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Investigation of Fishing Efficiency of Crayfish *Pontastacus leptodactylus* (Eschscholtz, 1823) in Keban Dam Lake

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Abstract:. This study was carried out to determine the catch efficiency of crayfish fishing in Keban Dam Lake during the crayfish fishing season between July 1 and November 1, 2023. The study was conducted by applying a face-to-face questionnaire to 45 fishermen engaged in crayfish fishing, and fishing data were obtained from cooperative records. In the crayfish fishing season from Keban Dam Lake, it was found that 45 boats engaged in crayfish fishing in 5 regions, Kemaliye, Ağın, Keban, Aydıncık and Çemişgezek. A total of 43.600 fykenets were used and 33.430 kg of crayfish were caught. Aydıncık region started crayfishing for the first time this season with 16 fishermen. The CPUE values for crayfish fishing in Keban Dam Lake were found to be 10.87 g for Ağın region. 10.14 for Keban region. 6.75 for Çemişgezek region. 7.87 for Kemaliye region and 6.58 for Aydıncık region. The yield per hectare for crayfish fishing in 28.450 hectares of Keban Dam Lake was determined to be 6.3 kg. In addition, among the reasons why fishermen in the region prefer crayfish fishing; it was determined that crayfish prices are higher than fish prices and they receive their income immediately in cash.

Keywords: *Pontastacus leptodactylus*, CPUE, fykenet, Keban Dam Lake, Elazığ

Keban Baraj Gölü Kerevit *Pontastacus leptodactylus* (Eschscholtz, 1823)'un Avcılık Veriminin Araştırılması

Özet: Bu çalışma, Keban Baraj Gölü'nde 1 Temmuz- 1 Kasım 2023 yılı kerevit av sezonunda gerçekleştirilen kerevit avcılığının av veriminin tespit edilmesi amacıyla yapılmıştır. Çalışma, kerevit avcılığı yapan 45 adet balıkçıya yüz yüze anket uygulanarak ve kooperatif kayıtlarından avcılık verileri alınarak gerçekleştirilmiştir. Keban Baraj Gölü'nde; Kemaliye, Ağın, Keban, Aydıncık ve Çemişgezek, olmak üzere 5 bölgede, 45 adet teknenin kerevit avcılığı yaptığı, toplam 43.600 adet kerevit pinteri kullanıldığı ve 33.430 kg kerevit avlandığı tespit edilmiştir. Aydıncık bölgesi ilk defa bu sezon 16 balıkçı ile kerevit avcılığı yapmaya başlamıştır. Keban Baraj Gölü kerevit avcılığı için CPUE değerleri; Ağın Bölgesi için 10.87, Keban Bölgesi için 10.14, Çemişgezek Bölgesi için 6.75, Kemaliye Bölgesi için 7.87, Aydıncık Bölgesi için 6.58 g/pinter/gün olarak bulunmuştur. Keban Baraj Gölü 28.450 hektar alanda yapılan kerevit avcılığı için hektara düşen verim 6.3 kg olarak tespit edilmiştir. Ayrıca bölgedeki balıkçıların kerevit avcılığını tercih etme sabepleri arasında; kerevit fiyatlarının balık fiyatlarından daha yüksek olması ve gelirlerini nakit olarak hemen almaları olarak saptanmıştır.

Anahtar Kelimeler: *Pontastacus leptodactylus*, CPUE, Pinter, Keban Baraj Gölü, Elazığ

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INTRODUCTION

Crayfish (*Pontastacus leptodactylus*) are the most important animal product obtained after fish in inland waters. In addition to being an important source of protein, crayfish are also very tasty and expensive, making them one of the most luxurious aquaculture products (Erdemli, 1982; Duman and Pala, 1998; Patır et al., 2002). It started to be utilized as a foodstuff after the 1830s in the world. The formation of traditional consumption culture in many European countries increased the commercial value of the species. In Türkiye, after World War II, especially after 1968, it became a good source of income for inland fishermen with its increasing export potential until the 1990s (Cilbiz et al., 2020).

Crayfish, which is one of the economic inland water products of our country and widely found in many lakes, ponds and reservoirs, has provided important foreign currency inflows for our country's economy with its exports that started in 1963 and gradually increased (Örkün, 1977; Balık et al., 2005).

P. leptodactylus is found naturally in many lakes, reservoirs and rivers of Anatolia and has a wide distribution in Eastern Europe and the Middle East (Köksal, 1988; Kokko et al., 2018). In our country, it is a natural product of lakes Eğirdir, Beyşehir, Akşehir, Eber, Çivril, Apolyont and Manyas. Also it has settled in other water sources later (Erençin and Köksal, 1977; Çelikkale et al., 1982; Bolat, 2001; Harlıoğlu, 2002). In parallel with this, the number of freshwater resources where crayfish are fished in our country is increasing day by day (Yüksel, 2007). Keban Dam Lake is one of the water bodies where crayfish are stocked in this way. Crayfish fishing in Keban Dam Lake was started from the Ağın region. Crayfish was brought to this region from Lake Eğirdir and released into the dam lake.

The oldest data on crayfish production based on fisheries in the world is the production amount reported as 487 tons for 1950 in the United States of America. The production, which was around 500 tons in the 1950s, was recorded as 10.000-15.000 tons in the 1980s and reached 25.298 tons in 1993. In 2016, it was 15,782 t (Cilbiz et al., 2020). There are 22 fish species and subspecies belonging to 6 families in Keban Reservoir (Ekingen and Sarıeyyüpoglu, 1981). In addition, the crayfish (*Pontastacus leptodactylus* Eschscholtz, 1823), which was introduced to the reservoir later, has adapted to the reservoir and become a prey species.

In 2022, the amount obtained from crayfish fishing in our country was recorded as 622 tons (Tuik, 2023). The catch, which started in 1994 with 17 tons in the region of Ağın, was realized in 2004 with a total of 3 tons in the regions of Kemaliye, Keban and Çemişgezek. In the 2023 crayfish fishing season, Aydıncık region has started to actively fish. Thus, after the Kemaliye, Agın, Çemisgezek and Keban regions of Keban Dam Lake, commercial fishing was carried out in a total of 5 fishing regions with Aydıncık region.

While the free fishing season in Türkiye was applied as June 15-December 24 until 2006, it started to be applied as July 1-November 1 after 2006. With the communiqué numbered 2/1 regulating the fishing of fishery products for commercial purposes, the legal fishing length of 9 cm was increased to 10 cm. There is no legal regulation on mesh size of fyke nets in Türkiye. However, single-entry fyke nets with 17 mm mesh size are used without bait (Çılgın and Aksu, 2015).

MATERIALS and METHODS

The study was carried out in the crayfish fishing areas of Keban Dam Lake from July 1 to November 1, 2023. Face-to-face interviews were conducted with fishermen by visiting the Keban Dam Lake 1st fishing area (Kemaliye), 2nd fishing area (Ağın), 3rd fishing area (Keban), 4th fishing area (Çemişgezek), and 6th fishing area (Aydıncık) (Figure 1). The fykenets used by the fishermen and the catch data were

observed on site. Fykenets measurements were made with calipers and steel meters. Crayfish fishing in the Ağın region was carried out together with the fishermen. Catch data were taken from the records of the buyer contractor of crayfish in Keban Dam Lake.

Catch per unit effort (CPUE) was calculated as grams of crayfish per fykenet per day, considering the duration the fishermen kept their fykenet in the water. Yields per hectare and per boat were computed. Furthermore, the study examined the reasons why fishermen in the region prefer crayfish fishing and assessed the challenges they encounter. The results were then analyzed.

Figure 1. Keban Dam Lake (Elazığ), crayfish fishery regions 1st fishery area (Kemaliye), 2nd fishery area (Ağın), 3rd fishery area (Keban) and 4th fishery area (Çemişgezek) and 6th fishery area (Aydıncık) regions.

RESULTS

It was determined that the fykenet used in Keban Dam Lake was equipped with 210d/6 PA nets with 17 mm mesh size, single entrance, double venter. The circle at the entrance was semicircular (D-shaped) and the others were made of 4 circles in round shape (Figure 2).

Figure 2. The D-shaped (4-circle) fykenets used in crayfish fishing (2023 Crayfish season).

10 of 13 fishermen in Ağın region, 8 of 16 fishermen in Keban region, 9 of 32 fishermen in Çemişgezek region, 2 of 7 fishermen in Kemaliye region, and 16 of 18 fishermen in Aydıncık region also fish for crayfish. Crayfish caught in Keban Dam Lake are offered for sale with a length of 10 cm and longer. It was observed that the fykenets used for catching crayfish also catch non-target fish species such as *Mastacembelus mastacembelus* (Figure 3).

Figure 3. The crayfish caught in Keban Dam Lake (Ağın region).

The ratio of crayfish fishermen to total fishermen was highest in Aydıncık region (88.8%) and lowest in Kemaliye and Çemişgezek region (28%). The number of fykenet used by the fishermen varied between 400-2500 pieces per vessel. Çemişgezek region has the highest number of fykenet used in total and Kemaliye region has the lowest number. In addition, Aydıncık region have started crayfish fishing this year with 400 fykenet (10 fishermen) (Table 1, Figure 4).

Table 1. The distribution of the number of fishermen and fykenets quantities according to fishing regions.

Region	Parcel Area (Hectar)	Total Fishermen	Fishermen of Crayfish	Numbers of Fykenets
Kemaliye	2000	7	2	3.000
Ağın	4700	13	10	12.000
Keban	5000	16	8	6500
Aydıncık	7200	18	16	9600
Çemişgezek	9550	32	9	13.500
Total	28.450	86	45	43.600

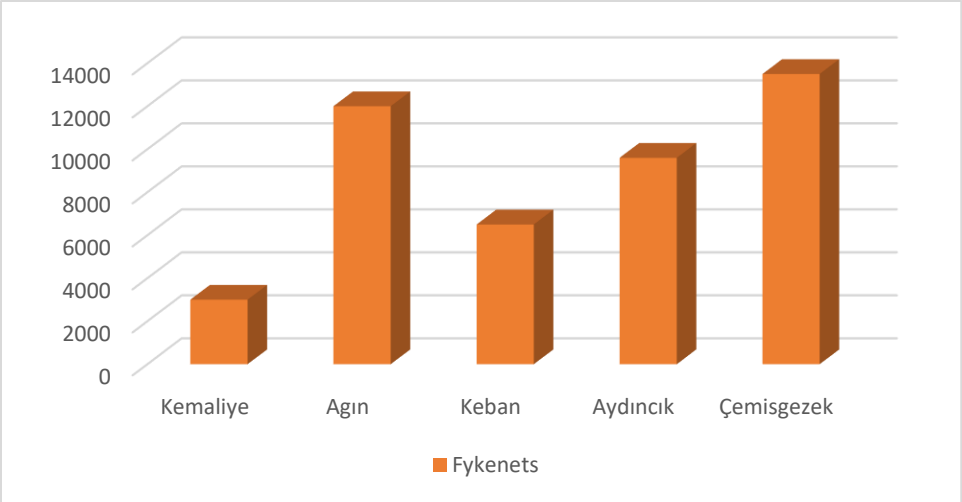

Figure 4. The number of fykenets quantities according to fishing regions.

In the 2023 crayfish fishing season, it was determined that 33.430 kg of crayfish were caught in total. The highest fishing efficiency was determined as Ağın region with 11.230 kg and the lowest was determined as Kemaliye region with 2150 kg. The total catch per unit effort (CPUE) in Keban reservoir was 41.62 g (Table 2).

Table 2. The distribution of CPUE and crayfish amounts according to fishing regions.

Region	Amounts of crayfish (kg)	CPUE	Yield per hectare (kg)	Yield per boat (kg)
Kemaliye	2.150	7.87	1.07	1.075
Ağın	11.230	10.28	2.38	1.123
Keban	6.000	10.14	1.2	750
Aydıncık	5.750	6.58	0.79	359.37
Çemişgezek	8.300	6.75	0.86	922.2
Total	33.430	41.62	6.3	4.229

The highest CPUE value was in Ağın region with 10.28 g, while the lowest was in Aydıncık region with 6.58 g. Again, the highest yield per hectare was recorded in Ağın region and the lowest in Aydıncık region (Figure 5).

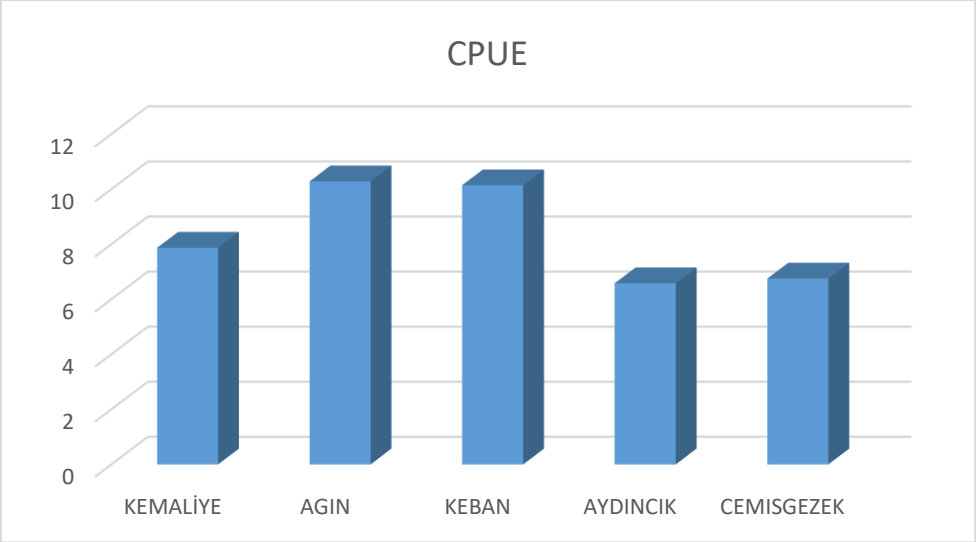

Figure 5. The CPUE values according to fishing regions.

Among the reasons why Keban reservoir fishermen prefer crayfish fishing, it was determined that crayfish prices are higher than fish prices, and they receive their income in cash immediately. In 2023, the price of crayfish was determined to be 150 TL. Additionally, it was determined that crayfish fishing is preferred due to reasons such as the decrease in fish yield caused by overfishing and damage to fishing nets due to unfavorable conditions like water pollution, which increases the cost of fishing.

DISCUSSION and CONCLUSION

There are many scientific studies on crayfish in different fields in Türkiye. These studies generally include crayfish biology (Balik et al., 2005; Bolat and Kaya, 2016; Balık et al., 2006; Berber and Balık 2006; Berber et al. 2010; Bök et al., 2013), aquaculture (Farhadi and Harlıoğlu, 2018; Erişir et al., 2006; Bahadır Koca et al., 2015), population dynamics (Bolat 2001; Berber et al., 2012; Yüksel et al., 2013), fishing technologies (Balık et al., 2002; Balık et al., 2003; Bolat et al., 2010) and genetics (Akhan et al., 2014).

In the previous studies on the production amounts of the species; Bolat (2001) mentioned the study titled 'Estimation of Population Size of Freshwater Lobsters (A. leptodactylus Eschscholtz, 1823) in Eğirdir Lake Hoyran region'. Additionally, Harlıoğlu and Harlıoğlu (2004) in their study titled 'The harvest of freshwater crayfish, *Astacus leptodactylus* (Eschscholtz, 1823) in Turkey' mentioned the total production amounts between 1977 and 2002. Studies on crayfish fishery in Keban Dam Lake are limited. These studies include socio-economic status of fishermen of the region, reproduction characteristics, growth characteristics of population and stock determination studies (Duman and Gürel, 2000; Duman and Pala; 1998; Duman et al., 1999; Dartay et al., 2013; Yüksel and Duman, 2011; Demirol and Yüksel, 2013). In this study conducted in Keban Dam Lake during the crayfish fishing season from July 1 to November 1, 2023, it was determined that 45 boats were engaged in crayfish fishing in 5 regions, namely Kemaliye, Agın, Keban, Aydıncık, and Çemisgezek, using a total of 43,600 crayfish fykenets, resulting in a catch of 33,430 kg of crayfish. The Aydıncık region commenced crayfish fishing for the first time this season with 16 fishermen. CPUE values for crayfish fishing in Keban Dam Lake were found as 10.87

g/fykenet/day for Agın region, 10.14 for Keban region, 6.75 for Çemisgezek region, 7.87 for Kemaliye region and 6.58 for Aydıncık region. The yield per hectare for crayfish fishing in 28,450 hectares of Keban Dam Lake was determined as 6.3 kg.

In the study titled investigation of crayfish (*Astacus Leptodactylus* Eschscholtz, 1823) population size in Keban Dam Lake by Yüksel and Duman (2011), the catch per unit effort (CPUE) was calculated as 0.93 crayfish/fykenets/7 days. Crayfish density was estimated as 1.82 individuals/m2 in the Ağın region and 2.08 individuals/m2 in the Keban and Çemişgezek regions. The total stock in terms of number was estimated as 219,8560 individuals in Ağın region, 2672800 individuals in Keban region and 479,9142 individuals in Çemişgezek region, and in terms of weight as 58482 kg in Ağın region, 71,096 kg in Keban region and 127,657 kg in Çemişgezek region.

The density of crayfish of catchable size (≥ 9 cm) was determined as 1.17 individuals/m^2 in Ağın region, 1.37 individuals/m^2 in Keban region and 1.40 individuals/m^2 in Çemişgezek region. The number of crayfish of catchable size was estimated as 1,413,360 individuals in Agın region, 1,760,450 individuals in Keban region, 3,230,192 individuals in Çemisgezek region, 44,380 kg in Ağın region, 55,278 kg in Keban region and 101,428 kg in Çemişgezek region.

Bolat (2001), calculated the catch per unit effort as 0.17 crayfish/fykenets/day in the fishing trials conducted between July and December 1999 in Hoyran region of Lake Eğirdir. In the same period, the month with the highest catch per unit effort was December (0.23 crayfish/fykenets/day). In 2000, the catch per unit effort was calculated as 0.13 crayfish/fykenets/day and the months with the highest catch effort were November (0.20 crayfish/fykenets/day) and December (0.18 crayfish/ ykenets/day).

Bolat and Aksoylar (1997), determined the number of crayfish per unit (fykenets) as 2.68 pieces for a 10-month period and 0.27 pieces for a 1-month period in their study conducted in Lake Eğirdir.

Suggestions for solutions to the problems experienced by fishermen fishing crayfish in Keban Dam Lake are as follows;

- Inadequate diesel oil support from the state (4.250 TL for one time (in 2023 year),
- Excessive lake rent and reduction of the amount,
- Increasing interest-free credit support,
- Suggestions such as starting the season earlier are offered.

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