Ivestigations on the fishing of the exotic Pacific mullet *(Mugil so-iuy)* caught on the Black Sea Coast

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Abstract Pacific mullet (*Mugil so-iuy*), an egzotic species of the Black Sea, start to appear in the Black Sea Turkish coastline in May, when the sea temperature is around 16-17 °C. They yield a high catch during the period between May 15 and July 15. This is also the period during which egg-bearing fish draw closer to coastal waters and lay their eggs. These fish which come close to the coast at the start of reproduction are caught by fishermen using nets called “snail nets”. The catch per unit effort (CPUE) of these nets is 31.2±23.4 kg/boat/day. Immature fish accounted for 35.2% and 23.0% of the catch in 2002 and 2003, respectively.

Catching Pacific mullet, which is a species new to the ecosystem in the Black Sea,also exerts a heavy pressure on egg-bearing individuals due to the concentration of catching during the reproductive period of the species. This pressure should be relieved. The minimum fishing size of 35 cm stipulated for Pacific mullet by the Ministry conflicts with the size of first maturity of the species (40 cm). The minimum harvest length of this species should be increased to 45 cm and harvesting should be restricted to 15-20 days in the period between 1 and 30 June.

Introduction

Pacific mullet *(Mugil so-iuy*) named Russian mullet by Turkish fishermen live naturally in the Vladivostok region of Amour Basin. Mugil so-iuy is an euryhaline species and was introduced to Şabolat Lagoon in the north coast of the Black Sea, but acclimation of the species was unsuccessful and stock of Pacific mullet was exhausted in 1970 (Ünsal 1991). It is reported that the Pacific mullet, seen since 1990 in the Southern Black Sea, acclimated well to the Black Sea’s ecosystem and has created a dynamic stock (Okumuş and Başçınar 1997). The population showed high salinity tolerance and is fully adapted to fresh water which allows them to colonize extensive near-shore areas of the sea and to occupy specific ecological niches (Serkov 2004). They have migrated up to the Aegean Coast (Kaya *et al*. 1997). Instead of the decreased fish stocks in the Black Sea at the beginning of 1990s, the Pacific mullet gained important economic status and appeared in the catches of coastal fishermen more than expected (Zengin *et al*. 1998). Unsal (1992) and Kaya *et al*. (1997) reported a new occurrence of this species in the Black Sea. Okumuş and Başçınar (1997) studied the population structure, growth and reproduction of Pacific mullet captured at the south side of the Black Sea.

It is aimed to report the characteristics of the capture fisheries for Pacific mullet, which is caught during its reproductive stage and to suggest some measures for the protection

of the stocks despite being exotic to the Black Sea and the ecological interaction with native grey mullet species.

Material and methods

This research was implemented along the Trabzon coast when the Pacific mullet move to these coastal waters for reproduction between May and July (Okumuş & Başçınar 1997) in 2002 and 2003. The data about fish catches was from samples brought to the Trabzon Bazaar. An index of CPUE was used as an indicator of fishing intensity to show changes in yield as a result of the fishing efforts. The improving scale suggested by Holden and Raitt (1974) was taken as a reference (Phiri and Sharikihara 1999) for this aim. The length at first sexual maturity was obtained by using the lengths of individuals at the immature stage (stages of I and II) and the lengths of individuals at the mature stage (stages of III, IV and V) (Holden & Raitt 1974).

Results

Capture methods

Pacific mullet is seen along the Black Sea coasts of Turkey from the middle of May when the sea temperature is about 16-17 °C and the salinity is about 17-18‰ (Table 1). Generally, it has been observed that their optimum fishing time is between 15 May and 15 July. With the effect of water temperature it has been determined that the earliest fishing time is 7 May; the latest is 19 August. Wooden fishing vessels with lengths about 8.8 (6-12) m and motor powers about 59.4 (25-205) HP are used for Pacific mullet fishing. The plan of the design of gillnets used for Pacific mullet fishing and the situation of the net during the operation is shown in Figures 1 and 2, respectively. The capture operation is implemented three times (2-4) per day and one operation takes 4 or 5 hours.

Table 1. The months with intense catch of Pacific mullet along the coast of South Black Sea, and water temperatures during these months

Years	Starting of the fishing	Ending of the fishing	Catching time (days)	[1]Surface water temperature (°C)		
				May	June	July
[2]1997	19 May	1 July	42	22.3	23.7	26.1
[2]1998	12 May	26 June	44	16.9	22.3	24.5
[2]1999	20 May	15 June	35	18.1	25.5	25.0
[2]2000	13 May	15 June	32	15.2	20.5	23.8
[2]2001	20 May	15 June	25	15.3	19.3	25.3
[3]2002	31 May	12 July	43	13.8	19.8	25.1
[3]2003	25 May	27 June	32	15.1	20.8	22.8

1 From the records of Trabzon Central Fisheries Research Institute 2: data from Samsun Fish Bazaar 3: Data from this study

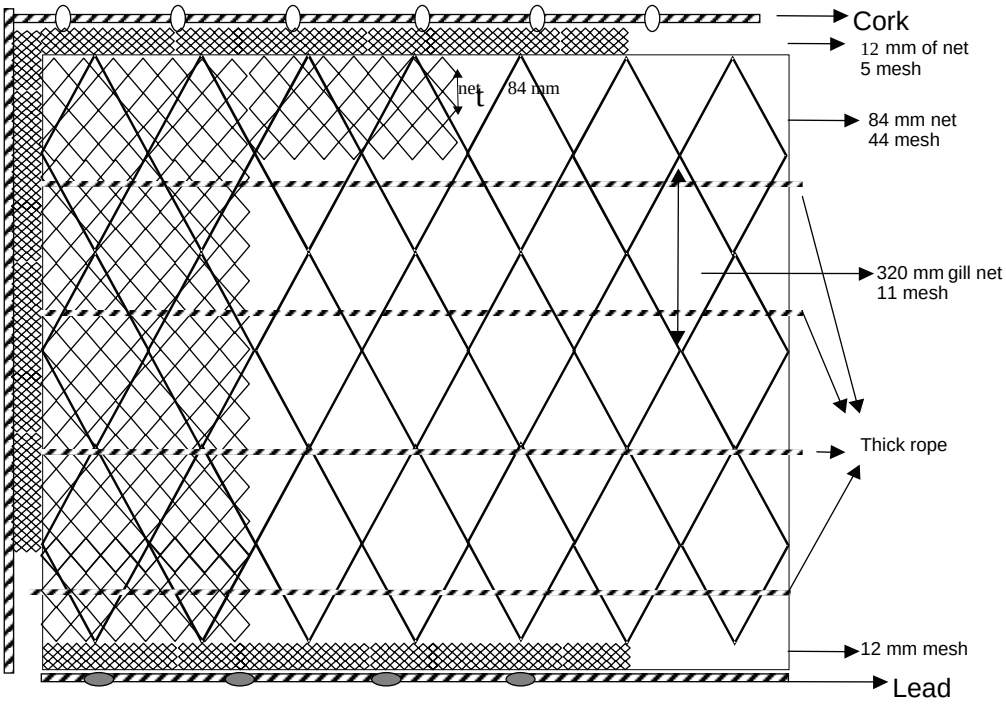

Figure 1. Design of a Pacific mullet net

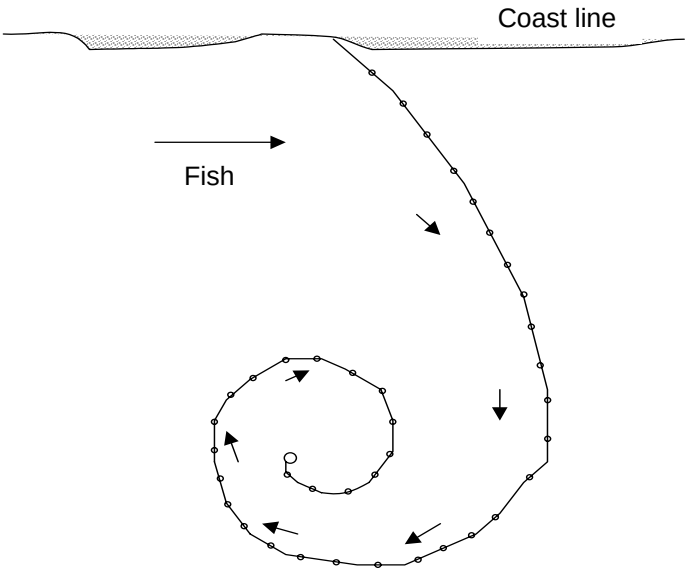

Figure 2. Position of a Pacific mullet net during the fishing operation

The properties of fishing

The catch per unit effort for Pacific mullet was assessed with (voli) nets during fishing in the May-July period. The catch per unit effort (CPUE) of these nets is 31.2±23.4 kg/boat/day, ranging between 1.5-875.0 kg/boat/day. The fishing amounts in unit power decreases at the beginning of the fishing period and reach the highest between 1-15 June and 15-30 June (Fig. 3). The distribution length-frequencies of the landed fish are

shown in Figure 4. The average total lengths of the population is 46.5 (SE = 0.58, *n* = 158) cm and 51.8 (SE = 0.67, *n* = 161) cm for two years.

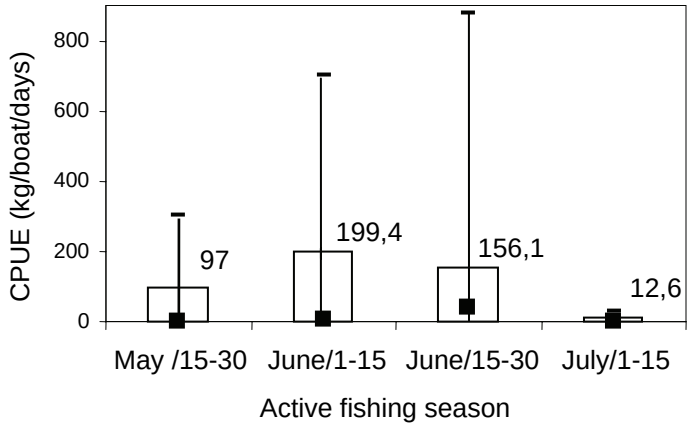

Figure 3. Minimum and maximum CPUE for the Pacific mullet 2002 – 2003

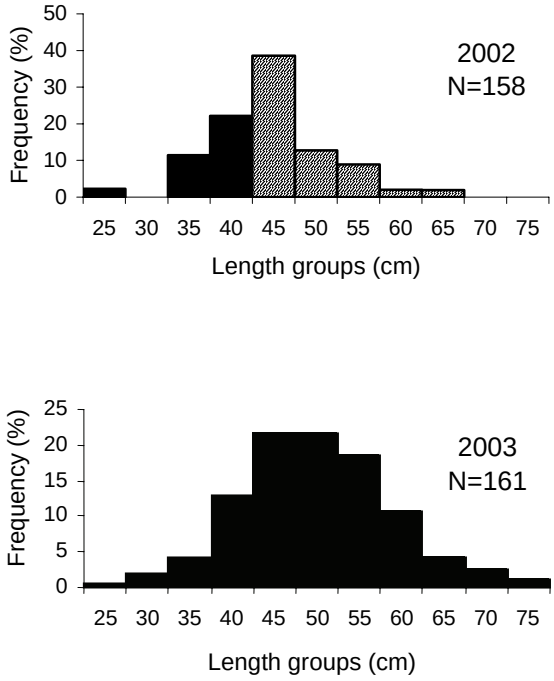

Figure 4. Length – frequency distribution Pacific mullet landed between 2002 – 2003 The distribution of length of all individuals (male and female) having a length of greater than 40 cm (hatched bars) is shown for 2002 (constituting the minimum first maturity length)

Length at the first maturity

In 2002 and 2003 35.9% and of 19.8%, respectively of individuals had not reached maturity. The proportion male and female individuals having not reached the first maturity was 28.9% and 19.8% in 2002, and 9.1% and 37.8% in 2003 (Fig. 5). In the

population of Pacific mullet, the length when 50% of fish reached first maturity (Lc) is 47.2 cm for the female individuals; 43.6 cm for a minimum length and 51.4 cm for a maximum length. For the male individuals Lc is 40.4 cm, 37.6 cm for a minimum length and a 43.6 cm for a maximum length (Fig. 6).

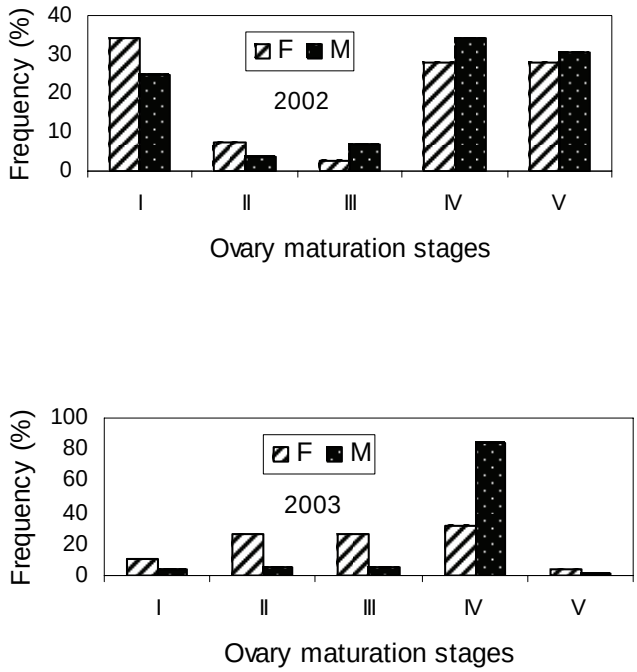

Figure 5. Development stages of Pacific mullet gonads during the capture periods

Discussion

Pacific mullet became important, entering the Black Sea and established itself among the native grey mullet species (*Mugil cephalus*, *Liza aurata* and *Liza saliens)* stocks (Zengin *et al.* 1998). Landings of grey mullet exhibit a decreasing trend, (Fig. 7) related by the arrival of Pacific mullet to the Black Sea. Pacific mullet reach a length of 60 cm in 5 years after hatching (Okumuş & Başpınar 1997). Possibly the only tool to reduce the interaction between Pacfic mullet and the local species is minimum catch size to control Pacific mullet stocks and held establish a balance between native mullet species.

There is no precise description of the distribution of Pacific mullet migration to date, but it is reported that the *Mugil so-iuy* winter on the Crimean coasts of the Northern Black Sea and usually under the ice in the gulfs connected to the sea (Shilyakhov & Charova 2003).

The fishing season for Pacific mullet is 25 days at minimum, 44 days at maximum and 36 days on average (Table 1). In this period fish approach the coastal waters until a depth of 3 – 3.5 m (Fig. 8). Fish catches reach their maximum level between 1 and 30 June (Fig. 3).

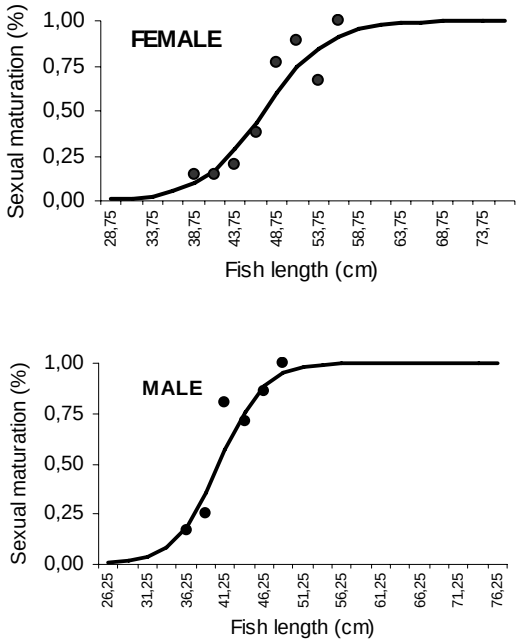

Figure 6. Size at first maturity for female and male Pacific mullet

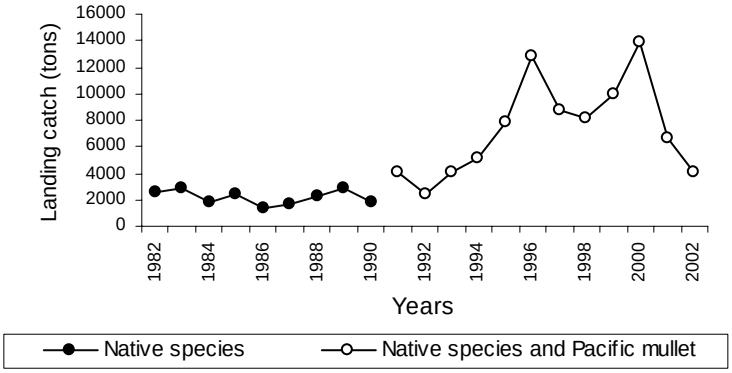

Figure 7. Grey mullet catches along the South Black Sea coasts.

The intensity of fishing of the Pacific mullet, completely in the reproductive period of the fish, forms an important fishing pressure on the reproductive female stock. Fish catches declined from 12-13 000 t in 2000 to 4000 t in 2001-2002 (Fig. 7). It is necessary to reduce this fishing pressure suggesting the minimum length restriction of 35 cm (total length) for the Pacific mullet is not sufficient, with regards either the reproduction biology or the stock management. The minimum sized at first maturity of the Pacific mullet population in the Northern Black Sea, is 37.6 cm for males and 43.6 cm for females, average for both is 40 cm (Fig. 6). Approximately 19.8% and 35.9% of the fish caught had not matured (Fig. 4). The percentage of the male and female individuals having not reached maturity in the period May-July was 35.2% and 23.5% respectively for the years of 2002 and 2003 (Fig. 5).

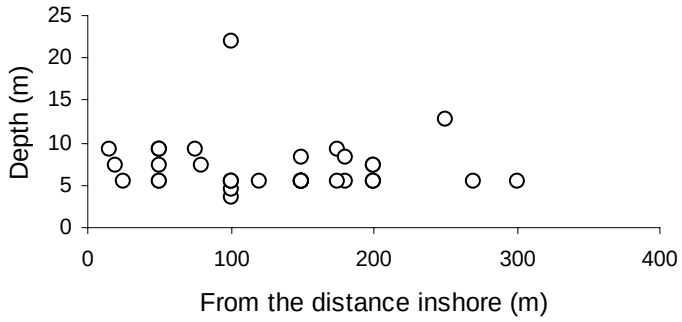

Figure 8. The distance and depth of fishing zone for the Pacific mullet

Fishing for Pacific mullet, a very new species for the Black Sea ecosystem, has to be re-examined, taking into consideration the population specifics of this species. Today's minimum fishing restriction length of 35 cm has to be modified to 45 cm. A minimum fishing restriction length of 38 cm (standard length) is applied in the Northern Black Sea coasts (Shilyakhov and Charova 2003). This minimum length restriction is not sufficient for the survival of the stock of this species. In addition the quantity of fish caught needs to be determined and declared each year.

Stock management strategy for fish caught during their reproduction period should be applied for Pacific mullet, for example using total allowable catch (TAC). The most suitable example to this application is *Arctoscopus japonicus* (Masuda *et al.* 1984; Zengin 2001). A similar monitoring programme can be applied for the capture of Pacific mullet in Turkey. In the long term, after having determined the quantity to be taken from the stock (TAC) each year (Van Beek *et al.* 1990) based on the landings (catch should be recorded separately from native species of the mullet), the fishing must be restricted to 15 - 20 days, between 1 and 30 June (Fig. 3), to ensure fishing is sustainable.

Although it has an omnivores, benthic organisms are the principal foods of the Pacific mullet. The species is an opportunist species (Zaitsev & Mamaev 1997) but also acts as a plankton consumer against organisms like *Mneoipsis leidy* and competes with sturgeons sharing the same habitat (Tsarin 1997). Thus it is necessary to research the feeding competition with the native mullet species and related species and its possible impact on survival of native grey mullet species.

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The effect of dissolved oxygen on sediment-water phosphorus exchange in Mogan Lake

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Abstract Aerobic and anaerobic phosphorus release from the sediment of shallow and eutrophic Mogan Lake was investigated in experiments. During the study period, water temperature was held stable at 20±1^{o}C in laboratory conditions, daily total soluble orthophosphate (SRP), dissolved oxygen and pH measurements were done. Phosphorus release from sediment was estimated by using the differences of daily SRP concentrations, sediment volume and the sediment surface area. In aerobic conditions, the concentration of SRP ranged between 4.21±0,20 mg m^{-3} and 7.94±0.25 mg m^{-3} and the estimated P flux changed from –0.087 μg $m^{-2}d^{-1}$ to 0.083 μg $m^{-2}d^{-1}$. In anaerobic conditions overlying water SRP concentration fluctuated between 6.19±0.18 mg m^{-3} and 19.60±0.29 mg m^{-3}, and sediment phosphorus release ranged between –0.048 μg $m^{-2}d^{-1}$ and 0.147 μg $m^{-2}d^{-1}$. In this study sediment phosphorus release in anaerobic conditions were found to be approximately two fold higher than under aerobic conditions and in the continuing eutrophication in Mogan Lake the drivingly factor was thought to be water chemistry.

Introduction

Eutrophication in the world is a major environmental issue. Of the key factors causing eutrophication phosphorus has been identified as the most crucial one. For this reason, in aquatic environments numerous mechanisms have been proposed to be responsible for the release of phosphorus from lake sediments into lake water. In these systems it is hard to monitor the release of phosphorus from sediments and the causal factors of phosphorus release in the long term. The factors causing the release were examined in a laboratory by Drake & Heaney (1987), Boers & Hese (1988) and Sinke *et al.* (1990). Phosphorus can be released from sediment under aerobic and anaerobic conditions. However, release of phosphorus into anaerobic lake water may be greater when compared with the release of phosphorus into aerobic lake water (Shaw & Prepas 1990; Nguyen *et al*. 1997).

In sediment phosphorus release mechanisms the most important causal factor is the dissolved oxygen concentration of the water. Absorption of phosphorus into ferric iron complexes prevented phosphorus release into aerobic lake water (Kleeberg & Schlungbaum 1993). Cerco (1989) investigated the effects of water temperature, dissolved oxygen and nutrient concentration on the exchange of nutrients in sediment-water interface in shallow and eutrophic Gunston Lake and determined that sediments tended to release phosphorus at low dissolved oxygen concentrations but no effect of temperature was apparent.

Phosphorus release from the peaty sediments of the shallow and eutrophic Loosdrecht Lakes (Netherlands) were studied in the laboratory in a continuous flow system. The highest release rates (up to 4 mg $m^{-2}d^{-1}$) were determined in August and the lowest (0.2 $mg.m^{-2}d^{-1}$) in winter. According to the researchers temperature was found to be the most impotent factor controlling release; only temperatures above 13°C allowed release in summer (Boers & Hese 1988). Sinke *et al*. (1990) calculated the phosphorus fluxes over the sediment-water interface using measured concentration gradients in the pore water of eutrophic Loosdrecht Lakes (Netherlands) and compared the fluxes with the measured phosphorus fluxes under laboratory conditions. It was demonstrated that phosphorus fluxes measured in laboratory were significantly correlated with the pore water characteristics.

This study aims to determine the effects of aerobic and anaerobic factors on the quantitative release of phosphorus level from littoral sediment of Mogan Lake into the overlying water. The research was carried out under standardized laboratory conditions.

Materials and methods

Sediment and water samples

Mogan Lake is located in the close vicinity of Ankara (20 km far from the city centre) which is a shallow (average depth ~ 2.8 m), eutrophic and alluvial lake with a total watershed area of 925 km^2 and volume of 10.20 million m^3. The whole area is internationally protected for its wetland habitat. The major sources that affect water quality and trophic status of the lake are mainly agricultural runoff, untreated or semi-treated domestic effluents and industrial wastewaters from marble plants located in the west side of the lake (Boşgelmez *et al.* 2005).

Sediment samples were collected at a selected station in the middle of the Mogan Lake's west side by using a plexiglass tube with 50 mm diameter and 20 cm height, and overlying water was taken above the sediment by siphoning in March 2005. Another study was conducted to find out the potential phosphorus release into Mogan Lake between July 2004 and June 2005. The amount of the released phosphorus and some physical characteristics of the overlying water are given in Table 1.

Table 1. Measured phosphorus release and some physical properties of the overlying water in Mogan Lake (Topçu 2006)

Date	Phosphorus release ($\mu g.m^{-2}d^{-1}$)	Water temperature(°C)	Dissolved oxygen($mg.L^{-1}$)	pH
July 2004	0.042	24.90±0.06	6.21±0.00	8.83±0.01
August 2004	0.032	25.60±0.07	6.15±0.00	7.83±0.00
September 2004	0.033	23.25±0.14	6.97±0.01	8.32±0.00
October 2004	0.018	18.25±0.14	6.20±0.00	8.51±0.00
November 2004	0.002	5.28±0.11	10.13±0.01	8.82±0.00
December 2004	0.020	5.48±0.05	9.33±0.00	8.88±0.00
January 2005	0.018	5.68±0.05	9.52±0.00	8.88±0.00
February 2005	0.009	6.90±0.04	8.98±0.01	8.71±0.00
March 2005	0.017	12.55±0.03	7.72±0.03	7.48±0.01
April 2005	0.044	15.54±0.02	7.83±0.01	8.03±0.01
May 2005	0.043	18.83±0.01	8.43±0.01	8.53±0.01
June 2005	0.062	22.42±0.01	8.86±0.01	8.78±0.01

Experimental study

Samples were analyzed in the laboratory without further treatment. In the laboratory, collected sediments were put into the aquaria and the overlying water was replaced very carefully in order not to disturb or resuspend any sediment. Sediment to overlying water was held at a proportion of 1/3. The experiment was conducted in an aerobic (DO_2>7 mg L^{-1}) and anaerobic conditions (DO_2 <1 mg L^{-1}) (Premazzi & Provini 1985; Ruban & Demare 1998; Temperate & Pedrozo 2000). During the 31-day experiment, water temperature was stable (20 ± 1^0C) and by measuring the overlying water's daily SRP concentrations, the effects of dissolved oxygen on phosphorus release was determined (Fig. 1).

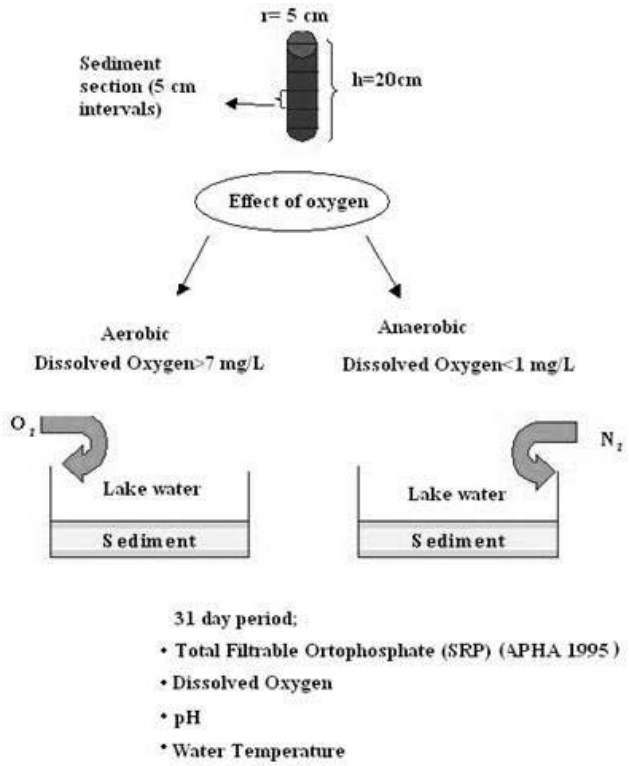

Figure 1. The experimental study design

Estimation of phosphorus flux at the sediment-water interface

Phosphate flux was measured in both aerobic and anaerobic conditions between 1 April and 1 May. Furthermore daily dissolved oxygen, pH and water temperature were measured. Phosphorus flux was calculated according to Ruban and Demare (1998) taking into account:

ΔC= the difference of SRP concentration

Δt = during the period considered

V = the volume of the lying sediment

S = the sediment surface area

Hence the flux (in $\mu g\ m^{-2}d^{-1}$)= ϕ

$\phi = \Delta c.V / \Delta t.S$

Results

Sediment phosphorus fluxes are reported as the average flux in replicate samples and are presented in Figures 2 and 3.

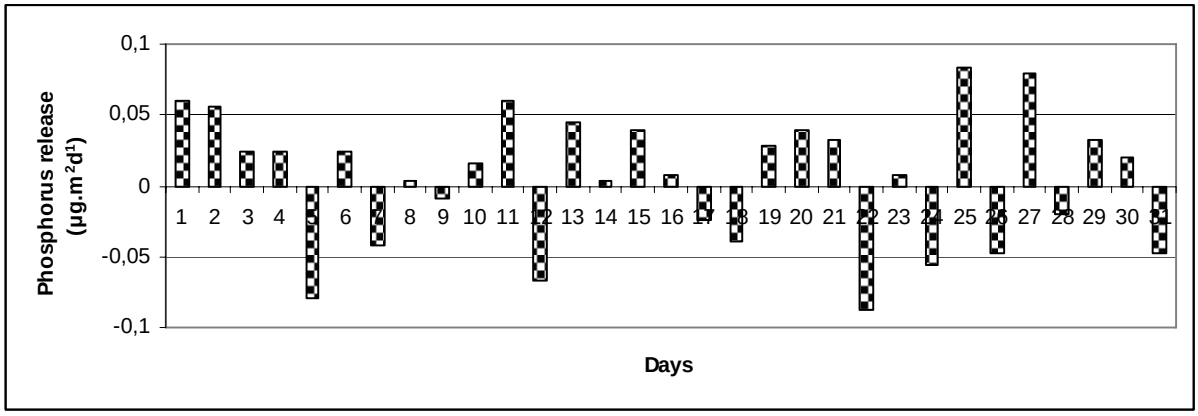

Figure 2. Measured aerobic phosphorus flux

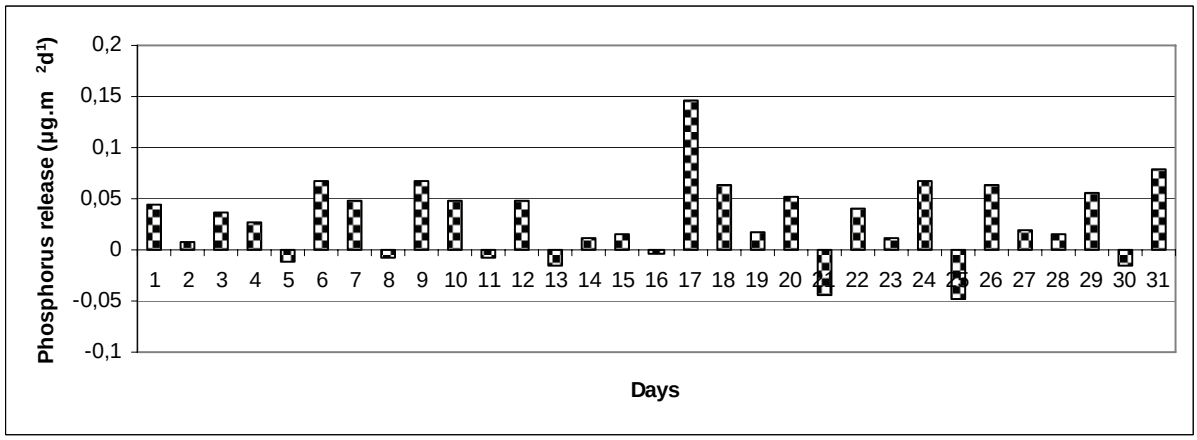

Figure 3. Measured anaerobic phosphorus flux

In aerobic and anaerobic conditions dissolved oxygen concentration and pH values were found to be 8-8.5 mg L^{-1}, 7.2-8.0 and 0.7-0.9 mg L^{-1}, 7.5-8.9, respectively. In aerobic conditions, the minimum phosphorus flux was –0.087 µg $m^{-2}d^{-1}$ (22^{th} day) and the maximum value was 0.083 µg $m^{-2}d^{-1}$ (25^{th} day). On the other hand, in anaerobic conditions flux changed between –0.048 µg $m^{-2}d^{-1}$ (25^{th} day) and 0.147 µg $m^{-2}d^{-1}$ (17^{th} day) (Fig. 2, 3).

Discussion

Lennox (1984) investigated the exchange of phosphorus between the epilimnetic (shallow zone) sediment and water column in Lough Ennell (Ireland). Experimental results indicated that phosphorus release is possible under both aerobic and anaerobic

conditions. Aerobic release was determined as 0.025 mg $m^{-2}d^{-1}$ while in anaerobic conditions it was measured as 0.183 mg $m^{-2}d^{-1}$. In Mogan Lake the anaerobic phosphorus release was greater than the aerobic phosphorus release; in this context the data derived from this study support the findings of previous authors. This study suggests sediment phosphorus release is not correlated to aerobic or anaerobic conditions (Fig. 2, Fig. 3).

Shaw and Prepas (1990) investigated the relationships between phosphorus in bottom sediments of seven Alberta Lakes; trophic status of all lakes varied from meso-eutrophic to eutrophic. The calculated potential phosphorus release from sediments to lake water ranged between 0.04 mg $m^{-2}d^{-1}$ and 1.5 mg $m^{-2}d^{-1}$. In a previous study, nine eutrophic Alberta Lakes in summer months the phosphorus release rates were determined between 0.01 and 2.31 mg $m^{-2}d^{-1}$ (unpublished data). In this study, sediment phosphorus release rates in anaerobic conditions were quantitatively higher than the release rates measured in aerobic conditions.

Under aerobic conditions the sediments were a sink of phosphorus. Whereas, under anoxic conditions, the sediments were a source of phosphorus until the overlying water column attained orthophosphate concentration of 1 to 1.4 mg L^{-1} (Cerco 1989). In Mogan Lake, overlying water's orthophosphate concentration was found to be ranged between 45.85±3.98 mg m^{-3} (July) and 112.10±0.91 mg m^{-3} (November) during the synchronized study (Topçu 2006) conducted in situ. Explaining the very low phosphorus release and the data derived from this study is in accordance with Cerco (1989)'s determinations.

In Esthwaite Water (England), a productive lake, the rate of release of phosphorus from intact sediment cores was measured in the laboratory as a function of the pH of overlying water. The measured maximum phosphorus release rate was 75 mg $m^{-2}d^{-1}$ at pH=10.5. It is determined that, phosphorus release from the littoral sediments may equal or exceed both external sources and hypolimnetic inputs during periods of high pH associated with times of maximum algal biomass (Drake and Heaney 1987). In Mogan Lake, it is difficult to say that pH is the effective factor on the phosphorus release mechanism due to the minimal fluctuation of pH level minimal both in aerobic (7.2-8.0) and in anaerobic conditions (7.5-8.9).

Pore water chemistry in Mogan Lake was monitored for a year (July 2004-June 2005) in the middle of the west side of the lake. Phosphorus fluxes over the sediment-water interface were calculated using measured concentration gradients in the pore water. Minimum and maximum phosphorus releases were found 0.002 μg $m^{-2}d^{-1}$ in November and 0.062 μg $m^{-2}d^{-1}$ in June. In addition, overlying water's high TFe (152.00±7.21 mg m^{-3}-526.40±10.30 mg m^{-3}) and SRP (18.68±1.16 mg m^{-3}-66.75±1.52 mg m^{-3}) concentrations leaded to low phosphorus release (Topçu 2006). In laboratory conditions, phosphorus release level was found to be low in both aerobic and anaerobic conditions. This transport is diffusional, but strongly dependent on the biological processes which promote the diffusion upwards as also indicated by the oxygen-dependent phosphorus release rates. It is determined that phosphorus release level was not high enough to affect the trophic level of the lake. In conclusion the low release of phosphorus in the laboratory for both aerobic and anaerobic conditions is supported by the high TFe and SRP concentrations of overlying water obtained in the lake study and thus this has no serious threat to lake recovery currently, but needs further investigation.

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Gillnet selectivity for pike, *Esox lucius*, in Lake Karamık, Turkey

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Abstract Gillnet selectivity parameters the pike, *Esox lucius* L., were estimated from catches taken by five experimental gillnets of stretched mesh sizes of 36, 40, 44, 50 and 60 mm in Lake Karamık, Turkey. The length selectivity of each mesh size was described by four different models (normal location, normal scale, gamma and lognormal) of the 'Share Each LEngth's Catch Total' (SELECT) method. According to model deviance values, lognormal model gave the best fit for gillnet selectivity of pike. Estimated modal lengths were 20.4, 22.7, 25.0, 28.4 and 34.0 cm for 36, 40, 44, 50 and 60 mm mesh sizes, respectively. Modal length and spread increased with mesh size.

Introduction

Pike, *Esox lucius* L. is a commercially important freshwater fish species in Turkey. Unfortunately, pike stocks were overexploited by fishermen. Exploitation of fish stocks is dependent on availability, fishing effort and gear selectivity (Huse *et al.* 2000). In Lake Karamık, key fishing methods were gillnets and trammel nets because of ease of use, low cost, and possibility to be set at any depth and in areas with difficult bottom conditions. Knowledge of the size selectivity of fishing gear types is crucial to fisheries management in order to establish a maximum sustainable yield (Millar & Holst 1997; Huse *et al.* 2000), allowing exploited fish stocks to be assessed and regulated (Regier & Robson 1966; Hamley 1975). To minimize gear selectivity the length frequency distribution of fish populations are adjusted (Carol & Garcia-Berthou 2007). In general, indirect estimates of gillnet selectivity are obtained by comparing the observed catch frequencies across several mesh sizes (Millar & Holst 1997). The length frequency distribution of the population and the selectivity parameters are thus estimated simultaneously (Hovgård & Lassen 2000). Different approaches to indirect estimates have been used to obtain the selection curve using various manipulations of the selection equation. Holt's method (1963) is one of the most commonly used methods for estimating gillnets selectivity. However, this method is restrictive. Recently, the SELECT method has been used (Millar & Holst 1997; Millar & Fryer 1999; Millar 2000). This is a statistical model that estimates gillnet selection curves from comparative gillnet catch and provides a cohesive approach to selectivity analyses.

Several studies of gillnet selectivity have been carried out for a variety of marine species using the SELECT method (Madsen *et al*. 1999; Huse *et al*. 2000; Poulsen *et al.* 2000; Dos Santos *et al*. 2003; Grégoire & Lefebvre 2003). But, gillnet selectivity studies using the SELECT method for freshwater fish species are scarce (Albert 2004; Psuty-Lipska *et al*., 2006; Carol & Garcia-Berthou 2007).

The aim of this study was to model the size selectivity of gillnets used in commercial pike fishery in Lake Karamık. The results are of major importance for improving the management of pike in this fishery.

Materials and methods

Study area

Lake Karamık (38° 29' N and 30° 55' E) is in the west of central Anatolia region of Turkey. It is a small (38 km^2) and shallow (average depth 2-3 m) lake, at an altitude of 1067 m and annual mean water temperature is 14°C. Lake Karamik is eutrophic, with most of surface area of the lake was covered by vegetation (Gündüz 1984; Şen *et al*. 1994). The main species in this lake are *Esox lucius*, *Cyprinus carpio*, *Alburnus orontis*, *Gambusia affinis*, *Cobitis turcica*, *Knipowitschia caucasica* and *Astacus leptodactylus*. However, during our study period only *E. lucius* and *C. carpio* were commercially exploited, preferred fishing methods included gillnets, trammel nets and traps.

The study was conducted between March 2002 and February 2003. Sampling was carried out monthly at three different localities of the lake using monofilament gillnets of mesh sizes (stretched mesh) of 36, 40, 44, 50 and 60 mm. Each net had a length of 100 m and a hanging ratio of 0.50. All nets were set in the afternoon and lifted the following morning. Nets were hauled individually, the catch removed and the species separated and fish length measured (fork length, FL, mm).

The gillnet selectivity was estimated by the SELECT method through R code developed by Millar (http://www.stat.auckland.ac.nz/~millar/selectware/R/gillnets /gillnetfunctions.R. The length selectivity of each mesh size was described by four different models (normal location, normal scale, gamma and lognormal) of the 'Share Each LEngth's Catch Total' (SELECT) method (Millar & Fryer 1999).

Results

During the study a total of 1237 pike were caught. The largest group of specimens (369 pike) were caught by gillnet with a mesh size of 44 mm, while largest mesh size of 60mm was least productive.

Gillnet selectivity was estimated from catch data (in Table 1) and selectivity curves are shown in Figure 1 for mesh sizes. Model deviance of lognormal model was lower than those of normal location, normal scale and gamma models. These results showed that lognormal model gave the best fit for pike in Lake Karamık. In addition, it was determined that the model deviances from the gamma and lognormal selection curve models were not influenced by the fishing power assumption.

The residual plot reveals some curious features of these data. It appears that the fishing power of the largest mesh (60 mm) was less than modelled because of the predominance negative residuals. This result showed that gillnet of mesh size of 60 mm caught higher than expected catch of these sizes of pike.

Table 1. Length-frequency distributions of pike caught by gillnets of different mesh sizes (36, 40, 44, 50 and 60 mm).

	Mesh size (mm)				
Fork length (cm)	36	40	44	50	60
18	5	1	0	0	0
19	26	8	0	0	0
20	16	26	1	1	0
21	35	59	8	0	0
22	23	44	34	1	0
23	15	26	79	4	0
24	11	17	73	23	0
25	9	19	44	38	0
26	4	21	19	50	2
27	4	6	19	36	3
28	5	7	17	15	6
29	1	5	12	11	13
30	5	4	6	9	8
31	1	1	4	8	6
32	0	4	6	5	6
33	2	0	1	4	1
34	1	0	1	3	5
35	0	0	0	1	1
36	0	1	1	2	1
37	0	1	0	0	2
39	0	0	0	0	1
41	1	0	0	0	0
42	0	0	0	0	1
45	0	0	0	0	1
Total	200	290	369	261	117

Table 2. Selectivity parameters for various models. The model deviance is the likelihood ratio goodness of fit statistic and it has 94 degrees of freedom for each of the models shown.

	Equal fishing powers		Fishing powers α mesh size	
Model	Parameters	Model deviance	Parameters	Model deviance
Normal location (Fixed spread)	(k, σ) = (0.56683, 3.83534)	405.02	(k, σ)= (0.579, 3.888)	397.78
Normal scale (Spread α m_j)	(k_1 ,k_2) = (0.583, 0.089)	503.90	(k_1 ,k_2) = (0.597, 0.088)	506.22
Gamma (Spread α m_j)	(α, k) = (0.012, 47. 639)	411.60	(α, k) = (0.012, 48. 639)	411.60
Lognormal (Spread α m_j)	(μ_1, σ) = (3.036, 0.142)	371.36	(μ_1, σ) = (3.057, 0.142)	371.36

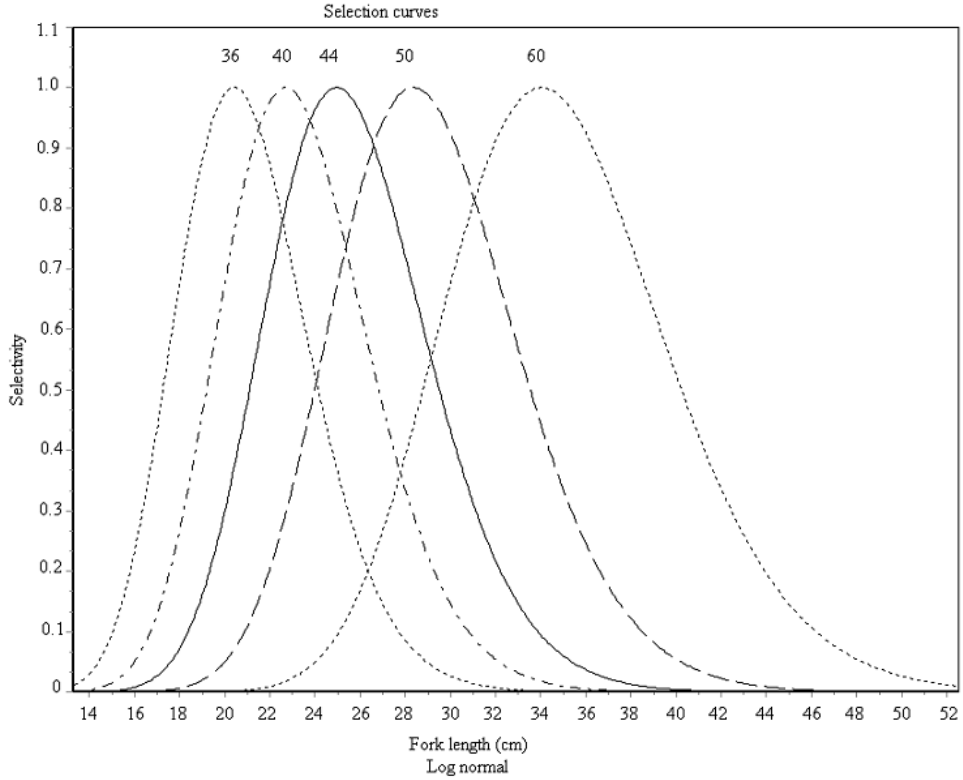

Figure 1. Selection curves of mesh sizes for lognormal model Modal length and spread values for mesh sizes were given in Table 3. As seen in Table 3, both modal lengths and spreads increased with mesh size.

Discussion

The lognormal model gave the best fit for gillnet in Lake Karamık. In general, gillnet selectivity curves may approach normal curves when most fish are wedged or gilled (Hamley 1975). However, when a large proportion of fish are tangled in the net, catch data are skewed to the right, fitting better to gamma or lognormal models or multimodal models (Hamley 1975; Kurkilathi *et al*. 1998). In most studies, selectivity curves take unimodal form (Hamley 1975) and the best fit was also achieved using a normal scale model (Poulsen *et al*. 2000). Carol and Garcia-Berthou (2007) reported that the normal scale had the best fit for *Alburnus alburnus, Rutilus rutilus, Squalius ceohalus* and *Scardinius erythrophthalmus*, while normal location for *Cyprinus carpio* and *Chondrostoma miegii*. On the other hand, lognormal model gave the best fit for *Barbus graellsii* and *Sander lucioperca*. Psuty-Lipska *et al*. (2006) found that the bimodal model was the best fit for gillnet selectivity of *Perca fluviatilis*.

Recently, studies in several fish species have shown that bimodal curves may yield better fit than unimodal models (Poulsen *et al*. 2000; Fujimori and Tokai 2001; Dos Santos *et al*. 2003; Erzini *et al*. 2003). But, in our study the bimodal model was not available in the gillnet functions of SELECT.

Table 3. Modal lengths and spread values.

Mesh size (mm)	Modal length (cm)	Spread
36	20.420	3.012
40	22.689	3.346
44	24.958	3.681
50	28.362	4.183
60	34.034	5.020

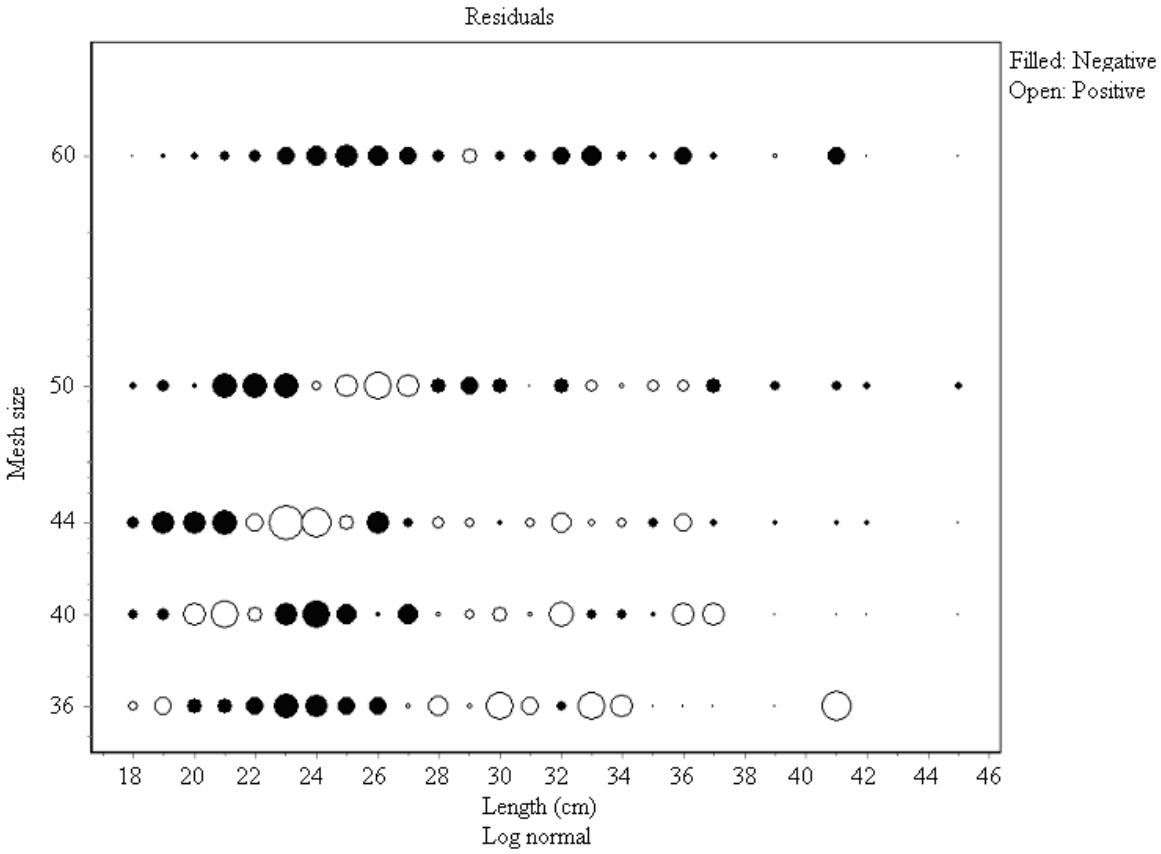

Figure 2. Deviance residuals plot for the lognormal selection curve fits.

Deviance residual plot showed that positive and negative residuals were nearly equal for mesh size of 36, 40, 44 and 50 mm. But, negative residuals were predominance for 60 mm mesh sized net. If the deviance residuals are clustered on one-side with positive or negative area, the model is judged unsuitable (Dobson 1993; Tokai & Mitsuhashi 1998). The results showed that gillnet selectivity for pike may vary with fish sizes. Especially large pike have very sharp and numerous teeth. Therefore, in the fishing with gillnets probability of capture of pike by entangling in the teeth was higher for large individuals.

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Ichthyofauna of the Çobanlar Stream (Samsun, Turkey)

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Abstract The research was conducted to determine the fish species inhabiting in the Çobanlar Stream within the Yeşilırmak Delta between April 2004 and July 2005. Electric fishing, cast netting, fishing line and fisherman's dip net were used to catch fish samples. As a result of evaluated individuals caught from the study area, 12 species belonging to 4 families (Cyprinidae, Esocidae, Mugilidae, Gobiidae) were identified. This paper gives the diagnostic characteristics of these fish.

Introduction

The first record of the fish fauna in Turkeys was reported by Abbott in 1835 (Kuru, 2004). Foreign researchers that visited the country between 1835 and 1940 collected fish samples from throughout Turkey and placed them in museums located in London, Hamburg, Belgrade and Bucharest, before publishing scientific reports regarding their findings. A large part of the inland fish fauna of Turkey has been determined by both native and foreign researchers since 1940, these ichthyofauna investigations intensified after 1970. These studies were generally directed towards large freshwater systems. It is important to study fish species that inhabit smaller freshwater rivers or lakes, as it enables us to document the existence of unknown fish species as well as species that have high economical importance. This research was conducted in the Çobanlar Stream which, to date, had not been investigated from the viewpoint of fisheries.

Materials and methods

The investigation area was located in the southeast of Samsun province (36°00'-37°00' east longitudes, 41°00'-41°30' north latitudes). The samples were captured using various equipment and techniques. Metric characters were measured by dial caliper with 95% confidence limits and a fish measurement scale. All meristic characters were counted by lancet and fish needle under a stereoscopic binocular microscope. For the genus and species identifications, the following were referred to: Berg 1962, 1964, 1965; Kuru 1975, 1980; Whitehead *et al.* 1986; Fischer *et al.* 1987; Szczerbowski 2001; Mater *et al.* 2002.

Table 1. Fish species biometric measurements.

Family	Species	Diagnostic Characteristics													
		SL(mm)	SL/BD	SL/HL	HL/ED	HL/ID	ID/ED	D	V	A	P	L.lat	L.tran	PT	N
Cyprinidae	*Alburnus chalcoides* (Güldenstädt)	63-95	4.73-5.21	4.17-4.37	2.99-3.32	3.96-4.59	0.65-0.84	III 8	II 9	III 13-14	I 16-17	63-65	11-12	2.5-5.2	3
	Capoeta tinca (Heckel)	95-155	4.27-4.87	4.07.4.57	3.55-4.41	2.58-2.95	1.24-1.65	IV 8 (9)	II (7) 8 (9)	III 5	I 17-19	71-82	13-16/9-12	2.3.4-4.3.2	34
	Carassius gibelio (Bloch)	56-138	2.45-2.87	2.13-3.82	2.70-4.69	2.45-3.91	1.05-1.42	IV (14) 16-18	II 7-9	III 5	I 14-18	(29) 30-32	6-7/6-7	4-4	30
	Squalius cephalus (Linnaeus)	76-170	4.07-4.82	3.78-4.27	3.91-4.19	2.44-2.98	1.39-1.85	III 8	II 7-8	III 7-8	I 14-17	43-46	6.5-7.5/3-4		8
	Rhodeus sericeus (Pallas)	41-68	2.88-3.15	4.00-4.68	2.51-3.28	2.37-2.66	1.07-1.32	III 9	II 6-7	III (8) 9 (10)	I 9-11	4-7	5-6/3-4	5-5	32
	Rutilus rutilus (Linnaeus 758)	83-130	3.12-3.65	4.00-4.46	3.51-4.23	2.24-2.82	1.50-1.56	III 9-10	II 8	III 10-11	I 15-17	43-48	8-9/3-4	6-6	2
	Vimba vimba (Linnaeus 758)	140	3.91	4.04	3.50	3.04	1.15	III 8	II 9	III 16	I 16	57	11/5	5-5	1
	Scardinius erythrophthalmus (Linnaeus 758)	73-90	3.55-3.81	4.03-4.41	3.12-3.49	2.32-2.82	1.26-1.35	III 8	II 7-8	III 10	I 13-15	39-40	7-7.5/3	3.5-5.3	5
Esocidae	*Esox lucius* Linnaeus	180-255	5.81-6.10	3.19-3.23	5.51-6.35	4.66-5.32	1.17-1.30	VII-VIII	II 9-10	VII-VIII	I 13-15	120-126	14/14-17		4.
Mugilidae		SL(mm)	SL/BD	SL/HL	HL/ED	HL/ID	ID/ED	D1	D2	A	P	Sq	PC	N	
	Mugil cephalus (Linnaeus)	147-155	4.57-4.81	4.06-4.14	3.70-3.81	2.38-2.36	1.55-1.65	IV	I 8	III	II 15-16	45-50	2	2	
Gobiidae		SL(mm)	SL/BD	SL/HL	HL/ED	HL/ID	ID/ED	D1	D2	V	A	P	Sq	N	
	Neogobius gymnotrachelus (Kessles 1857)	78-95	4.53-4.83	3.28-3.48	4.27-4.33	12.43-14.27	0.30-0.34	VI	I 15-16	I 5	I 12-13	16-17	57-58	3	
	Proterorhinus marmoratus (Pallas 1814)	34	4.50	3.47	4.67	10.32	0.45	VI	I 16	I 5	I 13	15	43	1	

SL: Standard length **BD:** Body depth **HL:** Head lenght **ED:** Eye diameter **ID:** Interorbital distance **D:** Dorsal fin **D_1:** First dorsal fin **D_2:** Second dorsal fin **V:** Ventral fin **A:** Anal fin **P:** Pectoral fin **L.lat.:** Lateral line scales **L.tran.:** Line transversal scales **Sq:** Number of scales on a line between the back of the head and the beginning of the caudal fin in the fish without lateral line **PT:** Pharyngeal teeth **PC:** Number of pyloric caeca **N:** Specimen number.

Results

In this study, twelve species belonging four families from the Çobanlar Stream were identified. Biometric measurements and counts of fish species were recorded (Table 1).

Discussion

Our findings were similar to previous data recorded in similar research projects. The investigation area had relatively high fish diversity, although twelve taxa have been determined in this study, further investigations may reveal that other fish species subspecies may be present. Individuals caught and identified included; *Alburnus chalcoides*, *Capoeta tinca*, *Carassius gibelio*, *Squalius cephalus*, *Rhodeus sericeus*, *Rutilus rutilus*, *Scardinius erythrophthalmus*, *Vimba vimba* from Cyprinidae; *Esox lucius* from Esocidae; *Mugil cephalus* from Mugilidae; *Neogobius gymnotrachelus*, *Proterorhinus marmoratus.*

This stream is a natural resource and provides a proportion of the protein requirements for the people living in the area. *Esox lucius* and *Mugil cephalus* inhabit the stream and have an economic importance but these species are illegally exploited by the people in the area. Consequently, the continuity of life in the stream is threatened. There is no doubt that the introduction of species that are of economical importance, due to their high meat yield, could relieve the pressure on fish stocks and contribute to the national development of Turkish fisheries.

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Lessons available from anglers' records: Case study of the Brno reservoir (Czech Republic)

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Abstract The majority of open water bodies of the Czech Republic are managed by the anglers´ unions. Angling has considerable effect on fish stocks but appropriate management approaches to address these impacts are often lacking. According to internal rules of the Czech angler unions, recording the outcomes of angling events and fish caught and taken is obligatory for all anglers. Thus, the anglers´ records provide a very important and valuable source of information about the exploitation effort, stocking efficiency (rate of return), fish growth, natural recruitment, fish assemblage composition and other stock characteristics. These figures are of particular importance in bigger reservoirs, where the evaluation of fish assemblage structure, abundance and biomass is quite difficult. An example from Brno reservoir is presented to show the utility of anglers´ records for the evaluation of angling effort, fish assemblage composition, trends of water quality development and interspecific relationships in fish community.

Introduction

Recreational fisheries (angling) are the sole user of fish stocks in open water bodies of the Czech Republic. It can affect fish populations but appropriate management approaches to address these impacts are often lacking (Arlinghaus 2006). According to the internal rules of angler unions operating in the Czech Republic (Czech Anglers´ Union and Moravian Anglers´ Union) recording information about the angling event into the "File of records about angling performances and catches" is obligatory for an angler before angling commences and is after the angling event is completed. Thus, the anglers´ records provide a very important and high valued information about the particular fishing ground attendance, stocking efficiency (rate of return), fish growth, natural recruitment, fish assemblage composition (see also Draštík *et al.* 2004). These figures are of particular importance in bigger reservoirs, where the evaluation of fish assemblage structure, abundance and biomass are very difficult and inaccurate.

Brno reservoir is situated in the immediate neighbourhood of the city of Brno (450 000 inhabitants). It results in strong exploitation of the reservoir for recreational purposes (angling, swimming) and water sports (sailing, water-skiing, boating, wind-surfing).

Comprehensive limnological investigations, including the monitoring of pollution sources in the watershed, have been performed in the reservoir from the early 1990s through to the present day, which showed poor water quality in the reservoir and

surrounding catchment. The influence of industrial, municipal and agricultural pollution (point, diffuse and aerial sources) resulted in an excessive inflow of nutrients and other pollutants (heavy metals, organic compounds, radioactivity) into the reservoir. Improper landscape management during the previous period of agriculture intensification resulted in pronounced sediment erosion. On average, 63.8 t P and 1707.9 t N are transported to the Brno reservoir annually. The reservoir has become eutrophic, which is characterised by considerable summer stratification of dissolved oxygen concentrations – whilst over-saturation (up to 16.6 mg L^{-1} O_2) occurs in the euphotic layer; very low concentrations or even anaerobic conditions are regularly recorded in the hypolimnion during June – early September. Nutrients, iron and manganese are liberated and released from thick bottom sediments during the anaerobic conditions (Drábková & Maršálek 2004). Thus one of the tasks for fish biologists was to contribute to the restoration process of the Brno reservoir environment by evaluating the fish assemblage using angler records and to consider if (and how precise) do these records reflect the changes in water quality.

Material and methods

Brno reservoir (259 ha) is situated in the middle stretch of the Svratka river, which is an important stream for the southern Moravia region (Czech Republic). From the fisheries point of view, Brno reservoir is particularly important for recreational fishing. The operation of the reservoir was initiated in early 1940s and its main objectives were to protect the city of Brno from flooding and to optimise the discharges for downstream drinking-water abstraction, industry and irrigation. Its dam has a hydropower water plant.

For the purposes of the evaluation, data recorded in angler records about the angling events in the "File of records about angling performances and catches" were summarized and elaborated. The entry about angling performance includes the date and the name (or number) of the fishing ground at the beginning of fishing. All fish caught that are above the legal size limit and expected to be retained must be immediately recorded after landing. All other fish caught in an angler´s possession, which are below the size limit, must be recorded after finishing the angling performance, summarizing the number of fish and their weight for each species separately.

Data about angling intensity and efficiency, and fish species and size composition on Brno reservoir were available since the 1970s from anglers´ records with exception of angling performance. The recording of each (not only successful) angling performance was introduced in 1991. Both figures about stocking rates and angler catches in individual years were provided by the headquarters of the Moravian Anglers´ Union.

Results

Mean annual angling effort intensity in Brno reservoir between 1991 and 2006 was 54 816 ± 10 393 angling trips (man/day performance). Mean annual angling yield amounted to 32 690 ± 7411 kg (27 293 ± 7428 fish individuals), which corresponds to an angling yield of 148 ± 34 kg per ha. Cyprinid species predominated anglers´ catches (Table 1). Common carp (*Cyprinus carpio*) represents 39.5 and 70.3% by number and biomass of the total angling yield from the reservoir, respectively. Common bream (*Abramis brama*) is also of importance contributing 42.2 and 18.7% of catch by number

and biomass, respectively. Catches of other non-predatory cyprinid coarse fish (tench, *Tinca tinca*, chub, *Leuciscus cephalus*, nase, *Chondrostoma nasus* and herbivores) do not exceed several tens of individuals fish per year.

At present, asp (*Aspius aspius*) is an important predatory fish in the reservoir with 0.8 and 1.0% proportion on total catches. Records of asp only appeared in anglers' records in 1974 (Fig. 1). The average individual weight of the catch of small cyprinids (besides bleak, *Alburnus alburnus*, and roach, *Rutilus rutilus*, also rudd, *Scardinius erythrophthalmus*, crucian carp, *Carassius carassius*, Prussian carp, *Carassius gibelio* and others) showed a long-term exponential relationship ($y = 538e^{-0.0004x}$, $n = 33$, $P < 0.05$) with the average weight of asp, thus offering evidence about the impact of the asp population upon small cyprinids. The size of small cyprinids appears to be related to the size of asp; as asp decline in mean size their impact on small cyprinid recruitment through predation seems to decline the mean size of small cyprinids increases. (Fig. 2). The mean size of small cyprinids in 1961–1973 (period before asp appeared in angler records) was 167 g (44-287 g) and rose to 940 g in 1994. The biggest asp caught by anglers was 8.10, 7.60 and 7.20 kg in 1988, 1992 and 2002, respectively.

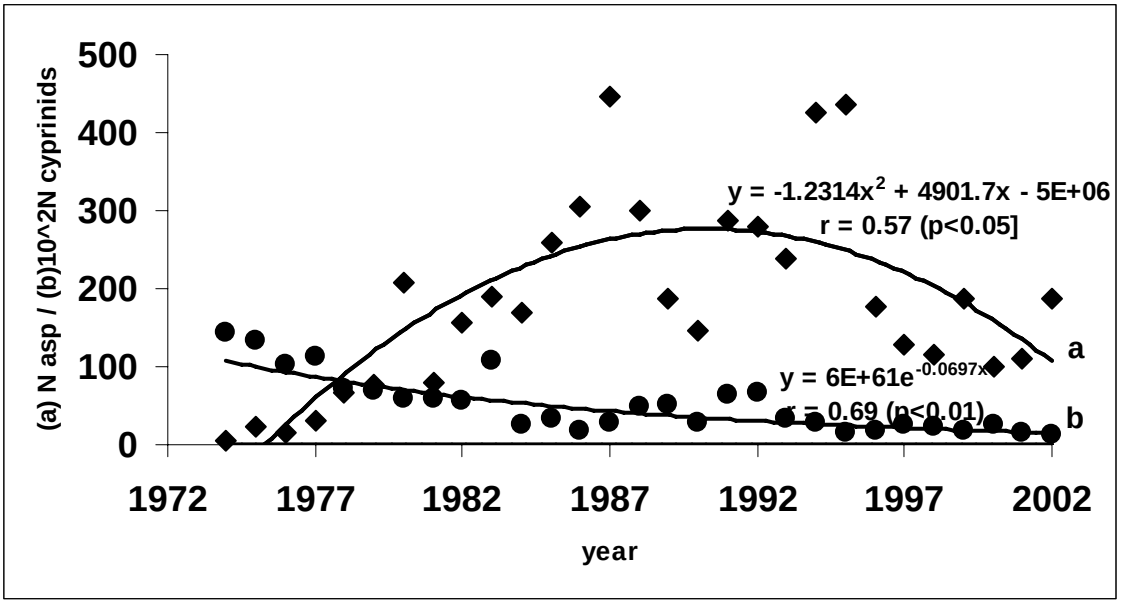

Figure 1. The course of annual catch rates of asp (a) and small game cyprinids (b) in numbers of individuals (n.)

On average 7044 individual pike (*Esox lucius*) are released each year, which corresponds to 4.3% rate of return in angler catches. Zander (*Sander lucioperca*) is the most important predatory fish species of Brno reservoir, but as with pike, their catch rates have decline in recent years. On average, 530 one-year-old equivalent individuals (879 kg) are recorded in anglercatches every year with a long-term mean size around 1.5 kg. Mean annual stocking rate is equivalent to 9121 one-year-old individuals, which corresponds to a 5.8% recapture rate. Capture of European catfish (*Silurus glanis*) is rare in Brno reservoir. On average, 6 catfish (52 kg) are caught each year, which corresponds to a 0.7% recapture rate. Catfish individuals weighing 38.5, 59 and 71 kg were caught by anglers in 1976, 2002 and 2006, respectively. Perch, *Perca fluviatilis*, are one of the dominant species in angler catches with 869 individuals (270 kg) caught

each year, which represents 0.8% of the total angling yield from the reservoir. A perch weighing 1.20 kg was recorded in 2004.

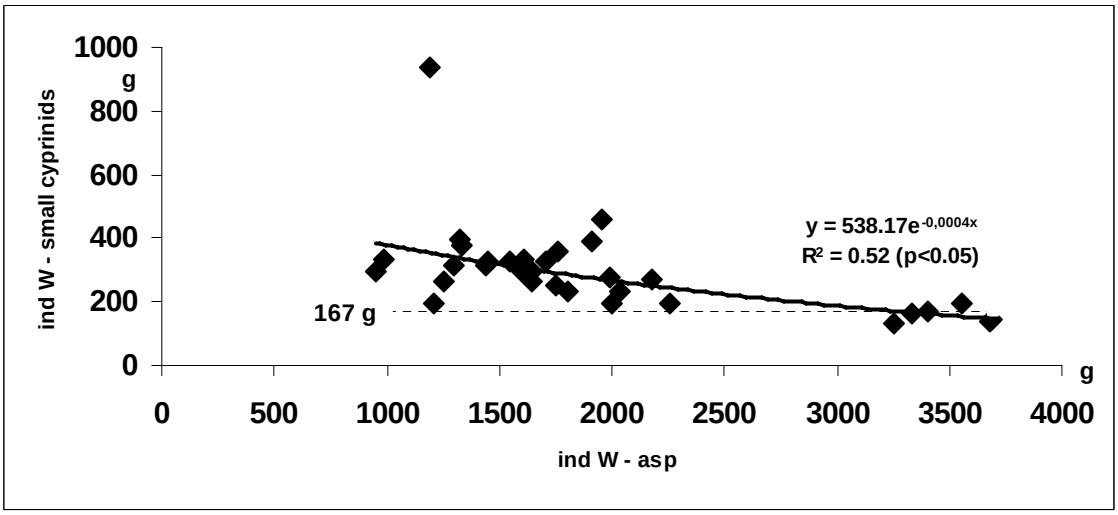

Figure 2. The relationship between mean size of asp and small game cyprinids in anglers' records. Note: 167 g - the mean size of small game cyprinids in anglers' records before asp appearance in 1974.

Eel, *Anguilla anguilla*, yield has decline over time but individual size have increased, suggesting no recruitment to the population. On average, 177 individuals (140 kg) are caught each year, representing a 3.3% recapture rate. The annual mean catch of salmonids (rainbow trout, *Oncorhynchus mykiss*, brook trout, *Salvelinus fontinalis*, brown trout, *Salmo trutta* m. *fario*) and grayling, *Thymallus thymallus*, amounted to 108 individuals (43 kg).

Discussion

The approximity of a big city, valuable nature and landscape features, good availability by road and/or shuttle bus and boat traffic and regular fish stocking are important prerequisites for high interest of anglers in this fishing ground. However, the unfavourable status of the fish stocks in Brno reservoir has been often mentioned in relation to water quality. Adámek (2000) used angler caches to better understand the relationship between water quality and fish stocks in the Brno reservoir. It appears that annual stocking is the biggest determinant of cyprinid catch and return rates (Table 1). This is because of their predominance in the fish assemblage and the enormous interest of Czech anglers in common carp, which is regularly released in amounts exceeding the limit of annual stocking programme. On the other hand, the angler interests in other non-predatory cyprinid coarse fish have declined in recent years, which support the tendency of these cyprinids to become overpopulated; a trend that is undesirable from the point of view of water quality management.

Fish are capable to develop a considerable pressure upon the other biotic items of water ecosystem ("top down" effect) (e.g. Komarkova 1998, Lammens 1999, Romare e*t al.* 1999). In water bodies with "put and take" angling management, the development of a fish assemblage corresponding to the water quality requirements is extremely difficult. Anglers often concentrate their effort on fish species that are desirable for helping

maintain good water quality (predators) because they control the benthivorous and planktivorous cyprinids and/or they require enhanced stocking with undesirable (from the water quality point of view) fish like common carp (Arlinghaus & Mehner 2003) making any effort for "biomanipulation" inefficient (Adámek 1993).

Table 1. Mean annual stocking numbers, catches and rate of return in Brno reservoir (1992-2002). Note: *Herbivorous fish - grass carp, *Ctenopharyngodon idella*, silver carp, *Hypophthalmichthys molitrix* and bighead carp, *Aristichthys nobilis;* ** Others - roach, *Rutilus rutilus*, rudd, *Scardinius erythrophthalmus*, ruffe, *Gymnocephalus cernuus*, Prusian carp, *Carassius gibelio*, crucian carp, *Carassius carassius*, bleak, *Alburnus alburnus* etc.; % of limit – percentage of fish released according to the stocking limit assigned by the Ministry of Agriculture, rate of return – percentage of fish individuals captured in relation to number of fish individuals released

Fish species	Stocking rate		Catches		
	Number	% of maximum	Number	kg	Rate of return (%)
Brown trout, *Salmo trutta* m.*fario*			29	11	
Rainbow trout, *O. mykiss*	371		74	29	19.9
Brook trout, *Salvelinus fontinalis*			2	< 1	
Grayling, *Thymallus thymallus*			3	2	
Pike, *Esox lucius*	7044	78.0	300	619	4.3
Carp, *Cyprinus carpio*	18834	121.1	10760	22338	57.1
Tench, *Tinca tinca*	75		96	70	128.0
Bream, *Abramis brama*	4518	123.4	11485	5948	254.2
Chub, *Leuciscus cephalus*			65	30	
Barb, *Barbus barbus*			2	3	
Nase, *Chondrostoma nasus*			16	13	
*Herbivorous fish	145		19	72	13.1
Asp, *Aspius aspius*	0	0.0	217	325	
Perch, *Perca fluviatilis*			869	270	
Zander, *Stizostedion lucioperca*	9121	82.8	530	879	5.8
Wels, *Silurus glanis*	882	101.2	6	51	0.7
Eel, *Anguilla anguilla*	5432		177	140	3.3
**Others	3132		2567	984	82.0
TOTAL			27217	31785	

The proportion of the non-predatory to predatory fish biomass (F/C ratio) is a simple expression of the balance in particular fish community (Holčík & Hensel 1972)

supplying useful information with respect to other biotic components of the ecosystem. Values between 3.0 and 6.0 indicate optimal ratio whilst values >10 demonstrate undesirable condition of fish community with strong prevalence of non-predatory fish. In the Brno reservoir, the F/C ratio was constantly raising after its considerable decline in late 1970s, reaching its highest value in 2000 as indicated by decreasing portion of predators in anglers´ catches (Fig. 3). Since 1983, the F/C value has exceeded the upper threshold of optimum of 6.0) and since 1992 even the level 10.0, which is considered as an upper limit of a well-balanced fish assemblage composition. After a certain decline in mid-1990s, it showed an increasing tendency (Fig.5) until a sudden drop in 2001-02 caused by a severe decline of water level due to reconstruction works on the dam hydropower turbines, resulting in enormously successful fishing for zander (>30 kg per ha on average) in the inflow area of the reservoir.

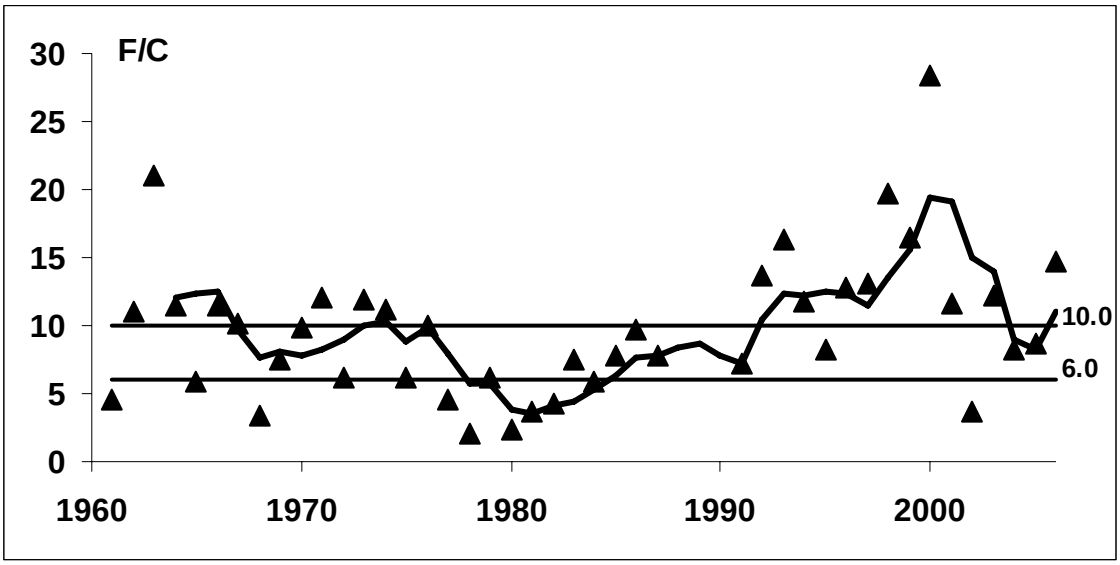

Figure 3. The course of the F/C coefficient in 1961 – 2006. Note: Values between 6.0 – 10.0 indicate optimal ratio between non-predatory and predatory fish biomass.

Undesirable development of fish composition in Brno reservoir corresponded with worsening water quality and regular occurrence of cyanobacterial water blooms over past 10 –15 years. It is difficult to judge what was the primary cause – did the populations of predatory species decline due to the deterioration of water quality or did the water quality decline due to decreasing biomass of predatory fish and progressing ichthyo-eutrophication?

The asp population arises exclusively from natural recruitment, because no stocking was been provided since 1983, despite this species being included in the original (but still valid) stocking programme. In the 1980s, there were signs of asp overpopulation, peaking in early 1990s, as reflected by the dramatic decline in small cyprinids like bleak and roach. Subsequently, the lowest catch rates (both in terms of abundance and biomass) were recorded since early 1990s. On average, the annual catch of asp amounted to 201 individuals (333 kg).

In addition to asp spawning in the main tributary, zander also spawn naturally in the reservoir, as indicated in high values of the return rates. The reservoir provides very good habitat conditions both for spawning and the fry of zander and perch (Adámek, unpubl.). The shoreline with a shallow hard-bottom littoral in the lower part provides very good conditions for zander and perch fry, whilst the upper canyon-shaped part corresponds fully to the requirements of adult and older fish.

Regarding the other fish species of angler interest, pike is regularly stocked as advanced fry, and to a lesser extent as one- or two-year-old fish, but their occurrence in angler catches has declined in the last 20 years. European catfish was stocked in rather low number but regularly and catches are low. Glass eel have been stocked irregularly due to unstable deliveries. As a consequence, annual eel yields have declined, accompanied by increasing individual size. Nevertheless, its average rate of return amounting to 3.3% is high, influenced by irregular stocking and possible downstream migration from upper water bodies. Poupě (1979) reported the former return rate of eel from the Brno reservoir as 7.2%.

Salmonid catches are registered quite frequently – usually as a consequence of release of rainbow trout and brook trout or due to downstream migrations from upper trout fishing grounds and/or trout ranching streams (brown trout and grayling). Salmonid fish occurrence suggests there is good water quality in the upper part of the reservoir (inflow area).

Currently, the rules of Brno reservoir fisheries management are subject to re-elaboration associated with partial draining to remove sediment. Thus, fish rescues and their safe transfer to other fishing grounds are crucial and will require careful supervision of public, media, scientific and animal welfare institutions. Anglers´ records about exploitation of the fish assemblage in the reservoir will be useful to help make decisions about how to proceed with this action. However, despite their usefulness, the validity of data obtained from angler records must be treated with caution because they are influenced by angler preferences for certain fish species and tendencies to overestimate their catch (particularly regarding fish size). Nevertheless, as demonstrated in this study the information they provided might be worthy for general evaluation of the composition and prosperity of the fish assemblage.

Acknowledgement

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The economic value of recreational fishing: An example of a Hungarian multifunctional pond fish farm

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Abstract The multifunctionality of Hungarian aquaculture has become an important issue as it is increasingly recognised that pond farms contribute to rural wealth not only through the production of fish, but also by the social benefits of services and ecological functions, which are frequently undervalued.

Recreational fishing and related tourism will play a key role in the multifunctionality of aquaculture, as angling provides high economic value to society. Whilst the economic value of commercial fisheries and aquaculture can be estimated in a relatively easy way through the analysis of market statistics, the economic value of recreational fisheries is not fully reflected in the market price of fishes caught and fishing licenses or day tickets. However, using the so-called "travel cost method", data on angling-related transactions can be used to estimate the total economic value of recreational fishing. This paper demonstrates a case study on the economic valuation of angling in a Hungarian multifunctional pond fish farm.

Introduction

With the increasing dominance of hypermarkets and supermarkets in the fish retail sector in Hungary, the traditional pond fish farmers are faced with many problems in marketing their production of fish and the farm's gate selling price hasn't been raised for years due to the asymmetric bargaining power of the parties. Given the continuously increasing production costs, the producers are urged to:

- Find new marketing channels or methods, or
- Diversify their profile through multifunctional operation. The increased number of income sources reducing the share of revenues from wholesale marketing of farmed fish **(**Figure 1).

Considering the relatively high value attached to recreational fishing (Shrestha *et al.* 2002; Barnes *et al.* 2002; Loomis 2005) the introduction of angling ponds in farms could address the problem of decreasing profits in two ways. On the one hand, as the anglers buy and take home the caught fish, it helps to market a share of produced fish at a higher price (angling centres generally apply higher prices for caught fishes than the wholesale prices), without transportation and harvesting costs. Whilst on the other hand angling raises the non- traditional income sources of farms: entrance tickets and revenues from related tourism-based services (e.g. buffet, angler-shop, restaurant, camping).

This paper investigates the econometric background of a selected Hungarian fish farm that operates a 3 ha angling pond with approximately 1000-1500 visitors per year. The case study focuses on the question of the optimal entrance ticket price, which allows the

farm's management to obtain the maximum share of the total value attached to recreational pond-fisheries in the given region.

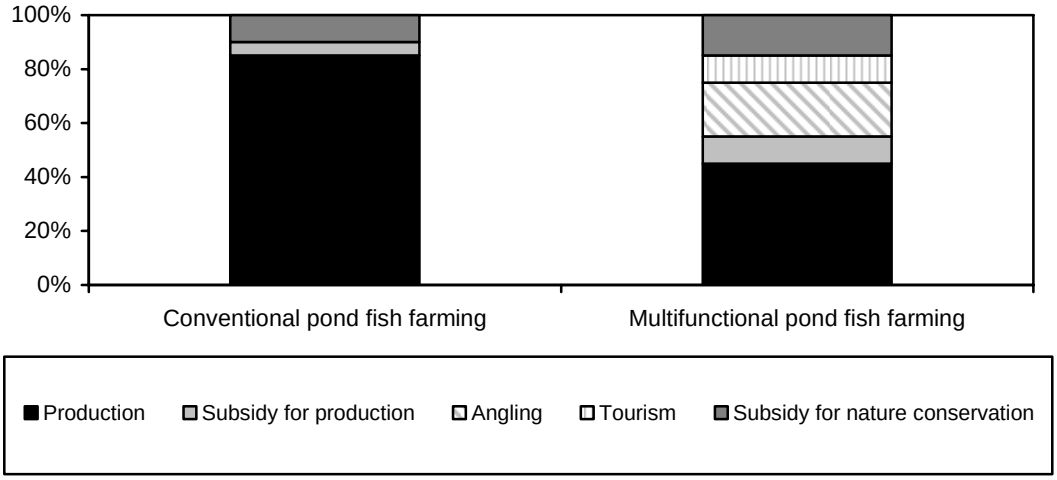

Figure 1. Structure of the revenue in conventional pond fish farms and multifunctional pond fish farms in Hungary (Váradi 2007).

The Aranyponty Angling Centre in Szarvas

The investigated farm is located near Szarvas, south-eastern Hungary. Although there are many opportunities to fish in natural waters in this area due to the abundance of rivers and cut-off lakes, this is the only angling centre of this kind in this area. The closest major angling centres are 50-60 km from Szarvas. The farm's total pond surface is 150 ha, of which 3 ha are open to anglers. The angling centre is open every day from April to September, between sunrise and sunset. In the grounds of the Angling Centre, the owner operates a buffet and a small shop for selling bait and other accessories. The price of the entrance ticket was 1200 HUF in 2004 (the investigated year). The visitors also had to pay to take away caught fish. According to the current legislation related to recreational fishing, every visitor has to be registered by name and postal address. A total of 1227 tickets were sold, most of them to local people. As there are many weekend houses along the cut-off lake in Szarvas, during the summer many people from other regions of Hungary spend their free time in the town. This accounts for approximately 200-400 visits to the farm during the fishing season.

Material and methods

The Zonal Travel Cost Method was used to analyse the demand for the local angling centre. The method is widely used to assess the value of parks, lakes and other sites which are used for recreational activity. The basic premise of the Travel Cost Method (TCM) is that the total costs incurred by individuals to enjoy a given recreational activity can be used as a surrogate price for access to the site. The model assumes that the recreational fishermen don't make a distinction among the costs (price of entrance tickets, the cost of travelling to the angling site, the cost of time, price of baits, etc.), all these cost are aggregated before making a decision to visit the angling site.

The TCM can be applied in two alternative methods: the individual or the zonal method. In this case the zonal method was used, to reduce data collection.

The Zonal TCM is applied by collecting information on the number of visits to the site from different zones, which can be defined as circular zones around the site, geographical regions or administrative districts. Assuming a normal (decreasing) demand curve for recreational activities, the zones further from the investigated recreational sites typically have fewer visitors per zone, as the travel cost (and the travel time) increases while the other costs are generally the same. By regressing the data for different zones, the following trip generating function (so-called first-stage demand function) can be drawn:

$V = F\ (TC, TT, I, S)$,

Where *V* represents the visitation rates (number of angler days/ zone) from the different zones, *TC* represents the travel cost (and other costs incurred), *TT* represents the travel time, which is generally monetized, *I* represents the income level of the different zones and *S* represents other socio-economic or any other variables which could affect visitation rates. The coefficient of *TC* and *TT* must be negative to successfully apply the model (with the increase of travel cost and travel time, the visitation rate decreases), while the coefficient of I is generally positive, indicating, that a higher income results in higher visitation rates. (In case of some inferior recreation sites the coefficient of the income variable can be negative. Ahmed et al. 2007)

Once this trip generating function has been determined, it can be used to define a real demand curve (so-called second-stage function) for the angling centre. This is done by considering what impact an increase in entrance ticket price would have on aggregate demand, and using this to trace out a curve. In practice it means that it can be calculated what impact a 200 HUF increase in ticket price would have on visitation rates from a given zone through analysing the visitation rates from those zones and which inhabitants spend 200 HUF or more on travelling to the angling centre. Generally linear, log-linear, reciprocal, linear-log and double-log function forms are applied in TCMs, each of them has some advantages over the others. In this case the linear type regression was chosen (Gürlük *et al.* 2007).

Once the real demand function for the angling centre is determined, the *TR* (Total Revenue) function can be traced out as it is the multiplication of the ticket price and the estimated number of visitors (which is a function of the price of the entrance ticket), at every price level. In case of a normal, decreasing (Marshallian) demand curve, this *TR*-function has a so-called reversed **U**-shape, which reaches its maximum at a definable price level. Considering that the total costs of the angling centre are more or less fixed (as the major share of it is not a function of visitors), the *Π*-function (Profit-) function can be traced out by the subtraction of the fixed cost from the *TR*- function.

Results

The data on the number and addresses of visitors were collected from the Angling Centre's registration system. The income and population statistics were taken from the Hungarian Statistical Central Office's (HCSO) homepage. The visitor statistics for 2004 were analysed. That year 1227 entrance tickets were sold, the price of the tickets was

1200 HUF. As the presence of multi-destination trips can disturb the application of the Travel Cost Method, the visitors were separated into 3 groups:

a) The *first group* (called local group) contained 510 visits, which originated from the nearby (less than 40 km) settlements around Szarvas. These visits (of course one visitor can buy entrance tickets more than once a year) are almost surely made up of one-day, single-purpose trips by the anglers, which provide a good background to the use of the travel cost model. Nine zones were created in this small region (Fig. 2).

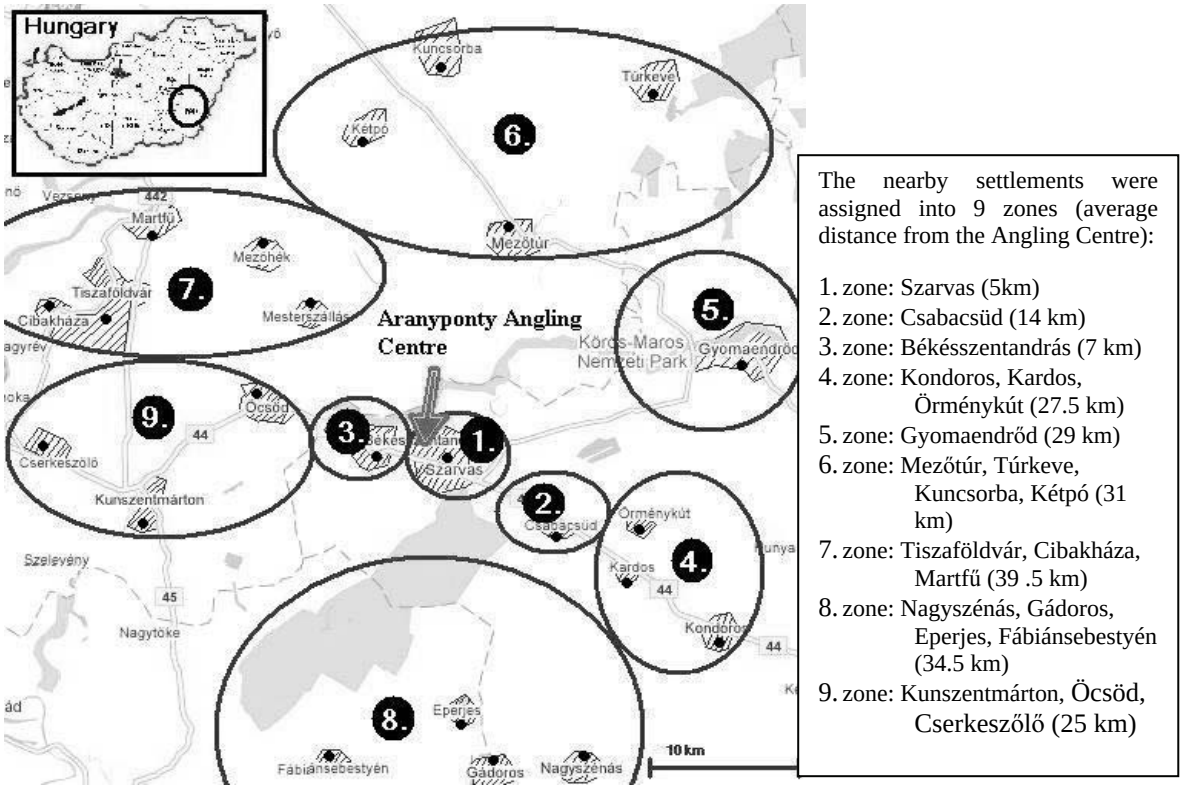

Figure 2. Specification of the travel zones in the *first group* of visitors (one-day, single-purpose trips)

Statistics on the income of settlements were not available; therefore no income variable was used. The total cost (ALL COST) is the total price of the entrance ticket (P), the travel cost (TC) and the cost of travel time (TT).

To calculate the TC, the average price of fuel in 2004 was used (243 HUF/litre – HCSO) and the fuel consumption was calculated to 7.5 litres per 100 km. As the average size of the angling groups were 2 people per trip, the total travel cost per trip was halved to get the travel cost per person. To estimate the cost of travel time (TT) the widely used rate of 1/3 of the national average wage rate was applied (see Chen *et al.* (2004) and Gürlük *et al.* (2007)). To measure the time spent on travel a 60 km/h average speed was used. Similar to methods used by Chen et al (2004) and Bülov *et al*. (2007) a home dummy variable (HD) equal to unity was used when travel originated from Szarvas, the nearest town. This is needed because of the large visitation rate from Szarvas. (Table 1.)

Table 1. Variables in the *first group*'s regression model

Zone	Number of angler days (Tickets sold)	Population	Visitation rate (V) (Tickets/Pop.)	Total costs (HUF)/ angler (ALL COST) (P+TC+TT)	Home dummy (HD)
1.	250	18 497	0.0135	1 324	1
2.	15	2 077	0.0072	1 547	0
3.	22	4 107	0.0054	1 373	0
4.	7	7 240	0.0010	1 881	0
5.	20	15 381	0.0013	1 918	0
6.	124	30 578	0.0041	1 968	0
7.	27	25 164	0.0011	2 178	0
8.	24	12 788	0.0019	2 054	0
9.	22	13 907	0.0016	1 819	0
Total	511	129 739			

As expected, in the first group, the linear TCM can be applied very successfully; the dependent variable is explained by the independent variables at the rate of 88.1 %, which is statistically significant in a 0.001 probability level. The results indicate that travel cost is a significant (P <0.03) determining factor of the angling visitation rates. (Table 2.)

Table 2. Regression results in the first group

Variable	Est. coefficient	*P*-value
Constant	1.530E-02	<0.02
Total costs (ALL COST)	-6.717E-06	<0.03
Home dummy (HD)	7.105E-03	<0.02
R^2= 0.881		
F statistic = 22.22*		0.0015

Among the first group of zones, using the regression results the linear first-stage demand function can be written for the Aranyponty Angling Centre as follows:

V = 0.0153027 - 0.0000067 *ALL COST* + 0.0071047 *HD*

b) The *second group* of visitors consisted of those anglers travelling from a distance of 40-90 km, and whose visits theoretically might be attributed to the single purpose of spending a day in the Angling Centre. However, it is estimated that only 60-70 percent of the tickets sold (594 in this group) were the result of a one-day, single-purpose trip, which is typical from a TCM point of view. The rest of the anglers were probably on holiday in Szarvas (a proportion of them own weekend houses in Szarvas), in this case the travel cost doesn't affect the visitation rates. Therefore, as expected, the coefficient of the ALL COST variable was considerably lower in the regression, which means, that the visitation rate is not so sensitive to changes in the costs (Table 3).

The European nomenclature of territorial units (NUTS) was used to create the zones in this group of visits, 8 NUTS of 4 level regions were selected to be the zones in this group (Table 3). The method of calculation of the *TC* and *TT* were the same apart from the average speed. In the second group an average speed of 70 km h^{-1} was assumed during the travel from the zone to the Aranyponty angling centre. An attempt was made

to include an income variable (I), but it did not have any significant effect on visitation rates. The regression results for the *second group*'s zones are listed in Table 4.

Table 3. Specification of the travel zones in the second group

Statistical region	Number of angler days (Tickets sold)	Population	Visitation rate (*V*) (Tickets/Pop.)	Total costs/ angler (A*LL COST)* *(P+TC+TT*) HUF	Income/ person/year (*I*) 1 000 HUF
Békéscsabai	118	74 453	0.00158	2415	411
Gyulai	115	53 431	0.00215	2796	332
Békési	59	42 109	0.00140	2415	267
Sarkadi	6	25 611	0.00023	3035	180
Szeghalmi	50	43 471	0.00115	2534	275
Orosházi	96	54 134	0.00177	2248	325
Mezőkovácsházi	28	45 703	0.00061	2892	230
Karcagi s	22	47 428	0.00046	2953	326
Total	494	813 157			

Table 4. Regression results in the second group

Variable	Est. coefficient	*P*-value
Constant	5.389E-03	<0.03
Total costs (ALL COST)	-1.584E-06	0.067
r^2= 0.468		
F statistic = 5.28*		0.061

Among the second group of zones, using the regression results the linear first-stage demand function for the Aranyponty Angling Centre was:

$V = 0.0053891 - 0.000001584\ ALL\ COST$

c) The third group consisted of 222 visits, which were made by visitors from remote regions (>90 km away), who were surely on holiday in Szarvas, and not visiting only for the purpose of one day fishing. In the regression analysis only the income variable (*I*) showed any significance (P <0.1), the ALL COST variable, as expected did not show any significance. For this reason in later analysis (building the second-stage demand function) the visits from this group of zones were considered as stable (222 at every price level) in the range of 0 - 2000 HUF per ticket.

The next step of the econometric analysis was the building of the second-stage demand trip. To estimate the relationship between the number of visitors and the price of an entry ticket, estimated coefficients from the regressions were used to calculate visitation rates from all the 3 groups of each zone of origin as the price of an entry ticket were increased and decreased in 50 HUF increments (Fig.3).

As the Angling Farm's revenue from the sale of entry tickets is equal to the multiplication of the number of tickets sold and the price of the tickets, it is easy to determine the Total Revenue function. For example, according to the regression results with a ticket price of 1000 HUF the farm could sell 1480 tickets in a season, which would mean 1 480 000 HUF revenue from entrance fees (Fig. 4). Of course the angling shop and the buffet would generate additional revenue.

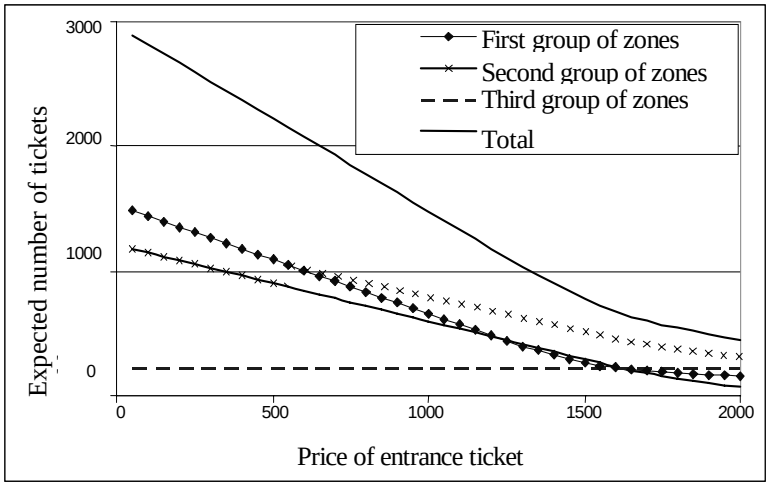

Figure 3. The expected number of visits at different price levels in the Aranyponty Angling Centre (Inverse type of the Marshallian "inverse demand function")

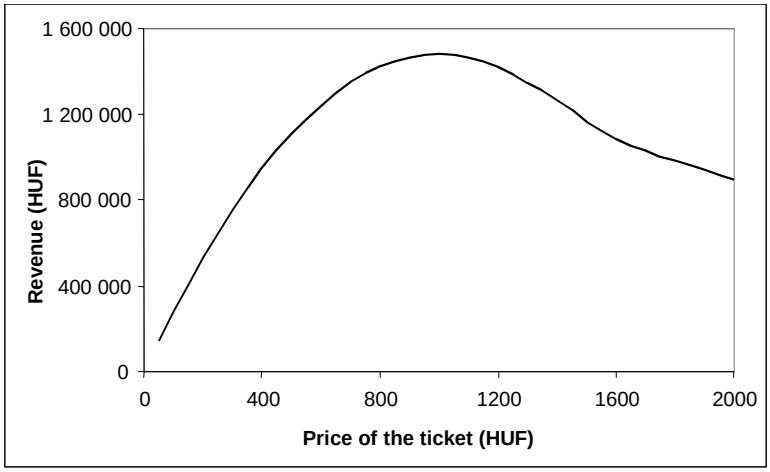

Figure 4. The Total Revenue (TR) function of the Aranyponty Angling Centre

Considering the relatively stable level of the total cost of the farm, according to the TCM presented in this study, the maximum profit can be captured at a ticket price of 1000 HUF. This means that the election of the 1200 HUF price level by the Farm's management was too high, as the actual level of revenue is lower than the optimal revenue by 60 000 HUF. However the farm has other incomes related to angling; the profit from the buffet and the angling shop is a function of the number of anglers, therefore a higher number of ticket sales results in higher profit. This means that the optimal ticket price for the farm's management is below 1000 HUF as indicated above, the number depends on the profit made on the angler's average additional spending.

Conclusions

Recreational fishing is an important recreational activity in Hungary, 3.2% of the total population are registered anglers. Analysis of the behaviour and preferences of visitors to a Hungarian Angling Centre suggests that the anglers prefer natural waters and conditions compared to the angling centre's ponds. The maximum possible revenue based on the applied TCMs is relatively low compared to the high value attached to recreational fisheries.

The higher catch rates in angling centres don't appear to be a sufficient factor in attracting the anglers away from natural waters. These farms must take steps towards creating a near-natural environment in the farms (planting waterside trees, leaving some part of the natural reed bed, shaping the ponds with curves, peninsulas, etc.) in order to attract more recreational fishermen and raise the demand for entrance tickets to the farm.

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Sociological analysis of sustainable fisheries management of the endemic pearl mullet in the fishing villages of Lake Van, Turkey

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Abstract The sociological research was carried out in eight fishing villages where the main income source is the pearl mullet fishery. The research has four main objectives: (1) determining main fishing inclinations (2) finding out social, cultural and individual sources of positive and negative attitudes toward external intervention to traditional fishing practices for use in sustainable fisheries management in the area (3) compiling preferences regarding alternative sources of income (4) determining general demographic structure, communal and cultural status of the fishermen living around Lake Van. The research demonstrated that during the spawning season fishing practices are determined by a complex set of sociological factors. It is commonly accepted that to change already existing attitudes is not an easy task. The research has concluded that education and "openness to innovations" are two major factors, which show a statistically significant relationship with attitudes toward the ban on fishing during the spawning season. The research also concluded that the economic loss caused by the ban could at least partly be compensated by offering alternative sources of income to those who suffer from the loss. As far as the alternative source of income is considered, the surveyed villagers indicated that their choice would be cattle breeding.

Introduction

The need to conduct a sociological analysis in the coastal villages of Van Province was born out of a simple question: despite efforts towards conservation and sustainable fisheries management of the endemic pearl mullet, why were some of the villages responding positively to the ban on spawning season fishing whilst others were being resistant?

Over the years, the combined efforts of the Fisheries Department of Van Yuzuncu Yil University (particularly those of Professor Mustafa Sarı), local NGOs (e.g. The Association of Nature Observers), international organizations (e.g.UNDP), national NGOs, the media and a host of volunteers most of which are university students, have resulted in exceptional advances towards the conservation of the species and the sustainability of pearl mullet fishing. The overall population of the species has increased, fishing productivity has tripled, the average size of pearl mullet has increased from 16.5 cm to 19.5 cm, and the average number of fish per kilogram has decreased from 17 to 11. The observational evidence has given no signs of visible differences between the villages resisting the ban and those approving it. Given the fact that, on the

surface, there are no significant differences amongst the villages observed, there must be a "deeper" reason or set of reasons resulting in the structural difference in the attitudes towards illegal fishing activity and the ban on fishing during the spawning season.

To investigate this, a sociological survey has been designed with four main objectives:

(1) To determine the villager's basic tendencies and fishing practices (2) to identify social, cultural and individual differences between the fishermen who favour the spawning season fishing ban and those who oppose it (3) to determine preferred alternative income sources to recuperate income losses resulting from the ban (4) to generate general demographic, social, and economic data on the fishing villages. A total of 4966 villagers were surveyed and a sample of 248 respondents was chosen using geographical cluster sampling. The clusters were chosen using a quota technique in order to include attitudes towards the ban on spawning season fishing. As a result eight villages with different attitudes were chosen. Out of the eight villages surveyed, three (Çitören, Çelebibağ, and Yalındüz) are known to be against the ban and winter fishing, three (Yeşilsu, Engilsu, and Dereağzı) are supportive of the ban and support winter fishing, and two (Karahan and Gölağzı) show mixed attitudes. Each one of the eight fishing villages is designated as a cluster and then a systematic random sampling technique applied to each cluster to determine the actual respondents. In the actual application of the survey, a total of 241 questionnaires were completed with success.

The questionnaire contained a total of 59 questions in six categories: (1) basic demographical information (2) fishing practices (3) use of means of mass communication, physical mobility, and perception of the status of the villages (4) household income sources (5) (potential) alternative income sources (6) social-cultural-individual openness index.

The concept of openness to innovations

Although observational evidence determined that there is no visible indicator governing the villager's attitude towards the fishing ban in the spawning season, the same category of evidence (and experiential insight coming out of participant observation for more than a decade) has hinted that villager's attitudes cannot be reduced to a simple moment of decision. This paper describes the major conclusions in order to shed some light on how the notion and the consequent concept of "openness to innovations" were reached.

Firstly, the academic and NGO work on the conservation and sustainable management of pearl mullet fisheries has been producing positive results so far. There is a large body of knowledge accumulated through this process, which is not limited by the technicalities of fishing practice and administrative/judicial dimensions. Perhaps more important than these issues a third type of knowledge has been developed: ethnographic. To scientists and activists dealing with pearl mullet, this is the most valuable resource. The core component of this knowledge is *active participation* and systematic grass roots public education. When placed next to such experience and knowledge, this research could only be considered as a simple step hoping to systematize certain notions regarding the lifestyles, socio-economic conditions, and values of Lake Van fishermen. Therefore, in designing the research concepts, corresponding variables and survey questions understanding was based on a diverse, mostly non-systematic, partly recorded

but very strong insight generated from below. This insight can be presented in the form of three propositions: (1) When implementing external intervention towards a social change, the human and ecological factors must be given equal weight (2) these two sets of factors indeed form an indivisible whole (3) any external intervention to a local community must be carried out with a thorough understanding of the community under consideration and by procedures which are not alien to them.

As far as Van province and the fishermen of Lake Van are concerned, the main challenge regarding the introduction of an innovation (e.g. winter fishing, fishing with larger mesh size nets etc.) has a lot to do with a general openness to the outside world, to the world beyond the mental limits of village life. As a rapidly modernizing country, Turkey has been struggling to digest modern life on all levels and this process has been particularly difficult for people living in the rural areas of the country. The same insight is even truer for the provinces located in the east, Van being one of them. It would be more than ironic to say that modernity has entered Turkey *from the West*. In this respect, the notion of transcending the communal limits was considered to be a key issue in the design of the research.

Secondly, the local knowledge and experience described above has proven that education and vertical public communication are very effective tools in the implementation of innovations, even if those innovations have an economic cost to the local people. Therefore, special attention was paid to the learning capacity of the villagers and the notion of education was not limited to formal education only. Aside from formal education, access to mass media and physical mobility were considered as important vehicles for what has been called “transcending the communal limits.”

Finally, there is the issue of the differences in attitudes toward innovations, which, as previously stated, was the initial motivation to conduct this research. In light of the above ideas, it was intended that a larger issue of openness, which extends to different areas of life beyond fishing practices be pinpointed. Thus, the concept of “openness to innovations” was operationally defined as:

> “Openness” is a concept designed to demonstrate the degree and ability of the heads of households living in the fishing villages of Van province to isolate themselves from traditional, cultural and social pressure mechanisms and within their relations with the community at large, their willingness to adopt democratic and ecological values including consideration of public good.

The resulting openness index was composed of three axes, each of which is composed of six variables. These axes are (1) social openness (2) cultural openness and (3) individual openness.

Results

It should be noted that the research did not yield a crystal clear, uni-dimensional, simple answer to the initial question. Rather, it is concluded that a web of complex factors have contributed to shaping the attitudes of the villagers towards innovations in sustainable fisheries management in Lake Van. A few important factors can be collected under three headings: (1) education (2) the need for alternative income sources and (3) openness to innovations index.

Education

If it were assumed formal education is a major factor contributing to a more enlightened, unselfish, and considerate point of view toward the benefits of the general public, the following hypothesis would be valid: as the years of formal education increase, the attitude toward the ban on spawning season fishing would be more positive. In other words, more educated people would be more supportive of the ban and winter fishing.

Table 1 shows the list of villages surveyed with three types of signs next to them: (+) indicating a positive attitude toward the ban; (-) indicating a negative attitude toward the ban and (+/-) indicating mixed attitudes toward the ban. The next column shows the head of the household's average years of formal education in an incremental fashion. As the table shows, more education is associated with positive attitudes toward the ban on spawning season fishing with the exception of one village (Yeşilsu).

Table 1. Average years of formal education received by the head of the household in villages and attitudes towards the ban on spawning season fishing.

Name of village	Average years of formal education	*n*
Yeşilsu (+)	3.62	29
Çitören (-)	3.73	30
Yalındüz (-)	3.91	32
Çelebibağ (-)	4.39	31
Total average	4.66	241
Engilsu (+)	4.68	31
Karahan (+/-)	4.81	32
Dereağzı (+)	6.09	33
Gölağzı (+/-)	6.26	23

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Those villages that are in favour of a change in fishing style mostly have average education levels above the total average education score (4.66 years). It should be noted that in this table the attitudes are derived from observational evidence, not from the survey. However, the survey did have questions measuring actual attitudes of the villagers. The hypothesis is tested on the basis of an index formed from eight questions asked to the villagers concerning winter fishing, the ban on spawning season fishing, consuming fish carrying eggs, etc. It should also be emphasised that there is a striking parallel between observational evidence regarding the attitudes and actual findings of the research.

A correlation test between attitudes and years of formal education showed a statistically significant positive correlation between years of formal education and attitudes (Pearson's $r = 0.153$ at 0.05 level). Although the correlation is not very strong, it can be said that there is a positive relationship between education and attitudes.

Need for alternative income sources

It is commonsense that depriving a person of his/her income source for whatever reason causes trouble. In other words, people normally don't want to experience a downward change in their economic status, especially by external intervention trying to create a change in attitudes, which may result in income losses. Obviously the struggle for sustainable fisheries management of the endemic pearl mullet in Lake Van is a case in point. What is suggested to the fishing communities is to give up the "easy fishing, easy money" formula and adopt a more troublesome method of fishing which promises an increase in income in the long term. In order to avoid outright refusal of the proposal of sustainable fishing (ban on spawning season fishing during summer time and encouragement of winter fishing), alternative income sources for those who have seen a loss of income must be considered. This commonsensical assumption can be validated by a simple cross tabulation procedure comparing alternative income sources and attitudes toward the ban. In this comparison, alternative income sources refer to the actual engagement in activities outside farming, animal husbandry and fishing. The results demonstrate that those who do not have an alternative income source are more likely to hold negative attitudes toward the ban (65%).

In lieu of the general philosophy regarding social change through external intervention, top-to-bottom imposition of alternative income generation suggestions is considered to be only partly effective, if at all. In policy formation, it is imperative that any external suggestion must consider the lifestyles, belief systems, attitudes and social and political statuses of the actual beneficiaries. In short, if one is hoping for a positive change in any community, the preferences of that particular community must be determined. To this end the survey included questions regarding alternative income sources.

When given a number of alternative income sources, a majority of respondents (47%) preferred cattle breeding. The reason behind this choice seems obvious, most of the households in our sample actually do engage in cattle stock farming, it is therefore a type of investment Van villagers are familiar with. Cattle breeding is also the preferred choice because cattle rather than sheep are widely considered as an investment in the area. In contrast, suggestions like tourism did not yield favourable responses (8%) despite the supposedly great tourism potential of the area. This result, once again, confirms the need to consult the people targeted by external intervention.

Openness to innovations index

Previously the notion of "openness to innovations" was described in terms of transcending the communal limits. The survey had quite a large number of variables pertaining to this situation. Those variables are, in fact, not limited with what is called "openness to innovations" index questions. However, the results presented here are intended to focus particularly on the index generated by utilizing 18 variables located on three axes, "social," "cultural," and "personal" openness. It should be noted that the distinction between the axes are not drawn by solid and unquestionable lines of demarcation. On the contrary, the distinction between, say, the categories of "social" and "cultural" is, mostly arbitrary and organic connections exist between the two. The same is true for all three axes. The production of these hypothetical categories is largely nominal and only to a certain degree essential.

This paper presents the aggregate effect of the index instead of dealing with each and every axis for the villages surveyed. On a scale of four opinions (absolutely disagree,

disagree, agree, absolutely agree), the respondents have answered a total of 18 questions. Each answer is converted into a score ranging from zero (absolutely disagree) to three (absolutely agree). In the end a range of scores between 1.33 and 2.67 for individual respondents was obtained.

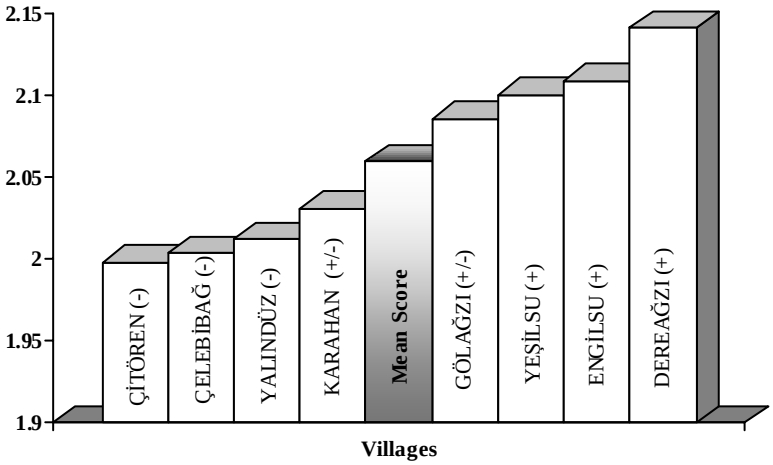

Figure 1: Line-up of villages according to scores in openness index.

Turning back to the initial question, this index can be utilized as a tool in understanding at least one dimension of the villager's attitudes towards the ban and other pertinent external interventions. Is openness to innovations a factor in villager's attitudes? Figure 1 demonstrates a line-up of villages with respect to the attitudes toward the ban (observational evidence) and their position in the openness index. It is clear that the villages that do not favour a change in the traditional methods of fishing are also those that score below the mean in the openness index. It should be noted that this line up is based on the observational evidence.

In a correlation test between the two indices of actual attitudes toward the ban and openness to innovations, the observational evaluation of the villages is again confirmed. This test yields a positive correlation between the attitudes and openness (Pearson's r = .193, at P <0.01 level). In other words, those individuals who favour external intervention into their fishing practices are more likely to score highly in the openness to innovations index. In fact, examining each village in terms of the actual attitudes and openness scores clearly demonstrates that those villages observed to favour the external intervention have higher scores in the openness index.

Conclusions

This paper focussed on three outcomes of a sociological survey conducted in the coastal villages of Lake Van, Van province. The research was designed to answer a particular question and to draw a general picture of the villages investigated. The question was about the factors contributing to different (positive and negative) attitudes toward external intervention to the villager's traditional fishing practices. The outcomes discussed are (1) the relationship between years of formal education and villager's

attitudes (2) villager's preferences to alternative income sources and (3) the relationship between "openness to innovations index" and attitudes.

As for the first and third issues, the research has demonstrated positive relationships between the variables, which can be formulated in two propositions:

> (1) As the years of formal education increase, attitudes toward the external intervention into traditional fishing practices become more positive.
>
> (2) The level of openness to innovations, which is described as the ability to mentally transcend the limits of communal life, is a factor contributing to positive attitudes towards the external intervention.

The second outcome concerns the villager's preferences towards alternative income sources. Alternative income sources are thought to be a significant factor towards sustainable fisheries management of pearl mullet since the introduction of new fishing techniques and the ban on spawning season fishing have economic costs for the Lake Van fishing communities. The majority of those surveyed indicated that the preferred alternative income source is cattle stock farming.

As emphasised, no successful external intervention into the established patterns of life can be considered complete without involvement of the affected individuals. This is only a part of a very long process of social change intended to contribute to the long-term informal communication between the stakeholders involved in the implementation of sustainable fisheries management of the endemic pearl mullet in Lake Van. It is evident that the findings of the research are open to debate and must be further tested both with scientific examination and interpersonal communication.

Socio-economic potential of angling native trout in Turkey

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Abstract Turkey inhabits the head waters of streams and rivers draining to 4 different basins, namely Black Sea, Mediterranean, Persian Gulf and the Caspian. As a consequence, the inland waters of this region have a vast aquatic diversity. These waters populate different varieties of native trout. Trout fishing (species specific) has a remarkable potential for angling tourism and is a spectacular attraction for the fishing enthusiasts. However, overexploitation, commercial fishing, untreated aquaculture waste disposal and ineffective control measures of government officials are some of the threats that we encounter in our fishing areas in Turkey.

Introduction

Rastgele-Der, Society of Amateur Anglers has been established in 2002 with an objective of developing angling in Turkey. Wastrels is an expression used among anglers meaning good luck in fishing (or like the Petri heil in German). Our core aim is to improve conservation of aquatic habitats especially that of native trout, which is the most fragile freshwater species and yet the most valued sport fish. The society has played a significant role in the improvement of Fishing Regulations from the renewal of the Circular for Amateur Fishing in 2006 with increasing efforts in struggling to conserve native trout species against threats such as overexploitation, pollution, over fishing and poaching. However, surrounded by three different seas (Mediterranean, Black and Marmara Sea) and inhibiting the headwaters of the main rivers of the Middle East flowing to 4 different basins, Turkey is unfortunately not capable of governing and managing this aquatic potential properly.

Anglers, not principally nature scientists or professionals like the aqua culturists, are only nature enthusiasts. Our benefit depends on the sustainability of the aquatic nature. As an angling association, our main purpose in attending such a symposium is actually to increase the attention of the governing authorities, global investors and especially the worldwide anglers to the vast potential Turkey inherits in fishing and actually fly fishing native trout. Sustainability of native trout stocks is the core of our interest and focusing on the socio-economic aspects of game fishing for native trout will be the method of this paper in reaching this end.

The natural potential

Turkey is a special place to study trout; first and foremost because it has received few to no introductions of non-native trout. Tortenese wrote in the 1950 s "*I am sure that no fry ever came from other countries. Such condition being nowadays rare, the study of these salmonids has an outstanding interest*". The streams of Turkey, unlike U.S.A and the European continent, have the potential of different native trout specimens. This fact actually attracts the attention of not only natural scientists but also of trout anglers who seek fishing different trout specimens from all around the world. What actually affects

the specimen variation is that the headwaters of rivers flow in to four different basins (the Mediterranean, Black, Caspian and the Persian Gulf). All originate from Turkey and have different climatic, terrain and chemical characteristics (Figure 1).

Figure 1. Turkish rivers and how they link to the Mediterranean Sea, Black Sea, Caspian Sea and the Persian Gulf.

Turkey has a remarkable geography for trout anglers. Trout caught in waters flowing to different basins shows different physical characteristic and colorings. Following fascinating photos of different specimens of brown trout fished by Rastgele-Der members reinforces this thesis (Figure 2).

However, even with all the specimen richness of Trout in Turkey, not all streams are favourable for fly fishing as you occasionally need several meters of casting distance in the waterway. Many of these streams where the best populations of native trout are found in Turkey are moderate or small headwater streams and thus the fishing tactics most well-suited to such streams are those used generally for small-stream fishing in mountainous or highland areas. When analyzing the topographic classification of Turkish rivers it is best to divide the country into 4 regions, Central and Eastern Anatolia Region, Central and Eastern Black Sea Region, Western Black Sea and the Aegean Region and the Mediterranean Region.

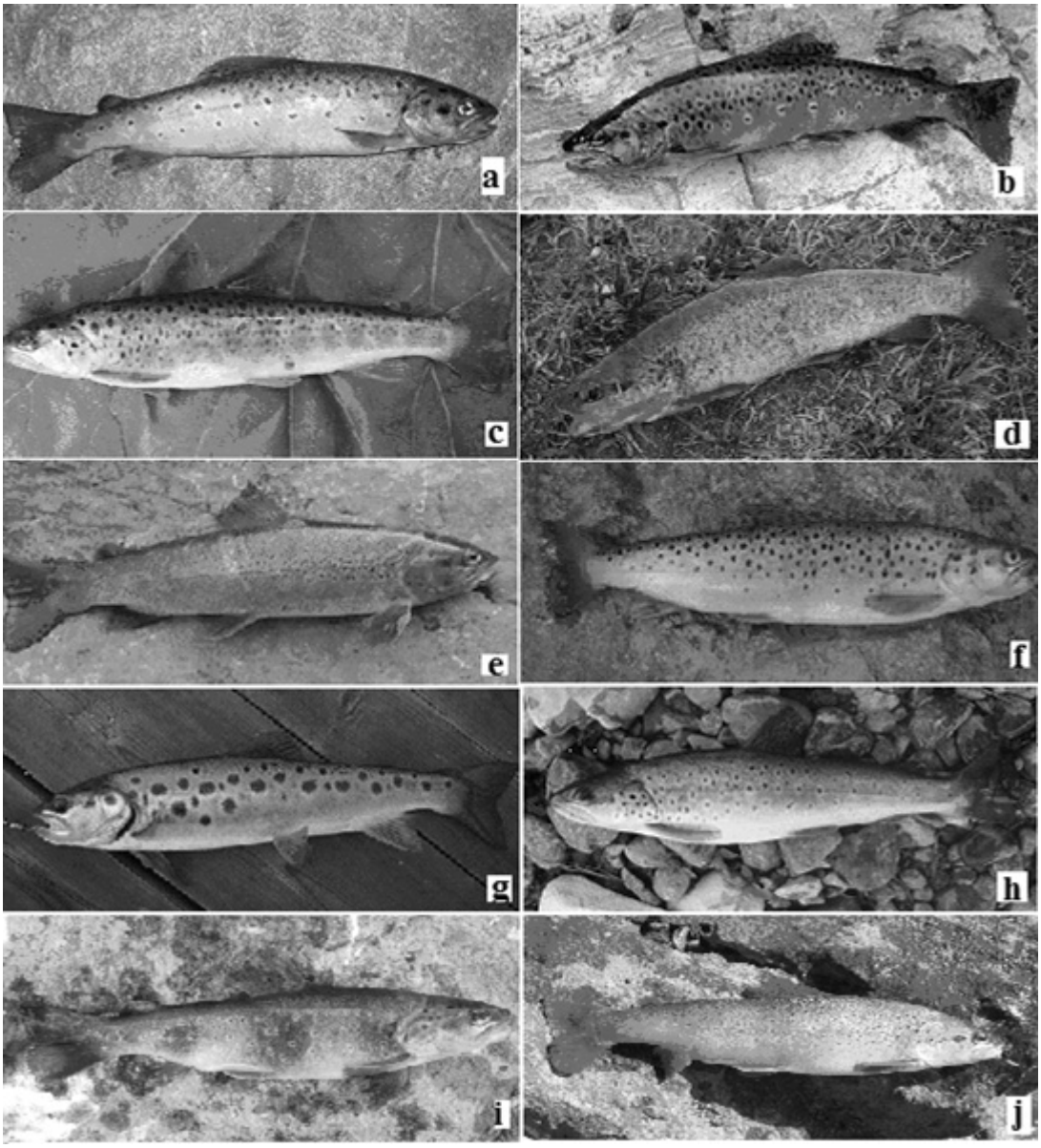

Figure 2. Physical differences between trout caught from different basins. Brown trout from the Aegean region (a & b); Western Black Sea region (c); Southern Eastern Anatolia (Sub Species Platycephalus) (d); Mediterranean region (e); Eastern Black region (f); Central Black Sea – Abant Lake (*Salmo trutta abanticus*) (g); North East Anatolia region (h); South East Anatolia (i & j).

Central and Eastern Anatolia Region

The topography of Turkey, starting from the central Anatolian plain, ascends as one travels east into mountainous highlands and ends at the borders with Georgia, Armenia, Iran, Iraq and Syria. This region produces two main rivers, Euphrates and Tigris that traverse Mesopotamia and flow into the Persian Gulf. In the numerous headwaters of these two rivers, one can find native trout that have inhabited these waters for millions

of years. However, as the topographic characteristics differ from one drainage to the next, the streams of Central and Eastern Anatolia will be studied separately in this paper.

In the Eastern Anatolia region, the best populations of native trout are generally found in headwaters where stream flow is low or moderate and the source springs are located at high altitudes where the elevation is steep. However the region is neither heavily populated nor wooded, and gradually lowering into the bottomlands of the valleys the streams generally receive tributaries which increase the flow and at these lower altitudes the streams lose gradient with a wide catchment basin creating a favourable condition for fly fishing. An example is the stream from the headwaters of Fırat (Euphrates).

The headwater streams located in Central Anatolia other than the Euphrates and Tigris actually are the waters of the rivers Seyhan and Ceyhan that drain to the Mediterranean sea and the stream basins of these waters are quite flat. They are fast-flowing, spring fed streams flowing steadily in a highland plateau at an altitude of 1700 m. The head water named Soğuksu is actually one of the best locations in Turkey for fly fishing. This stream gently flows through pastures and meadows of grass which is inhabited by an endemic sub-species of brown trout called *Platycephalus* only found in this region of the world (Figure 3).

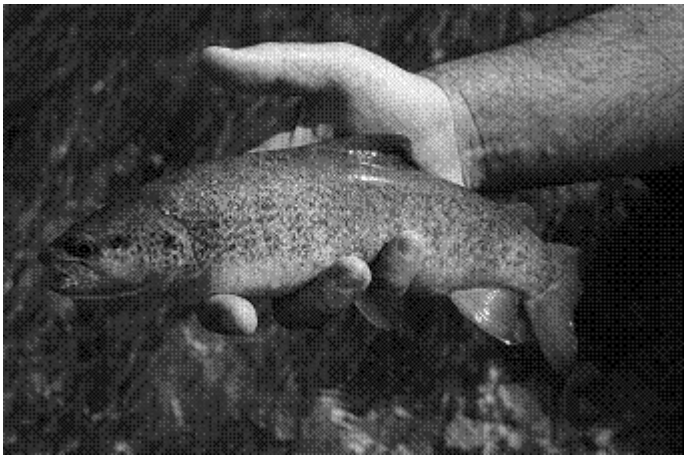

Figure 3. Platycephalus angled in Soğuksu Stream

Central and Eastern Black Sea Region

This region should also be studied in two different sub-categories as both areas differ from each other in topographic character.

The Central Black Sea region includes many small streams under dense vegetation. The flow rate of these streams varies from season to season as the headwater springs are quite small and are affected by the highland melting snows during the spring. Most of the streams only reach a satisfactory level of flow and steepness where the human populations get denser which as a result restricts trout waters that could be fished.

The Eastern Black Sea region on the other hand has an exceptional number of streams with excellent water quality, varied flow rates and densely wooded vegetation which provide the classic mountain landscapes trout fishers admire. The streams on the side of the Kaçkar Mountains that drain to the Black Sea basin also have native sea trout stocks

(*Salmo trutta labrax*) with huge trophy sizes. The rivers that you can find both *Salmo trutta macrostigma* and *Salmo trutta labrax* are the Fırtına, Çağlayan and İkizdere rivers located in the eastern part of Black Sea region. These 3 rivers have a high flow rate but a declining gradient closing to the sea which creates a favourable condition for fly fishing

This region of the country, which already is enjoyed by tourists interested in Alpinism, trekking and camping, has a remarkable potential in trout fishing but only if appropriate measures are taken.

Western Black Sea and the Aegean Regions

There are several ranges of mountains like the Yıldız in the west of the İstanbul metropolitan area which have several small free-stone streams draining to the Black Sea with a medium rate of flow but with a soft steepness which is perfect for fly fishing. However, the region is highly dense in population with well developed transportation facilities which affects the native trout populations inversely.

The Aegean on the other hand, especially the Biga Peninsula could be called as the heaven of native trout. The fish of this region have been genetically identified as being of Black Sea origin (although draining to the Aegean Sea) and are very bright coloured with fascinating physical characteristics. The streams flow from the highlands in a steadily descending attitude with lots of pools generated. The streams of the region however, are under extensive fishing pressure. The native trout has only survived in the highlands close to the springs or in national parks and protected conservation areas. The highland streams have a consistent flow rate during the spring season when the snow melts until the mid-summer in July. The climate is not favourable for the fish after July as the temperature of the water rises and the flow rates decreases tremendously.

Mediterranean Region

The streams of the Mediterranean have an excellent character for fly fishing. The streams flow out from the rocky cliffs of the Taurus Mountains into valleys where they drain to the Mediterranean Sea. The flow rate is very high and trout habitat lasts for kilometres, with streams flowing through steep pine-forested valleys, providing an idyllic setting for fly fishing. Some of the rivers are, Manavgat, Aksu, Alakır, Köprüçay and Dim. These are fascinating trout angling destinations but not all are inhabited exclusively by native trout any longer. The Aksu river has a flow rate of 1343 $hm^3\ yr^{-1}$ and the Köprü River 555 $hm^3\ yr^{-1}$.

Trout economy

Trout is a fish that has fascinated millions of people on our globe and actually not only in the northern hemisphere, but with the scientific developments of the 19th century, in the south as well. You can now fish trout in the rivers of Kenya in Africa or in lakes in Patagonia of South America. Humans have taken this marvellous creature to the lands they migrated or travelled. And with the spread of trout, so did angling. Today angling for trout, especially fly fishing accounts for millions of dollars of income to local and

national economies. "*A trout is too precious to be caught once*" being the motto of many anglers. Trout fishing is often catch and release and this behaviour would promote sustainability of trout in over pressured areas.

Rastgele-Der Society of Amateur Anglers in Turkey within this framework intends to develop and promote fly fishing trout in the rivers of Turkey with the aim of attaining sustainable management of trout stocks and being able to adopt a management strategy. For this reason there is need for an in-depth economic analysis of the fishing sector both in the world and in Turkey that will act as a comparative indicator of the economic and natural value that we posses, and which I believe are often unaware of.