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The Growth Features of Tench (*Tinca tinca* L., 1758) in Bayındır Dam Lake, Ankara, Turkey

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Abstract: The growth features of tench, *Tinca tinca*, in Bayındır Dam Lake were studied between March 1999 and February 2000. A total of 100 samples (51 males and 49 females) were examined. Age in both sexes ranged from age group I to V. The sex ratio was 1.04 and 1.0 for males and females respectively. The fork length and weight of females and males varied from 15.2 to 33.2 cm and 51.4 to 650.7 g and 15.7 to 34.7 cm and 52.8 to 822.6 g respectively. Age-length and age-weight relationships were obtained using the Von Bertalanffy growth equation. Allometric growth patterns were obtained from the length-weight relationships. The condition factor was 1.57 for females, 1.53 for males and 1.55 for both combined. In addition, the relative annual increases in length and weight of *T. tinca* for males, females and both sexes combined were also determined.

Key Words: *Tinca tinca*, Growth Features, Bayındır Dam Lake

Bayındır Baraj Gölündeki Kadife Balığının (*Tinca tinca* L., 1758) Büyüme Özellikleri

Özet: Mart 1999- Şubat 2000 tarihleri arasında Bayındır Baraj Gölünde *Tinca tinca* (L., 1758)'nin büyüme özellikleri çalışılmıştır. Toplam olarak 100 örnek (51 erkek ve 49 dişi)'te inceleme yapılmıştır. İncelenen dişi ve erkek bireyleri I-V yaşları arasında dağılım gösterdiği tespit edilmiştir. Eşey oranı sırasıyla erkeklerde % 51.0 dişilerde % 49.0 (1.04:1.0) olarak bulunmuştur. Çatal boy dişi bireylerde 15.2-33.2 cm, ağırlık 51.4-650.7 gr, erkek bireylerde 15.7-34.7 cm, ağırlık 52.8-822.6 gr olarak bulunmuştur. Yaş-boy ve yaş- ağırlık ilişkisi Von Bertalanffy'e göre hesaplanmıştır. Ayrıca, allometrik büyüme şekilleri boy- ağırlık ilişkilerinden ortaya çıkarılmıştır. Yıllık oransal boy ve ağırlık artışı ve yaş grubu için erkek, dişi ve heriki eşey için de hesaplanmıştır. *T. tinca* bireylerinin kondisyon faktörü, dişiler için 1.57, erkekler için 1.55 ve tüm populasyon için 1.55 olarak bulunmuştur.

Anahtar Sözcükler: *Tinca tinca*, Büyüme Özellikleri, Bayındır Baraj Gölü

Introduction

The tench, *Tinca tinca* L., commonly inhabits relatively shallow weedy lakes and slow flowing rivers. They feed on aquatic plants and have low growth rates. These fish do not have great economic importance; however, they contribute considerably to eutrophication and other processes. In eutrophic lakes, tench prevents the transition of inorganic nutrient salts, nitrogen and phosphorus accumulated in the sediment to the water by feeding on aquatic plants. They live on the bottom and in winter burrow in the mud at the bottom until spring and suffer from lack of oxygen (1,2). They mix the bottom mud continuously and play an important role in mineralization (2). These fish are widespread in Europe, and are also found in the anterior orient and western Siberia (3). In Turkey, it is reported in rivers flowing to the Black Sea from Thrace and northern Anatolia (2,3). Since the 19th century, these fish have been bred as an

important pool fish in central Anatolia, particularly for cleaning carp pools and garden pools (4).

Although several studies have already been conducted on these fish by Cerny (5), Weatherley (6), Gonzales et al. (7), and Pimpicka and Piros (8), in Turkey there are very few, such as Yiğit (9), Altındağ et al. (10), and Balık, et al. (11). The present study was conducted to observe the population structure and growth features of *T. tinca* in Bayındır Dam Lake.

Materials and Methods

Bayındır Dam Lake is located opposite the village of Bayındır near Bayındır Stream, 12 km south-east of the city of Ankara and 2 km east of the town of Kayaş (39°57'-32°53'). The lake's volume is 6.97 hm³, its area is 0.71 km² and its maximum depth 16.5 m (12). In the limnologic study report for the year 1978 prepared by

DSİ, it was reported that for the first time during 1971-1976 trout, silver fish and common carp were introduced into the lake (13). In the present study, the fish species reported in the lake were silver fish, pikeperch and tench.

During the present study, the physio-chemical parameters such as temperature, dissolved oxygen, pH and turbidity were determined in minimum and maximum values as 4.8-24 °C, 6.8-11.0 mg/L, 7.4-8.5, and 1.3-6.5 m respectively.

A total of 100 specimens (51 males and 49 females) were caught using gill nets of various mesh sizes (20, 30 and 60 mm). The sampling was done at three stations at Bayındır Dam Lake (Fig. 1) between March 1999 and February 2000. Fork length was measured to the nearest 1.0 mm and the fish were weighed to the nearest 0.1 g. Sex was determined from the gonad tissues either by macroscopically for large specimens or with the aid of a stereomicroscope for small ones. Sex ratio for significant difference from an expected 1:1 ratio for total specimens and for each group was tested statistically using Student's t-test at $P \leq 0.05$. Using the values of the fork length (cm) and weight (g) of each individual, the length-weight relationship was calculated following the Le Crens equation: $W = aL^n$ (14). The rational increase in length and weight was determined using the formulas; $OL = ((Lt - Lt - 1)/Lt - 1)$ and $OW = (Wt - Wt - 1)/Wt - 1$ (15,16).

Differences between growth and condition factor for the female and male groups within the same age groups and differences between measured and theoretical values for length were tested with a t-test at $P \leq 0.05$.

Results

Population structure

The age group and sex distribution of all specimens examined are shown in Table 1. Overall, 49.0% were females and 51.0% males. Age variation ranged between age group I to V and the most common was group I (33%), followed by group II (24%). Age groups I, II and III contained 78% of all specimens studied.

Length and weight composition

Length distribution was found to range from 15.2 to 33.2 cm in females and from 15.7 to 34 cm in males and this range for weight was from 51.4 to 650.7 g for females and from 52.8 to 822.6 g for males in age groups I and V respectively.

Growth

Age-length relationship

Growth equations of the theoretical length of an individual at any age were calculated with the Von

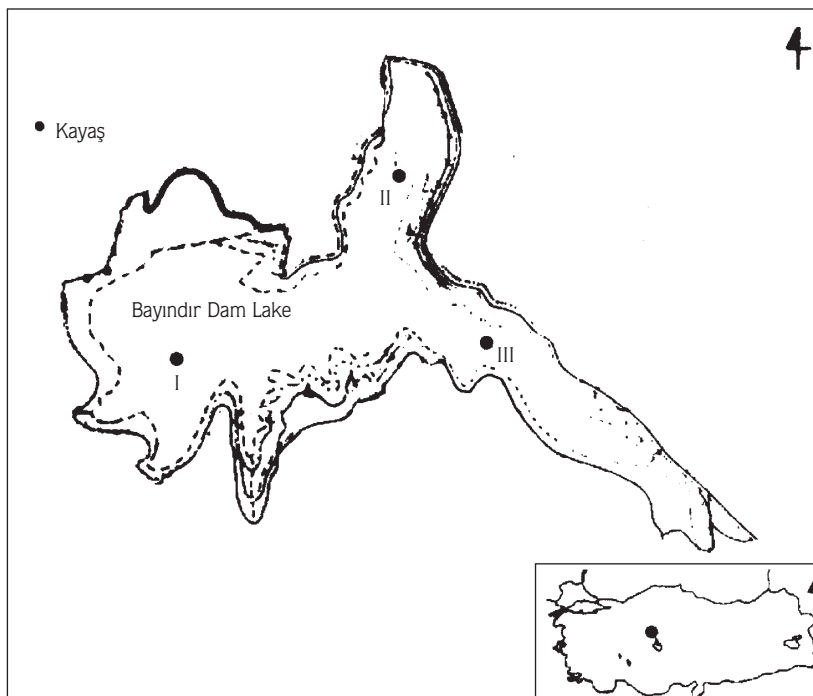


Figure 1. The location of Bayındır Dam Lake and sampling sites.

Table 1. The age and sex ratio of the tench from Bayındır Dam Lake.

Age Groups	Females		Males		Females + Males	
	N	%	N	%	N	%
I	15	30.61	18	35.29	33	65.9
II	16	32.65	8	15.69	24	48.34
III	11	22.45	10	19.61	21	42.06
IV	5	10.2	10	17.65	14	27.85
V	2	4.09	6	11.76	8	15.85
Total	49	100	51	100	100	100

Bertalanffy growth equation using age-length relationship growth parameters according to sex and the theoretical length of the specimen (Table 2). The average fork length of the age groups and the relative annual increase in length of females, males and combined sexes are given in Table 3. The proportional growth in both sexes and the age-length relationship curves are shown in Fig. 2.

Age-weight relationship

The growth (age-weight) parameters and equations of females and males were obtained in weight both theoretically and empirically for females, males and both combined in the different age groups. The relative annual increase and the age-weight relationship of fish examined are shown in Table 4 and the age-weight relationship of *T. tinca* is plotted in Fig. 3.

Length-weight relationship

The length of an individual whose weight is known and the weight of an individual whose length is known were calculated with the logarithmic length-weight relationship using the regression coefficient of length and weight ($W = aL^b$). The length-weight relationship curve is depicted in Fig. 4.

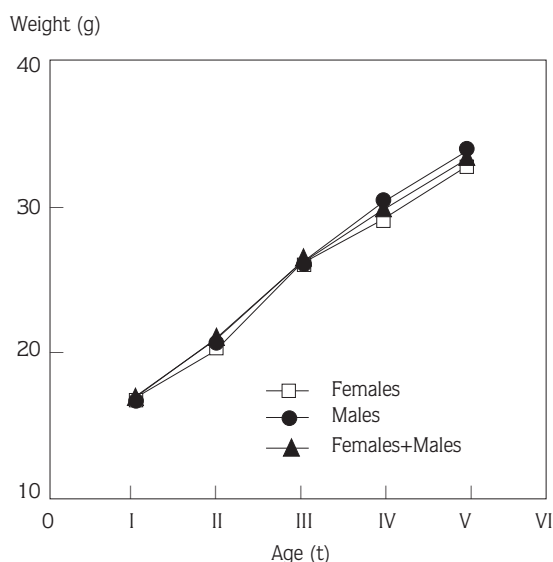


Figure 2. The curves of the age-length relationship of males and females, together and separately for *T. tinca* samples.

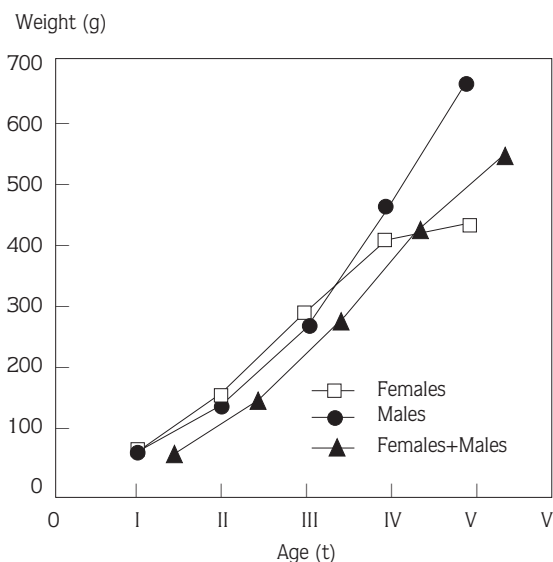


Figure 3. The curves of the age-weight relationship of males and females, together and separately for *T. tinca* samples.

Sex	Growth Parameters			Growth Equations
	L_{∞}	k	t_0	
Females	39.87	0.31483	-0.79751	$L_t = 39.87(1 - e^{-0.31483(t + 0.79)})$
Males	36.93	0.37399	-0.53242	$L_t = 36.93(1 - e^{-0.37399(t + 0.5324)})$
Both Combined	38.46	0.33505	-0.60690	$L_t = 38.46(1 - e^{-0.33505(t + 0.60690)})$

Table 2. Von Bertalanffy growth parameters and equations of the tench from Bayındır Dam Lake.

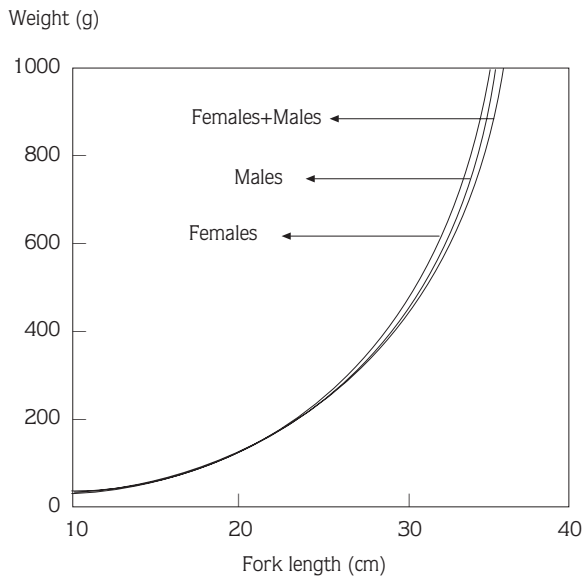


Figure 4. The curves of the length-weight relationship of *T. tinca* in Bayındır Dam Lake.

Condition factor

The condition factor of *T. tinca* was 1.57 for females, 1.53 for males and 1.55 for both combined. Condition values showed a gradual increase with length. Condition values of tench in relation to their age are given in Table 5.

Discussion

The age distribution of the tench population in Bayındır Dam Lake ranged between I and V age groups (49.0% females and 51.0% males: 0.96:1.00). In Kesikköprü Dam Lake, the age distribution between the same age groups was 51.43% for females and 48.57% for males (1:0.94), and the population density was high in age group IV (28.57 %) (10). In Bayındır Dam Lake it was high in age groups I and II (33% and 24% respectively; total 57%), (Table 1). In Işıklı Lake, most of the age variation was observed between age groups I and V i.e. 8.34% for females and 61.66% for males (1:1.16). High individual numbers were observed in age group I (55.93%) and II (33.2%) (11). In Vegoritıs Lake, high individual numbers in the tench population have been reported in age group III (18). The values obtained in the present study are similar to those of Işıklı Lake. However, the difference from those of Kesikköprü Dam Lake and Vegoritıs Lake may be attributed to the use of various nets of different mesh sizes, natural interspecific competition in the tench population and changes in the hunting load. Length distribution in the *T. tinca* population in Bayındır Dam Lake was 15.7-34 cm and 15.2-33.2 cm for females and males respectively. The length group that contained the most fish (43%) was the 15-21 cm group.

In Kesikköprü Dam Lake the length distribution in the

Table 3. The average fork length (cm) of the age groups and the relative annual increase in length of the tench from Bayındır Dam Lake.

Age Groups	N F:M	Female		Male		N F + M	Female + Male		T Test
		L (cm)	RFL (%)	L (cm)	RFL (%)		L (cm)	RFL (%)	
		Mean ± SD	(%)	Mean ± SD	(%)		Mean ± SD	(%)	
I	15:18	16.42 ± 0.63 (15-17)	0.302	16.61 ± 0.62 (15-17)	0.255	33	16.52 ± 0.62 (15-17)	0.278	P ≥ 0.05
II	16:8	21.38 ± 1.93 (18-23)	0.214	20.85 ± 2.36 (18-23)	0.258	24	21.12 ± 2.15 (18-23)	0.238	P ≥ 0.05
III	11:10	25.95 ± 0.87 (24-27)	0.125	26.23 ± 1.13 (24-27)	0.157	21	26.14 ± 1.0 (24-27)	0.139	P ≥ 0.05
IV	5:9	29.20 ± 2.46 (27-33)	0.127	30.34 ± 1.77 (28-34)	0.114	14	29.77 ± 2.12 (27-34)	0.120	P ≥ 0.05
V	2:6	32.90 ± 1.43 (30-34)	—	33.80 ± 1.27 (28-34)	—	8	33.35 ± 1.35 (28-34)	—	P ≥ 0.05

Table 4. The average weight (g) of different age groups and the relative annual increase in weight of the tench from Bayındır Dam Lake.

Age Groups	N F:M	Female		Male		Female + Male		t Test
		Mean ± SD	RW (%)	Mean ± SD	RW (%)	Mean ± SD	RW (%)	
I	15:18	66.79 ± 8.85 (51-77)	1.35	66.37 ± 9.88 (53-85)	1.21	66.58 ± 9.37 (51-85)	1.28	P ≥ 0.05
II	16:8	157.24 ± 47.58 (87-259)	0.86	147.3 ± 54.91 (76-242)	0.88	152.27 ± 51.25 (86-242)	0.87	P ≥ 0.05
III	11:10	293.53 ± 34.86 (290-343)	0.40	278.31 ± 43.05 (207-335)	0.65	285.92 ± 38.96 (207-343)	0.52	P ≥ 0.05
IV	5:9	412.58 ± 136.59 (329-651)	0.05	460.56 ± 102.47 (372-473)	0.43	436.57 ± 119.53 (328-650)	0.25	P ≥ 0.05
V	2:6	435.60 ± 260.40 (435-460)	—	659.55 ± 230.58 (497-823)	—	547.58 ± 245.49 (435-823)	—	P ≤ 0.05

Table 5. Relative Condition Indexes of the different age groups of the tench from the Bayındır Dam Lake.

Age Groups	N	Female Female:Male	Male Mean ± SD	Combined sex Mean ± SD	t Test Mean ± SD
I	15:18	1.51 ± 0.14 (1.36-1.78)	1.45 ± 0.29 (1.13-1.71)	1.48 ± 0.22 (1.13-1.78)	P ≥ 0.05
II	16:8	1.57 ± 0.15 (1.29-1.81)	1.56 ± 0.17 (1.26-1.80)	1.57 ± 0.16 (1.26-1.81)	P ≥ 0.05
III	11:10	1.6741 ± 0.09 (1.60-1.85)	1.53 ± 0.12 (1.31-1.70)	1.60 ± 0.11 (1.31-1.85)	P ≥ 0.05
IV	15:9	1.61 ± 0.14 (1.39-1.78)	1.63 ± 0.15 (1.41-1.88)	1.62 ± 0.15 (1.39-1.88)	P ≥ 0.05
V	2:6	1.57 ± 0.52 (1.22-1.79)	1.68 ± 0.40 (1.39-1.96)	1.63 ± 0.46 (1.22-1.97)	P ≥ 0.05

tench population has been reported to be 16.1-41.4 cm and 15.8-40.3 cm for females and males respectively (10). In Işıklı Lake most common length group in fork length was 12-17 cm (for all specimens 11.4-28.8 cm) (11). In Vegoritıs Lake, it was 17.2-36 cm as total length (17). The differences in length distribution in these studies may be due to the use of different nets of different mesh sizes.

In Bayındır Dam Lake, the maximum fork length of females and males in the tench population was 39.87 and 36.93 cm respectively. In Kesikköprü Dam Lake it was 41.76 and 36.97 cm for females and males respectively (10). In Işıklı Lake it was 33.85 cm (11).

In Bayındır Dam Lake the weight in total of the specimens examined was 51.4-650.79 and 52.8-822.6 g for females and males respectively. In Kesikköprü, it was 85-1350 and 83-1127 g for females and males respectively (10), and in Işıklı Lake the weight distribution was 33.9-152.3 g (11). The reason for the variations in weight may be the same, the use of nets of different mesh sizes.

The maximum weight in total of the tench population in Bayındır Dam Lake for females and males was 1073.82 and 929.08 g respectively. In Kesikköprü Dam Lake it was 1397.47 g for females and 957 g for males, and in Işıklı Lake it was 732.18 g for both sexes combined.

The length-weight relationship in fish may change with age, season, nutrition, sexual maturity and species (16,18). The length-weight relationship of tench in Bayındır Dam Lake for females, males and both combined was recorded by $\text{LogW} = -1.9142 + 3.0819 \text{ LogL}$ ($r^2 = 0.966$); $\text{LogW} = -2.1074 + 3.2151 \text{ LogL}$ ($r^2 = 0.961$) and $\text{LogW} = -2.0307 + 3.17471 \text{ LogL}$ ($r^2 = 0.971$) respectively. In Kesikköprü, it was $\text{LogW} = -3.9315 + 3.2470 \text{ LogL}$; $\text{LogW} = -2.294 + 3.0358 \text{ LogL}$ and $\text{LogW} = -2.0343 + 3.1743 \text{ LogL}$ for females, males and both combined respectively (10). In Işıklı Lake this relationship was $\text{LogW} = -1.7447 + 3.01 \text{ LogL}$ for both sexes combined (11).

The length-weight relationship in the tench population in Bayındır Dam Lake show a regression coefficient ("a,b" values) of growth type in fish. It was 3.089, 3.2151 and 3.1747 for females, males and both combined respectively. In Kesikköprü, these values for females, males and both combined were 3.247, 3.0358 and 3.1743 respectively and in Işıklı Lake, it was 3.01 (10,11). These values reveal that the regression coefficient varies between 3.01 and 3.17.

The age-length values of the *T. tinca* population in Bayındır Dam Lake in relation to each age group were 16.42 cm for age group I, 21.38 cm for age group II, 25.95 cm for age group III, 29.2 cm for age group IV and 32.9 cm for age group V for females and 16.61 cm for age group I, 20.85 cm for age group II, 26.23 cm for age group III, 30.34 for age group IV and 33.8 cm for age group V for males. In Kesikköprü Dam Lake, these values were 16.4 cm for age group I, 22.93 cm for age group II, 25.98 cm for age group III, 29.73 cm for age group IV, 31.41 cm for age group V and 35.14 cm for age group VI for females, and 15.8 cm for age group I, 23.23 cm for age group II, 26.2 cm for age group III, 28.35 cm for age group IV, 31.83 cm for age group V and 34.11 cm for age group VI for males (10). In Işıklı Lake, they were 14.09 cm for age group I, 18.6 cm for age group II, 22.63 cm for age group III, 26.08 cm for age group IV and 27.4 cm for age group V (11). In Vegoritis Lake, age-length values in total length were 17.2 cm for age group II, 19.5 cm for age group III, 23.1 cm for age group IV, 25.8 cm for age group V, 30.1 cm for age group VI and 36 cm for age group VII (17). In Dgal Wielki Lake, Pimpicka and Piros (8) found age-length values in standard length for females of 5.5 cm for age group I, 8.78 cm for age group II, 12.05 cm for age group III and

18.03 cm for age group IV. Differences in length in relation to age may be attributed to temperature variations affecting fish growth, different latitudes of the study areas and different ecological conditions of the lake studied.

The age-weight values of the tench population in Bayındır Dam Lake in relation to each age group were 66.79 g for age group I, 157.24 g for age group II, 293.53 g for age group III, 412.58 g for age group IV and 435.6 g for age group V for females and 66.37 g for age group I, 147.3 g for age group II, 278.31 g for age group III, 460.56 g for age group IV and 659.55 g for age group V for males. The same values for tench in Kesikköprü Dam Lake were 86 g for age group I, 186 g for age group II, 360.4 g for age group III, 535.8 g for age group IV, 648.72 g for age group V and 890.5 g for age group VI for females, and 83 g for age group I, 246.5 g for age group II, 308.57 g for age group III, 421.5 g for age group IV, 647.78 g for age group V and 762.86 g for age group VI for males (10). In Işıklı Lake age-weight values for the tench population were 53.8 g for age group I, 127.08 g for age group II, 229.27 g for age group III, 330.07 g for age group IV and 355.8 g for age group V (11). These values reveal that weight values of fish in relation to age are highest in Kesikköprü Dam Lake and lowest in Işıklı Lake, indicating that tench population in Kesikköprü was well fed when compared to Bayındır Dam Lake and Işıklı Lake.

The condition factor of the fish population shows changes with gonadal development, age, seasonal changes in growth and net mesh size (14,16).

The condition factor of tench population in Bayındır Dam Lake was 1.57, 1.53 and 1.55 for females, males and both combined respectively. In Kesikköprü Dam Lake, the condition factor for females, males and both sexes combined was 1.99, 1.92 and 1.95 respectively (10). Compared with these values, the condition factor of the tench population of Bayındır Dam Lake is low. This decrease in the condition factor may be attributed to the decreased food abundance, different mesh sizes of the nets used and the high population density of tench in the lake. Condition values of tench in relation to their age are given in Table 5. The lowest condition values for females (1.2232) was found in age group V and the highest (1.6741) in age group III. In males the lowest (1.4519) was observed in age group I and the highest (1.6815) in age group V. In both sexes, the condition coefficient

shows an increase during the early years of life and it decreases after sexual maturity. Pimicka and Piros (8) found the highest condition coefficient in tench females in age group III in Dgal Wielki Lake.

In conclusion, tench are found in several natural and dam lakes in Turkey. Although it is not an economically

important fish, it may be consumed as an alternative in the future when stocks of economically important fish decrease. In addition, these fish may also be used to clean carp pools and in the mineralization process. The present study provides basic information about the growth and population structure of tench in Bayındır Dam Lake.

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