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RESEARCH PAPER

The Stock Assessment of Crayfish (*Astacus leptodactylus* Eschscholtz, *1823*) in the Keban Dam Lake

Ferhat Demirol[1,*], Fahrettin Yuksel[2], Fatih Gunduz[1], Abdulmutalip Beri[1], Mehtap Guler[3], Tacettin Yildirim[1], M. Zulfu Coban[4]

[1] Fisheries Research Institute, 23000, Elazığ, Turkey.
[2] University of Munzur, Faculty of Fisheries, 62000, Tunceli, Turkey.
[3] Directorate of District Food Agriculture and Livestock, Avcılar, Istanbul, Turkey.
[4] University of Fırat, Faculty of Fisheries, 23119, Elazığ, Turkey.

* Corresponding Author: Tel.: +90 424 241 1085; Fax: +90 424 241 1087;
E-mail: ferhatdemirol@hotmail.com

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Abstract

In this study, estimating of catchable stock size, stock density and the amount of annual allowable catches of crayfish population in the Keban Dam Lake was aimed. The Schnabel Method, one of the multiple marking methods, was used to estimate crayfish stock size. The caught crayfish were branded by an electric soldering iron. Mean weight of crayfish that have the minimum allowable length (TL≥10 cm) was detected as 41 g and catch per unit effort (CPUE) was calculated to be 0.13 crayfish/fyke-net/day both 2012 and 2013. It was determined that the density of crayfish that have greater than (or equal to) total length of 10 cm was 0.91 individual per m^2 for 2012 and 1.07 individual per m^2 for 2013. Accordingly, the biomass of crayfish that have minimum landing size (TL≥10 cm) was estimated to be 80,258 kg for 2012 and 74,671 kg for 2013. The total amount of annual allowable catch in the Keban Dam Lake was estimated at 26.7 tons. For individual regions it reached: 7.1 tons for Ağın, 6 tons for Keban, 7.7 tons for Çemişgezek and 5.9 tons for Ova fishing regions.

Keywords: Mark-recapture, schnabel method, stock density, CPUE.

Introduction

One of the most important products obtained from inland waters is crayfish. Besides being an important protein source, crayfish is considered to be luxury water product due to its exquisite taste and high price (Aksu & Harlıoğlu, 2015; Demirol & Yüksel, 2014). The number of freshwater sources in Turkey from which the crayfish is fished has risen comparing to the previous years. However, this rise has been provided without conducting necessary scientific studies by taking the crayfish from one random water source and throwing it in another one (Çılğın & Aksu, 2015; Yüksel & Duman, 2012). Keban Dam Lake is one of the water sources in which the crayfish has been stocked in this way. In 1980, the crayfish was placed in the dam lake through unofficial channels where it adapted to the environment. The fishing of crayfish in the dam lake started in 1994 with 17 tons production, while the production increased to 35 tons by the beginning of 2000. In the last years, the amount of the crayfish collected with 28 fishing boats was between 15 and 19 tons. The crayfish fishing in the Keban Dam Lake is conducted in a limited area (Kemaliye, Ağın, Çemişgezek and Keban fishing grounds), the scientific studies to have concentrated on these limited areas. However, it is known that the crayfish is widespread throughout the whole dam lake. After taking necessary measures and conducting scientific research, the production can rise to the desired amount (Çoban *et al*., 2012; Demirol *et al*., 2015; Yüksel & Celayir, 2010).

The crayfish faces many problems in its natural environment. The main problems endangering crayfish population in water environment are: diseases and parasites, predators, cannibalism, inappropriate environment conditions such as pollution or drought and problems caused by humans, directly or indirectly, such as extreme fishing (Aksu & Harlıoğlu, 2016).

In order to conduct efficient and sustainable fishing of economically rather valuable crayfish, the fishing needs to be regulated according to scientific data. From this perspective, it is very important to know population density, quantity, and distribution. The stock analysis needs to be conducted in order to preserve such a valuable and limited product for the fishermen in the area. The estimation of population size provides valuable information in ecological field studies, especially when species face the risk of extinction. Description of several field methods for estimating the size open and closed populations, and which require that mark-recapture techniques be employed, are available in the literature (Krebs, 1989). Mark-recapture studies have been proven useful for obtaining information on the migration, growth, population size and mortality rates of many aquatic animal species. This estimation method requires a methodology designed to assess the population size within a known area. It can be carried out either in terms of relative abundance using catch per unit effort data, absolute abundance using census methods or mark-recapture techniques (Bolat, Mazlum, Demirci, & Koca, 2011; Pollock, Nichols, Brownie, & Hines, 1990).

The goal of this study is to determine the situation of the crayfish population in Keban Dam Lake, its density and yearly amounts that can be fished by using mark and recapture method. The obtained results will contribute to the management of the crayfish fishing, but they will also serve as an example to other crayfish population analysis.

Materials and Methods

Study Area

The Keban Dam Lake, one of the biggest inland water reservoirs in Turkey, has a surface area of 675 km^2 in the maximum water level (845 m altitude) and a water volume of 30.6x10^9 m^3. It is situated between the 38°37' N-39°20' N and 38°15' E-39°52' E coordinates (Yüksel & Celayir, 2010). The study was carried out in Ağın, Keban, Çemişgezek and Ova fishing areas of the Keban Dam Lake. The commercial crayfish catching in the Keban Dam Lake has been conducted only these fishing areas.

The Ağın fishing area on the Dam Lake spreads on the total of 4,700 hectares. However, since the crayfish is distributed on the coastal region in 5-15 m depths, the total surface area is calculated as 490,000 m^2. The Keban fishing area on the Dam Lake spreads on the total of 5,000 hectares. However, since the crayfish is distributed on the coastal region in 5-15 m depths, the total surface area is calculated as 280,000 m^2. The Çemişgezek fishing area on the Dam Lake spreads on the total of 9,550 hectares. However, since the crayfish is distributed on the coastal region in 5-15 m depths, the total surface area is calculated as 450,000 m^2. The Ova fishing area on the Dam Lake spreads on the total of 10,620 hectares. However, since the crayfish is distributed on the coastal region in 5-15 m depths, the total surface area is calculated as 2,250,000 m^2 (Figure 1).

Study Period

The mark-recapture method was used for estimating the catchable crayfish population size and stock density in the study area. The marking was conducted twice in 2012 and 2013 in October, November, and December in stations chosen in four fishing areas. These months were preferred because in this period fishing activities are officially over, the shell change season is completed and the crayfish start to actively take the bait.

Crayfish Sampling and Marking

In the fishing surveys, it was used a total of 1200 crayfish fyke-nets, which used prevalently in the region, with D form and 36 mm stretched mesh size, structured with five hoops and a barrier. The fyke-nets were left in water for a period of 1 week. In order to ensure that the marked specimens are evenly distributed within the population, at least 4 days were left to pass between two markings.

A 6 m long motorized fibreglass boat was used for placing and pulling up the fyke-nets, while a digital calliper with 0.1 mm precision and terrain scales with 0.1 g precision were used for size and weight measurements.

One of the best methods for marking the crustaceans, the cauterization method, was used as a marking method in the study. A 60 amp storage battery and 12 volt soldering iron were used for this purpose. The hard layer of the shell is gently touched leaving a small trace (Figure 2). The marked crayfish was placed back in the area where it was caught in a way that would ensure homogeneous distribution.

Data Analysis

Catch per unit effort was calculated using the number of crayfish/fyke-net/day ratio. Data was evaluated according to the years (2012 and 2013) when the test was conducted and according to the areas where it was conducted.

It was assumed that the effective area for each Fyke-net was 5 m in diameter, and the unit area for each test zone was calculated respectively. Since the crayfish is seasonally distributed between 5-15 m depth in the dam lake, the surface area of this depth was taken into account for calculating total area. The average weight of crayfish with minimum allowable length (≥10 cm) was determined to be 41 g. The biomass in weight was calculated with this value taken into consideration. In order to predict the stock density of the minimum sized catchable crayfish, crayfish specimens larger than 10 cm were taken into consideration.

A multi-marking model, the "Schnabel Method", was used for this purpose. Schnabel (1938) used the main formula from the Peterson Method to estimate population size, while Chapman (1952) improved it in the following manner in order to produce more accurate estimation.

The population size; $$N = \frac{\Sigma C_i \times M_i}{\Sigma R_i + 1}$$

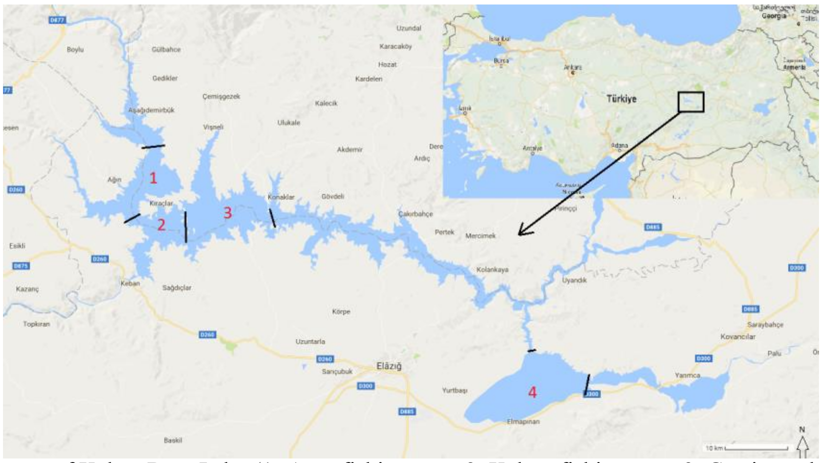

Figure 1. Fishing areas of Keban Dam Lake (1: Ağın fishing area, 2: Keban fishing area, 3: Çemişgezek fishing area, 4: Ova fishing area).

Figure 2. The crayfish marked by an electric soldering iron

The standard error of population size;

$$\sqrt{\mathrm{Varyans}(1/N)} = \sqrt{\frac{\sum R_i}{\sum (C_i \times M_i)^2}}$$

In these equations;
N: Population size
C_i: The number of caught individuals
M_i: The number of marked individuals
R_i: The number of caught individuals with mark

95% confidence interval for population size;

Upper limit (1/N) = 1/N+t(0.975, n-1) √Varyans (1/N)

Lower limit 1/N = 1/N - t(0.975, n-1) √Varyans (1/N)

$$\frac{1}{\text{Upper Limit }(1/N)} > N > \frac{1}{\text{Lower Limit }(1/N)}$$

In calculating the natural mortality rate (M), we benefited from Ursin (1967). The fishing mortality was determined by tracking the fishing data. The stock exploitation rate (E) was taken as 0.5 in order to determine the potential yield (PY) (Gulland, 1971). “SPSS 22.0” and “Microsoft Excel” package programs were used for the statistical evaluation of the obtained results.

Results

During the total of 44 fishing operations in 2012 and 2013 years on four different fishing areas of Keban Dam Lake were caught respectively: 7056 and 8745 specimens of crayfish, in this 3316 and 4110 specimens which have above minimum landing size (≥10cm TL). It has been determined that in both two years 47% of the amount fished with the fyke-nets traditionally used in the area was above minimum landing size (≥10cm TL). The total average length of the crayfish caught was 98.58±0.24 mm, while the total average weight was 28.9±0.25 g. The average length of crayfish above minimum landing size was

111.02±0.25 mm, while the average weight was 40.50±0.37 g. The CPUE of crayfish captured in the four different fishing regions of the dam lake have varied between 0.08 and 0.22 ind/fyke-net/day and between 3.14 and 8.95 g/fyke-net/day. The highest CPUE was found in the Keban locality of the dam lake in both 2012 and 2013 (0.19 and 0.22 ind/fyke-net/day). The lowest CPUE in 2012 was in Çemişgezek area (0.10 ind/fyke-net/day), while the lowest CPUE in 2013 was in Ova area (0.08 ind/fyke-net/day). The CPUE calculated for the whole dam lake was 0.13 ind/fyke-net/day in both 2012 and 2013 (Table 1). The fishable stock was assessed using mark-recapture method conducted twice in 2012 and 2013 on the total of 4 stations on Keban Dam Lake; three of them in areas where commercial crayfish fishery are conducted (Ağın, Keban and Çemişgezek) and one of them in the area where crayfish fishery is not conducted (Ova). In 2012, during the total of 26 marking operations, 7056 specimens of crayfish were caught (C_i) 3996 of which were marked (M_i), while 123 marked crayfish were recaptured (R_i). The recapture ratio in this period was calculated as 3.08 (% R_i/M_i). In 2013, during the total of 18 marking operations, 8745 specimens of crayfish were caught (C_i) 6626 of which were marked (M_i), while 223 marked crayfish were recaptured (R_i). The recapture ratio in this period was calculated as 3.37 (% R_i/M_i). The details of marking operations according to the stations are shown in Table 2. The number of crayfish per m^2 in Ağın fishing area was determined to be 1.45 and 0.62 in 2012 and 2013, respectively. According to this, in 2012 the estimated number of specimens above minimum landing size (≥10 cm) in Ağın area was 708,000 (29,041 kg), while in 2013 it was 301,736 (12,371 kg). When all the data from the study is used, the estimated crayfish population density in Ağın area is 1.04 ind/m^2, while the estimated fishable population size is 504,868 specimens or 20,706 kg (15,916-29,707 kg, 95% CI). In order for the sustainable crayfish fisheries, it is determined that the yearly potential yield to be 7,123 kg (Table 3). The number of crayfish per m^2 in Keban fishing area was determined to be 0.99 and 2.05 in 2012 and 2013, respectively. According to this, in 2012 the estimated number of specimens above minimum landing size (≥10 cm) in Keban area was 277,803 (11,390 kg), while in 2013 it was 572,734 (23,482 kg). When all the data from the study is used, the estimated crayfish population density in Keban area is 1.52 ind/m^2, while the estimated fishable population size is 425,269 specimens or 17,436 kg (14,582-21,685 kg, 95% CI). In order for the sustainable crayfish fisheries, it is determined that the yearly potential yield to be 5,998 kg (Table 3).

The number of crayfish per m^2 in Çemişgezek fishing area was determined to be 0.93 and 1.48 in 2012 and 2013, respectively. According to this, in 2012 the estimated number of specimens above minimum landing size (≥10 cm) in Çemişgezek area was 419,426 (17,196 kg), while in 2013 it was 665,593 (27,289 kg). When all the data from the study is used, the estimated crayfish population density in Çemişgezek area is 1.21 ind/m^2, while the estimated fishable population size is 542,510 specimens or 22,243 kg (18,051-29,712 kg, 95% CI). In order for the sustainable crayfish fisheries, it is determined that the yearly potential yield to be 7,651 kg (Table 3).

The number of crayfish per m^2 in Ova fishing area was determined to be 0.25 and 0.12 in 2012 and 2013, respectively. According to this, in 2012 the estimated number of specimens above minimum landing size (≥10 cm) in Ova area was 551,984 (22,631 kg), while in 2013 it was 281,195 (11,529 kg). When all the data from the study is used, the estimated crayfish population density in Ova area is 0.19 ind/m^2, while the estimated fishable population size is 416,590 specimens or 17,080 kg (15,014-19,856 kg, 95% CI). In order for the sustainable crayfish fisheries, it is determined that the yearly potential yield to be 5,876 kg (Table 3).

In the estimated population size study conducted in the four fishing areas on the Keban Dam Lake, it has been determined that the lowest crayfish population density per m^2 was 0.12 ind/m^2 in Ova area in 2013, while the highest crayfish population density was 2.05 ind/m^2 in Keban area in 2013. When the total estimated fishable stock is calculated, the lowest biomass was 11,390 kg in Keban area in 2013, while the highest biomass was 29,041 kg in 2012 in Ağın area. In order for the fishing operations on the whole Dam Lake to be sustainable, the yearly potential yield amount needs to be 26,648 kg (Table 3). The estimated stock sizes of the study areas according to years are shown as a graph on Figure 3.

Discussion

Crayfish is one of the most important species for the Keban Dam Lake fishing. When the crayfish fishing started on the dam lake in 1994, no fishing management plan was conducted. The goal was to obtain the biggest possible amount of product, even though crayfish stock size, density, and distribution were unknown. This approach caused overfishing in the areas where commercial fishing is conducted (Keban, Ağın, Çemişgezek), while the fishing is not conducted in other areas, even though sufficient crayfish stock can be found there. Also, all of the scientific studies on the subject of crayfish were conducted only in the areas where there is commercial crayfish fishing (Aksu & Harlıoğlu, 2015; Aksu & Harlıoğlu, 2016; Ateş & Aksu, 2013; Çılğın & Aksu, 2015; Demirol *et al*., 2015; Demirol & Yüksel, 2014; Duman & Pala, 1998; Harlıoğlu & Aksu, 2002; Kutluyer, Aksu, & Aksu, 2013; Yüksel & Duman, 2011; Yüksel & Duman, 2012; Yüksel, Demirol, & Gündüz, 2013).

In this study, 3316 and 4110 specimens of crayfish above minimum landing size (≥10cm TL)

Table 1. Catch per unit effort (CPUE) for crayfish sampled in the four fishing regions of Keban Dam Lake in 2012 and 2013

Fishing Areas	Survey 2012		Survey 2013	
	CPUE±SE (ind/fyke-net/day)	CPUE±SE (g/fyke-net/day)	CPUE±SE (ind/fyke-net/day)	CPUE±SE (g/fyke-net/day)
Ağın (4700 ha)	0.12±0.02	5.03±0.98	0.10±0.02	4.27±0.76
Keban (5000 ha)	0.19±0.05	7.74±1.90	0.22±0.04	8.95±1.76
Çemişgezek (9550 ha)	0.10±0.03	4.16±1.35	0.17±0.02	7.04±0.92
Ova (10620 ha)	0.14±0.03	5.68±1.19	0.08±0.01	3.14±0.25
Total (29870 ha)	0.13±0.02	5.25±0.81	0.13±0.02	5.51±0.71

Table 2. The data related to marking surveys (C_i: The amount of caught crayfish, M_i: The amount of marked crayfish, R_i: The amount of recaptured crayfish)

Fishing Areas	Survey 2012				Survey 2013			
	C_i	M_i	R_i	% R_i/M_i	C_i	M_i	R_i	% R_i/M_i
Ağın	1,618	946	15	1.59	1,253	1,008	21	2.08
Keban	1,800	1,079	30	2.78	2,682	2,036	32	1.57
Çemişgezek	2,509	1,802	33	3.05	3,076	2,100	42	2.00
Ova	1,129	889	45	5.06	1,734	1,482	128	8.64
Total	7,056	3,996	123	3.08	8,745	6,626	223	3.37

Table 3. The estimated stock density, catchable stock size and potential yield of crayfish in the four fishing regions on Keban Dam Lake

Year	Fishing Areas	ind/m^2	Catchable Stock (ind)	Catchable Stock (kg)	95% CI (kg)	Potential Yield (kg)
2012	Ağın	1.45	708,000	29,041	21,974 – 42,807	9,990
	Keban	0.99	277,803	11,390	9,409 – 14,426	3,918
	Çemişgezek	0.93	419,426	17,196	12,668 – 26,762	5,915
	Ova	0.25	551,984	22,631	19,475 – 27,008	7,785
	Total	0.91	1,957,213	80,258	63,526 – 111,003	27,609
2013	Ağın	0.62	301,736	12,371	9,857 – 16,606	4,256
	Keban	2.05	572,734	23,482	19,754 – 28,944	8,078
	Çemişgezek	1.48	665,593	27,289	23,434 – 32,662	9,387
	Ova	0.12	281,195	11,529	10,553 – 12,704	3,966
	Total	1.07	1,821,258	74,671	63,598 – 90,916	25,687
Average	Ağın	1.04	504,868	20,706	15,916 – 29,707	7,123
	Keban	1.52	425,269	17,436	14,582 – 21,685	5,998
	Çemişgezek	1.21	542,510	22,243	18,051 – 29,712	7,651
	Ova	0.19	416,590	17,080	15,014 – 19,856	5,876
	Total	0.99	1,889,236	77,465	63,562 – 100,960	26,648

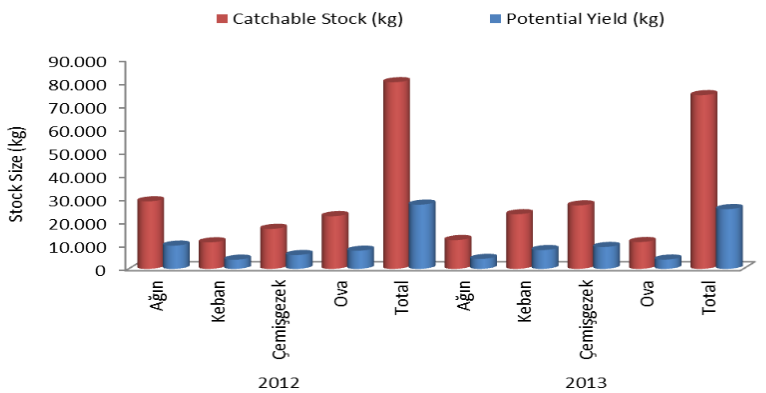

Figure 3. The estimated catchable stock sizes and potential yield in the four fishing regions of Keban Dam Lake.

were caught in years 2012 and 2013 respectively during the total of 46 fishing surveys in four different fishing areas on Keban Dam Lake. The catch per unit effort (CPUE) of the dam lake in general was calculated as 0.13 ind/fyke-net/day for both years, while the weight was calculated as 5.51 g/fyke-net/day in 2012 and as 5.25 g/fyke-net/day in 2013. The CPUE, when calculated according to the area, shows variation between 0.08 and 0.22 ind/fyke-net/day. In the study conducted on Eğirdir Lake in Hoyran area by Bolat (2001), CPUE was calculated as 0.17 ind/fyke-net/3 days and 0.18 ind/fyke-net/3 days for years 1999 and 2000 respectively. These values can also be expressed as approximately 0.06 ind/fyke-net/day. This value is lower than the values obtained in the present study. It is well known that CPUE can be different in each habitat, it can also be different in each station chosen within the habitat or in different study periods. It is considered that the crayfish population in Eğirdir Lake declined due to the "crayfish plague" which in turn caused the value difference. Also, the yield doubled when the bait was used in the fyke-nets (Bolat, Mazlum, Günlü, Bilgin, & İzci, 2011). In a study conducted by Yüksel and Duman (2011) in Ağın, Keban and Çemişgezek areas on the Keban Dam Lake, CPUE for Ağın area was 0.86, for Keban area was 1.08, for Çemişgezek area was 0.85 and for the Keban Dam Lake in general was 0.93 number of crayfish/fyke net/7 days. When the results are expressed as ind/fyke-net/day, the average for the dam lake was calculated as 0.13 ind/fyke-net/day. This value is identical to the values obtained in the present study. In a study conducted by Dartay and Ateşşahin (2013) in Pertek fishing area on the Keban Dam Lake, CPUE was 0.2 ind/fyke-net/survey. Also, in the same study, the month with the highest yield was November and the month with the lowest yield was March. In a research conducted by Demirol and Yüksel (2014) on the Keban Dam Lake, the CPUE was expressed as a weight (g/fyke-net/day) using the commercial and fishing data from the season in 2012. According to that, CPUE for Ağın area was calculated as 4.91, for Keban area as 7.09, for Çemişgezek area as 6.16 and for the Keban Dam Lake in general as 5.74 g/fyke-net/day. Even if, for some areas, the values obtained in this study are slightly different from the values obtained in the present study, the values calculated for the dam lake in general are compatible with each other.

In the present study, the population size and density was estimated with mark-recapture operations conducted in Ağın, Keban, Çemişgezek and Ova areas on the Keban Dam Lake in 2012 and 2013 between November and December. In the light of the conducted analysis, crayfish population density was between 0.12 and 2.05 ind/m^2 depending on the area, while the average was 0.99 ind/m^2. If the average of both two years is taken into consideration, it is estimated that there are 1,889,236 pieces of fishable size crayfish, which is 77,465 kg in weight; while the potential yield weight needed for sustainable fishing is estimated to be 26,648 kg. Also, it was concluded that the mark-recapture method is the most suitable one for estimating crayfish stock density since the method gave good results, the crayfish life was not affected by the cauterization technique and the marks did not fade. Skurdal, Qvenild, and Taogbol (1992) determined in a similar way that the mark-recapture method is the most suitable one for observing crayfish populations. Rabeni, Collier, Parkyn, and Hicks (1997) concluded in their comparative study that "Reduction Method and Stock Size Assessment" method is not as efficient as "Mark and Recapture" technique. Elser, Junge, and Goldman (1994) have determined in their study that the best method for marking crayfish is cauterization. Yüksel and Duman (2011) pointed out that the trace on cauterized crayfish did not disappear after the crayfish changed its shell.

Köksal, Korkmaz, and Kırkağaç (2003) used single marking and recapture method (Peterson Method) to estimate crayfish population size in Ankara-Dikilitaş Pond. Two operations on different dates were conducted in the study and the population size depending on the dates was estimated to be 23,843 and 18,011 pieces of crayfish respectively. Crayfish density in the first operation was calculated as 199 ind/ha or 6.47 kg/ha, while in the second one it was calculated as 150 ind/ha or 4.91 kg/ha. In a study conducted on Eğirdir Lake in Hoyran region, Bolat (2004) used to mark and recapture method (Schnabel Method). The crayfish stock density in the I Period was 1.92-3.20 ind/m^2, while in the II Period it was 3.41-5.05 ind/m^2. In a study conducted by Yüksel and Duman (2011) on the Keban Dam Lake in Ağın, Keban and Çemişgezek areas using the same method, the calculated stock density of crayfish above minimum landing size at that time (≥9cm TL) was 1.17 ind/m^2 in Ağın area, 1.37 ind/m^2 in Keban area, 1.40 ind/m^2 in Çemişgezek area and the average was 1.31 ind/m^2. The estimated stock size determined in the same study was 44,380 kg for Ağın area, 55,278 kg for Keban area, 101,428 kg for Çemişgezek area and 201,086 kg for the whole lake. When the obtained values are examined, even though the estimated stock density values are compatible with the ones in the present study, there are serious differences between estimated fishable stock sizes. This is because the minimum landing size in the study conducted by Yüksel and Duman (2011) was 9 cm, while in the present study it was 10 cm due to the legal changes in minimum landing size. The inconsistency is also caused by a different method used by the researchers for determining the areas in which crayfish is distributed. Yüksel *et al*. (2013) used Leslie depletion model with the commercial fishing data from the 2012 commercial fishing season in their stock assessment study conducted on the Keban Dam Lake. Their stock assessment was 28,450 kg of crayfish above landing size in areas on the Keban Dam Lake where commercial fishing is conducted (Ağın, Keban and Çemişgezek) before the season 2012. Since the method used in this study is different, it is normal that the obtained results are not compatible.

The crayfish fishing on the Keban Dam Lake is conducted more consciously (knowledgeable) comparing to other fish species in the lake. The number of crayfish fishermen is limited and each fisherman has his own area. As a result, the fishermen working with crayfish have adopted this little creature. The fishermen are making an effort not to conduct excessive fishing. For example; the fishermen voluntarily closed the season early when the crayfish prices started to fall with the beginning of September and left the product in the water so it can be fished in the next season when it is more valuable. Fishing in forbidden periods, fishing of specimens below landing size and fishing with forbidden means on the Keban Dam Lake can be observed with other species of fish, but not with crayfish (Demirol & Yüksel, 2014). Also, it has been determined that illegal crayfish fishing activities such as fishing for certain gender (female specimens are preferred), using bait for fishing and fishing outside fishing season are not conducted on the Keban Dam Lake.

The economic value of the crayfish species commercially fished in Turkey called "Turkish crayfish" or *Astacus leptodactylus* (Esch., 1823) is rather high. However, the yearly yield is unfortunately much below the desired level. The effect of a disease that occurred in the past called crayfish plague was certainly significant. However, almost 30 years have passed since and one of the reasons that the crayfish stocks have not recovered and brought to the desired level is the absence of the stock management plan. Instead of leaving the populations head to head with the fishermen or by themselves, an effective management plan prepared in the light of the scientific studies would prove to be invaluable in bringing the populations to the desired levels. The basic principle of the ecosystem approach to fisheries is to transfer the stock quantity and diversity to the next generations. Nowadays, different methods are used throughout the world to manage crayfish fishing and decrease the pressure on the stocks such as closing the worn out reservoirs for fishing for a certain period of time, bait bans, increasing the minimum landing size or banning fishing for a specific gender. Also, in many places natural populations are supported by leaving the crayfish offspring unharmed. Similar practices were applied from time to time in our country as well to regulate crayfish fishing. However, the success of these practices was limited since they were not decisively applied nor was there effective control mechanism. The basic principle should be to design the fishing power according to the determined yearly amount that can be fished from the stocks. In another word, the crayfish fishing should be based on a principle of obtaining the minimum expense from the determined yearly potential yield. In this way, "excessive fishing" that causes population depletion and "insufficient fishing" that does not use the maximum potential of the stocks can be prevented and unnecessary investments can be avoided. Even if the most modern fishing tools are used, fishing should be considered primitive if it is conducted without knowing population size, yield, distribution and yearly change.

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