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Catch effort Analysis in Lake Manzalah (Egypt) with reference to Trammel and Seine Net-Operating Boats.

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Received 29th July 2010, Accepted 26th October 2010

Abstract

Analysis of fish yields and efforts performed in Lake Manzalah during the period 1995 – 2008 were done. Production trends of Tilapia fish revealed a decreasing trend (r = -0.8132) while those of family Mugilidae and *Clarias* sp. revealed increasing trends along the period of study. The increasing trend of *Clarias* sp. reflects an increasing eutrophication of the lake environment. Fluctuations of fish yields from year to another reflects the overfishing problems caused either by increasing efforts, illegal fishing gears or both of them combined with variations of the environmental conditions that affect the character of the trophic relations in the ecosystem of the lake. Small boats used with trammel net operating fishermen were most lucrative than those used for seine (surround) net operating fishermen. CPUE of both small and large boats cannot be compared without being standardized and could be considered as initial phases of exploitation. A catch and effort data recording system should be proposed to provide an accurate estimate of the total annual catch of the lake. Improvements of the lake fishery should be based on many criteria which are also discussed.

Keywords: Catch, Effort, Lake Manzalah, Egypt.

1. Introduction

Four water bodies lie adjacent to the Mediterranean Sea on the fringe of the Nile Delta; namely; Lake Mariut, Lake Edku, Lake Burollus and Lak Manzalah. The Delta lakes constitute about 3% of the total water area of the Egyptian fisheries (Al-Sayes, 1976), but the current configuration of these lakes is rapidly, changing due to the natural processes and man's activities (Saad, 1990). Lake Manzalah, the largest Delta lake, is lying in the eastern region of the Nile Delta. Its area had been reduced to 1200 km^2 by 1980 (Meininger and Mullie, 1981).

Lake Manzalah, is recognized as an important fishing area and that ensuring optimal use of the physical resources of the lake and surrounding lands will provide an impetus for moving the country towards an improved social and economic well-being. It yields about 38.02% of the total fish production of the northern Nile Delta lakes and is considered as the second major source of fish after Lake Burollus (GAFRD, 2006). Estimating the risk of extinction or decline of a population in a population viability analysis often requires estimates of the variability in vital rates in both the efforts and catch per unit efforts exerted to execute the fish population. Catch per-unit-effort is used in many ways. First it can be used to describe changes in the abundance of the stock from year to year. Used with total catch data, it can also be used to describe a simple model from which the long-term sustainable yield from a stock can be calculated (Gulland, 1969). Very few studies were carried out on the lake (El-Karyony & El- Karachily,1988 ; El-Karyony, 1994), but such studies didn't correlate the efforts to any type of the fishing boats used in the lake.

The annual fish yields and efforts performed are important criteria required for the proper management of the lake fishery therefore, the present work aims to analyze the fish catches and fishing efforts performed in Lake Manzalah during the period 1995-2008, in order to evaluate these parameters which may help for its fishery management.

2. Materials and Methods

The present study is based on data obtained from fish statistical reports of the General Authority of Fish Resources Development (GAFRD, 1995-2008). Statistical analysis of time – series was performed on the total fish production and the common fish species and the rate of their changes for assessing variations in fish production of the lake . The analysis embraced also the information collected by the author on a questionnaire basis from the boats' owners specially small trammel net-operating boats and seine (surrounding) net-operating large boats in order to analyze the fish annual catch as well as the catch per unit effort exerted in both two types of fishing nets that use two different boats.

Statistical analysis was carried out using minitab-15 computer program in order to get the most suitable and best – fitting relationships between the different parameters.

3. Results and Discussion

Records of total catches are usually and before any other information important for economic reasons. However, catch tells us little about the state of the fishery and to have a real understanding of the fishery some measures of fishing effort is required. It is not always easy to collect a meaningful index of fishing effort but sometimes quite crude estimates will suffice. The total fish catch estimated by GAFRD (1995 – 2008) the fishing effort (as numbers of licensed boats and licensed fishermen) of Lake Manzalah during the period of study are shown at Table (1).

The total fish catch during the period of study varied between a maximum of 78.3 thousand ton in 1998 (I.N.=131.4) and a minimum of 36.8 thousand ton in 2007 (I.N. =61.7) with an annual average of about 58 thousand ton (Table, 1 & Figure 1). In fact this period can be divided into two different sub-periods. The first sub-period from 1995 to 2000 can be characterized by a growing trend in the fish catch (r = +0.71) while the second one from 2001 to 2008 revealed a decreasing trend in fish catch (r = - 0.81).

The relationship between the total lake fish catch and the successive years was found to follow the best fitted polynomial regression equation revealing a secular trend:

$$Y = -1800098 + 1801\,X - 0.4502\,X^2 \qquad (1)$$

where Y = Total catch , X = Time in Year

$R^2 = 0.64$, $F = 9.87$, $P = 0.004$

From the equation (1), it can be seen that:

1. The total fish production of Lake Manzalah represent a proximated parabolic curve with an overall decreasing trend (- 0.4502) (Figure 1).
2. Coefficient of determination is about 0.64 and the equation was significant at P = 0.004.
3. Although F-test (9.87) was high, the equation was significant with a relatively higher determination coefficient.

Table 1. Evolution of fish production, CPUE in Lake Manzalah during 1995 - 2008.

Year	Total Fish production (x10^3 ton)	I.N.	Catch/man (ton)	I.N.	Catch/boat (ton)	I.N.	boats No.	fishermen No.	Tilapia Catch (ton)	Mugilidae Catch (ton)	*Clarias* sp. Catch (ton)
1995	59.6	100	5.2	100	15.5	100	3838	11514	35503	465	3844
1996	52.5	88.1	2.4	46.2	7.3	47.1	7171	21513	32881	301	2114
1997	63.1	105.9	3.3	63.5	9.9	63.9	6358	19074	39826	2745	5206
1998	78.3	131.4	3.4	65.4	13	83.9	5999	17997	40050	308	2814
1999	65	109.1	6.9	132.7	20.9	134.8	3109	9327	33929	3083	5893
2000	74.1	124.3	4.5	86.5	13.5	87.1	5477	16431	39573	3693	11585
2001	68.4	114.8	7	134.6	20.98	134.8	3260	9780	34767	4125	10759
2002	58.4	98	8.2	157.7	24.6	158.7	2377	7131	29703	4170	8943
2003	65.02	109.1	5	96.2	14.86	94.8	4376	13128	30054	15193	13548
2004	63.8	107.1	7	134.6	21	135.5	3033	9099	26882	15012	9646
2005	39.9	67	4.4	84.6	13	83.9	3013	9039	17364	5084	7272
2006	41.2	69.1	5.6	107.7	16.7	107.7	2469	7407	17547	1838	9597
2007	36.8	61.7	2	38.5	5.9	38.1	6288	18864	20539	2130	5445
2008	46.5	78	6.2	119.2	18.5	119.4	2509	7527	25557	3175	5689
Average	58		5.1		15.4		4234	12702	30298.2	4380.1	7311.1

Note; No. of fishermen = No. of boats x 3 (as an average no./boat), I.N.= Index Number compared to 1995 as a base year.

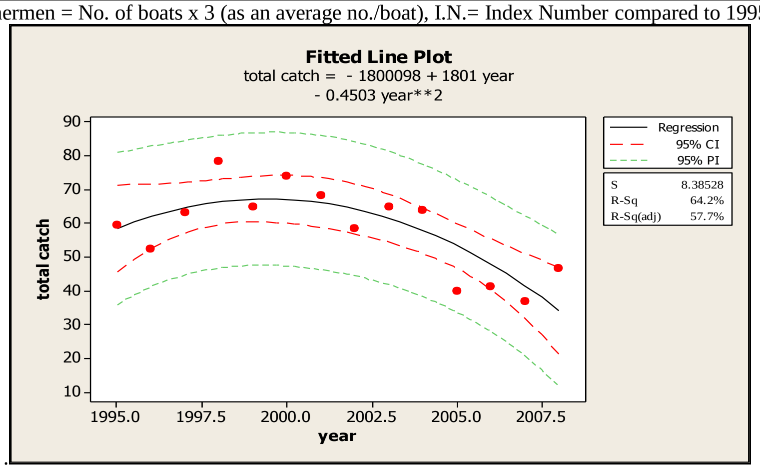

Figure1. Trends of fish production at Lake Manzalah (1995 – 2008).

It is obvious from Figure (1) that the fish production decreases with time reflecting an increasing eutrophication of the lake and deterioration of the environmental conditions (El-Karyony, 1994) and pollution of the lake water (Saad, 2003). Beside many other factors as sea connection problems, reduction of the freshwater supply, over- fishing with a continuing increase of fishing effort units, that contribute to fisheries decline (Kraiem *et al*., 2009).

3.1. Fish species in Lake Manzalah

The main fish families dominating Lake Manzalah are Cichlid species (mainly tilapia species), Cat fish (Mainly *Clarias* sp.) and grey mullet. Tilapia fish represented about 55% , *Clarias* sp. about 12.2% and Mugilids about 6.83% of the total fish catch during 2008 as shown at Table (1) (GAFRD, 2008).

The relationship between tilapia fish catch and time progression was found to follow the polynomial regression model:

$$Y = -\ 4.90E{+}11 + 7.35E{+}08\ X - 366925\ X^2 + 61.09\ X^3 \qquad (2)$$

where Y = Fish yield of Tilapia **,** X = Time in Year

$R^2 = 0.858$, $F = 20.22$, $P < 0.0005$

From the equation (2) and Figure (2) it can be seen that,

(1) Tilapia fish catch approximated the parabolic curve with a sharp decreasing trend.

(2) Coefficient of determination is about 0.858 ($P< 0.0005$). The equation was more significant than the quadratic model (R^2= 0.74, P=0.05).

The maximum catch of Tilapia fish (40050 tons) was found in 1998 and then decreased to 17364 ton in 2005. This decrease may be due to the same reasons discussed above.

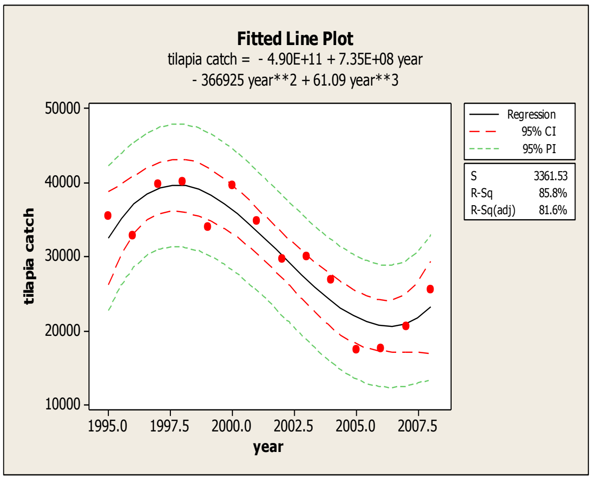

Figure 2. Trends of Tilapia fish production at Lake Manzalah (1995 – 2008).

The second group prevailing the fish catch in Lake Manzalah was represented by cat fish (mainly *Clarias gariepinus*) which constituted more than 12% during 2008 (GAFRD, 2008).

The best fitted polynomial regression equation describing catfish-successive years is shown in figure (3) and represented by:

$$Y = -\ 6.20E{+}08 + 618841\ X - 1545\ X^2 \qquad (3)$$

where Y = Catfish , X = Time in Year

$R^2 = 0.62$, $F = 8.98$, $P = 0.005$

It can be seen from the equation that, *Clarias* species trend revealed a parabolic curve with a coefficient of determination 0.62 (P = 0.005).

An increased trend of the catch was observed, varying between a minimum 2114 tons during 1996 reaching a maximum in 2003 (13548 tons) after which a decreasing trend occurred in the following years. The increase of the catch may be due to the fact that *Clarias* sp. are very resistant to the unfavourable environmental conditions in the lake with a decrease in oxygen content (El-Karyony, 1994; Saad, 2003 & Kraiem *et al*., 2009) while the following decrease may be due to the increased efforts exerted .

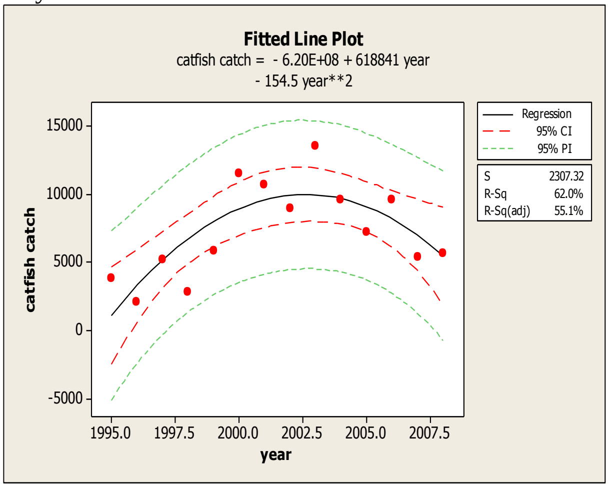

Figure 3. Variations of Catfish sp. production at Lake Manzalah (1995 – 2008).

Mullets (Mugilidae) species: The best established equation is as follows:

$$\text{Log } Y = -\ 4540392 + 2750296\ \text{Log } X - 416491\ \text{Log } X^2 \qquad (4)$$

where Y = Mullets , X = Time in Year

$R^2 = 0.617$, $F = 8.87$, $P = 0.005$

It can be seen from the equation (4) that mullets are approximated with the parabolic curve (Figure 4). The coefficient of determination is about 62 % (P = 0.005) in the logarithmic model. Due to over estimation of the catch during the years 2003 and 2004, they were excluded from the calculation process to determine the significance of the relation. It was found that the relation was less significant (R^2=0.57, P=0.021). Therefore, equation (4) was the more logic one.

The polynomial regression equation as follows (cubic model) was not significant:

$$Y\ (\text{Mullets}) = 2.61E{+}11 - 3.92E{+}08\ X + 195937\ X^2 - 32.66\ X^3$$

$R^2 = 0.476$, $F = 3.03$, $P = 0.08$

The minimum catch of mullets was shown during 1996 (301 tons) and the maximum catch was in 2003 (15193 tons). The variability of the catch may be due to the less resistant nature of these mullets to the unfavorable environmental conditions (El-Karyony, 1994), beside pollution of the lake water (Saad, 2003).

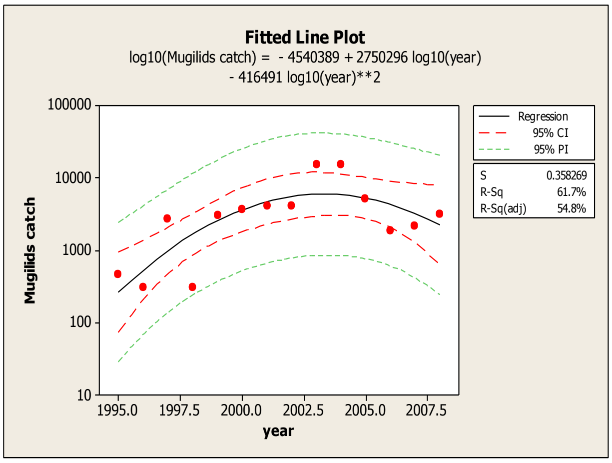

Figure 3. Variations of Mugilids fish production at Lake Manzalah (1995 – 2008).

It was found that both the catch per boat and catch per man were statistically insignificant in relation to either successive years in the time series or total fish production.

The coefficient of determination (R^2) between catch/boat and the successive years was 0.22 (P=0.251) and it was also, similar between catch/man and the successive years also. This means that only one-fifth of the catch per unit effort was explained and related to the successive years. Also, the coefficient of determination between catch/boat and the total catch was 0.229 (P=0.239) and that of catch /man was 0.251 (P=0.203). Hence, it is concluded that the relations between CPUE with either the successive years or the total catch were insignificant.

El- Karachily *et al.* (1986) in their study on the catch per unit effort in the northern Egyptian Delta lakes, during the period 1962-1983, stated that fish catch from each lake was positively correlated with the catch per unit effort (fishermen, boat), while the number of fishermen and fishing boats at any of these lakes were insignificantly correlated with the annual catch. So, they concluded that the number of fishermen and the number of boats can be treated as a rough measure of the fishing effort, where as the catch per man and the catch per boat may be treated as a rough measure of fish density in these lakes. However, they added that these measures of fishing effort or fish density are not the affecting factors in the lakes. Also, Wadie *et al.* (1989) working on lake Mariut during the period 1965-1986 showed insignificant variation between fish catch, number of licensed fishermen and the annual catch per man. They said that an increase in fishing effort will not improve the catch, but rather may lead to over fishing.

3.2. Catch per unit effort in small trammel net – operating boats

Fishing by trammel nets in Lake Manzalah is usually carried out by small boats of the third class "Canoe-like faloukas without sails" with mean crew size 2 men. (El-Bokhty, 2004). As illustrated in Table (2), the estimated annual catch per man reached an average 2.5 tons and differed from season to another. The lowest catch per man was observed in winter (294 Kg.) and the highest was recorded during summer (1.03 tons).

Also, The estimated annual catch per boat was averaged 5.8 tons and in consequence with the catch per man, the catch per boat was lowest at winter season (642 Kg.) and highest at summer season (2.5 tons). It is well known that trammel nets are passive fishing gears and their catch depends on moving the target species towards them and as the fish tends to settle down on the ground during the cold wind and abnormal environmental conditions prevailing in winter, hence the lowest trammel net catch (catch/man & catch/boat) was recorded.

3.3. Catch per unit effort in large seine net – operating boats

In light of the apparently favorable environmental conditions and the presence of widely aquatic vegetations in most areas of the lake enhanced fishing by seine or surrounding nets (locally known as El-Tara) especially at the southeastern, eastern and middle regions beside the high catch obtained. Boats used in fishing by this method are large wide beam sailing boats with crew size varying between 10 and 20 fisherman. (El-Bokhty, 2004).

As seen from Table (3), the estimated annual catch per man reached 3186.48 Kg and differed from season to another. The lowest catch per man was observed in spring (442.2 Kg) and the highest was recorded in summer (1128.6 Kg). The estimated annual catch per boat was averaged 38.72 tons and hence with the catch per man, the catch per boat was lowest in spring season (6151.2 Kg) and highest was during autumn season (13642.2 Kg). The highest catch per man was observed during summer due to the lower number of fishermen employed per boat in this season as well as the highest catch per boat during autumn due to the highest number of fishermen. The lower catch either per man or per boat was noticed during spring because of reduction of the aquatic vegetations due to the increased salinity (Morsi, 1994) combined with decreasing the freshwater input to the lake and as a result of this, fishing by this method is restricted to the southeastern area where the aquatic vegetations still flourished from the freshwater discarded from the nearby drains (El-Bokhty, 2004). Similar results have also showed that, the southeastern region recorded the highest annual catch per boat due to its high biological productivity which is caused largely by the inflow of nutrient-rich water from the nearby drains (Khalil & Bayoumi,1988 ; Thomas, 1994).

Here we should know that, one third or one fourth of the total boat catch is directed to the boat's (and net) owner according to a previous deal with other participating fishermen and the rest of the catch is divided between them.

Table 2. Daily & seasonal average catches per units of efforts in different seasons using small trammel net boats, Lake Manzalah (2004).

Season	Av.No.men/boat day ± s.e.	Av. No.fishing days/season	Av. Catch/man/ day (kg)	Av.Catch(Kg)/ boat/day ±s.e.	Av.Catch/man/ season (kg)	Av.Catch(Kg) /boat/season
Winter	2.24± 0.03	60	4.9	10.7± 0.36	294	642
Spring	2.2 ± 0.03	66	6.8	15 ± 0.22	448.8	990
Summer	2.4 ± 0.04	75	13.7	32.8 ± 0.52	1027.5	2460
Autumn	2.2 ± 0.02	72	10.6	23.3± 0.43	763.2	1677.6
Annual catch	2.3	273	9	20.45	2533.5	5769.6

Table 3*. Daily & seasonal average catches per units of efforts in different seasons using large seine net boats, Lake Manzalah (2004).

Season	Av.No.men/boat day ± s.e.	Av. No.fishing days/season	Av. Catch/man/ day (kg)	Av. Catch/boat/ day (kg)±s.e.	Av. Catch/man/ season (kg)	Av. Catch/ boat/ season (kg)
Winter	15.8± 0.9	66	8.68±0.6	124±6.5	572.88	8184
Spring	15 ± 1.03	66	6.7±0.3	93.2±5.3	442.2	6151.2
Summer	10.8 ± 0.6	66	17.1±1.6	162.7±6.6	1128.6	10738.2
Autumn	19.7 ± 2.03	66	15.8±1.9	206.7±16.2	1042.8	13642.2
Annual catch	15.3	264	12.07	146.65	3186.48	38715.6

*Table (3). c.f. El-Bokhty,2004.

It was shown by many authors (El-Karyony, 1994 & El-Bokhty,2004) that small boats were most lucrative than large or medium boats due to their lowest relative and fixed costs as well as increasing returns.

Maclaren (1981) suggested that the number of unlicensed fishing boats in Lake Manzalah during 1979, based on extensive boat counts, interviews and aerial survey, are commonly thought to be underestimated by at least 40%. The situation is true as there is a big difference between the catch per man and per boat either in small and large boats as obtained from the present results and that of the official results released by GAFRD (1995-2008), in addition to this, it is difficult to compare between the catch per unit effort between two different fishing methods with two different fishing boats or even between two units of the same type as one may be more efficient than the other, hence each one was studied separately and could be considered as an initial phase of exploitation.

Therefore, it is necessary to propose a recording system to provide an accurate estimate of the total annual catch of the lake as well as the accurate number of fishing boats according to their classification and the real number of fishermen to get real estimates of fishing efforts in comparable boat units. This could be achieved through knowing the number of boats per fishing method, average number of trips per fisherman per month, number of fishing months per year per fisherman, monthly sampling for effort and catch per unit of effort of the different boats and daily records of fish used domestically by native fishermen or sold as possible.

Recommendations

For improvement of the lake fishery, it is necessary to carry out many steps. The most important of these steps, the mesh size of the different fishing gears should be controlled to prevent overfishing problems and to save the fish stocks inhabiting the lake. Prevention of illegal fishing methods that seriously damage the ecosystem of the lake such as trawling boats (Al-Qerba). Decreasing the efforts performed on the lake. All these steps should be going on parallel with elimination of man-made barriers that hinder water circulation in the lake as well as treatment of industrial and organic drain water discarded into the lake.

Acknowledgment

I'm greatly indebted to Prof. A. Al-Sayes, Prof. of Fishing Gears,N.I.O.F. for revising the manuscript . My grateful thanks to Prof. Altaf Ezzat, Oceanogr. Dept., Fac. Sci., Alex. Univ. for her guidance, comments and criticism.

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تحليل جهد الصيد في بحيرة المنزلة (مصر) مع الإشاره إلى المراكب العاملة بالشباك ثلاثية الطبقات و الحلقية

العزب العزب بدر البختى و سعيد محمد عبد الحافظ
المعهد القومي لعلوم البحار و المصايد – مصر

بتحليل الإنتاج السمكي و الجهد المبذول في بحيرة المنزلة خلال الفترة بين 1995 – 2008 وجد أن إنتاج أسماك البلطي يتجه إلى النقصان (r = - 0.8132) بينما تزايد كلا من اتجاهي إنتاج العائلة البوريه و القطيه (القراميط) .

تزايد إنتاج القراميط خاصة يعكس تزايد التلوث العضوي داخل البحيرة (eutrophication).

تزايد جهد الصيد مع استخدام الشباك الغير قانونيه تسببا في الصيد الجائر بالإضافه إلى الظروف البيئية والتي قد تؤثر على بيئة المياه في البحيرة أدى إلى تذبذب الإنتاج السمكي من سنه إلى أخرى كما أنه لايمكن مقارنة الجهد المبذول للمراكب الصغيرة و الكبيرة معا لاختلاف نوعى الشبكتين وبالتالي كفاءة كل واحدة و يمكن اعتباره كصورة أوليه للإستغلال السمكي في البحيرة .

ينبغي اقتراح نظام تسجيلي لإنتاج الأسماك و الجهد المبذول لإعطاء التقديرات الدقيقة للإنتاج السمكي في البحيرة كما نوقشت عدة معايير لتحسين مصايد البحيرة.