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Effect of Net Twine on Efficiency of Trammel Nets for Catching Carp (*Cyprinus carpio* Linnaeus, 1758) in Lake Beyşehir and Silver Crucian Carp (*Carassius gibelio* Bloch, 1782) in Lake Eğirdir

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Abstract

Fishing experiments were carried out with four trammel net types from May 1998 to August 1999, to determine the influence of net twine type (monofilament and multifilament) on efficiency of trammel nets for catching carp, *Cyprinus carpio* Linnaeus, 1758 in Lake Beyşehir and silver crucian carp, *Carassius gibelio* Bloch, 1782 in Lake Eğirdir. Each net type had four nets with mesh sizes of 56, 80, 100 and 120 mm (stretched mesh of inner walls).

Type A nets (monofilament inner wall and outer walls) were more efficient than the other net types (type B, monofilament inner and multifilament outer walls; type C, multifilament inner wall and monofilament outer walls; and type D, multifilament inner wall and outer walls) for capturing carp and silver crucian carp. Effect of monofilament net twine on efficiency of trammel nets was found to be 3.07 and 2.70 times higher than multifilament net twine for capturing carp and silver crucian carp, respectively. Monofilament inner walls of trammel nets were more efficient than multifilament inner walls for both carp and silver crucian carp. However, no significant difference in catching efficiency of monofilament and multifilament outer walls was found.

Key words: Monofilament, multifilament, net twine, trammel net, efficiency

Introduction

Trammel nets and gillnets are widely used in freshwater fisheries of Turkey, but the use of trammel nets is less common than gillnets. In principle, because of the nature of its construction, a trammel net is able to catch small size and big size fish, so the catching efficiency is relatively higher than gillnets (Koike and Matuda, 1988). Trammel net is a triple net wall in which between wide mesh stretched outer walls a rather loose interior net is inserted. A fish encountering the net, pushes against the loose interior net and a pocket is formed around the fish in which it becomes entrapped.

The catching efficiency of trammel nets depends on the use of the right materials having least thickness without reduction in strength, lesser visibility, softness, desired elasticity and knot strength. The colour of material, mesh size and hanging ratio also influence the efficiency of trammel nets. There is no ideal material having all the desired properties, and therefore, the selection of the best available material for a specific purpose is important (Klust, 1982). Many studies have been carried out on comparison of catching efficiencies of multifilament and monofilament nets. Most of them indicated that monofilament nets were more efficient than multifilaments (Kuşat, 1996; Balık, 1998; Balık and Çubuk, 2000; Balık, 2001; Thomas *et al*., 2003). However, Stewart (1987) and Machiels *et al*. (1994) found that multifilament nets were more efficient than monofilament nets for catching some species.

Carp in Lake Beyşehir and silver crucian carp in Lake Eğirdir are mostly fished with trammel nets. Before the beginning of the 1990s, multifilament trammel nets were used for fishing in these lakes, but in last 20 years, the use of monofilament trammel nets has been spread. Knowledge of effect on catching efficiency while a new material are used for construction of passive nets such as trammel nets is fairly important for fisheries management and for improving commercial fishing. Especially, exploitation of fish stocks is dependent on effort, catchability and selectivity of gear used, and the fishermen's choice of time and fishing area (Huse *et al*., 2000). Therefore, in this study it was examined the effect of monofilament and multifilament net twines on efficiency of trammel nets for catching carp, *Cyprinus carpio* Linnaeus, 1758 in Lake Beyşehir and silver crucian carp, *Carassius gibelio* Bloch, 1782 in Lake Eğirdir.

Materials and Methods

The experimental fishing operations were carried out in both Lakes Beyşehir and Eğirdir (Figure 1). These lakes are the largest and second largest fresh water lakes of Turkey. Both lakes are also located in the "Göller Bölgesi". Lake Beyşehir has a surface area of 690 km^2 and its mean depth is 6 m, and the altitude is 1121 m. The total surface area of Lake Eğirdir is 468 km^2, and its mean depth is about 8-9 m. This lake is 918 m above of the sea level.

In this study, a total of 16 trammel nets

comprising four net types were tested for capture of carp in Lake Beyşehir and silver crucian carp in Lake Eğirdir. Each net type had four nets with mesh size of 56, 80, 100 and 120 mm (stretched mesh of inner wall). The length and hanging ratio of each net were 100 m and 0.50, respectively. These net types were: Type A, inner wall and outer walls from monofilament; type B, inner wall from monofilament and outer walls from multifilament; type C, inner wall from multifilament and outer walls from monofilament; type D, inner wall and outer walls from multifilament. Apart from net materials, the construction of the experimental nets of the same mesh size was very similar and they were fished in the same way and in the same area. The technical features of the nets were given in Table 1.

Experiments were conducted monthly in the fishing areas of Akburun, Gölkaşı and Çiftlik villages of Lake Beyşehir and in the Bridge Fishing Area of Lake Eğirdir from May 1998 to August 1999. All nets were set simultaneously in the same areas of both lakes to give more or less identical fishing conditions. In all fishing trials, the nets were fastened end to end from their float and lead lines, and the first net was fastened to the vessel which drifts along with the nets. The end of the last net was fastened to a buoy. During the trials, the nets were set in the mornings and hauled the following mornings. On landings, fishes caught

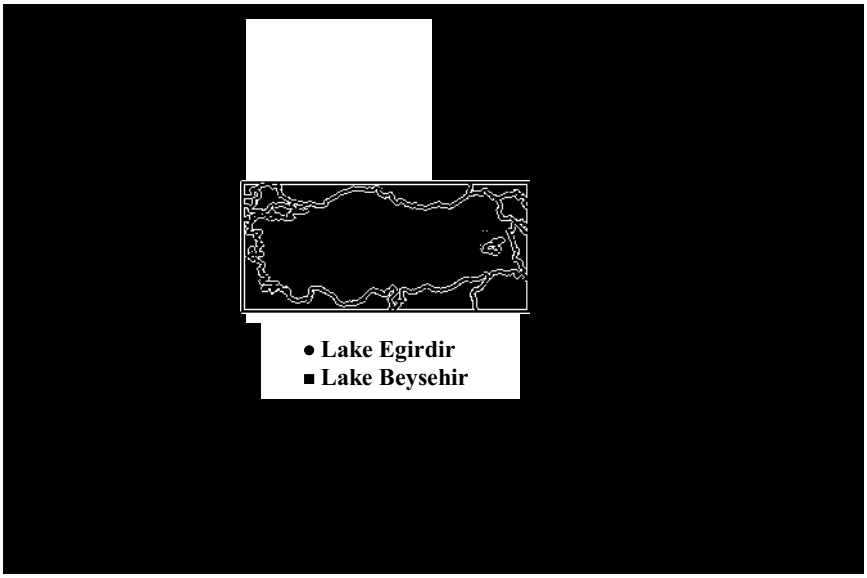

Figure 1. Maps of Lake Beyşehir and Eğirdir showing study areas.

Table 1. Technical features of trammel nets used during trials in Lake Beyşehir and Eğirdir

	Inner wall				Outer walls			
Net types	Mesh size (mm)	Twine thickness (mm or denier)	Depth of the net mesh (cm)		Mesh size (mm)	Twine thickness (mm or denier)	Hung depth mesh (cm)	
A	56	0.18	100	487	460	0.37	7	280
	80	0.18	50	348	480	0.37	5	209
	100	0.23	50	435	500	0.37	6	261
	120	0.23	50	522	500	0.37	7	305
B	56	0.18	100	487	460	210X6	7	280
	80	0.18	50	348	480	210X6	5	209
	100	0.23	50	435	500	210X6	6	261
	120	0.23	50	522	500	210X6	7	305
C	56	210X2	100	487	460	0.37	7	280
	80	210X2	50	348	480	0.37	5	209
	100	210X2	50	435	500	0.37	6	261
	120	210X2	50	522	500	0.37	7	305
D	56	210X2	100	487	460	210X6	7	280
	80	210X2	50	348	480	210X6	5	209
	100	210X2	50	435	500	210X6	6	261
	120	210X2	50	522	500	210X6	7	305

from each net were removed separately from each net and each fish was measured in fork length (L, mm) and weighed in total body weight (W, g).

Analysis of variance (ANOVA) was used to test differences of the catches caught with the same mesh-sized nets of different net types. Least Significant Difference test was applied for comparison of pairs of the mean catch of carp and silver crucian carp caught in the net types. In addition, differences between average lengths and weights of fishes captured in the same mesh-sized nets of net types were tested by Student *t*-test (Yurtsever, 1984; Çömlekçi, 1988; Elbek *et al*., 2002).

Results

Carp Fishing

A total of 46 fishing trials were conducted in Lake Beyşehir using all kinds of four net types. In the trials, 466 carps were caught with 16 trammel nets belonging to four net types. Except of carp, tench (*Tinca tinca*), pikeperch (*Sander lucioperca*), chub (*Leuciscus lepidus*) and nose (*Chondrostoma regium*) were also caught in the nets. Tench were the most abundant fish in the catch. The second most abundant fish species was carp. The numbers and percentages of carp captured with the same mesh-sized nets of different trammel net design were given Table 2.

Table 2 showed that 38.8, 32.8, 15.7 and 12.7% of total carp catch were caught by the type A, B, C and D nets, respectively. Of the four mesh-sized nets used for each net type, 56 mm gave higher catch than the other mesh sizes for carp. Total catches of carp captured in the other mesh sizes of the net types were similar. For catching carp in Lake Beyşehir, type A nets caught an average 1.18, 2.48 and 3.07 times more carp than the types B, C and D nets, respectively (Table 3). Differences in catching efficiencies were significant ($P<0.05$) between types A and C, A and D, B and C, B and D for capturing carp. In addition, monofilament inner walls were found to be average 2.53 (A+B/C+D) times more effective than multifilament. However, monofilament outer walls was only average 1.20 (A+C/B+D) times more efficient than multifilament for catching carp.

The average lengths and weights of carp captured by different mesh-sized nets of the net types were given in Table 4. The average lengths of carp captured by 80 mm mesh-sized nets of the types A and D, C and D, and the average weights of carp captured by the same mesh-sized nets of the types C

Table 2. Numbers (N) of percentages (N%) of carp captured by mesh size and trammel net type in Lake Beyşehir

	A		B		C		D		Total	
Nets	N	N%	N	N%	N	N%	N	N%	N	N%
56	66	33.5	71	36.0	29	14.7	31	15.7	197	42.3
80	33	39.8	31	37.3	13	15.7	6	7.2	83	17.8
100	38	42.2	27	30.0	19	21.1	6	6.7	90	19.3
120	44	45.8	24	25.0	12	12.5	16	16.7	96	20.6
Total	181	38.8	153	32.8	73	15.7	59	12.7	466	100

Table 3. The relative efficiency of the same mesh-sized nets for each of the net types A, B, C and D for catching carp in Lake Beyşehir

Nets	A:B	A:C	A:D	B:C	B:D	C:D
56	0.93	2.28	2.13*	2.45*	2.29*	0.94
80	1.06	2.54*	5.50*	2.38*	5.17*	2.17
100	1.41	2.00	6.33*	1.42	4.50*	3.17*
120	1.83	2.32*	7.33*	2.00	1.50	0.75
Mean	1.18	2.48*	3.07*	2.09*	2.59*	1.24

*: All the values are significant ($P < 0.05$).

Table 4. Average lengths and weights of carp captured by the same mesh-sized nets of the net types in Lake Beyşehir (s: Standart deviation)

	A		B		C		D	
Nets	L±s	W±s	L±s	W±s	L±s	W±s	L±s	W±s
56	16.0±2.4	92±60	15.6±3.3	92±141	15.3±1.3	71±12.9	16.5±4.0	114±169
80	23.1±4.3	281±192	23.3±4.9	292±227	24.2±3.9	325±185	20.0±2.6	182±66
100	31.3±3.5	636±199	31.1±3.1	619±139	32.7±4.2	729±288	33.6±4.2	721±234
120	35.5±4.8	957±467	35.6±6.6	965±497	34.7±2.9	819±202	35.0±4.3	899±256

and D were statistically different (P<0.05). On the other hand, differences between the types A and B, A and C for the average weights of carp captured by 56 mm mesh-sized nets were also statistically significant (P<0.05). Similarly, the average weights of carp captured by 100 and 120 mm mesh sizes of the types B and C were also statistically different (P<0.05).

Silver Crucian Carp Fishing

During the study, 27 fishing trials were conducted for catching silver crucian carp in Lake Eğirdir. In trials, a total of 882 silver crucian carps were caught with the experimental nets. Besides silver crucian carp, pikeperch, carp and vimba (*Vimba vimba*) were caught by the experimental nets. However, silver crucian carp was the dominant fish species in the catch.

The numbers and percentages of silver crucian carp captured by mesh size and net type were given in Table 5. Most of the silver crucian carp were caught by the nets of type A. Totally, 37.1% of silver crucian carp catch was caught in the nets of this net type. This net type was followed by the type B, C and D nets, respectively.

Comparisons of the catches captured in the net types showed that the type A nets caught 1.11, 2.34 and 2.70 times more silver crucian carp than the type B, C and D nets, respectively (Table 6). There was no statistically difference (P>0.05) between the catches of type A and B, C and D nets. However, differences of silver crucian carp catch captured in the nets of the types A and C, A and D, B and C, B and D were significant (P<0.05).

The average lengths and weights of silver crucian carp captured by the same mesh-sized nets of the net types were given in Table 7. The average lengths of silver crucian carp captured by 120 mm mesh-sized nets of types A and D, and the average weights of silver crucian carp captured by 100 mesh-sized nets of types A and C, B and C, C and D were statistically different (P<0.05).

Discussion

The results of this study showed that type A nets were more effective than the other net types for catching both carp in Lake Beyşehir and silver crucian carp in Lake Eğirdir. This trammel net type was followed by types B, C and D for catching both

Table 5. Numbers (N) and percentages (N%) of silver crucian carp caught by mesh size and trammel net type in Lake Eğirdir

	A		B		C		D		Total	
Nets	N	N%	N	N%	N	N%	N	N%	N	N%
56	32	34.8	17	18.5	17	18.5	26	28.3	92	10.4
80	212	36.7	213	36.9	93	16.1	59	10.2	577	65.4
100	60	40.3	46	30.9	15	10.1	28	18.8	149	16.9
120	23	35.9	18	28.1	15	23.4	8	12.5	64	7.3
Total	327	37.1	294	33.3	140	15.9	121	13.7	882	100

Table 6. The relative efficiency of the same mesh-sized nets for each of the net types A, B, C and D for catching silver crucian carp in Lake Eğirdir

Nets	A:B	A:C	A:D	B:C	B:D	C:D
56	1.88	1.88	1.23	1.00	0.65	0.65
80	1.00	2.28*	3.59*	2.29*	3.61*	1.58
100	1.30	4.00*	2.14	3.0	1.64	0.54
120	1.28	1.53	2.88	1.20	2.25	1.88
Mean	1.11	2.34*	2.70*	2.10*	2.43*	1.16

*: All the values are significant (P < 0.05).

Table 7. Average lengths and weights of silver crucian carp captured by the same mesh-sized nets of the net types in Lake Eğirdir (s: Standart deviation)

	A		B		C		D	
Nets	L±s	W±s	L±s	W±s	L±s	W±s	L±s	W±s
56	19.4±3.2	185±84	19.1±3.1	184±95	18.8±2.8	164±79	18.9±2.3	169±66
80	19.9±1.5	199±46	19.8±1.5	197±47	19.7±1.4	196±41	20.0±1.9	204±83
100	23.4±2.1	353±105	23.1±2.1	341±110	24.1±3.0	409±149	22.7±2.6	323±107
120	25.9±2.2	514±134	25.5±3.0	495±163	24.7±2.1	444±124	24.1±2.3	425±147

species. Type A nets (inner and outer walls from monofilament) were 3.07 and 2.70 times more efficient than the type D nets (inner and outer walls from multifilament) for carp in Lake Beyşehir and silver crucian carp in Lake Eğirdir, respectively.

In addition, it was determined in this study that the monofilament inner walls were average 2.53 times for catching carp and 2.38 times for silver crucian carp more effective than multifilament inner walls. However, no significant difference in catching efficiency of monofilament and multifilament outer walls was found ($P>0.05$). Comparisons of the effect of the net twine types of inner and outer walls for catching carp and silver crucian carp showed a much greater effect of the net twine type on the inner wall construction than the outer walls. The reason may be difference between mesh densities of inner wall and outer walls. Therefore, twine type of only inner walls of trammel nets is important for catching carp and silver crucian carp.

The results of this study were agreed with previous studies. Balık and Çubuk (2000) found that monofilament trammel nets have caught 2.08 times more tench than multifilament trammel nets in Lake Beyşehir. For catching pikeperch, Kuşat (1996) and Balık (1998) reported monofilament gillnets as 1.85 and 1.98 times more efficient than multifilament gillnets in Lakes Eğirdir and Beyşehir, respectively. According to Thomas *et al*. (2003), monofilament was 1.5 times more efficient than multifilament for catching penaeid prawns (*Penaeus indicus*). There are many factors which affect the catching efficiency of trammel nets, such as mesh size of the outer net, tension acting on the net due to buoyancy of floats, visibility of netting, change in the shape of netting by the current and others (Koike and Matuda, 1988). Steinberg (1964) also stressed the need for having nets of materials with low visibility and found that monofilament nets have higher catching efficiency than multifilament nets. However, Njoku (1991) reported that monofilament gillnets do not always perform better than multifilament gillnets. Machiels *et al*. (1994) found monofilament gillnets to be more efficient than multifilament for bream, *Abramis brama*, but less efficient for pikeperch. Stewart (1987) compared nets used in British cod fisheries and found that the multifilament net has a better catch than monofilament nets.

There was an increase in average lengths and weights of both species with increasing mesh size. Generally, trammel net selectivity is affected by the elasticity and flexibility of the net twine. Monofilament net twine is more elastic and flexible than multifilament. Meshes of a more elastic twine can be stretched to be larger size by a struggling fish (Hamley, 1975). However, there was no systematic relation among the sizes of fishes captured in the same mesh-sized nets of the net types.

The fishing circular for carp fishing prohibits the catching of smaller than 30 cm in total length (Anonymous, 2004). The mean lengths of carp caught with 100 mm mesh-sized nets of net types ranged from 31.1 to 33.6 cm in fork length. According to these values, minimum mesh size of trammel nets for catching carp should not be less than 100 mm.

In conclusion, catching efficiency of trammel nets has increased about three times for catching carp in Lake Beyşehir and silver crucian carp in Lake Eğirdir because of using the monofilament net twine instead of multifilament net twine on construction of the trammel nets. This situation provided more economic fishing activity for the local fishermen, but by the time it caused over-fishing for especially carp stocks in both lakes. Therefore, the use of monofilament trammel nets should be prohibited or fishing effort should be decreased for catching carp in Lake Beyşehir. On the other hand, for catching silver crucian carp in Lake Eğirdir it should be used only the monofilament trammel nets of less than 120 mm mesh size. Otherwise, the decreasing of the carp populations will be unavoidable in the near future. In addition, these results in Lake Beyşehir and Eğirdir showed that if catching efficiency of the nets improves, some regulations for fishing should be applied at the same time to prevent over-exploitation of fish stocks.

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