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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Selection of multifilament trammel nets with different mesh width in Lake Erçek

Erçek Gölü'nde farklı ağ göz genişliğine sahip multifilament fanyalı uzatma ağlarının seçiciliği

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Abstract: This study was conducted in Lake Erçek, located in the Van Lake basin. The study examined the selectivity of multifilament trammel nets used in the fishing of pearl mullet (*Alburnus tarichi*, Güldenstädt, 1814) in the lake. The efficiency of nets with mesh sizes of 22 mm, 24 mm, and 26 mm was evaluated in the research. A total of 5.336 pearl mullets were caught in the study carried out between October 2021 and April 2022. 1.296, 1.721 and 2.319 fish were caught from nets with mesh sizes of 22. 24 and 26 mm, respectively. The aim of the study was to determine the most suitable mesh size for sustainable pearl mullet fishing in Lake Erçek. The Holt (1963) method was used to calculate the selectivity parameters. This method considers the fish length and mesh size to determine which size of fish can be caught by the nets. The calculations showed that nets with a 26 mm mesh size had the highest efficiency and contributed to the preservation of fish stocks by allowing smaller fish to escape. The optimum catch lengths for the 22 mm, 24 mm, and 26 mm nets were calculated as 21.15 cm, 22.47 cm, and 23.69 cm, respectively. It was particularly noted that nets with a 22 mm mesh size caught fish below the legal catch size, which could negatively affect the sustainability of the fish stocks. As a result, it was concluded that nets with a 26 mm mesh size are the most suitable option for sustainable fishing in Lake Erçek. The findings of the study provide important data for the conservation of pearl mullet stocks and for the sustainable management of fishing practices.

Keywords: Lake Erçek, Holt method, multifilament trammel nets, pearl mullet, selectivity

Öz: Bu çalışma, Van Gölü havzasındaki Erçek Gölü'nde yürütülmüştür. Çalışmada gölde inci kefali (*Alburnus tarichi*, Güldenstädt, 1814) avcılığında kullanılan multifilament fanyalı uzatma ağlarının seçiciliği incelenmiştir. Araştırmada 22 mm, 24 mm ve 26 mm ağ göz genişliklerine sahip ağlar kullanılarak balık yakalama verimliliği değerlendirilmiştir. Ekim 2021 ile Nisan 2022 tarihleri arasında gerçekleştirilen çalışmada, toplamda 5336 inci kefali yakalanmıştır. 22, 24 ve 26 mm göz genişliğine sahip ağlardan sırasıyla 1296, 1721 ve 2319 adet balık yakalanmıştır. Çalışmanın amacı, inci kefali stokunun sürdürülebilir avcılığına katkı sağlamak için en uygun ağ göz genişliğini belirlemektir. Seçicilik parametrelerinin hesaplanmasında, Holt (1963) metodu kullanılmıştır. Bu metot, balık boyu ve ağ göz açıklığını dikkate alarak ağların hangi boydaki balıkları yakalayabileceğini belirler. Hesaplamalar sonucunda, 26 mm ağ göz genişliğine sahip ağların en yüksek verimliliği sağladığı ve küçük balıkların kaçmasına olanak tanıyarak balık stoklarının korunmasına katkı sunduğu tespit edilmiştir. Çalışma sonucunda, 22, 24 ve 26 mm ağ göz genişliğine sahip ağların optimum yakalama boyları sırasıyla 21,15 cm, 22,47 cm ve 23,69 cm olarak hesaplanmıştır. Özellikle 22 mm ağ göz genişliğine sahip ağların, yasal avlanma boyutunun altında balıkları yakaladığı ve bu durumun stokların sürdürülebilirliğini olumsuz etkileyebileceği belirlenmiştir. Sonuç olarak, 26 mm ağ göz genişliğine sahip ağların Erçek Gölü'nde sürdürülebilir balıkçılık için en uygun seçenek olduğu ortaya konmuştur. Çalışmanın bulguları, inci kefali stoklarının korunması ve sürdürülebilir avcılık yönetimi için önemli veriler sağlamaktadır.

Anahtar kelimeler: Erçek Gölü, Holt metot, fanyalı ağlar, inci kefali, seçicilik

INTRODUCTION

Lake Erçek is the second largest lake after Lake Van in the Lake Van Basin. The lake water is alkaline with pH values ranging from 10.75 to 9 (Yıldız, 1997). The only endemic fish species currently available in Lake Erçek is pearl mullet from the Cyprinidae family (*Alburnus tarichi*, Pallas 1811). Fishing is one of the most important economic activities in the World (Aure et al., 2019) In recent years, overfishing pressure on fish stocks around the world has brought many stocks to the point of collapse (Williams, 1998). Considering the outputs of fishing activities, it is important to use fishing gear with high selectivity (Çınar and Kuşat, 2015; Millar, 1992). Selectivity depends on the type and size of fish caught and their combination during fishing operations; target species or fish individuals of legal size can be selected. Trammel nets and gillnets are used to fish catching a significant proportion of the fishing in Türkiye's inland waters (Kuşat, 1996). Commercial inland fishing occurs on mainly lakes and dam lakes (Cilbiz and Ateşşahin, 2024). In Türkiye inland waters where the use of large-scale fishing gear is prohibited, gillnets and trammel nets are one of the most commonly used fishing gear. Due to their high selectivity, trammel nets are thought to be very important for sustainable fishing (Kocabaş et al., 2018). Selectivity in trammel net is associated with the shape, size, and behavioral characteristics of the fish, and the colour, mesh size, hanging ratio and rigging factor of the net. (Rosman and Maugeri, 1980; Özyurt and Yeşilçimen, 2013). Mesh size in trammel net is the main factor determining selectivity (Von Brandt, 1975). Although Lake Erçek contains the largest pearl mullet stock in the basin after Lake Van, a limited number of studies have been carried out in the lake. In Lake Erçek; studies have been carried out on plankton species (Yıldız, 1997), the pearl mullet population structure

(Gündoğdu, 2010), carrying capacity of lake (Akkuş and Sarı, 2013) and seasonal temperature distribution (Meydan and Akkol, 2020). In Lake Van; the selectivity properties and catch efficiency of trammel nets used in pearl mullet fishing in Lake Van were investigated by Çetinkaya et al. (1995), The catch efficiency of trammel nets with different rigging factors and rope thicknesses used in pearl mullet fishing in Lake Van was investigated by Sarı and Tokaç (2000), The selectivity of multifilament nets used in pearl mullet (*Alburnus tarichi*, Güldenstädt, 1814) fishing was investigated by Pala (2021). Although there are different studies on determining the selectivity of trammel nets used in pearl mullet fishing in Lake Van, there is no selectivity study conducted in Lake Erçek. This situation creates uncertainty in terms of fisheries management in the lake. In this study, the selectivity of multifilament trammel nets with mesh sizes of 22, 24 and 26 mm used in pearl mullet fishing in Lake Erçek was determined. Selectivity parameters of the nets used in the study were calculated by the Holt (1963) method and the effects of different mesh sizes on the fish population were evaluated. It is thought that the findings will contribute to the development of fisheries management strategies and the protection of the pearl mullet stock in the lake.

MATERIALS AND METHODS

The study was carried out in Lake Erçek (Figure 1) between 31.10.2021 and 10.04.2022. Covering an area of 114 km^2, Lake Erçek is the second largest lake in the basin following Lake Van. It has a maximum depth of 40 m and an average depth of 18.45 m (Sarı and İpek, 1998). The only endemic fish species currently available in Lake Erçek is pearl mullet from the Cyprinidae family.

The nets used in the study are trammel nets traditionally used in Lake Erçek. A total of 27 samplings were made at different points of the lake. The technical plan of the trammel nets used in the study are given in Figure 1, 2 and 3. In this study, the hanging ratio in the outer panels in inner panel sections of the outher panel-type trammel nets are the same and set to 0.5.

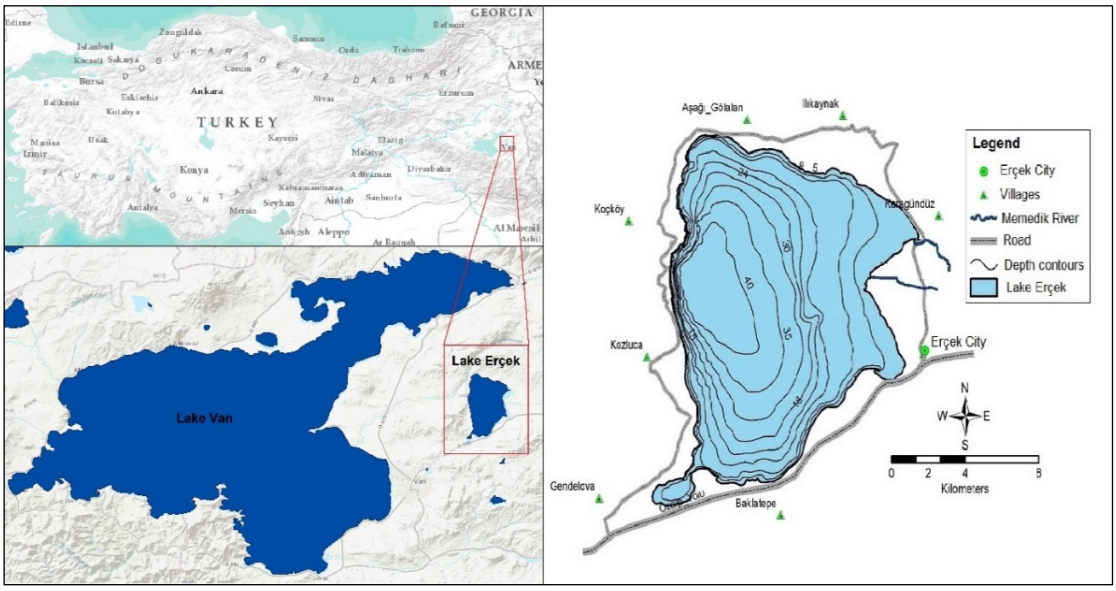

Figure 1. Study area

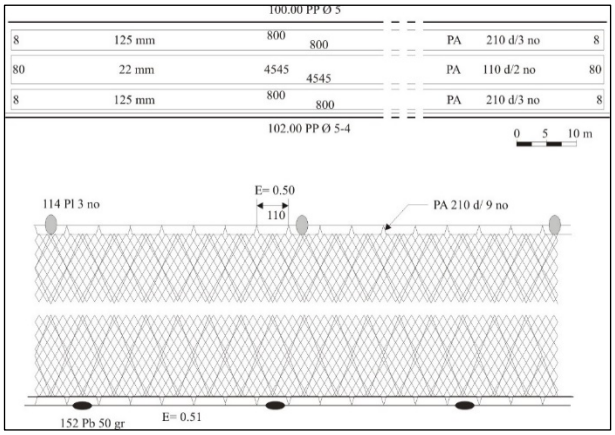

Figure 2. Technical plan of the nets with 22 mm mesh size

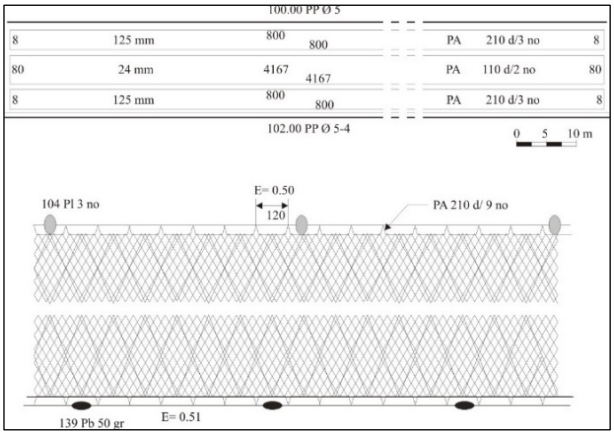

Figure 3. Technical plan of the nets with 24 mm mesh size

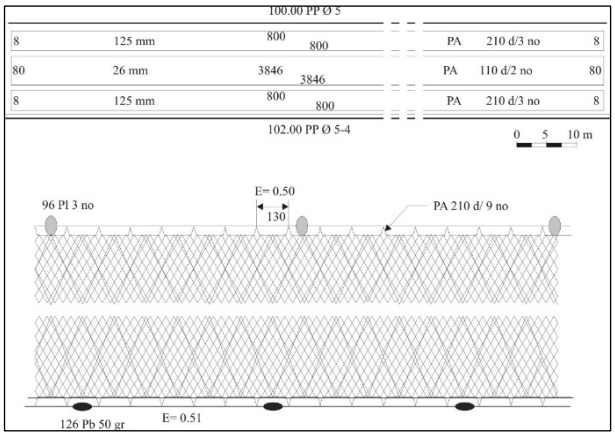

Figure 4. Technical plan of the nets with 26 mm mesh size

Holt (1963) method was used to calculate selectivity. The Holt method, which takes into account fish length and mesh size, was used to calculate selectivity parameters. Fish caught from nets with different mesh sizes were determined according to their size groups; the number of fish caught in large mesh nets was divided by the number of fish caught in small mesh nets to obtain the natural algorithm. Linear regression analysis is used to examine the relationships between size range (L) and logarithmic ratios. As a result of this analysis, parameters such as the slope and intercept between specific independent and dependent variables are calculated.

The formula for calculating the optimum capture size for a small mesh and large mesh net:

$Lm_1 = (-2a * m_1) / (b * (m_1 + m_2))$

$Lm_2 = (-2a * m_2) / (b * (m_1 + m_2))$

m_1, m_2 = Mesh size of small mesh and large mesh net (mm)

Lm_1, Lm_2 = Optimum catch size of small mesh and large net (cm)

Standard Deviation According to Nets:

$SD = \{1 / (n - 1)\ \Sigma\ [-2a_i\ (m_{i_1} - m_i)] / [b_i^2\ (m_i + m_{i_1})]\}^{(1/2)}$

n: Total number of observations

a_i: Selectivity coefficient

m_{i_1}, m_i: Averages of mesh sizes

b_i: Selectivity curve coefficient

Calculation of the Selection Factor for Two Nets with Consecutive Mesh Sizes:

$SF=-2a/b*(m_1 + m_2)$

The catch rates are calculated as a function of length for each net according to the size group. Using the function s(Li), the selectivity curve is drawn for each net:

$s(L_i) = e^{((L - Lm_1)^2 / (2 * s^2))}$

$s(Li)$= selectivity curve function of the mesh with i mm bar length

Lm_1: optimum catching length of the mesh with i mm bar length

RESULTS

In the study, a total of 5336 pearl mullet were caught; 1296 from 22 mm nets, 1721 from 24 mm nets and 2319 from 26 mm nets with different mesh sizes. It was determined that the fork lengths of the caught fish varied between 17-26 cm (Table 1). It was observed that there were injuries and deformations in the caudal fins of the fish caught especially in 22 mm and 24 mm nets. Therefore, fork length was used in the study.

Table 1. Percentage of fish caught by size groups

Length (cm)	22 mm net		24 mm net		26 mm net	
	Quantity	Percent (%)	Quantity	Percent (%)	Quantity	Percent (%)
17	3	0.231481	0	0	0	0
18	5	0.385802	0	0	0	0
19	58	4.475309	5	0.290528	0	0
20	215	16.58951	123	7.147007	11	0,474342
21	387	29.86111	240	13.94538	140	6,037085
22	412	31.79012	390	22.66124	240	10,34929
23	117	9.027778	756	43.92794	715	30,83226
24	63	4.861111	153	8.890180	1122	48,38292
25	36	2.777778	54	3.137710	86	3,708495
26	0	0	0	0	5	0,21561
Total	**1296**		**1721**		**2319**	**5336**

When the size distribution of fish caught with a 22 mm mesh size, multifilament trammel net is examined, it is seen that 16.59 % of the fish caught are in the 20 cm size group, 29.9 % in the 21 cm size group and 31,8 % in the 22 cm size group. The lowest rates are in the 17 cm size group with 0.23 % and 18 cm size group with 0.38 % (Figure 5). When the size distribution of fish caught with a 24 mm mesh size multifilament trammel net is examined, it is seen that 14% of the fish caught are in the 22 cm size group, 22.7% in the 23 cm size group and 48.5% in the 24 cm size group. The lowest ratio is seen in the 19 cm size group with 0.29% and the 25 cm size group with 3.14% (Figure 6). When the size distribution of fish caught with 26 mm mesh size, multifilament trammel net is examined, it is seen that 10.4% of the fish caught are in the 21 cm size group, 30.9% in the 22 cm size group and 43.9% in the 23 cm size group. The lowest rate is seen in the 20 cm size group with 0.5% and in the 25 cm size group with 3.7% (Figure 7).

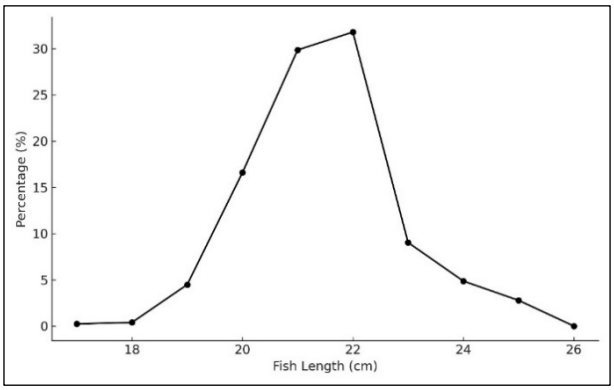

Figure 5. Length-percentage graph of fish caught with 22 mm

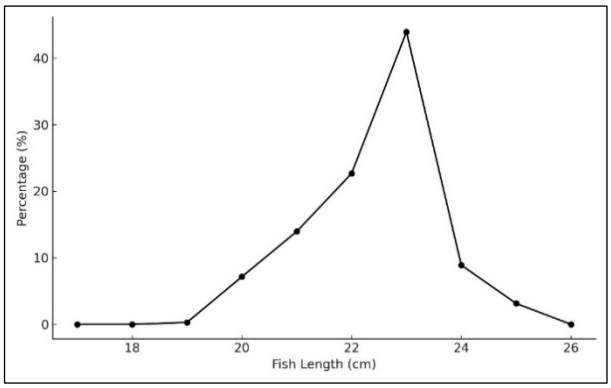

Figure 6. Length-percentage graph of fish caught with 24 mm

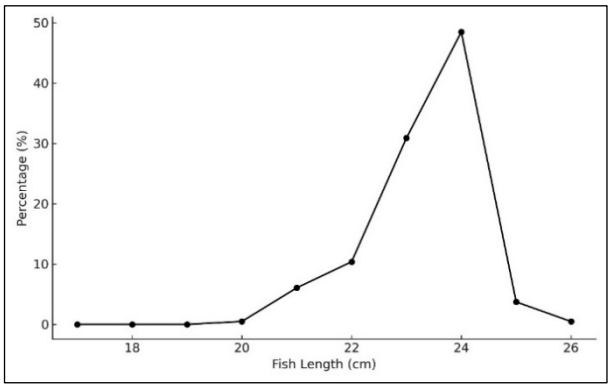

Figure 7. Length-percentage graph of fish caught with 26 mm

Calculation of selectivity parameters of 22-24 mm trammel nets;

It was determined that fish with a maximum length of 22 cm were caught in the net with a mesh size of 22 mm, and fish with a maximum length of 23 cm were caught in the net with a mesh size of 24 mm (Table 2).

In the regression analysis; the intersection point with the y-axis (a): -10.901, slope (b): 0.493 was calculated. The optimum catch length of the 22 mm net: 21.150. The optimum catch length of the 24 mm net: 23.072 (Figure 8). Standard deviation: 3.900. Selectivity factor: 0.480. Catch rates of 22 and 24 mm nets; PA: exp[-(L-21.150)2 / 2*(3.900)2] and PB: exp[-(L-23.072)2 / 2*(3.900)2].

Table 2. Selectivity values of 22-24 mm trammel nets

Length (cm)	$C1(22)$	$C2(24)$	$C2/C1$	$\ln(C2/C1)$	PA	PB
17	3	0		Not Used		
18	5	0				
19	58	5	0.086207	-2.45101	0.859	0.579
20	215	123	0.572093	-0.55845	0.957	0.733
21	387	240	0.620155	-0.47779	0.999	0.868
22	412	390	0.946602	-0.05488	0.976	0.962
23	117	756	6.461538	1.865867	0.893	0.999
24	63	153	2.428571	0.887303	0.765	0.972
25	36	54	1.5	0.405465	0.6143	0.8849

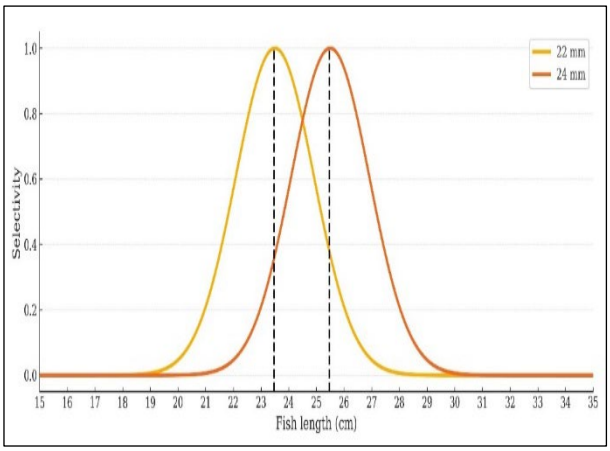

Figure 8. Selectivity curves of 22-24 mm mesh size

In the study, the highest number of fish was caught in the 26 mm trammel net (Table 3).

Table 3. Selectivity values of 24-26 mm nets

Length(cm)	$C2(24)$	$C3(26)$	$C3/C2$	$\ln(C3/C2)$	PA	PB
19	5	0		Not Used		
20	123	11	0.089	-2.414	0.957	0.431
21	240	140	0.583	-0.539	0.999	0.639
22	390	240	0.615	-0.485	0.976	0.838
23	756	715	0.945	-0.055	0.893	0.970
24	153	1122	7.333	1.992	0.765	0.994
25	54	86	1.592	0.465	0.6143	0.899
26		5		Not Used		
27		2				

In the regression analysis; the intersection point with the y-axis (a): -14.58, slope (b): 0.640 was calculated. The optimum catch size of the 24 mm mesh: 21.870. The optimum catch size of the 26 mm mesh: 23.692 (Figure 9). Standard deviation: 2.847. Selectivity factor: 0.450. The catch rates of 24 and 26 mm meshes; PA: exp[-(L-21.870)2 / 2*(2.847)2] and PB: exp[-(L-23.697)2 / 2*(2.847)2].

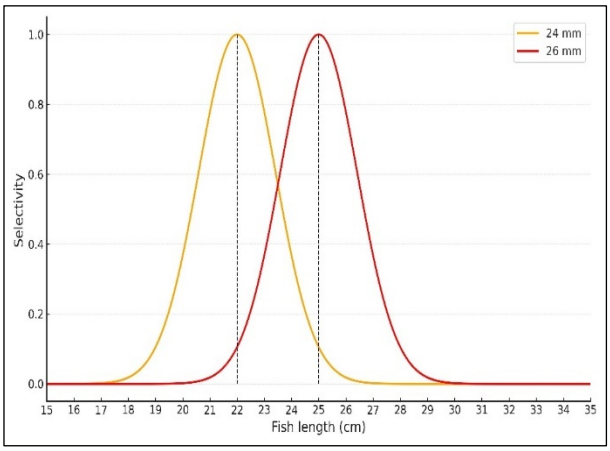

Figure 9. Selectivity curves of 24-26 mm mesh size

DISCUSSION

This study is the first selectivity study conducted in Lake Erçek. When the studies on the selectivity of multifilament trammel nets used in Lake Van pearl mullet fishing were examined; Çetinkaya et al. (1995) used 17 mm, 20 mm and 24 mm mesh widths in pearl mullet fishing. They reported the optimum catch length to be between 15.5-20.6 cm. In the study conducted by Pala (2021) using multifilament trammel nets in Lake Van, the optimum catch length was determined as 20.76 cm for 20 mm mesh widths, 22.07 cm for 22 mm and 24.11 cm for 24 mm. Although the optimum catch lengths determined in the studies conducted in Lake Erçek are similar to the study conducted by Pala (2021), it is seen that they are different from the studies conducted in previous years. Different aquatic ecosystems have different ecological characteristics such as temperature, food and environmental conditions. Therefore, it is expected that different results will be obtained in selectivity studies conducted in different aquatic ecosystems. Langerhans et al. (2003) reported that the same fish species living in different habitats may differ morphologically depending on environmental effects. Another reason for obtaining different optimum sizes in the studies is thought to be due to the fact that the amount of illegal hunting carried out during the pearl mullet breeding season has been largely prevented with conservation efforts in recent years. According to the Communique No. 6/1 on the Regulation of Commercial Aquatic Products Fishing, which regulates fisheries in Türkiye, the minimum catch length of pearl mullet is specified as 18 cm. However, it was determined that the 22 mm net used in the study caught individuals below the minimum catch length of 17 cm (Table 1). Therefore, it is thought that the use of 22 mm nets in the lake will harm the stock. While the 26 mm nets used in the study caught fish with a minimum length of 20 cm, it was observed that they mostly caught fish with a length of 24 cm (Table 1). In addition, it was determined in the study that the 26 mm nets caught the most fish with 2314 individuals. In this respect, the 26 mm nets catch the large fish in the stock and allow the development of small fish. This situation is beneficial for the sustainability of the pearl mullet stock of Lake Erçek. The most important outputs in fisheries management are fuel and labor. Reducing these outputs is one of the basic elements for the continuity of fishing. Since more fish are caught in the same period compared to the other nets used in the study and these fish are in the range of 23-24 cm according to their fork lengths, the use of 26 mm nets will contribute to the fishing carried out in the lake to gain a more economically efficient structure.

CONCLUSION

The results of this study underscore the importance of using highly selective fishing gear, such as multifilament trammel nets, for the sustainable management of the pearl mullet population in Lake Erçek. It was observed that nets with a 26 mm mesh size effectively target larger fish, allowing smaller fish to escape, thus supporting the renewal of the fish stock. On the other hand, the use of 22 mm mesh nets, which were found to capture fish below the legal size limit, poses a threat to the sustainability of the population and could negatively affect the stock if not managed properly. This study provides essential data that can contribute to fisheries management decisions in Lake Erçek, promoting both the long-term sustainability of the pearl mullet population and more economically efficient fishing practices. Future research should focus on determining the selectivity parameters of monofilament nets used in the lake to enhance fisheries management. Additionally, given that pearl mullet rely on two rivers flowing into the lake for spawning, it is crucial to investigate how potential hydrological droughts in the coming years might impact the stock. This would offer valuable insights into preserving the pearl mullet population in the face of environmental changes.

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AUTHORSHIP CONTRIBUTIONS

Seda İlmen Çevik: Data acquisition, writing, validation. Mustafa Akkuş: Data acquisition, statistical analysis, editing.

STATEMENT OF CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest or competing interests.

ETHICS APPROVAL

The research was approved by Van Yüzüncü Yıl University Animal Experiments Local Ethics Committee in terms of sampling and use of experimental animals with decision number 2021/11-11 at the meeting held on 25.11.2021. All researchers declare that all trials were conducted in accordance with ethical values.

DATA AVAILABILITY

The corresponding author should be contacted for questions about datasets.

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