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The Feeding Features of The Pike-perch (*Stizostedion lucioperca*) Population in Lake Beyşehir

İsmet BALIK

Eğirdir Fisheries Research Institute, Eğirdir, Isparta-TURKEY

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Abstract: The stomach contents of pike-perch (*Stizostedion lucioperca*) in Lake Beyşehir were investigated. The stomachs of 474 pike-perch were studied between March 1995 and February 1996.

76.6% of specimens had full and 23.4% had empty stomachs. The contents of the stomachs consisted of *Gammarus sp.* (77.5%), *Mysis sp.* (14.7%), Chironomidae (4.3%), pike-perch (2.7%) and others (0.8%). Around 20.9% cannibalism was estimated and it was widespread among individuals with a length of 11–60 cm. In addition, it appears that pike-perch can consume fellow specimens with a mean size of 35.9% of its length.

Key Words: Pike-perch, *Stizostedion lucioperca*, stomach content, cannibalism, Lake Beyşehir.

Beyşehir Gölündeki Sudak (*Stizostedion lucioperca*) Populasyonunun Beslenme Özellikleri

Özet: Bu araştırmada, Beyşehir Gölü sudaklarının (*Stizostedion lucioperca*) mide içerikleri incelendi. Mart 1995–Şubat 1996 tarihleri arasında 474 adet sudağın midesi alındı.

Sudak midelerinin % 76.6'sının dolu, % 23.4'ünün boş olduğu saptandı. Dolu mide içeriklerini *Grammarus sp.* (% 77.5), *Mysis sp.* (% 14.7), Chironomidae (% 4.3), sudak (% 2.7) ve diğerleri (% 0.8) oluşturmuştur. 11–60 cm arası boylardaki sudaklar arasında % 20.9 oranında kanibalizm görülmüştür. Ayrıca, sudakların boylarının ortalama % 35.9'u kadar olan kendi türünün bireylerini yutabildikleri tesbit edilmiştir.

Anahtar Sözcükler: Sudak, *Stizostedion lucioperca*, mide içeriği, kanibalizm, Beyşehir Gölü.

Introduction

The pike-perch is a species of European origin. In Turkey, there are natural stocks in Bafra lagoons, and Lakes Çekmece and Terkos in Marmara region. Pike-perch were first introduced into Lake Eğirdir and Mermere (Ahmetli) in Turkey (1). This species was introduced into Lake Beyşehir from Eğirdir Lake in 1978 and 1980. When the pike-perch were introduced, there were 8 species in Lake Beyşehir, namely *Cyprinus carpio*, *Leuciscus lepidus*, *Chondrostoma regium*, *Capoeta pestai*, *Alburnus akili*, *Acanthorutilus anatolicus*, *Gobio gobio*, *Gobitis bilseli* and crayfish *Astacus leptodactylus* (2). *Tinca tinca* was introduced into Lake Beyşehir a few years ago (3). However, only 3 of the original 8 fish species were found in the lake during this study, namely *Cyprinus carpio*, *Leuciscus lepidus* and *Chondrostoma regium*. In Turkey, in different habitats some features of the pike-perch have been investigated by different researchers, such as Karabatak (4) in Hirfanlı Dam, Erdem et al. (5) in Lake Beyşehir, İkiz (6) in Mamasın Dam, and Aral and Büyükhatipoğlu (7) in Bafra Lagoons.

However few studies have been carried out on the diet of pike-perch. For example, the feeding features of pike-perch were investigated in Lake Eğirdir by Campbell (8) and Becer and İkiz (9) and in Demirköprü Dam by Sarı (10). A similar study on the pike-perch of Lake Beyşehir will help us to understand the temporal and spatial changes in the feeding habits of this species. Therefore the stomach contents of pike-perch were investigated.

Materials and Method

This study was carried out in Lake Beyşehir between March 1995 and February 1996. Monthly samples were taken with gill nets with different mesh sizes. A total of 474 pike-perch were sampled.

Fork lengths of individual fish were measured to the nearest 0.1 cm and then the stomach of each fish was preserved separately in 4% formalin for later identification in the laboratory (11). After the contents of the stomachs were analyzed, prey materials were separated into groups and counted. The length of preys

in the stomachs were measured with a ruler. The diet of pike-perch was classified according to length.

Results

The diet of the pike-perch population

The stomachs of 131 specimens were completely empty and 363 of them were full with varying ratios. The number of specimens with full stomachs were highest in winter (86% of the total samples) followed by spring (82.9%), summer (70.9%) and autumn (49.6%) (Table 1).

Table 1. Seasonal variations in stomach fullness of pike-perch.

Seasons	Full		Empty	
	N	N%	N	N%
Spring	92	82.9	19	17.1
Summer	90	70.9	37	29.1
Autumn	57	49.6	58	50.4
Winter	104	86.0	17	14.0
Total	363	76.6	131	23.4

Although the sampling was conducted monthly, the data were evaluated seasonally. According to these observations, in spring especially individuals between 11

and 30 cm length consumed mainly the *Grammarus sp.* Another prey for this size class was young pike-perch. In summer, *Mysis sp.*, was added to former food organisms. In autumn, the importance of *Grammarus sp.* was lower in the diet of pike-perch, while in winter once again *Gammarus sp.* was the main prey organism and the importance of *Mysis sp.* decreased (Table 2 and Figure 1).

Irrespective of season, the most important food organism for the size class of between 11–20 cm appeared to be *Gammarus sp.* (71.1%), followed by *Mysis sp.* (23.9%) and Chirinomids (3.6%) (Table 3). Cannibalism starts at the size of 11–20 cm (Figure 2) and the most important food item of the 31–40 cm size class was young pike-perch.

When the overall data are combined, the most important food items for the pike-perch population of Lake Beyşehir are *Gammarus sp.* (77.5%), *Mysis sp.* (14.7%), Chirinomids (4.3%), fellow specimens (2.7%) and others (0.8%).

Cannibalism

The rate of cannibalism in the population of pike-perch may vary depending upon the feeding problems in their habitats. The cannibalism rate in this study was found to be quite high. Cannibalism was relatively high among the individuals larger than 11 cm and it increased gradually with fish size (Table 4).

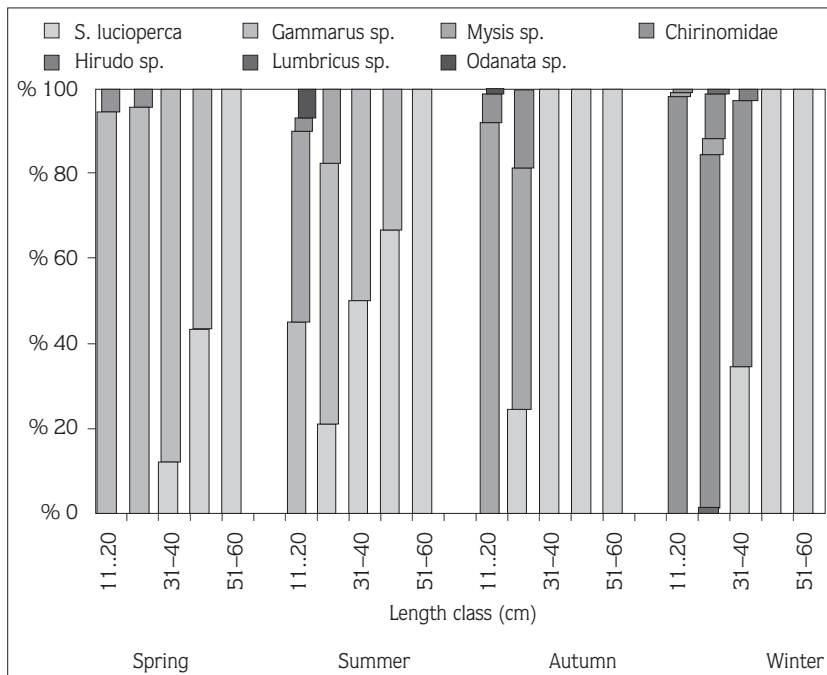


Figure 1. Seasonal variations in occurrence of various food items in the stomach of the pike-perch.

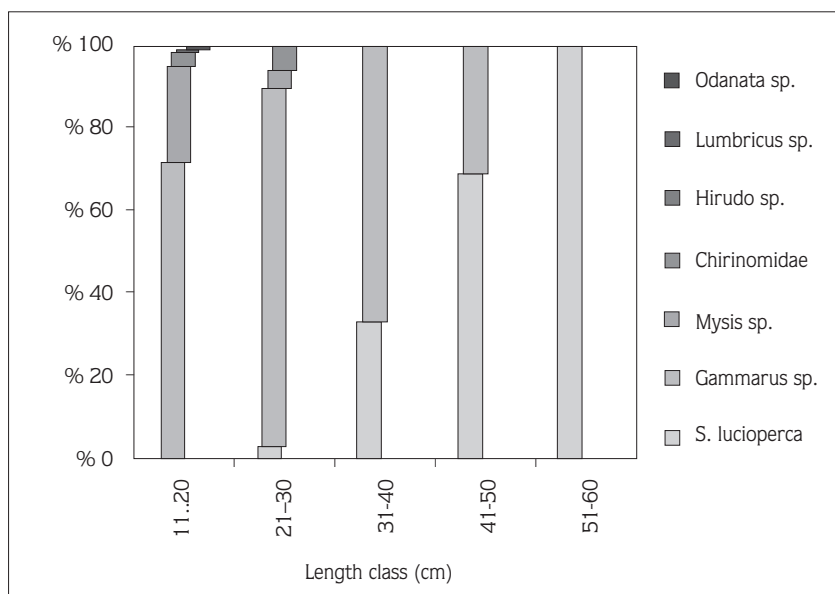


Figure 2. The variations of food items for various size classes of pike-perch.

Table 2. Seasonal variations in stomach contents of various size classes of pike-perch. [N: The number of fish sampled, (): The number of stomachs with prey organism].

	Length class (cm)	N	<i>Gammarus sp.</i>	<i>Mysis sp.</i>	Chironomidae	<i>Odonata sp.</i>	<i>Hirudo sp.</i>	<i>Lumbricus sp.</i>	<i>S. lucioperca</i>
Spring	11-20	41	656(29)	1(1)	43(11)	–	–	–	1(1)
	21-30	50	1346(39)	19(5)	45(4)	–	–	–	7(6)
	31-40	10	58(1)	–	–	–	–	–	9(6)
	41-50	8	4(2)	–	–	–	–	–	6(5)
	51-60	2	–	–	–	–	–	–	2(2)
Summer	11-20	65	288(25)	365(26)	20(3)	23(10)	6(2)	–	–
	21-30	38	117(12)	33(2)	–	1(1)	–	–	41(13)
	31-40	15	7(1)	–	–	–	–	–	7(6)
	41-50	8	6(2)	–	–	–	–	–	12(5)
	51-60	1	–	–	–	–	–	–	1(1)
Autumn	11-20	53	2(2)	342(13)	25(8)	–	6(4)	–	1(1)
	21-30	23	–	21(1)	6(1)	–	–	–	9(9)
	31-40	28	–	–	–	–	–	–	16(16)
	41-50	9	–	–	–	–	–	–	5(5)
	51-60	2	–	–	–	–	–	–	1(1)
Winter	11-20	56	1193(50)	11(1)	22(4)	–	2(2)	–	1(1)
	21-30	45	613(28)	27(7)	78(4)	–	1(1)	4(1)	7(6)
	31-40	15	24(1)	–	–	–	–	–	13(11)
	41-50	3	–	–	–	–	–	–	5(3)
	51-60	2	–	–	–	–	–	–	3(1)

Table 3. Size dependant distribution of the number of food groups in the stomachs of pike-perch [n: The number of food items, (): The number of stomachs having prey organism].

Length class (cm)		<i>Gammarus sp.</i>	<i>Mysis sp.</i>	Chirino- midae	<i>Odonata sp.</i>	<i>Hirudo sp.</i>	<i>Lumbricus sp.</i>	<i>S. lucioperca</i>
11-20	n	2139(106)	719(41)	110(26)	23(10)	14(8)	0	3(3)
	%	71.1	23.9	3.6	0.8	0.5	0	0.0
21-30	n	2076(79)	100(39)	129(9)	1(1)	1(1)	4(1)	64(34)
	%	87.4	4.2	5.4	0.0	0.0	0.2	2.7
31-40	n	89(3)	-	-	-	-	-	45(39)
	%	66.4	-	-	-	-	-	33.6
41-50	n	10(4)	-	-	-	-	-	28(18)
	%	26.3	-	-	-	-	-	73.7
41-50	n	-	-	-	-	-	-	9(5)
	%	-	-	-	-	-	-	1000
Total	n	4314(192)	819(80)	239(35)	24(11)	15(9)	4(1)	149(99)
	%	77.5	14.7	4.3	0.4	0.3	0.1	2.7

Table 4. The number of stomachs of pike-perch investigated according to size class of pike-perch and the number of prey fish (pike-perch) in their stomach content. [N: The number of stomachs. (): The number of stomach content prey fish (pike-perch)].

Length class (cm)	N	The number of prey fish in stomach	The percentage of cannibalism
11-20	215	3(3)	1.4
21-30	156	64(34)	21.8
31-40	68	45(39)	57.4
41-50	28	28(18)	64.3
51-60	7	7(5)	71.4
Total	474	147(99)	20.9

The size of the prey fish increased gradually with the size of predator individuals. The average prey length consumed by pike-perch between 21 and 30 cm was

estimated as 36.8% of the predator length. This proportion was 31.6% for 31-40 cm, 33.4% for 41-50 cm and 37.9% for 51-60 cm size classes (Table 5). In general, the mean prey size consumed by pike-perch was found to be 35.9% of the predator length.

Discussion

It was found that 76.6% of specimens had full and 23.4% had empty stomachs. The content of the stomachs consisted of *Gammarus sp.* (77.5%), *Mysis sp.* (14.7%), Chirinomids (4.3%), *Odanata sp.* (0.4%), *Hirudo sp.* (0.3%), *Lumbricus sp.* (0.1%) and prey fish (pike-perch) (2.7%).

According to Becer and İkiz (9), 46% of the pike-perch samples in Lake Eğirdir had empty and 54% had full stomachs. The main food items for this pike-perch stock were *Gammarus sp.* (45.86%), *Mysis sp.* (23.13%) and *Asellus sp.* (15.24%). In the same lake

Table 5. The average size (L) of prey and predator pike-perch with their rational length relations ((B/A).100) and standard errors (SE). [A: length of predator pike-perch, B: length of prey pike-perch and (): minimum and maximum (B/A.100)].

Length class (cm)	N	L (cm) ± SE of pike-perch		(B/A).100
		predator	prey	
11-20	1	17.1	15.5	90.6
21-30	25	26.3±0.6	9.7±0.8	36.8±2.7 (13.3-72.3)
31-40	18	35.8±0.7	11.4±1.0	31.6±2.7 (14.9-55.6)
41-50	5	46.4±1.2	15.6±1.5	33.4±2.6 (26.9-40.6)
51-60	3	56.3±2.7	22.7±3.9	37.9±5.3 (29.4-46.1)
Mean		33.1±1.3	11.7±0.7	35.9±2.0 (13.3-90.6)

according to Campbell (8), pike-perch eat Mysids, Chironomids, Gammarids, Isopods and fish species. Sarı (10) found Chironomid larvae and pupa (65.56%), fishes (24.06%), Gammarids (8.89%) and other insect groups (1.50%) in the stomachs of the pike-perch in Demirköprü Dam.

The main food items of the pike-perch population in spring were *Gammarus sp.* and the prey fish (small pike-perch). The food items were similar in summer, namely *Gammarus sp.*, *Mysis sp.* and prey fish. *Gammarus sp.*, which was the main food of pike-perch in spring and summer, was less important in autumn. The popular food organisms for pike-perch in this period

were *Mysis sp.*, Chironomids and prey fish. In winter, the importance of *Gammarus sp.* as a food item increased again together with *Mysis sp.*, Chironomids and prey fish, respectively.

Finally, this study has shown that the popular food items of pike-perch smaller than 30 cm were *Gammarus sp.* and *Mysis sp.* The food item for individuals larger than 30 cm were mainly prey fish (pike-perch).

In Lake Beyşehir, cannibalism among pike-perch was found to be 1.4% for 11-20 cm, 21.8% for 21-30 cm, 57.4% for 31-40 cm, 64.3% for 41-50 cm and 71.4% for 51-60 cm length classes. The average cannibalism of the pike-perch population was determined to be 20.9%. Campbell (8) found the cannibalism rate to be 96% for pike-perch in Lake Eğirdir. In the Netherlands, in Lake IJssel Willemsen (12) reported a 0.14% cannibalism rate for pike-perch. The same author reported a cannibalism rate of 4% for pike-perch in Veluwemeer.

The pike-perch in an ambush-pursuit predator that feeds at low light densities or at night (13). The maximum prey length consumed by pike-perch is nearly 50% of the predator length (12, 14-16). In this study, mean prey length consumed by pike-perch was estimated to be 35.9% of the pike-perch in Lake Beyşehir. The maximum proportion was 55% in Lake Beyşehir, but in Lake IJssel the size of the prey in relation to that of the predator was lower for pike-perch within the length range 11-70 cm from 45 to 15% (12).

It can be concluded that food items of the pike-perch population in Lake Beyşehir are invertebrates. There appears to be intensive cannibalism among the pike-perch. The level of cannibalism should be decreased. Therefore, new prey fish species for pike-perch feeding should be introduced into Lake Beyşehir.

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