

*Full Length Research Paper*

# Breeding properties of *Esox lucius* (L., 1758) living in Kapulukaya Dam Lake (Kirikkale, Turkey)

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This study involves the investigation of the breeding properties of *Esox lucius* (L., 1758) living in Kapulukaya Dam Lake in Turkey. It was observed that the fish reaches sexual maturity at the age of 3, and the breeding period starts in February and ends in March. The highest and lowest gonadosomatic index (GSI) values were determined in February and July, respectively. The average egg number per fish was estimated to be  $19781.75 \pm 12051.09$ . The relations between the fecundity (F), body length (L) and body weight (W) were found as  $F = 0.00137275 \times L^{2.675}$  ( $r = 0.85$ ) and  $F = 32.38038307 \times W^{0.9564}$  ( $r = 0.87$ ).

**Key words:** *Esox lucius*, Northern pike, breeding, Kapulukaya Dam Lake, Turkey.

## INTRODUCTION

Northern pike (*Esox lucius*) from Esocidae family is a commonly hunted fish due to its tasty meat. It generally lives in lakes but it is frequently seen in rivers and stream. Although it is known as a freshwater form, it occasionally enters soda waters (Geldiay and Balik, 1988). Celikkale (1988) reports that it lives in warm, calm, stagnant or slow flowing waters that are up to 1500m of altitude. It is also reported that it prefers, primarily, shallow cool-waters which have productive and mesotrophic-eutrophic environments (Casselman and Lewis, 1966).

Some of the researches related to Northern pike in Turkey and in the world include Healey (1956), Munro (1957), Kipling and Frost (1967), Kennedy and Fitzmaurice (1969), Tanyolac and Karabatak (1974), Mann (1976), Koz'min (1980), Karabatak (1982), Aksun (1987), Omeroglu (1996), İlhan and Balik (2003), Balik et al. (2006), Erdem et al. (2007), Yagci et al. (2009). These authors studied the reproductive biology of the Northern pike.

The aim of this study was to investigate the reproductive biology such as the spawning period, length of first sexual maturity and fecundity of the population of Northern pike in Kapulukaya Dam Lake. Northern pike is also almost the most important fish species in Kapulukaya

Dam Lake. Despite its economical importance, there is no adequate recent information about biological characteristics of pike population in this lake.

## MATERIALS AND METHODS

This study was carried out on 328 *E. lucius* (111 females and 198 males) caught between November 2001 and October 2002 in Kapulukaya Dam Lake constructed on Kizilirmak River (Figure 1). The fish were caught with trap nets having a length of 20, 40, 60 m, width of 2.5 - 3 m and mesh size of 18, 23, 32, 36, 45, 55 and 60 mm.

The weight and the fork length of the fish were measured at an accuracy of 0.1 g and 1 mm. Approximately, 30 - 40 scales were taken from the dorsal fin to ligne lateral of each fish and they were appropriately prepared for age determination (Lagler, 1966; Geldiay and Balik, 1988).

The gender of the fish was determined from their gonads. The fecundity was investigated on 84 female individuals. The ovaries of each fish were weighed. A piece of the ovary from each fish weighing 1 g was used for the determination of the number of eggs under a stereo microscope. The total fecundity of each individual was then determined using the ratio of this 1 g piece to the total weight of the ovary.

The diameter of approximately thirty eggs taken from the upper, middle and lower parts of the ovaries were measured by the use of calipers and the variation of the diameter according to months was determined. The numbers of eggs were estimated by gravimetric methods (Bagenal, 1978).

The ovaries of the females were followed throughout the breeding period and the number and ratio of the ones which did not spawn

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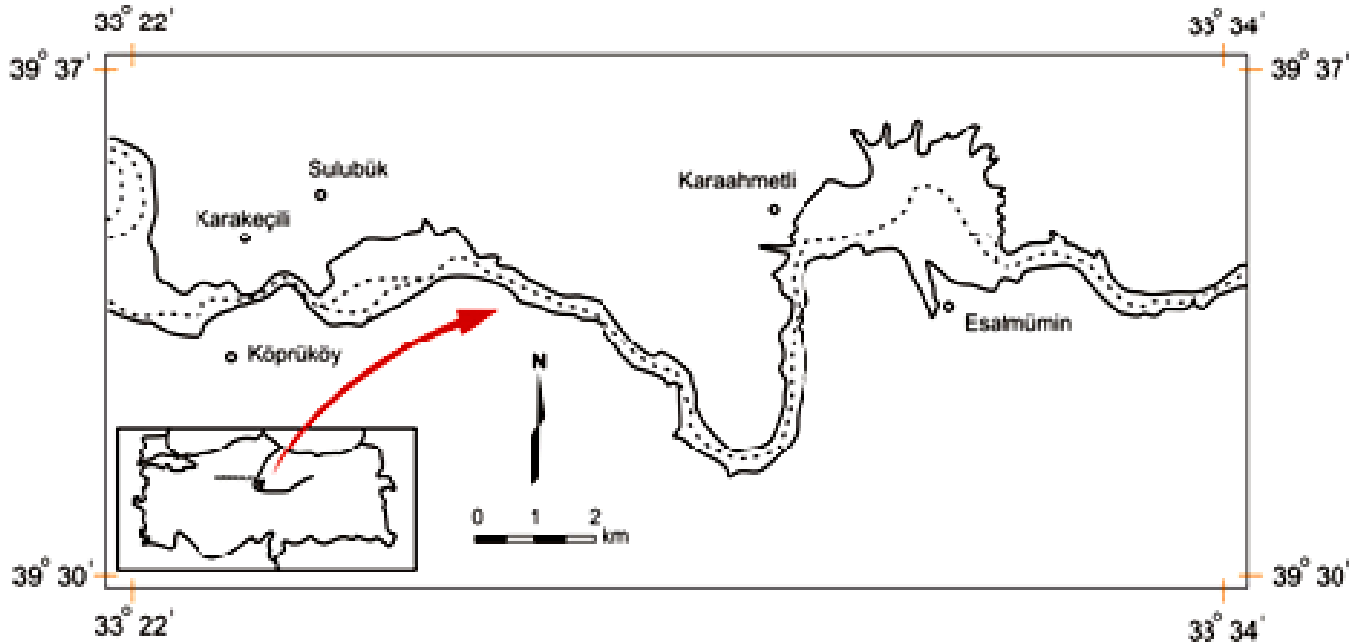


Figure 1. Kapulukaya Dam Lake.

eggs were tabulated. The period of breeding was determined according to gonadosomatic index (GSI), variation in egg diameter according to months and the number of individuals who did not spawn eggs. GSI was computed using the following equation (Lagler, 1966; Bagenal, 1978):

$$\text{GSI} = (\text{GW} / \text{W}) \times 100$$

Where GW = gonad weight, and W = body weight).

Sexual maturity was confirmed by noting macroscopically the presence of "yolked eggs" or sperm in the gonads (Nikolsky, 1963). On the other hand, fecundity (F) - fork length (FL) and fecundity - body weight (WT) were calculated with regressions analyses. Fecundity (F) was calculated from the equation (Nikolsky, 1969).

$$F = a \cdot L^b \text{ and } F = a \cdot W^b$$

For each species or population, the parameters "a" (proportionality constant or regression intercepts) and "b" (regression exponent) of the following form were estimated.

## RESULTS

The investigation of the gonads of *E. lucius* individuals living in Kapulukaya Dam Lake showed that they reach sexually maturity at the age of 3. The monthly variations in GSI values and egg diameter were followed. The GSI value was found to be highest in February and the lowest in July and started to increase after that (Figure 2). It was determined that the egg diameter reached a maximum value of 1.95 mm in March and ovaries were empty in May (Figure 3). The fecundity was determined to range between 12577.79 and 47270.00 and increase with fish age (Table 1).

The assessment of the main spawning season of this species in the dam lake was based on the GSI and analyses of seasonal development in mean egg diameter and water temperature (Table 2). The examination of the monthly variations of GSI values and egg diameter of the fish revealed that its breeding takes place between February and March (Table 2).

It was determined that the egg diameter of *E. lucius* in Kapulukaya Dam Lake reached maximum value in March (Table 2 and Figure 3).

The regression equations were  $F = 0.00137275 \times L^{2.675}$  ( $r = 0.85$ ) for fecundity and fork length (L) and  $F = 32.38038307 \times W^{0.9564}$  ( $r = 0.87$ ) for fecundity and weight (W). The statistical results of these relations are given in Figure 4.

## DISCUSSION

The breeding age of *E. lucius* living in Kapulukaya Dam Lake was found to be 3. Aksun (1987) determined the breeding age of the *E. lucius* individuals in Karamik Lake as 2, Karabatak (1982) found the same values as 2 in Aksehir Lake, İlhan (1999) and İlhan et al. (2003) found the same values as 2 in Isikli Dam Lake, Yagci et al. (2009) found the same values as 2 in Isikli Dam Lake. Healey (1956), Munro (1957) and Kennedy and Fitzmaurice (1969), Mann (1976), Cubuk et al. (2000), on the other hand, determined the age of breeding for *E. lucius* as 2 or 3 for both sexes.

The spawning period of *E. lucius* individuals living in Kapulukaya Dam Lake was determined to be between February and April. Tanyolac and Karabatak (1974),

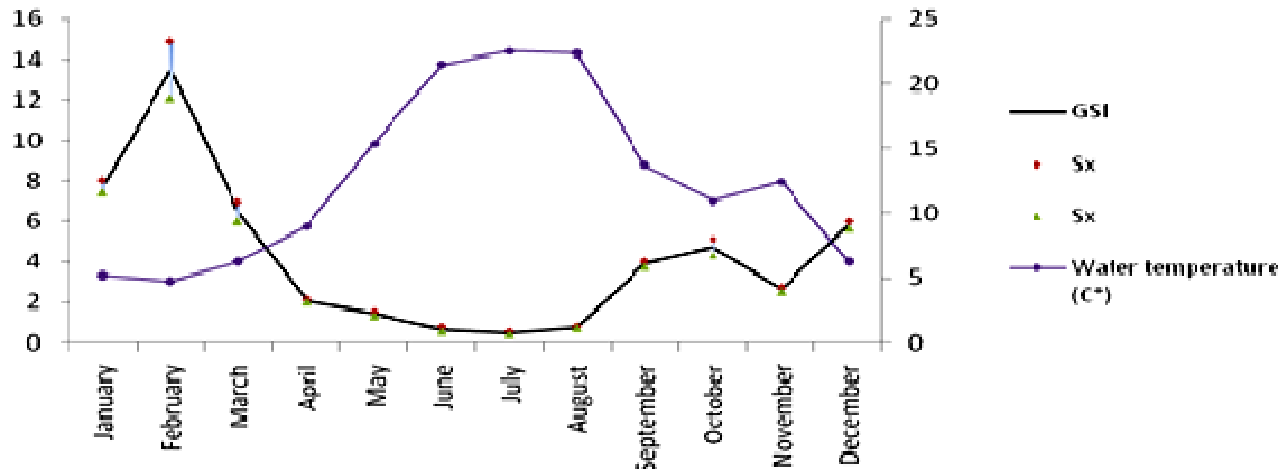


Figure 2. The variation of gonadosomatic index (GSI) and water temperature *E. lucius* living in Kapulukaya Dam Lake according to months (S<sub>x</sub>: Standard error).

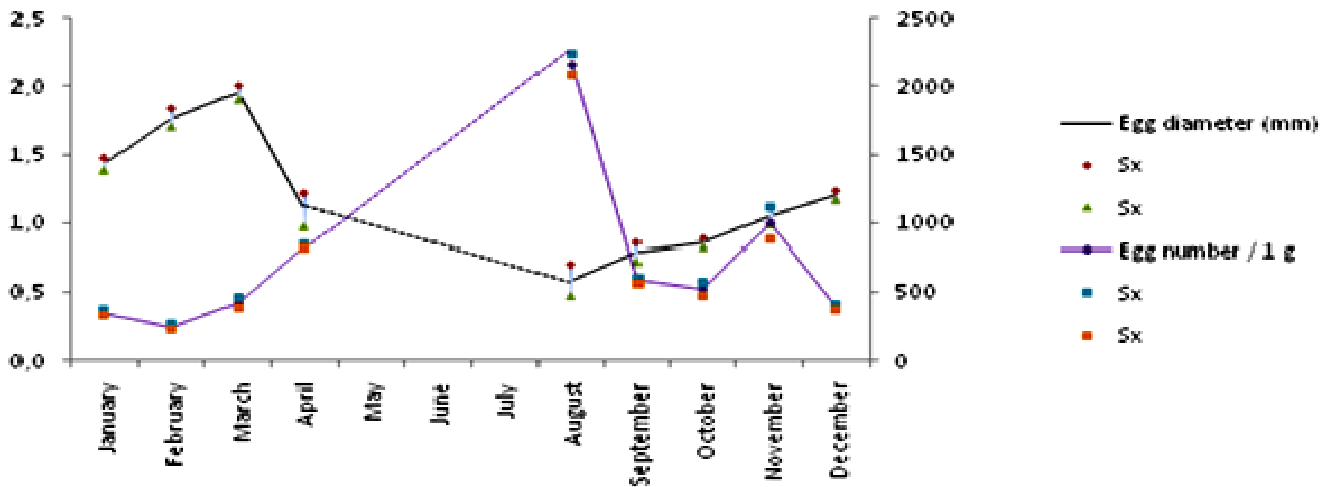


Figure 3. Seasonal changes in egg diameter and egg number of *E. lucius* living in Kapulukaya Dam Lake (S<sub>x</sub>: Standard error).

Table 1. The average fork length, weight and fecundity of female *E. lucius* according to age.

Age	N	FL ± S <sub>x</sub> (mm)	W ± S <sub>x</sub> (g)	F ± S <sub>x</sub>	95% Confidence limit (CI)
III	29	415.51 ± 28.51	603.10 ± 218.64	12577.59 ± 672.07	11905.52 - 13249.66
IV	26	469.80 ± 14.72	748.57 ± 136.21	19511.92 ± 1066.28	18445.65 - 20578.20
V	9	524.44 ± 23.51	1075.55 ± 291.20	32684.13 ± 2365.81	30318.32 - 35049.95
VI	6	575.83 ± 48.82	1618.33 ± 487.29	39395.00 ± 2687.66	36707.34 - 42082.66
VII	4	667.50 ± 42.72	2232.50 ± 245.40	47270.00 ± 5303.83	41966.17 - 52573.83

S<sub>x</sub> = Standard error.

Karabatak (1982), Aksun (1987), Cubuk et al. (2000), Balik et al. (2006) and Erdem et al. (2007) on the other hand determined this period as February - March for *E. lucius* populations in Mogan, Aksehir, Karamik, Apolyont,

Karamik and Apolyont lakes, respectively. İlhan (1999), İlhan and Balik (2003) and Yagci et al. (2009) determined this period as February - April in Isikli Dam lake, while Lenhardt and Cakic (2002) determined this period as

**Table 2.** The average fork length, weight and fecundity of female *E. lucius* according to age.

Months	GSI (X ± Sx)	95% Confidence Limit (CI)	Egg diameter (mm) (X ± Sx)	95% Confidence limit (CI)	Egg number/g (X ± Sx)	95% Confidence limit (CI)	Water temp. (°C)
November	2.63 ± 0.09	2.45 - 2.81	1.05 ± 0.06	0.93 - 1.16	1000.0 ± 112.40	779.70 - 1220.30	12.45
December	5.82 ± 0.17	5.49 - 6.15	1.20 ± 0.03	1.13 - 1.26	394.64 ± 19.86	355.72 - 433.36	6.25
January	7.73 ± 0.29	7.16 - 8.30	1.43 ± 0.05	1.33 - 1.51	348.75 ± 15.75	317.89 - 379.61	5.20
February	13.49 ± 1.38	12.47 - 14.51	1.76 ± 0.06	1.63 - 1.89	248.46 ± 18.72	211.75 - 285.17	4.75
March	6.48 ± 0.45	5.59 - 7.37	1.95 ± 0.04	1.83 - 2.04	419.70 ± 41.51	338.34 - 501.08	6.25
April	2.07 ± 0.04	1.98 - 2.16	1.09 ± 0.12	0.85 - 1.33	828.00 ± 10.07	808.25 - 847.75	9.00
May	1.43 ± 0.07	1.27 - 1.58	*	*	*	*	15.40
June	0.67 ± 0.09	0.48 - 0.86	*	*	*	*	21.50
July	0.48 ± 0.06	0.48 - 0.48	*	*	*	*	22.50
August	0.77 ± 0.02	0.72 - 0.81	0.59 ± 0.12	0.36 - 0.81	2162.50 ± 74.65	2016.18 - 2308.82	22.35
September	3.88 ± 0.12	3.64 - 4.11	0.79 ± 0.07	0.65 - 0.92	586.67 ± 18.56	550.29 - 623.04	13.75
October	4.74 ± 0.37	4.01 - 5.46	0.86 ± 0.03	0.79 - 0.92	526.43 ± 54.87	418.89 - 633.97	10.95

S<sub>x</sub> = Standard error; \* = could not be measured

February - April in River Danube. Bregazzi and Kennedy (1980) state that the spawning period of *E. lucius* individuals in Southern Eutrophic lake as March and Koz'min (1980) found the same values as April-May in Lacha lake.

The surface water mean temperature of Kapulukaya Dam lake was 4.75°C in February and 9°C in April when *E. lucius* spawns its eggs. The increase of temperature was found to have a positive effect on egg spawning process. Tanyolac and Karabatak (1974) report that the surface water mean temperature of Mogan lake was 5 - 11°C in February - March, the breeding period of *E. lucius*. Karabatak (1982) indicates that the surface water temperature of Aksehir lake was 3°C in February and 13°C in March which corresponds to the breeding period of *E. lucius* population living there. Aksun (1987) reports that the surface water temperature of Karamik lake was 4.1°C in February and 10.6°C in March, the breeding period of *E. lucius*. Omeroglu (1996) found the same values as 6.9°C in February and 10.8°C in April in Manyas Lake. Kipling and Frost (1967) showed that the surface temperature of Windermere Lake in March - May was 6 - 8°C when *E. lucius* living in the lake start to breed. Koz'min (1980) found the same value as 4.8°C in April and 7.8°C in May in Lacha lake.

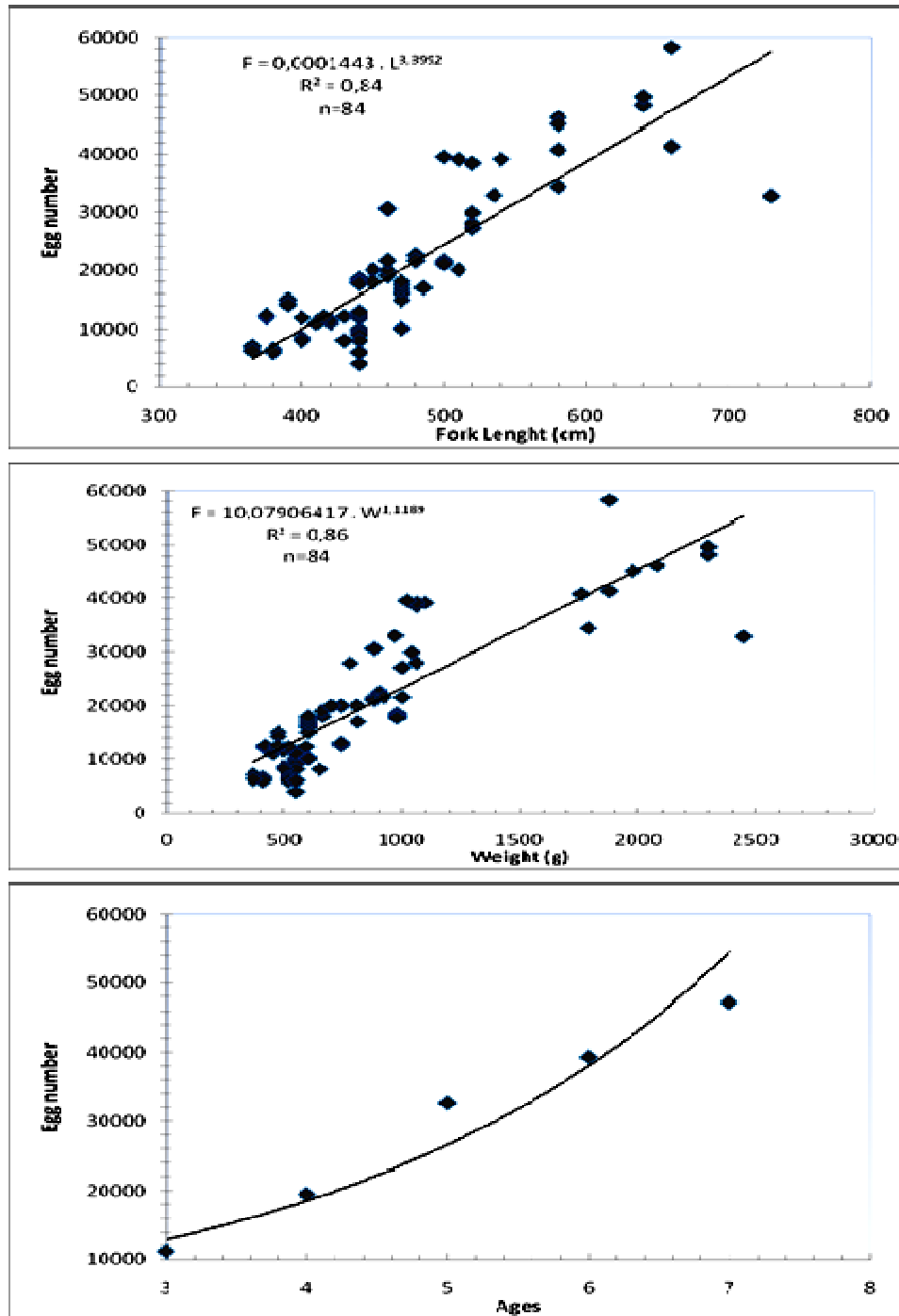
Karabatak (1982) calculated the total fecundity of *E. lucius* which ranged from 2800 to 120200 eggs per female in Aksehir lake. Aksun (1987) determined this value as 8975 to 32157 for *E. lucius* population in Karamik lake. Cubuk et al. (2000) calculated the total fecundity of *E. lucius* which ranged from 4784 to 39652 eggs per female in Apolyont lake. İlhan and Balik (2003) calculated the total fecundity of *E. lucius* which ranged from 1461 to 48888 eggs per female in Isikli Dam lake. Yagci et al. (2009) found the same value as 1845 to

91944 eggs per female in Isikli Dam lake. Erdem et al. (2007) found the average fecundity value as 15471 ± 1486. Lenhardt and Cakic (2002) calculated the total fecundity of *E. lucius* which ranged from 524 to 123896 eggs per female. This value was found to be 19781.75 ± 12051.09 for Kapulukaya Dam lake. Fecundity is affected by fish age, length, weight, egg size, feeding of fish, season and environmental conditions (Nikolsky, 1963).

The egg diameter of *E. lucius* was found to range between 0.50 and 2.16 mm in Karamik lake (Aksun, 1987), 1.69 and 2.58 mm in Karamik lake (Balik et al., 2006) and 0.69 and 2.41 mm in Isikli Dam lake (Yagci et al., 2009). Erdem et al. (2007) calculated the average egg diameter of *E. Lucius* individuals as 2.15 in Uluabat lake. The egg diameter was found to range between 0.30 and 2.35 mm in Kapulukaya Dam lake.

A positive correlation between fecundity and fish weight and length has been described in most freshwater fish populations (Ünlü and Balci, 1993). Balik et al. (2006) found the regression equations of *E. lucius* as  $F = 2.8963 L^{2.3722}$  ( $r = 0.59$ ) for fecundity and fork length (L) and  $F = 58.998 W^{0.9354}$  ( $r = 0.67$ ) for fecundity and weight (W) in Karamik lake. Yagci et al. (2009) found the regression equations of *E. lucius* as  $F = 1.5844 L^{2.669}$  ( $r = 0.70$ ) for fecundity and fork length (L) and  $F = 124.07 W^{0.866}$  ( $r=0.74$ ) for fecundity and weight (W) in Isikli Dam lake. The relations between the fecundity (F), body length (L) and body weight (W) were found as  $F = 0.00137275 \times L^{2.675}$  ( $r=0.85$ ) and  $F = 32.38038307 \times W^{0.9564}$  ( $r = 0.87$ ) in this study. This result agrees with other studies.

In conclusion, *E. lucius* was able to adapt well in Kapulukaya Dam lake because of its good reproduction ability. Therefore, we suggest that specimens should not be caught before they reach sexual maturity age and from the beginning of June and the end of July to be



**Figure 4.** Relationships between fecundity - fork length fecundity - total weight and fecundity - ages of *E. lucius* living in Kapulukaya Dam Lake.

able to preserve the *E. lucius* population in this lake.

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