www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 14: 905-913 (2014) DOI: 10.4194/1303-2712-v14_4_09

Multifilament Gillnet and Trammel Net Selectivity for the Silver Crucian Carp (*Carassius gibelio* Bloch, 1782) in Eğirdir Lake, Isparta, Turkey

Mehmet Cilbiz[1,*], Zübeyde Hanol[1], Nihal Cilbiz[1], Şakir Çinar[1], Soner Savaşer[1]

[1] Eğirdir Fisheries Research Institute, Eğirdir, Isparta, Turkey.

* Corresponding Author: Tel.: +90.246 3113460; Fax: +90.246 3113463;
E-mail: mehmetcilbiz@hotmail.com

Received 22 June 2013
Accepted 27 November 2014

Abstract

The aim of this study was determine the selectivity of gillnet and trammel net with different mesh sizes for *C. gibelio* in Eğirdir Lake. Gillnets with mesh sizes of 32, 40, 50, 60, 70, 80 and 90 mm; and trammel nets with of 100, 110, 120, 130 and 140 mm were tested for catching of *C. gibelio*. Fieldwork was carried out in two different station of Eğirdir Lake, in a monthly period from December 2009 to April 2010 and with a total of 10 catching trials. The SELECT method was used to determine the selectivity parameters. Number of 592 *C. gibelio* species were caught in the experiments which the lengths ranged between 7.3 - 34.8 cm. According to the Bi-modal model which gave the lowest deviation for multifilament gillnets, the optimum lengths were determined as 8.74, 10.92, 13.65, 16.38, 19.11, 21.84 and 24.57 cm for 32, 40, 50, 60, 70, 80 and 90 mm mesh sizes respectively. According to the Normal scale model which gave the lowest deviation for trammel nets, optimum lengths were determined as 27.20, 29.92, 32.64, 35.36 and 38.08 cm for 100, 110, 120, 130 and 140 mm mesh sizes in trammel net respectively.

Keywords: Gillnet, trammel net, selectivity, SELECT method, *Carassius gibelio*.

Eğirdir Gölü'nde (Isparta-Türkiye) Gümüşi Havuz Balığı İçin (*Carassius gibelio* Bloch, 1782) Multifilament Solungaç ve Fanyalı Uzatma Ağı Seçiciliği

Özet

Bu çalışmada, multi filament materyalden yapılmış 32, 40, 50, 60, 70, 80, 90 mm göz açıklığındaki solungaç ve 100, 110, 120, 130, 140 mm göz açıklığındaki fanyalı uzatma ağlarının, gümüşi havuz balığı avcılığındaki seçiciliği belirlenmiştir. Saha çalışması, Eğirdir Göl'ünde iki farklı istasyonda, Aralık-2009 ve Nisan-2010 döneminde aylık olarak toplam 10 avcılık operasyonu ile gerçekleştirilmiştir. Seçicilik parametrelerinin belirlenmesinde SELECT metot kullanılmıştır. Araştırma süresince 7,3-34,8 cm boy aralığında 592 adet balık yakalanmıştır. Solungaç ağları için en düşük sapmayı veren Bi-modal modeline göre yapılan hesaplamalar sonucunda, 32, 40, 50, 60, 70, 80, 90 mm göz açıklığındaki solungaç ağlarının optimum yakalama boyları sırasıyla 8,74, 10,92, 13,65, 16,38, 19,11, 21,84 ve 24,57 cm olarak; fanyalı ağlar için en düşük sapmayı veren Normal scale modeline göre yapılan hesaplamalar sonucunda 100, 110, 120, 130, 140 mm göz açıklığındaki fanyalı ağların optimum yakalama boyları sırasıyla 27,20, 29,92, 32,64, 35,36 ve 38,08 cm olarak bulunmuştur.

Anahtar Kelimeler: Solungaç ağı, fanyalı ağ, seçicilik, SELECT metot, *Carassius gibelio*.

Introduction

Silver crucian carp (*Carassius gibelio* Bloch, 1782) which have natural distribution areas in Korea, Northeast China, Russia (Zou *et al*., 2000; Tarkan *et al*., 2006) and in the Asian countries has been encountered first time (Baran and Ongan, 1988) in Gala Lake in Turkey; this species has been shown the rapid spread in a short time and firstly has been seen in all Thrace Region and then in many region of Turkey including the eastern places (Polat *et al*., 2011). Despite it is an invasive species, it has become an important source of income for Turkish fishermen with the recent emerging market in the Middle East. *C. gibelio* is 3rd most fishing species after common carp (*Cyprinus carpio* Linnaeus, 1758) and pearl mullet (*Chalcalburnus tarichi*, Pallas 1811) in inland waters of Turkey's. The total fishing production amount in 2012 was 5,090 tons and economical value of 1,192,300 $ (TUIK, 2013). Isparta province within the Eğirdir Lake is the 2nd in Turkey with the production of 1,140 tons annual and that correspond

© Published by Central Fisheries Research Institute (CFRI) Trabzon, Turkey
in cooperation with Japan International Cooperation Agency (JICA), Japan

to the 22.5% of the total production. *C. gibelio* has become one of the most contributing species to the annual gross product of Eğirdir Lake fishermen in 2012.

Ensure the sustainability of Turkey fisheries resources by healthy and productive way is possible with proper operation of the stocks (Sümer *et al*., 2007). For many years, it is known that gillnets are more selective than other catching gears (Sümer *et al*., 2007). Enhancing selectivity of catching gears has a great importance to ensure continuity of stocks and to obtain the maximum continuous product (Sümer *et al*., 2007). The basic principle in gillnets; based on the capture of actively moving fish to the mesh from the end of nose, behind the gill cover or trapped in the front of the dorsal fin (Pope *et al*., 1975; Sümer *et al*., 2010). The catching of trammel nets based on the catching of fisheries by forming bag in the inner panel after passing outer panel (Hoşsucu, 2011).

Trammel and gillnets are used commonly by inland fishermen in Turkey. It is useful, low cost and efficient fishing gear for fishermen who have 5-8.50 m boats with 7-13 HP motors. A fishermen may use 2000-2500 m nets as daily for catching in Eğirdir Lake.

Due to the being dominant species in many parts inland waters of Turkey and with the commercial value *C. gibelio* has become the target species with marketable of all length (20 cm and above). Because of the small mesh sizes are more efficient in the catching of this fish, mesh sizes of the nets drop as much as 60-70 mm especially in lakes which haven't been implemented any restriction. And also fishing gears using in catching of it affect the other species directly. Because there is no any legal length limit, the optimum commercial length for *C. gibelio* are shaped in accordance with request of traders. This has been caused an extremely adverse catching pressure on the other species. Although it is an invasive species, due to the catching of it affect the other species directly, knowing the selectivity of nets that have different mesh sizes in the catching of this species has gained importance in recent years. Because the using of monofilament gillnets has been prohibited recently for fishing in Turkey, the use of multifilament gillnets has been the subject in all catching grounds. With this study, scientific data will be provided to the fishery management authorities with respect to selectivity of multifilament nets which has a new application in the catching of *C. gibelio*.

Fighting with *C. gibelio* which starting reproduction in the first year in many source through catching is quite difficult when considering the sustainability of other species. However, know which mesh sizes net catch which length of *C. gibelio* form a key point of fight with catching.

In this study, the selectivity characteristics of gillnets and trammel nets that were made of multifilament material and have 32, 40, 50, 60, 70, 80, 90 and 100, 110, 120, 130, 140 mm mesh sizes were determined for catching of *C. gibelio*.

Materials and Method

The study was carried out in two different station of Eğirdir Lake, between December 2009 and April 2010 with a monthly period and a total of 5 catching trials (Figure 1). In catching trials, gillnets that are made of multifilament material with 32, 40, 50, 60, 70, 80 and 90 mm stretched mesh sizes which have 210 denier / 2 and lengths of 100 m and trammel nets with 100, 110, 120, 130 and 140 mm stretched

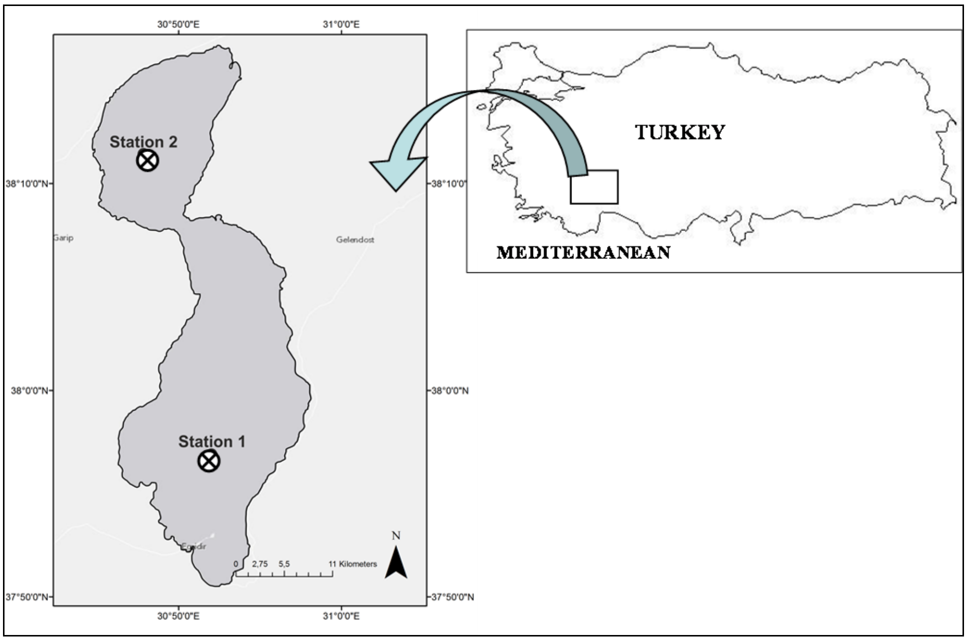

Figure 1. Study Area and sample station in Eğirdir Lake.

mesh sizes which have 210 denier / 2 (inner panels size) and 210 denier / 6 (outer panels) with E=0.50 hanging ratio were used. The depths of all nets were 50 meshes. Technical plan of the trial nets are shown in Figure 2. The fishing was carried out with renegade method and equipment made by adding to nets together (the nets were lowered into the water at dusk and drawn up at dawn). Average fishing time per catching operation was 16 hours. Catching fish were classified according to the nets and total lengths and determined with 1 mm precision measurement board and weights with 1g precision digital scale.

The SELECT (Share Each Length-class's Catch Total) method was used to determine selectivity (Millar, 1992; Millar and Fryer, 1999; Millar and Holst, 1997). This method assumes that the number of fish of length l caught with a mesh size with j size has a n_{lj} Poisson distribution, and is defined by the following equation (Acarlı *et al*., 2013):

$$n_{lj} \approx n_{lj} \approx \text{Pois}\,(p_j \lambda_l r_j(l)) \qquad (1)$$

where the abundance of fish determined as λ_l, length as l caught to net; and relative fishing intensity (the relative abundance of fish size as l, mesh size can catch as j) as $p_j(l)$. The Poisson distribution of the

Figure 2. Technical plan of trial nets (not in scale).

number of fish of size *l* caught by fishing gear with J mesh size is defined as $p_j(l)\lambda_l.r_j(l)$ the selectivity curve for *j* mesh size (Acarlı *et al*., 2013).

$$\sum_l \sum_j \{n_l \log[p_j \lambda_l r_j(l)] - p_j \lambda_l r_j(l)\} \qquad (2)$$

The data obtained from field studies were analyzed by PASGEAR version 2.4 (Kolding, 1999) computer program. The program calculates parameters of 5 different model (normal location, normal scale, log-normal, gamma, and bi-modal) based on SELECT (Millar, 1992; Millar and Fryer, 1999; Millar and Holst, 1997) method.

Model deviance of all models evaluated from calculations when the most suitable model is selected. The model that has greater standard deviation shows that the model in question is not appropriate to the obtained data (Park *et al*., 2004; Akamca *et al*., 2010). The most suitable model was chosen taking into account the lowest deviance value. Model equations of SELECT method as follows:

Normal location:

$$\exp\left(-\frac{(L-k.m_j)^2}{2\sigma^2}\right) \qquad (3)$$

Normal scale:

$$\exp\left(-\frac{(L-k_1.m_j)^2}{2k_2^2.m_j^2}\right) \qquad (4)$$

Log-normal:

$$\frac{1}{L}\exp\left(\mu+\log\left(\frac{m_j}{m_1}\right)-\frac{\sigma^2}{2}-\frac{\left(\log(L)-\mu-\log\left(\frac{m_j}{m_1}\right)\right)^2}{2\sigma^2}\right) \qquad (5)$$

Gamma:

$$\left(\frac{L}{(\alpha-1).k.m_j}\right)^{\alpha-1}\exp\left(\alpha-1-\frac{L}{k.m_j}\right) \qquad (6)$$

Bi-modal:

$$\exp\left(-\frac{(L-k_1.m_j)^2}{2k_2^2.m_j^2}\right)+c.\exp\left(-\frac{(L-k_3.m_j)^2}{2k_4^2.m_j^2}\right) \qquad (7)$$

Kolmogorov-Smirnov test was used to determine differences between size frequency distributions of fish caught by nets that have varying mesh sizes (Siegel and Castellan, 1988; Karakulak and Erk, 2008; Acarlı *et al*., 2013).

Results

A total of 10 catching operations, 592 *C. gibelio* were caught with length range of 7.3-34.8 cm. The distribution of fish according to the nets showed in Table 1. Average length (±SD) for gillnets of 32, 40, 50, 60, 70, 80, 90 mm mesh size were determined as 9.8±1.2, 10.9±1.1, 13.5±0.9, 17.4±1.5, 21.2±2.5, 22.4±1.8 and 23.3±1.4; for trammel nets of 100, 110, 120, 130, 140 mm mesh size were determined as 26.5±2.0, 26.3±2.1, 29.4±2.4, 30.3±2.2 and 29.3±2.9 respectively (Table 1). The total length–frequency distribution for different mesh sizes are shown in Figure 3 (for gillnets) and in Figure 4 (for trammel net).

Parameters of normal location, normal scale, log-normal, gamma, and bi-modal models calculated separately with the PASGEAR computer program and the results are showed in Table 2. As a result of comparing model deviations it was determined that the most appropriate model was bi-modal model for gillnet and was normal scale for trammel net (Table 2).

The selectivity curves drafted by the PASGEAR parameters according to the bi-modal and normal scale model as a result of obtained parameter are

Table 1. Number and average length of fish caught by trial nets

Net Type	Length of mesh size (mm)	Number of fish caught (n)	Percentage fish caught (%)	Average length±SD (cm)	Minimum length (cm)	Maximum length (cm)
Gillnets	32	51	8.62	9.8±1.2	7.3	14.5
	40	36	6.08	10.9±1.1	8.7	13.4
	50	27	4.56	13.5±0.9	11.4	15.2
	60	27	4.56	17.4±1.5	14.8	20.5
	70	52	8.78	21.2±2.5	12.4	26.8
	80	100	16.89	22.4±1.8	18.8	27.0
	90	60	10.14	23.3±1.4	20.4	26.8
Trammel net	100	120	20.28	26.5±2.0	22.7	34.8
	110	72	12.16	26.3±2.1	19.3	30.0
	120	18	3.04	29.4±2.4	24.1	34.8
	130	14	2.36	30.3±2.2	25.2	33.0
	140	15	2.53	29.3±2.9	22.9	34.8

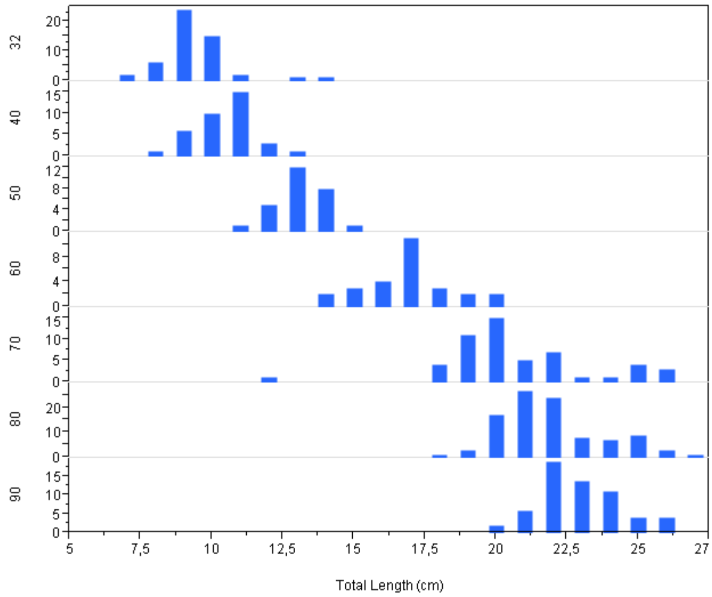

Figure 3. Total length frequency distribution of fish caught using different mesh sizes for gillnets.

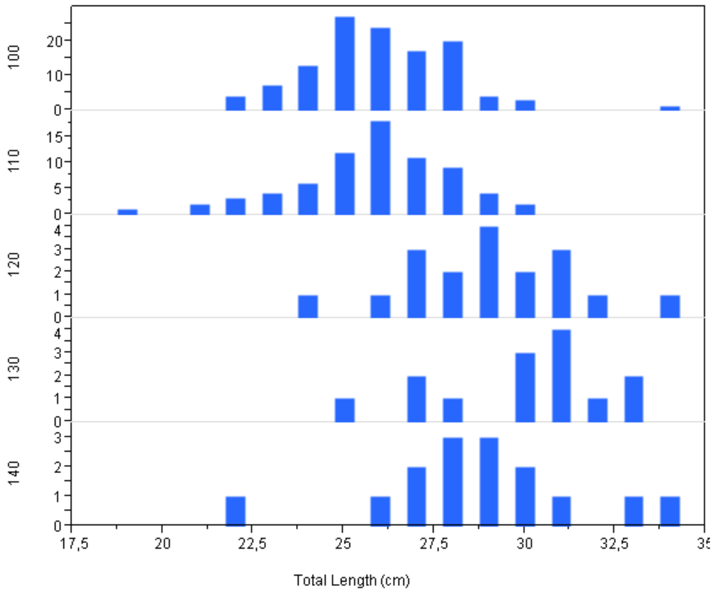

Figure 4. Total length frequency distribution of fish caught using different mesh sizes for trammel net.

Table 2. Selectivity parameter values for *C. gibelio*

Model	Net Group	Parameters	Modal Deviance	p-value	Degree of Freedom (d.f.)
Normal location	Gillnets	(k, σ)=(0.279, 2.115)	119.500	0.000000	50
Normal scale		(k_1, k_2)=(0.287, 0.034)	117.800	0.000000	50
Lognormal		(μ_1, σ)=(2.211, 0.115)	100.307	0.000000	50
Gamma		(k, α)=(0.004, 74.534)	104.945	0.000000	50
Bi-modal*		(k_1, k_2, k_3, k_4, w) (0.273, 0.018, 0.312, 0.042, 0.102)	**76.001**	**0.004686**	**47**
Normal location	Trammel Nets	(k, σ)=(0.268, 3.858)	83.952	0.000268	44
Normal scale*		(k_1, k_2)=(0.281, 0.032)	**72.925**	**0.003963**	**44**
Lognormal		(μ_1, σ)=(3.321, 0.132)	76.831	0.001593	44
Gamma		(k, α)=(0.004, 65.882)	75.333	0.002272	44
Bi-modal		No fit	-	-	-

*****parameters of appropriate model

showed in Figure 5 and Figure 6. The optimum length and spread values calculated according to the bi-modal (for gillnet) and normal scale (for trammel net) models for each net group that have different mesh size are shown in Table 3.

According to the results of Kolmogorov-Smirnov test that applied for query difference of length frequency distributions of fish caught by nets, difference were found between length distributions of all gillnet. As for trammel net apart from 100-120; 120-130 and 120-140 mesh size, the difference were determined in the length frequency distribution of fish caught by all of other trammel nets (Table 4, Table 5).

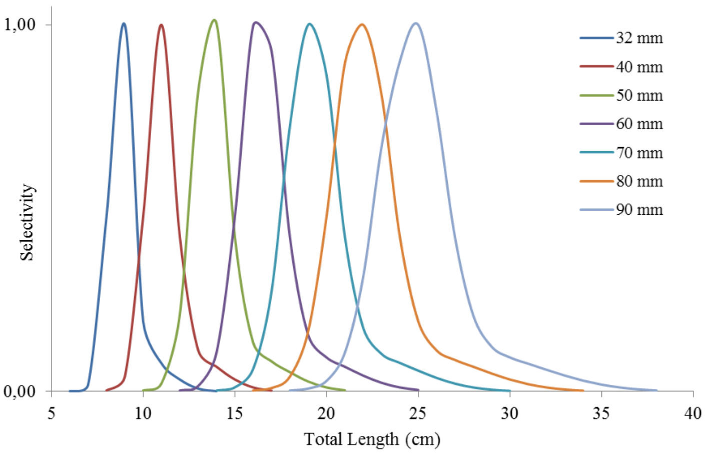

Figure 5. Selectivity curves of gillnets.

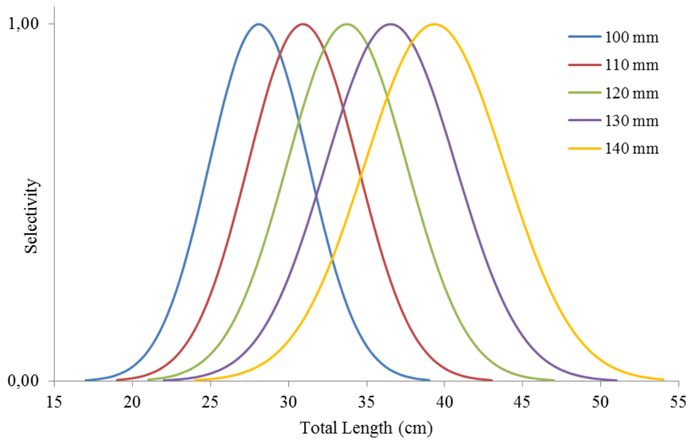

Figure 6. Selectivity curves of trammel net.

Table 3. Optimum length and spread values of *C. gibelio* according to the bi-modal (for gillnet) and normal scale (for trammel net) model

Net Group	Mesh size (mm)	Modal Length (cm)	Spread Value (cm)
Gillnets	32	8.74	0.58
	40	10.92	0.72
	50	13.65	0.90
	60	16.38	1.08
	70	19.11	1.26
	80	21.84	1.44
	90	24.57	1.62
Trammel net	100	27.20	3.00
	110	29.92	3.30
	120	32.64	3.60
	130	35.36	3.90
	140	38.08	4.20

Table 4. Result of the Kolmogorov-Smirnov test used to compare length frequency distributions of catch caught by gillnets

Net 1		Net 2		Kolmogorov-Smirnov Test		
Mesh Size	N	Mesh Size	N	D max	Critical Values (α=0.05)	Decision
32	51	40	36	0.4966	0.2872	H_0Reject
32	51	50	27	0.9285	0.3097	H_0Reject
32	51	60	27	0.9804	0.3097	H_0Reject
32	51	70	52	0.9821	0.2632	H_0Reject
32	51	80	100	1.0000	0.2325	H_0Reject
32	51	90	60	1.0000	0.2553	H_0Reject
40	36	50	27	0.8566	0.3332	H_0Reject
40	36	60	27	1.0000	0.3332	H_0Reject
40	36	70	52	0.9821	0.2905	H_0Reject
40	36	80	100	1.0000	0.2630	H_0Reject
40	36	90	60	1.0000	0.2833	H_0Reject
50	27	60	27	0.8984	0.3580	H_0Reject
50	27	70	52	0.9821	0.3186	H_0Reject
50	27	80	100	1.0000	0.2937	H_0Reject
50	27	90	60	1.0000	0.3121	H_0Reject
60	27	70	52	0.7626	0.3186	H_0Reject
60	27	80	100	0.8875	0.2937	H_0Reject
60	27	90	60	0.9688	0.3121	H_0Reject
70	52	80	100	0.3942	0.2310	H_0Reject
70	52	90	60	0.5673	0.2539	H_0Reject
80	100	90	60	0.3550	0.2177	H_0Reject

H_o: There are no significant difference between length frequency distributions (α=0.05, K=1.36).

Table 5. Result of the Kolmogorov-Smirnov test used to compare length frequency distributions of catch caught by trammel net

Net 1		Net 2		Kolmogorov-Smirnov Test		
Mesh Size	N	Mesh Size	N	D max	Critical Values (α=0.05)	Decision
100	120	110	72	0.0649	0.1994	H_0 Not Reject
100	120	120	18	0.6152	0.3154	H_0Reject
100	120	130	14	0.7444	0.3438	H_0Reject
100	120	140	15	0.5649	0.3358	H_0Reject
110	72	120	18	0.5985	0.3313	H_0Reject
110	72	130	14	0.7500	0.3584	H_0Reject
110	72	140	15	0.5811	0.3508	H_0Reject
120	18	130	14	0.3889	0.4533	H_0 Not Reject
120	18	140	14	0.2602	0.4473	H_0 Not Reject
130	14	140	15	0.2632	0.4790	H_0Reject

H_o: There are no significant difference between length frequency distributions (α=0.05, K=1.36).

Discussion

The largest catches of *C. gibelio* were observed in the 80 mm mesh size gillnet and in the 100 mm mesh size trammel net. These findings are agreement with the Çınar and Kuşat (2010) and Sürer and Kuşat (2013).

The comparisons of the selectivity studies of *Carassius* sp. between present and previous research results are showed in Table 6. Korkmaz and Kuşat (2013) reported Holt (1963)'s optimum lengths as 25.35, 27.88 and 30.42 cm for 100, 110 and 120 mm mesh size nets and these findings lower than our results. It is thought that this difference results from method used in selectivity. Balık (2008) reported that 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 commonly this is a statistical model that estimates gillnet selection curves from comparative gillnet catch and provides a cohesive approach to selectivity analyses.

The optimum lengths for 70, 80, 100, 140 mm mesh size nets (mesh size bar length converted to mesh size stretched) reported as 18.97, 21.68, 27.10, 37.94 cm according to Mahon *et al*. (2000) by Lorenzoni *et al*. (2010) are shows a great similarity with what we reported as 19.11, 21.84, 27.20 and 38.08 cm.

The optimum lengths reported by Cilbiz *et al*. (2014) as 11.76, 14.70, 17.64, 20.58, 23.52, 26.46 cm for 40, 50, 60, 70, 80 and 90 mm mesh size nets are a bit higher than determined in this study. It is thought that this case results from differences in growth and feeding characteristics of fish depending on the habitat changes. Balık and Çubuk (2001) reported that

Table 6. The comparisons of the selectivity studies of *Carassius sp*. between present and previous research results

Species	Author	Location	Method	N	Mesh Size (mm)	Material	Modal Length (cm)
C. auratus	Lorenzoni *et al.* (2010)	Lake Trasimeno (Italy)	Mahon *et al.* (2000),		22[b]		11.92
					25[b]		13.55
					28[b]		15.18
					35[b]		18.97
					40[b]		21.68
					50[b]		27.10
					70[b]		37.94
					80[b]		43.36
C. gibelio	Korkmaz ve Kuşat (2013)	Lake Eğirdir, Turkey	Holt (1963)	131	100[a]	Monofilament Trammel Net	23.77
				169	110[a]		26.14
				100	120[a]		28.52
				119	100[a]	Multifilament Trammel Net	25.35
				58	110[a]		27.88
				31	120[a]		30.42
C. gibelio	Cilbiz *et al.* (2014)	Lake Manyas, Turkey	SELECT	100	40[a]	Monofilament Trammel Net	11.76
				296	50[a]		14.70
				551	60[a]		17.64
				577	70[a]		20.58
				643	80[a]		23.52
				475	90[a]		26.46
C. gibelio	Present Study	Lake Eğirdir, Turkey	SELECT	51	32[a]	Multifilament Gillnet	8.74
				36	40[a]		10.92
				27	50[a]		13.65
				27	60[a]		16.38
				52	70[a]		19.11
				100	80[a]		21.84
				60	90[a]		24.57
				120	100[a]	Multifilament Trammel Net	27.20
				72	110[a]		29.92
				18	120[a]		32.64
				14	130[a]		35.36
				15	140[a]		38.08

[a] mesh size (stretched); [b] mesh size (bar length)

selectivity of gillnets can vary for each fish species and even for population of same species in different habitat therefore selectivity should be determine separately for each species which catching by this nets (Sümer *et al*., 2010).

In the current circumstances, national management strategy of *C. gibelio* which is an invasive species and has been found in Turkey's inland water approximately 25 years based on the inhibition of excessive proliferation with catching pressure rather than management of stock as a commercial species. However during the period it is seen that this strategy doesn't work and *C. gibelio* is still dominant species in many habitats. The main reason of this is first maturity length of fish is too small (11.5 cm) and this species have given progeny repeatedly until fishing by nets that's minimum mesh size determined by provincial directorates.

Isparta provincial directorate doesn't allow using of nets that mesh sizes less than 100 mm in order to protecting other species. According to our findings the optimal catching length of this mesh size net for *C. gibelio* is 27.20 cm. Acording to Balık *et al*. (2004) *C. gibelio* reproduction at least 3 times until reaching this length. This situation make it impossible fighting with this species through catching.

The first reproduction size is very important in fighting with *C. gibelio* through catching. Balık *et al*. (2004) have reported that L_{50} maturation length of *C. gibelio* as 10.3 cm with fork length. It is reported that fighting with fish that after L_{100} all individual reached maturation length of approximately 15 cm must begin at least in this length. When fork lengths are converted to the total lengths according to the equations reported by Gaygusuz *et al*. (2006) the 50 mm mesh sizes multifilament nets should be used for L_{50} maturation length (11.5 total length) and 60 mm mesh sizes for L_{100} maturation length (16.1 total length). However to combat with the species through catching, lowered the legal mesh size up to 50-60 mm likely cause some negative results on the other species in the environment, so it is an issue that needs to be considered on very good.

Acknowledgements

This study was financed by the Republic of Turkey, Ministry of Food Agriculture and Livestock, General Directorate of Agricultural Research and Policy. Furthermore, I would like to thank to the abolished Eğirdir Fisheries Research Institute.

References

Acarlı, D., Ayaz, A., Özekinci, U. and Öztekin, A. 2013. Gillnet selectivity for bluefish (*Pomatamus saltatrix*, L. 1766) in Çanakkale Strait, Turkey. Turkish Journal of Fisheries and Aquatic Sciences, 13: 349-353. doi: 10.4194/1303-2712-v13_2_17

Akamca, E., Kiyağa, V.B. and Özyurt, C.E., 2010. İskenderun Körfezi'nde Çipura (*Sparus Aurata*, Linneaus, 1758) avcılığında kullanılan monoflament fanyalı uzatma ağlarının seçiciliği. Journal of FisheriesSciences.com, 4(1): 28-37. doi: 10.3153/jfscom.2010004a

Balık, İ. and Çubuk, H. 2001. Selectivity of gillnets for catching rudd (*Scardinius erythrophtalmus* L. 1758) and white bream (*Blicca björkna* L., 1758) in Lake Ulubat (Apolyont,) (in Turkish). XI. Ulusal Su Ürünleri Sempozyumu, 04-06 Eylül, Mustafa Kemal University, Hatay: 1-10.

Balık, İ., Özkök, R., Çubuk, H. and Uysal, R. 2004. Investigation of some biologic characteristics of silver crucian carp, *Carassius gibelio* (Bloch 1782) population in Lake Eğirdir, Turk. J. Zool., 28: 19-28.

Balık, İ. 2008. Gillnet selectivity for pike, *Esox lucius* L. in Lake Karamık, Turkey. EIFAC Symposium on Interactions between Social, Economic and Ecological Objectives of Inland Commercial and Recreational Fisheries and Aquaculture, EIFAC Occasional Paper No: 44, Antalya: 93-99.

Baran, I. and Ongan, T. 1988. Gala Gölü'nün limnolojik özellikleri balıkçılık sorunları ve öneriler. Gala Gölü ve Sorunları Sempozyumu. Doğal Hayatı Koruma Derneği, İstanbul: 46-54.

Cilbiz, M., Küçükkara, R., Cilbiz, N., Çapkın, K. and Erol, K.G. 2014. Manyas Gölü'nde (Balıkesir-Türkiye) gümüş sazanı balığı (*Carassius gibelio* Bloch, 1782) avcılığında kullanılan monoflament sade uzatma ağların seçiciliğinin araştırılması. V. Doğu Anadolu Bölgesi Su Ürünleri Sempozyumu, 31 Mayıs-02 Haziran 2014, Elazığ.

Çınar, Ş. and Kuşat, M. 2010. Eğirdir Gölü'nde monoflament (tek kat) ve multiflament (çok kat) fanyalı ağların av verimliliklerinin karşılaştırılması. MSc thesis, Isparta: Süleyman Demirel University.

Gaygusuz, Ö., Gürsoy, Ç., Özuluğ, M., Tarkan, A.S., Acıpınar, H., Bilge, G. and Filiz, H. 2006. Conversions of total, fork and standard length measurements based on 42 marine and freshwater fish species (from Turkish Waters). Turkish Journal of Fisheries and Aquatic Sciences, 6: 79-84.

Holt, S.J. 1963. A method for determining gear selectivity and its application, ICNAF Special Publication, 5: 106-115.

Hoşsucu, H. 2011. Balıkçılık I. Ege Üniversitesi Yayınları, Su Ürünleri Fakültesi Yayın No: 55, İzmir, 247 pp.

Karakulak, S.F. and Erk, H. 2008. Gill net and trammel net selectivity in the northern Aegean Sea, Turkey. Scientia Marina, 72(3): 527-540.

Kolding. J. 1999. PASGEAR. A Data Base Package for Experimental or Artisanal Fishery Data from Passive Gears. University of Bergen. Dept. of Fisheries and Marine Biology: Bergen, Norway, 56 pp.

Korkmaz, B. and Kuşat M. 2013. Eğirdir Gölü, gümüşi havuz balığı, *Carassius gibelio* (Bloch, 1782) avcılığında kullanılan farklı göz büyüklüğündeki monoflament ve multiflament fanyalı ağların seçiciliği. MSc thesis, Isparta: Süleyman Demirel University.

Lorenzoni, M., Dolciami, R., Ghetti, L., Pedicillo, G. and Carosi, A. 2010. Fishery biology of the goldfish *Carassius auratus* (Linnaeus, 1758) in Lake Trasimeno (Umbria, Italy). Knowledge and Management of Aquatic Ecosystems, 396, 01. doi: 10.1051/kmae/20010001

Millar, R.B. 1992. Estimating the size-selectivity of fishing gear by conditioning on the total catch. Journal of the American Statistical Association, 87: 962-968. doi: 10.2307/2290632

Millar, R.B. and Fryer, R.J., 1999. Estimating the size-selection curves of towed gears. traps. nets and hooks. Reviews in Fish Biology and Fisheries, 9: 89-116. doi: 10.1023/A:1008838220001

Millar, R.B. and Holst. R. 1997. Estimation of gillnet and hook selectivity using log-linear models. ICES Journal of Marine Science, 54: 471-477. doi: 10.1006/jmsc.1996.0196

Park, C.D., Jeong, E.C., Shin, J.K., An, H.C. and Fujimori, Y. 2004. Mesh selectivity of encircling gill net for gizzard shad *Konosirus punctatus* in the coastal sea of Korea, Fisheries Science, 70: 553-560. doi: 10.1111/j.1444-2906.2004.00840.x

Polat, N., Zengin, M. and Gümüş, A. 2011. İstilacı balık türleri ve hayat stratejileri. Karadeniz Fen Bilimleri Dergisi, 1(4): 63-86.

Pope, J.A., Margetts, A.R., Hamley, J.M. and Akyüz, E.F. 1975. Manual of Methods for Fish Stock Assessment. Part III. Selectivity of Fishing Gear. Revision 1. FAO Fisheries Technical Paper No: 41, Rome, 65 pp.

Siegel, J. and Castellan, N.S. 1988. Non parametric statistics for the behavioural sciences. Statistics Series, 2nd Edition, Mc Graw Hill, New York.

Sümer, Ç., Özdemir, S. and Erdem, Y. 2007. Farklı göz genişliğinde monoflament ve multiflament solungaç ağlarının barbun balığı (*Mullus barbatus*) avcılığında seçiciliğinin hesaplanması. Fırat Üniv., Fen ve Müh. Bil. Dergisi, 19(2): 115-119.

Sümer, Ç., Özdemir, S. and Erdem, Y. 2010. Farklı göz açıklıklarında monoflament ve multiflament galsama ağlarının istavrit balığı (*Trachurus trachurus* L. 1758) için seçiciliğinin hesaplanması. E.Ü. Su Ürünleri Dergisi, 27(3): 125-128.

Sürer, M.İ. and Kuşat M. 2013. Eğirdir Gölü'nde monofilament ve multifilament sade uzatma ağlarının av ve ekonomik verimliliklerinin karşılaştırılması. SDÜ, Fen Bilimleri Enstitüsü Dergisi, 17(1): 43-48.

Tarkan, A.S., Gaygusuz, O., Gursoy, C., Acıpınar, H. and Bilge, G. 2006. A new predator species *Carassius gibelio* (Bloch, 1782) in Marmara Region: Succesful or not. Symposium on Management of Reservoirs and Fish Stocking, Mediterranean Fisheries, Production and Education Institute, Antalya: 195-204.

TUIK, 2013. Turkish Statistical Institute, Ankara. http://www.turkstat.gov.tr/PreTablo.do?alt_id=1005. (accessed 18 March 2013)

Zou, Z., Cui, Y., Gui, J. and Yang, Y. 2000. Growth and feeding utilisation in two strains of gibel carp. *Carassius auratus gibelio*: paternal effects in a gynogenetic fish. J. Appl. Ichthyol. 17: 54-58. doi:10.1046/j.1439-0426.2001.00245.x