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Effects of Water Temperature and Depth on the Catch Rate and Catch per Unit Effort for Mirror Carp *(Cyprinus carpio)* caught by Gillnets

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ABSTRACT

This study was conducted in Keban Dam Lake (38°49.271'N - 39°17.057' E) between July and March 2012 in Elazig, Turkey. In this study examined variations in CPUE fishing values of mirror carp (*Cyprinus carpio*) according to different hanging ratios (E=0.5, 0.67), materials (multi-monofilament and multifilament), water temperature, and water depth. CPUE values were found to be higher at 24.5 °C water temperature and 13.7 m water depth with multi-monofilament gillnets with a result of 15.23 g/m, and the lowest was with multifilament gillnets with a result of 3.95 g/m (0.5); however, multi-monofilament gillnets had a result of 23.28 g/m and multifilament gillnets 14.58 g/m (0.67) in July, respectively. Depending on the water temperature and the water depth, the CPUE values were higher in July than the other months. The lowest CPUE value was in March with 11.5°C water temperature and 18.5 m water depth. Finally, these findings clearly show that increasing and/or higher temperatures supported higher CPUE values. In contrast increasing depths gave rise to a decrease in CPUE values.

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All the authors designed the study. MD and TA performed the experiments. MD wrote the article. MD and ED evaluating data.

Key words
***Cyprinus carpio*, Mirror carp, Cpue, Multi-monofilament, Multifilament.**

INTRODUCTION

Catch per unit effort (CPUE) data from commercial fishing operations traditionally have been used as a relative index of fish stock abundance. There is a strong relationship between fish population and CPUE that is considered the index of concentration for natural fish stocks, and the rational alteration of CPUE shows the changes of fish stocks (Hyvarinen and Salojarvi, 1991; FAO, 1999; Shelton *et al*., 2001; Hinton and Maunder, 2003; Parsa *et al*., 2014). Thus CPUE takes the index of concentration for evaluation of natural fish stocks into account. This index can be affected by characteristics of fishing tools, material structure, hanging ratio, and mesh size as well as the ecological condition of the study area and the abundance of the target species in passive fishing. CPUE is determined more easily than the amount of biomass, thus it is highly important in making the correct decisions in fisheries management (Oztaş and Balık, 2012; Parsa *et al*., 2014). Gillnets are the most important passive fishing gears with characteristics like different structure, material, color, hanging ratio, and mesh size .The behavior of the target fish is a highly important factor for passive fishing operations like gill net fishing. Fish behavior can be changeable in different species and affected by the water temperature (Balık and Çubuk, 2001).

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CPUE value depends on the abundance of the target species (Ligtvoet and Mkumbo, 1991). Mirror carp (*Cyprinus carpio*) is a highly commercial species in Turkish inland waters. It prefers warm waters (20–28 °C) to live, and it reproduces in shallow waters when the water temperature is between 18 and 20 °C in the end of spring and summer. In the winter, it moves to deep water and hardly feeds (Ekingen, 1983; Atay, 1987; Çelikkale, 1991).

Carp production in Turkish inland waters was 9998.1 tons in 2011 (26.95% of all fisheries production) (TUIK, 2011). Keban Dam Lake in Elazig, Turkey, has the second highest inland fisheries production in Turkey, and fisheries operations have an economic importance for people who live nearby the dam lake. Mirror Carp is an important commercial fish species for the area, and it is highly caught by fishermen.

The main purpose of this study was to compare the CPUE values of mirror carp caught by multi-monofilament and multifilament gillnets configured with different hanging ratios depending on water temperature and depth.

MATERIALS AND METHODS

Study area

This study was conducted in Keban Dam Lake (38°49.271'N - 39°17.057' E) between July and March 2012 in Elazig, Turkey.

Sample collection

Multi-monofilament and multifilament gillnets (45,

50, 55, and 60 mm mesh size) were used in this region to fish mirror carp. Gillnets were configured with a 0.50 and 0.67 hanging ratio. A total of 18 fishing operations were conducted twice a month. Soak time for the nets was approximately 12 h, as nets were set in the night and retrieved the next morning. Water temperature and water depth were measured and recorded monthly (Table I).

Comparison of CPUE values was made of mirror carp caught with different hanging ratios (0.50 and 0.67) and different materials (multi-monofilament and multifilament) depending on water temperature and depth. The CPUE was estimated using the following formula:

$$CPUE = \Sigma = (Y/n) / N$$

Where; CPUE is amount of catch in each operation on fishing effort, Y is total weight of catch in fishing operation, N is number of fishing operations and n is length of gillnets (m).

Statistical analysis

Analysis of variance (ANOVA) was used to test the differences of the fish caught among the different hanging ratios and different materials. In addition the differences between the fish caught among the different groups were tested by the Duncan. A t-test was performed in the same groups.

RESULTS

The amount of mirror carp caught and the rational distributions of Keban Dam Lake are shown in Table I. The highest amount of fish was caught in multi-monofilament nets with a 0.50 hanging ratio in July, and the lowest amount of fish was caught in multifilament nets with a 0.67 hanging ratio in March. When the rational distribution is considered, the amount of fish caught by multi-monofilament nets with a 0.50 hanging ratio was 1.02 times more than that of caught by multi-monofilament nets with a 0.67 hanging ratio. The amount of fish caught by multifilament nets with a 0.50 hanging ratio was 1.06 times higher than the amount of fish caught by multifilament nets with a 0.67 hanging ratio.

A total amount of 79930.5 g fish were caught, with multi-monofilament gillnets representing 28.97% (E=0.50, 40400 g) and 28.35 % (E=0.67, 39530.5 g) and multifilament gillnets representing 21.95% (E=0.50, 30615 g) and 20.75% (E=0.67, 28874.3 g).

Table II shows monthly CPUE values depending on water temperature and water depth of mirror carp caught by multi-monofilament and multifilament with different hanging ratios (0.50 and 0.67). The highest CPUE value was accomplished with multi-monofilament gillnets with a 0.50 hanging ratio (101 g/m). The fish catch ratio increased with a decreasing hanging ratio (0.50). According to monthly data, the highest amount of fish caught was in July (E=0.67, CPUE= 23.28). The lowest CPUE value was in March by multifilament gillnets (E= 0.67, CPUE= 3.2). Thus the catch rate and catch per unit effort for carp were low in winter as fish go deep. The differences among monthly average CPUE, water temperature, and water depth values were statistically significant ($p<0.05$). The effect of water temperature, water depth, and the hanging ratio of multi-monofilament and multifilament nets on monthly CPUE values are shown in Figures 1 and 2. The maximum CPUE values were obtained by multi-monofilament nets with a 0.67 hanging ratio when the water temperature was high in the summer months, and the yield was getting lower with the decrease of the water temperature. The water temperature and water depth had differences among the months during the survey. In the summer months, while the water temperature was rising, the water depth decreased. As a result of this the difference between the CPUE value in July, which was the highest and in August was not statistically significant ($p>0.05$). In constrast the difference of CPUE values among other months were significant ($p<0.05$). The difference of CPUE values between multi-monofilament and multifilament nets was also statistically significant ($p<0.05$).

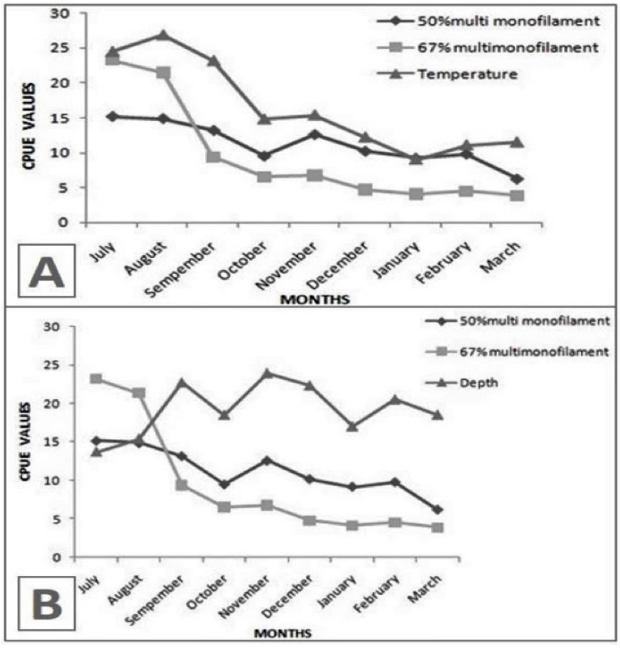

Fig. 1. Monthly CPUE values of mirror carp caught by multi-monofilament gillnets with different hanging ratios (0.5 and 0.67) depending on water temperature (A) and water depth (B).

Table I.- Rational distribution and amount of fish caught by multi-monofilament and multifilament with different configured hanging ratios.

Months	Amount of fish caught (g)				Rational distribution	
	Multi-monofilament	Multi-filament	Multi-monofilament	Multi-filament	Multi-monofilament	Multi-filalement
	(E=0.5)		(E=0.67)		0.5/0.67	0.5/0.67
July	6092	1580	12479	7809.5	0.4	0.2
August	5992	5520	11470	5467.2	0.5	1.0
September	5280	4715	5038.4	3323.2	1.04	1.4
October	3812	3840	3494.7	2358.4	1.09	1.6
November	5060	4160	3644.8	2304.8	1.38	1.8
December	4084	2880	2546	2090.4	1.60	1.3
January	3680	2720	2197.6	2251.2	1.67	1.2
February	3920	2880	2412	2036.8	1.62	1.4
March	2480	2320	2090.4	1232.8	1.18	1.8
Total	**40400**	**30615**	**39530.5**	**28874.3**	**1.02**	**1.06**

Table II.- Monthly CPUE values depending on water temperature and water depth of carp caught by multi-monofilament and multifilament with different hanging ratios (0.5 and 0.67).

Months	CPUE (g/m)					
	Multi-monofilament	Multi-filament	Multi-monofilament	Multi-filament	Av. Temp	Av. Depth
	(E=0.5)		(E=0.67)		(°C)	(m)
July	15.2	3.9	23.2	14.5	24.5	13.7
August	14.9	13.8	21.4	10.2	26.9	15.4
September	13.2	11.5	9.4	6.2	23.2	22.7
October	9.5	9.6	6.52	4.4	14.8	18.5
November	12.6	10.4	6.8	4.3	15.4	23.9
December	10.2	7.2	4.75	3.9	12.2	22.3
January	9.2	6.8	4.1	4.2	9.0	17.0
February	9.8	7.2	4.5	3.8	11.1	20.5
March	6.2	5.8	3.9	3.2	11.5	18.5
Total	**101**	**76.2**	**84.6**	**-**	**-**	**-**

Difference among groups with different letters was statistically significant ($p < 0.05$). In the same among group of CPUE values was statistically significant ($p < 0.05$).

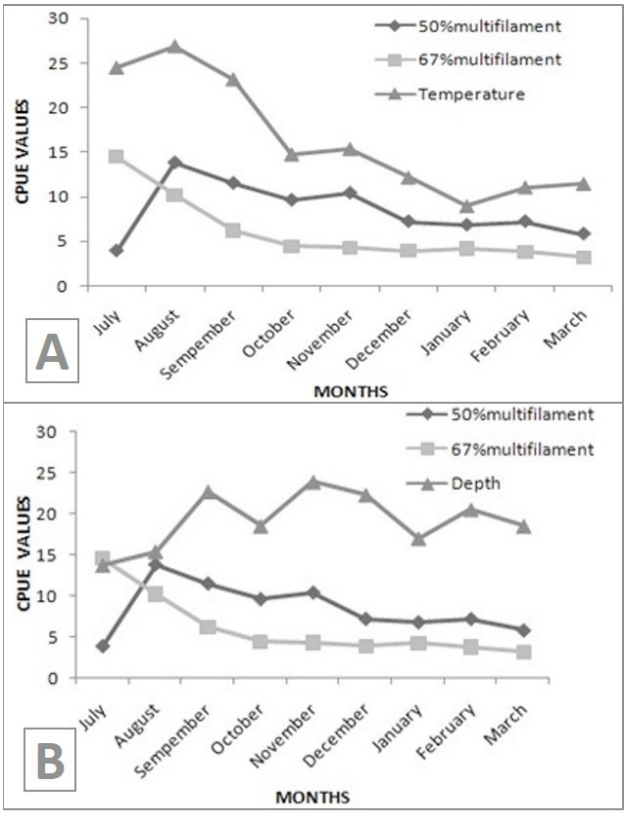

Fig. 2. Monthly CPUE values of mirror carp caught by multifilament gillnets with different hanging ratios (0.5 and 0.67) depending on water temperature (A) and water depth (B).

DISCUSSION

Plenty of factors, such as the behavior of target species, fishing depth, water dynamics, water temperature, material characteristics of fishing tools, and fishing operation time, can affect gillnet fishing (Bjordal, 1981; Akamca *et al*., 2008).

In the present study, it was determined that water temperature and water depth affected the CPUE value. The highest CPUE values were obtained when the water temperature was between 23.2°C and 26.9°C and the water depth was between 13.7 m and 15.4 m. These findings clearly show that increasing and/or higher temperatures supported higher CPUE values. In contrast increasing depths gave rise to a decrease in CPUE values. Balik and Cubuk (2001) specified that CPUE values for gillnets with 18, 20, 22, 26, 30 and 36 mm mesh sizes were 181.2, 170.5, 244.6, 123.4, 76.8 and 29.9 g/m, respectively and the CPUE value of mirror carp was 2.1 g/m in December. In the present study, the highest CPUE value of mirror carp was obtained in July as 23.28 g/m. Machiels *et al* (1994) reported different configured hanging ratios (0.25, 0.33, and 0.50) of gillnets, with the lowest hanging ratio increasing the fish amount. Nomura (1978) reported that the most suitable hanging ratios for gillnets ranged between 0.30 and 0.50. Backiel and Welcome (1980) identified that the nets with a 0.50 hanging ratio were more effective than gillnets with a 0.67 hanging ratio. In this study, we similarly concluded that the highest fish amount was obtained by the gill nets with the configured hanging ratio of 0.50. Parsa *et al*. (2014) investigated the effects of hanging ratio on the catch rate and CPUE of tuna in drifting gillnets in Bushehr coastal waters in the Persian Gulf. A total of 55889kg of various large pelagic species were caught during sixcruises in six months. Catches of 26409 and 29480 kg were related to gillnets with 0.50 and 0.60 hanging ratios, respectively. The CPUE did not differ significantly between the two types gillnets ($p>0.05$).

Our study determined that in nine month, multi-monofilament gillnets accounted for 28.97% (E=0.50, 40400 g) and 28.35% (E=0.67, 39530.5 g), and multifilament gillnets accounted for 21.95% (E=0.50, 30615 g) and 20.75% (E=0.67, 28874.3 g). Mirror carp is a highly commercial species in Turkish inland waters, including the Keban Dam Lake of the Elazig Province. In this study, the monthly differences of CPUE of mirror carp caught by multi-monofilament and multifilament during the fishing season were determined. Since mirror carp is a warm-water fish, it would be expected that its CPUE value would be higher in summer months and would be lower as the water temperature decreased. The findings in the present study supported this as the temperature appeared to be one of the most effective factors for CPUE value in Keban Dam Lake followed by hanging ratio and material characteristics.

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Conflict of interest statement

We declare that we have no conflict of interest.

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