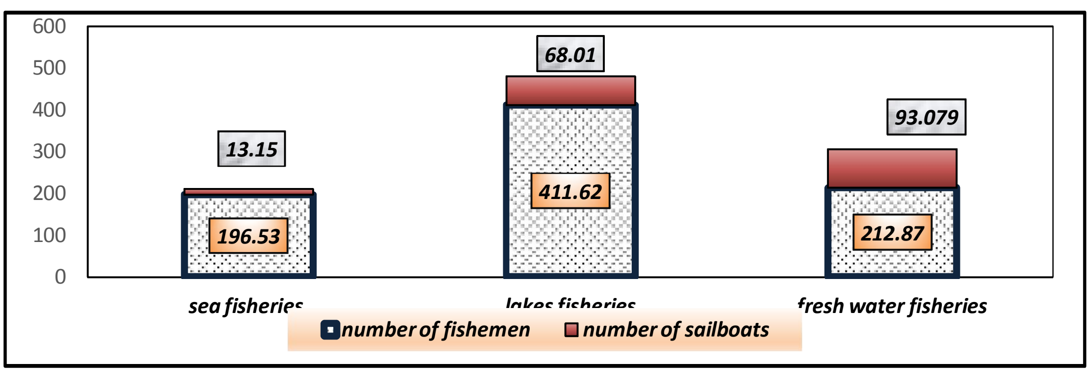

Fig.7. Weighted instability coefficients of number of fishermen (human labor) and number of boats (automatic labor) in Egyptian natural fisheries during (2000-2018)

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