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Study to Detect Impacts of Pollution on Fishery Biology of Tilapias in Lake Manzalah, Egypt

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ABSTRACT. The effect of pollution on fishery biology of tilapias was investigated on specimens caught seasonally by trammel nets from two differently polluted localities in Lake Manzalah during 2000. The less polluted one lies southwest (region A) and the other highly polluted lies in southeast (region B) of the Lake. Significant differences in fish abundance by weight ($F = 7.153$, $p < 0.05$) and by number ($F = 11.299$, $p < 0.05$) were observed between the two regions. Abundance by species revealed that *Oreochromis aureus, Sarotherodon galilaeus* and *Tilapia zillii* were significantly differed in number and *S. galilaeus* in weight among tilapias in areas of study. Size composition revealed regional differences in the case of *O. aureus* ($F = 23.155$, $p < 0.01$) and *S. galilaeus* ($F = 36.793$, $p < 0.01$). Individuals of age group 1 dominated the catch of all species in areas of study except for *O. aureus* whose individuals of age group 2 dominated its catch in region B. The overall ratio of males to females was 1:1.26 for *Oreochromis niloticus*, 1:1.11 for *O. aureus*, 1:1.03 for *S. galilaeus* and 1:0.72 for *T. zillii.* Chi-square test (X^2) revealed that the percentage of females is significantly higher than males in region B for all tilapia species except *T. zillii* comparing with the sex ratio for region A fishes. The mean values of condition factor of *O. niloticus* and *S. galilaeus* were higher in region A than region B. In addition, the natural mortality coefficient for *O. niloticus* inhabiting in region B was comparatively higher than that for region A.

KEY WORDS: Fishery biology, *O. niloticus*, *O. aureus, S. galilaeus, T. zillii*, Pollution, Lake Manzalah, Egypt.

Introduction

Lake Manzalah (Fig. 1) is the largest and the most productive among the Egyptian northern Lakes. Its fishery has traditionally been an important natural

FIG. 1. Map of Lake Manzalah showing the different regions of sampling.

resource. Historically, it has accounted for up to 15.4-21.0% of the total fish catch of all natural resources in Egypt and up to 48.0-51.3% of the total catch landed by the Egyptian northern lakes (Fig. 2). This contribution varies from year to year, in 1992 it accounted for approximately 48% of the Egyptian northern lakes catch. At its peak (1998) the total catch from Lake Manzalah was estimated at 78000 metric tones, which represented 51.3% of the total landing of the northern lakes and up to 19.2% of the total catch from all natural Egyptian resources. The catch was dominated by tilapia species, which accounted for up to 36.8% of the total lake catch during 1999. The total area of the Lake is about 90.485 hectare with an average depth of about 140 cm. The Lake is transverse by a number of small islands dividing the Lake into interconnected basins (Bahr), each Bahr varying from the other in water quality and fish species distribution (Ibrahim *et al*., 1997). The Lake is connected to the Mediterranean Sea through a main inlet at El-Gameel. It is also connected to the Suez Canal by several drains. The Lake receives wastes of fertilizers, domestic activity and industrial discharges through main drainage canales (Hados, Ramsis and Bahr El-Baqar) in southeast. The average annual inflow of water from Hados, Ramsis and Bahr El-Baqar that drains into the Lake is estimated as 6680×106 m^3/y (El-Sabrouti and Abaza, 1997). Acute pollution problems were attributed accordingly to that wastewater discharge (Kenawy and Hamza, 1993). According to Abdelhamid and El-Zarref (1996), the water of southern region of the Lake contains high level of Na, Ca, and Mg that consequently reflects high level of

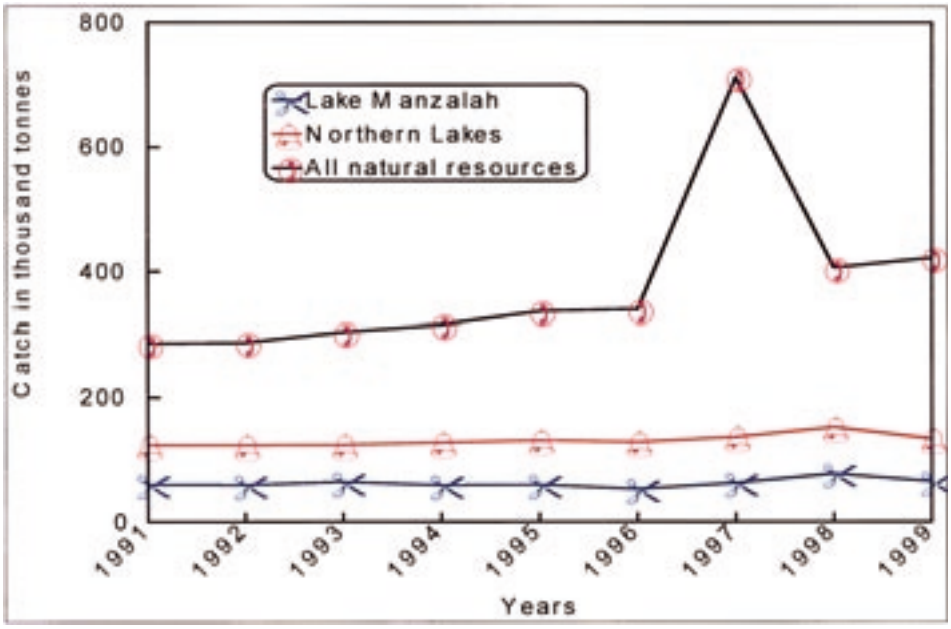

FIG. 2. Fish landings in tonnes from Lake Manzalah, northern lakes and all natural resources in Egypt.

Fe and Zn while, Bahr El-Baqar is characterized by higher levels of Fe and Cu. The same finding has noted by Dowidar *et al.* (1984). He mentioned that the concentrations of Fe, Mu, Cu, CO Cr, Ni and Pb in the dissolved form were higher in water off the outlet of Bahr El-Baqar drain than at any region of Lake Manzalah. This agrees with El-Sabrouti and Abaza (1997) they stated that the southeastern region (Bahr El-Baqar and Genka) was highly polluted area with heavy metals comparing with southwestern region. They mentioned that the concentrations of the heavy metals in the sediment of southeastern region were the following Cd (6.7 ppm), Co (59.8 ppm), Cu (62.3 ppm), Pb (100.5 ppm), Zn (103 ppm), Ni (108 pmm), Cr (192 pmm), Mn (1294 ppm), Fe (1.1%), Ca (2.3%) and K (3.0%). While their concentrations in southwestern region were 5.0 ppm, 52.9 ppm, 49.9 ppm, 70.2 ppm, 97 ppm, 89 ppm, 170 ppm, 1738 ppm, 1.1%, 2.2% and 3.8% respectively. On the other hand southeastern region of the Lake is located under intensive pollution problems as indicated from the anoxic conditions prevailed there such as the near depletion of DO in the surface and its low concentration near the bottom water, the pH values of 7.19-7.51 in the surface and 7.32-7.54 in the bottom as well as its sharp decrease in Ch-a contents as compared with southwestern region (Fahmy *et al.*, 1997).

The aim of this work is to investigate the influence of water pollution upon the fishery biology of tilapias from southwestern region (Bahr El-Hamra) and the southeastern region (Bahr El-Baqar and Genka) of the Lake. The first region is characterized by less pollution problem and the second one is located under the direct effect of pollution (Abdelhamid & El-Zarref, 1996 and Fahmy *et al.*, 1997).

Material and Methods

Historical data of catch was compiled from the General Authority of Fish Resources Development, Ministry of Agriculture, Egypt. Tilapias specimens were collected seasonally during 2000 from Bahr El-Baqar & Genka and El-hamra regions of Lake Manzalah by trammel nets. Total length and gutted weight for each fish was recorded to the nearest millimeter and 0. 1 gm respectively. The aging of fishes was carried out using scale readings to interpret age composition from length frequency distribution. Length-weight relationship was determined from the formula of Le Cren (1951). The gutted weight was used in order to exclude the effect of stomach contents and weight of gonads (Lagler, 1956; Ricker, 1975). The coefficient of condition (K) was calculated from the equation K = 100 W/L3 (*i.e.* Fulton condition factor). Where W = gutted weight in grams, L = total length in cm. This factor is often used as an approximation even when the allometric factor is theoretically more appropriate (Bagenal and Braum, 1971; Ricker, 1975). The natural mortality coefficient "M" was calculated by the method described by Ursin (1967).

Species composition, size & age composition, condition factor and natural mortality for tilapias species from different regions were statistically analyzed using two-way analysis of variance but differences in length-weight relationships and sex ratios were examined by covariance and chi-square test analyses respectively.

Results

1 – Relative Abundance of Tilapias

The relative abundance of tilapias (Table 1) in region A indicated that *Oreochromis aureus* dominated the tilapias catch weight (58%), followed by *T. zillii* (19.11%), *S. galilaeus* (13.59%) and *Oreochromis niloticus* (9.30%). Concerning numerical abundance, also *O. aureus* was come first (52.01%) followed by *S. galilaeus* (21.56%), *T. zillii* (18.18%) and *O. niloticus* (8.25%). In region B, *O. aureus* and *S. Galilaeus* were greatly dominated the tilapias catch amounting 40.70% & 43.58% by weight and 65.17% & 24.72% by number respectively, while other species were less abundant (< 10%).

TABLE 1. Abundance of tilapias species captured from region (A) and region (B) of Lake Manzalah.

Species	Region A				Region B				F-value	
	Number	N%	T.W.	W%	Number	N%	T.W.	W%	N%	W%
O. niloticus	39	8.25	930	9.30	32	5.99	688	8.26	1.3333	0.0555
O. aureus	246	52.01	6001	58.00	348	65.17	3582	40.70	8.9265*	0.7282
S. galilaeus	102	21.56	1399	13.59	132	24.72	3836	43.58	5.8896*	7.1173*
T. Zillii	86	18.18	1966	19.11	22	4.12	599	7.47	45.2738**	0.2376

*$p < 0.05$; **$p < 0.01$.

ANOVA statistical test applied for the obtained fish abundance in the two regions indicated the existence of significant differences by weight ($F = 7.153$, $p < 0.05$) and by number ($F = 11.299$, $p < 0.05$). The difference among species (Table 1) revealed that *O. aureus, S. galilaeus* and *T. zillii* were differed significantly in abundance by number while *S. galilaeus* by weight for tilapias captured from the two different regions .

2 – Size Composition

The catch of *O. niloticus* in region A was composed of fish in the length range of 8 to 16 cm having average length of 11.54 cm, highly percentage of them (74.36%) had the length of 10 to 12 cm. While the catch in region B was contained fish had length range of 5-15 cm with average length of 10.63 cm, the majority of them (65.63%) measured from 11-13 cm. Concerning *O. aureus* the region A had length range from 8 to 17 cm most of them (79.68%) ranged from 10 to 13 cm. Fish from region B had length range (5-18 cm), the majority of fish (68.39%) had length range 11 to 14 cm. The mean length range of region A fish (11.56 cm) was lowest than that of region B fishes (12.32 cm). *S. galilaeus* was represented in region A by fish ranging from 8 to 14 cm with average length (10.36 cm). The majority of fish (81.38 %) had length range of 8-11 cm. Fish from region B ranged from 5 to 18 cm, having average length 11.83 cm, most of them (91.67) ranged from 10 to 14 cm. The catch of *T. zillii* from region A was composed of fish ranging from 6 to 14 cm in total length with mean value of 10.55 cm, while region B fish ranged from 6 to16 cm with an average length of 11.23 cm. The major portion of the catch from region A (84.86%) and region B (68.18%) were dominated by individuals of length classes 9 to 12 cm and 11 to 13 cm respectively (Table 2).

Analysis of variance has employed to test the significances in differences of the mean fish lengths captured from these two regions. This statistical analysis showed significant differences for *O. aureus* ($F = 23.155$, $p < 0.01$) and *S. galilaeus* ($F = 36.793$, $p < 0.01$).

TABLE 2. Size composition of tilapias species in different regions of Lake Manzalah.

Species length (cm)	*Oreochromis niloticus*		*Oreochromis aureus*		*Sarotherodon*		*Tilapia zillii*	
	Region A N – %	Region B N – %	Region A N – %	Region B N – %	Region A N – %	Region B N – %	Region A N – %	Region B N – %
5		2 6.25		4 1.15		6 4.55		
6		3 9.38		15 4.31		1. 0.76	1 1.16	2 9.09
7		1 3.13		4 1.15			1 1.16	
8	1 2.56	1 3.13	5 2.03	2 0.58	12 11.77		4 4.65	1 4.55
9	1 2.56	1 3.13	14 5.69	6 1.72	12 11.77	1 0.76	14 16.28	1 4.55
10	7 17.95	1 3.13	54 21.95	25 7.18	36 35.29	14 10.61	18 20.93	2 9.09
11	14 35.9	8 25.00	53 21.55	38 10.92	23 22.55	17 12.88	28 32.56	4 18.18
12	8 20.51	8 25.00	51 20.73	81 23.28	9 8.82	46 34.85	13 15.12	5 22.73
13	3 7.69	5 15.63	38 15.45	71 20.40	8 7.84	29 21.97	6 6.98	6 27.27
14	2 5.13	1 3.13	22 8.94	48 13.79	2 1.96	15 11.36	1 1.16	
15	2 5.13	1 3.13	5 2.03	28 8.05		1 0.76		
16	1 2.56		3 1.22	21 6.04				1. 4.55
17			1 0.41	2 0.58		1 0.76		
18				3 0.86		1 0.76		
Total no.	39	32	246	348	102	132	86	22
Mean + Sd	11.54 + 1.652	10.63 + 2.697	11.56 + 1.655	12.32 + 2.421	10.36 + 1.440	11.83 + 2.080	10.55+ 1.452	11.23 + 2.369

3 – Age Composition

The age group 1 was dominant among all fish species from region A, and *O. niloticus, S. galilaeus* and *T. zillii* from region B. Age group 2 was more abundant among *O. aureus* in region B. Age group 0 was in the second priority in the case of *O. niloticus* from both regions and *S. galilaeus* from region A. Also it was in the third priority in the case of *O. aureus, T. zillii* and *S. galilaeus* from region B. Age group 3 was occupied the fourth priority for all species, while fish individuals of age group 4 were found only in the case of *O. aureus* from region A (Table 3).

ANOVA analysis (Table 4) revealed that there are significant differences in age composition of *O. niloticus* and *T. zillii* captured from regions A and B. For all tilapia species the representation of 0 group showed significant regional differences. Age 1 group was differed significantly only in the case of *O. niloticus* and *T. zillii.* Only *S. galilaeus* showed significant difference in abundance of age 2 group, group 3 which was represented in both regions only by of *O. aureus* also revealed significant difference between fish from these two regions.

4 – Sex Ratio

The overall ratio of males to females was 1:1.26 for *O. niloticus*, 1:1.11 for *O. aureus*, 1:1.03 for *S. galilaeus* and 1:0.72 for *T. zillii*. Chi-square test (X^2) was used to determine the effect of regional differences on the sex ratio of tila-

TABLE 3. Age composition of tilapias species in different regions of Lake Manzalah.

Species age group	*O. niloticus*		*O. aureus*		*S. galilaeus*		*T. zillii*	
	Region A N – %	Region B N – %	Region A N – %	Region B N – %	Region A N – %	Region B N – %	Region A N – %	Region B N – %
0	10-25.64	9-28.13	16- 6.50	28-8.05	24-23.53	7- 5.30	15-17.44	2- 9.09
1	23-58.97	18-56.25	135-54.88	145-41.67	64-62.75	82-62.12	47-54.65	15-68.18
2	6-15.39	5-15.63	89-36.18	151.43-73	14-13.73	42-31.82	23-26.74	5-22.73
3			5- 2.03	24-6.90		1- 0.76	1- 1.16	
4			1- 0.41					
Total number	39	32	246	348	102	132	86	22

TABLE 4. Analysis of variance of age composition of tilapias species from region (A) and region (B) of Lake Manzalah.

Species	Age 0		Age 1		Age 2		Age 3		Combined	
	F-value	p-level	F-value	p-level	F-value	p-level	F-value	p-level	F-value	p-level
O. niloticus	37.3333	0.00049	5.98291	0.04437	3.43137	0.10639			7.91589	0.02601
O. aureus	7.1008	0.04463	0.26167	0.63076	5.82321	0.06063	35.33614	0.00192	3.60144	0.11620
S. galilaeus	47.0870	0.00047	5.65116	0.05498	42.00000	0.00064			5.77045	0.05314
T. zillii	33.0000	0.00121	15.44681	0.00771					98.68421	0.00006

pias species. This analysis revealed that in region B the percentage of females is significantly higher than males for all tilapias species except *T. zillii* comparing with the sex ratio for region A fishes (Table 5).

TABLE 5. Sex ratio of tilapias species from region (A) and region (B) of Lake Manzalah.

Species	Region	Number		Percentage		Sex ratio	
		Male	Female	Male %	Female %	Male : Female	Chi-square
O. niloticus	Region A	17	20	45.95	54.05	1:1.18	2.8732
	Region B	10	14	41.67	58.33	1:1.40	
O. aureus	Region A	137	101	57.56	42.44	1:0.74	29.5586**
	Region B	129	194	39.94	60.06	1:1.50	
S. galilaeus	Region A	38	29	56.72	43.28	1:0.76	13.6034**
	Region B	50	62	44.64	55.36	1:1.24	
T. zillii	Region A	47	33	58.75	41.25	1:0.70	36.05909**
	Region B	11	9	55	45	1:0.82	

**$p < 0.01$.

5 – Length-weight Relationship

The regression equations of the relationship between length and weight and statistical analysis (covariance) for tilapias in different regions are presented in Table (6). It was obvious that only *O. niloticus* revealed no significant difference between fish captured from these two regions.

TABLE 6. Length-weight relationships of tilapias species from region (A) and region (B) of Lake Manzalah.

Species	Region	Length-weight equation	Correlation coefficient(r)	F-value	p-level
O. niloticus	Region (A) Region (B)	Log W = – 1.1537 + 2.7480 Log L Log W = – 1.7765 + 2.9530 Log L	0.9929 0.9979	0.2481	0.6201
O. aureus	Region (A) Region (B)	Log W = – 1.6910 + 2.8715 Log L Log W = – 2.0475 + 3.1990 Log L	0.9947 0.9978	36.0685	0.0001
S. galilaeus	Region (A) Region (B)	Log W = – 1.4915 + 2.7266 Log L Log W = – 1.9710 + 3.1275 Log L	0.9967 0.9968	5.5906	0.0189
T. zillii	Region (A) Region (B)	Log W = – 1.2908 + 2.5173 Log L Log W = – 1.8730 + 3.0903 Log L	0.9954 0.9963	4.9721	0.0279

6 – Condition Factor

The difference in Condition factor for examined species from these two regions statistically tested using analysis of variance.This test indicates that there are significant differences in the mean values of condition factor for *O. niloticus, S. galilaeus* from region A and B. *i.e.* fish inhabiting in the region A are heavier than those from the region B (Table 7).

TABLE 7. Condition factor (K) of tilapias species from region (A) and region (B) of Lake Manzalah.

Species	Region	No. of fish	Condition factor (K)		F-value	p-level
			Range	Mean – SD		
O. niloticus	Region (A) Region (B)	39 32	1.567-1.682 1.144-1.666	1.628-0.1420 1.321-0.1810	14.2289	0.0003
O. aureus	Region (A) Region (B)	246 348	1.313-1.710 1.066-1.616	1.467-0.1576 1.450-0.1901	0.7787	0.3779
S. galilaeus	Region (A) Region (B)	102 132	1.620-1.905 1.179-1.607	1.754-0.1695 1.470-0.1669	164.9259	0.0001
T. zillii	Region (A) Region (B)	86 22	1.407-1.949 1.518-1.893	1.651-0.1955 1.676-0.1109	0.0388	0.8443

7 – Natural Mortality

Comparing natural mortality coefficient of tilapias species from the two regions indicated that *O. niloticus* from region A revealed significantly lower natural mortality than that species living in region B (Table 8).

TABLE 8. Natural mortality of tilapias species captured from region (A) and region (B) of Lake Manzalah.

Species	Region	No. of fish	Natural mortality	F-value	p-level
O. niloticus	Region (A)	39	0.3332	9.8956	0.0025
	Region (B)	32	0.4161		
O. aureus	Region (A)	246	0.3471	0.3812	0.5372
	Region (B)	348	0.3426		
S. galilaeus	Region (A)	102	0.3667	0.683	0.4094
	Region (B)	132	0.3549		
T. zillii	Region (A)	86	0.3614	0.0072	0.9323
	Region (B)	22	0.3631		

Discussion

In the recent years the anthropogenic activities, especially from industrial, agricultural and domestic activities has increased the environmental pollution spoiling the ichthio-fauna living in aquatic system containing them. The heavy metal in fish, which are reaching man via the food chain, may have the effects on the ecosystem greater than that of the more common pollutants (Tayel and Shriadah, 1996). Many trace metals are known to be concentrated by marine organisms in food chain (El-Sokkary, 1980 and Shriadah & Emara, 1992). Also the pollution by pesticides from agricultural drainage is serious problem and its long-term environmental effects may by the incidence of poisoning of fish and other aquatic life forms (Jyothi and Narayan, 1999). Fahmy *et al.* (1997), in their study on the southwestern and southeastern sides (regions A and B) of Lake Manzalah, found that region B is suffer intensive pollution problems indicated by anoxic conditions including the near depletion of oxygen at the surface and its low concentration near the bottom water. The pH values were fluctuated from 7.19-7.51 in the surface and 7.32-7.54 at the bottom as well as such a sharp decrease in Chlorophyll contents compared with region A, also mentioned that region B shows high levels of Cd and Pb concentrations compared with unpolluted inland water.

Concerning the relative abundance of tilapias, it was found that *O. aureus* dominated the catch in the Lake by number and weight followed by *S. galilaeus*. Hosny (1987), also found that tilapias population was dominated by *O. aure-*

us in the same Lake. The increase abundance of *O. aureus* and *S. galilaeus* and decrease abundance of *T. zillii* in region B than region A, can be attributed to the fact that *O. aureus* has a wide spectrum of food (Bakhoum, 1995) which characterise the region B. Furthermore it tolerates a wide range of salinity (Chervinski and Zorn, 1974). Also region B had relatively higher fertility in phytoplankton grown up as the level of different nutrients in region B was higher than in region A (Fahmy *et al.*, 1997), so it more suitable for *S. galilaeus* which mainly feed on phytoplankton. The decreased abundance of *T. zillii* in region B may be due to it is more euryhaline (Chervinski and Hering, 1973). Similar results have been observed by Essa and Faltas (1997) on their work on tilapias in Lake Mariut. The present study support their finding on that the differences in relative abundance of tilapias species are controlled by zonal variation in the water quality, quantity of a valuable food of the Lake as well as the wide variation of primary production in the different zones.

The average length of *O. aureus* and *S. galilaeus* in region B was significantly larger than of region A fish. It can be attributed to the high concentration of different nutrients in region B comparing with region A.

The age group 1 was dominant among all fish species from region A and *O. niloticus, S. galilaeus* and *T. zillii* from region B, while age group 2 for *O. aureus* was more abundant in region B. Age group 0 followed it, which was in the second place in the case of *O. niloticus* from both regions and *S. galilaeus* from region A, this is explained that these tilapias species were relatively over exploited in both regions of the Lake.

The overall sex ratio for *O. aureus, S. galilaeus* and *T. zillii* indicated that the percentage of females are significantly higher than males in region B compared to region A. This can be attributed to the sexual differences in the degree of accumulation of trace metal in males and females organs (Miller *et al*., 1992 and Shakweer and Abbas, 1996).

According to Lagler *et al*. (1977), Length-weight relationship leads itself to comparison of individuals within and between different populations. In the present investigation it was found that there are significant differences between regressions of all examined species except *O. niloticus* from regions A and B. Condition factor gives an indication of the degree of the well-being of fish. It is used to indicate the suitability of an environment for a certain fish species by comparison with another environment (Ricker, 1971). However, the results revealed that the mean values of condition factor for *O. niloticus* and *S. galilaeus* were significantly higher in region A than for fishes from highly polluted area (region B). This is in agreement with the finding of Bayoumi and Khalil (1988), they found that tilapia species in North part of Lake Manzalah had condition

factor better than those inhibiting the southern parts (Drains sector). In addition, according to Bakhoum (1994), condition factor of *O. niloticus* and *O. aureus* from polluted basin was lower than that for non-polluted basin fishes of Lake Mariut.

The highest value of natural mortality for *O. niloticus* inhabiting in region B indicated that the environmental living conditions have deteriorated for this species. This effect probably occurs due to the poisoning effect of pesticides and trace metal, as well as low quality of water body, such as decreased transparency, pH, DO and high DOM and Chl-a (Fahmy *et al*. 1997).

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دراسة مقارنة لآثار التلوث على بيولوجية مصايد أسماك البلطي في بحيرة المنزلة – مصر

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المستخلص. تناولت هذه الدراسة تأثير التلوث على بيولوجية أسماك البلطي في بحيرة المنزلة حيث تم جمع عينات موسمية تم صيدها بواسطة الشباك ثلاثية الطبقات من منطقتين مختلفتين من حيث درجة التلوث وذلك خلال عام ٢٠٠٠م. وتقع المنطقة (أ) الأقل تلوثاً في الجزء الجنوبي الغربي من البحيرة أما المنطقة الأكثر تلوثا (ب) فتقع في الجزء الجنوبي الشرقي بالقرب من مصبات مياه الصرف. كما تم تحليل النتائج إحصائيا للوقوف على مدى فاعلية التباين الذي تم التوصل إليه.

وقد أثبتت الدراسة أن مصادر التلوث في البحيرة تؤثر تأثيرا معنويا على التركيب الكمي للمصيد من حيث الوفرة الوزنية ($F=7.153, p<0.05$) والوفرة العددية ($F=11.299, p<0.05$). حيث سجل التباين العددي للأنواع اختلافاً فى الأنواع الحسانى (*Oreochromis aureus*) والجليلى (*Sarotherodon galilaeus*) والأخضر (*Tilapia zillii*). كما لوحظ التباين الوزنى فقط لنوع الجليلى في منطقتي الدراسة. كما أثبتت الدراسة أن مصادر التلوث في البحيرة تؤثر تأثيرا معنويا وبما لا يدع مجالا للشك على باقي الصفات البيولوجية لمصائد أسماك البلطي كما يلى – التركيب الديموجرافى، حيث أظهر البلطي الحسانى والجليلى اختلافا معنوياً في التركيب الحجمى لكل منهما، كما سادت أفراد المجموعة العمرية الأولى المصيد لكل الأنواع في منطقتى الدراسة ما عدا البلطي الحسانى الذي سادت فيه أفراد المجموعة العمرية الثانية في المنطقة (ب)، كما أثبتت الدراسة السيادة المعنوية لنسبة الإناث لكل الأنواع في المنطقة (ب) مقارنة بالمنطقة (أ) فيما عدا البلطي الأخضر. كما لوحظ ارتفاع معامل الحالة

للنوعين النيلى(*Oreochromis niloticus*) والجليلى في المنطقة (أ). – معامل النفوق الطبيعي للبلطى النيلى كان مرتفعاً في المنطقة (ب) مقارنة بالمنطقة (أ).