To compare CPUE and YPUE values of sorting grid with 18, 20 and 22 mm bar spacing on fishing of crayfish with fyke net in Turkey

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Abstract

This study aimed to compare CPUE and YPUE values of the grid with 18, 20 and 22 mm bar spacing on crayfish fishing with fyke net in Turkey. For this purpose, sorting grids, which had 18 (SG18), 20 (SG20) and 22 mm (SG22) bar spacing were tested. A total of 90 fyke net, each group consisting was 30 used in the experiments. The grids were attached at the end of the fyke net. Covered-codend techniques were utilized to obtain the escapers. Caught crayfish were categorized according to gear type on the boat using a specific case. Twelve fishing operations were done in the study. A total of (codends & covers) 1495 crayfish were caught, 619 from codends and 876 covers as well. The caught crayfish number of trial codends were 226, 208 and 185 for SG18, SG20 and SG22 groups, respectively. The average total length of crayfish was computed as 109.71, 18.65 and 108.98 mm for SG18, SG20 and SG22, respectively. CPUE and YPUE values were calculated as 0.29 n/d and 11.33 g/d for SG18; 0.31 n/d and 11.50 g/d for SG20; 0.28 n/d and 10.21 g/d for SG22. No statistical differences between CPUE and YPUE values between the codends.

Keywords: CPUE, Pontastacus leptodactylus, fyke net, sorting grid.

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Introduction

Freshwater crayfish is keystone species in freshwater ecosystems. As ecosystem engineers, they have a high impact on freshwater ecosystem biodiversity. Due to the high economic value, the demand for crayfish increases daily. To take over demands, stocks have been severely damaged by increasing catching pressure, habitat destruction, pollution, disease, etc. (Cilbiz et al., 2020). The annual production in Turkey, which was close to 8,000 tons in the early 1980s, dropped below 1,000 tons in 2019 (FAO, 2021). This situation has revealed the necessity of better management of crayfish stocks.

Selectivity, especially size selectivity, has become very important in catching large individuals and eliminating individuals below marketable size from fishing. Crayfish are mainly captured by fyke net in Turkey (Occasionally obtained as gill net by-catch mostly in close season). From the previous studies, traditional fyke net length selectivity is too low (Bolat et al., 2010; Cilbiz et al., 2022). Some studies were conducted to improve selectivity, some of these studies are increasing codend mesh size (Bolat et al., 2010), using hexagonal mesh (Bolat and Uçgun, 2019), sorting grid and stiff rigged net (Cilbiz, 2019). These studies have shown that selectivity can be improved. However, an important point to remember is that while increasing selectivity, economic losses should be at a minimum level. For this reason, the catch per unit effort (CPUE) and yield per unit effort (YPUE) is important parameters that should never be ignored in studies to be carried out to improve size selectivity.

CPUE and YPUE are the main components of fishery stock assessments used by fisheries scientists. It can be used as an index of stock abundance, where some relationship is assumed between that index and the stock size. Catch rates by boat and gear categories, often combined with data on fish size at capture, permit a large number of analyses relating to gear selectivity, indices of exploitation and monitoring of economic efficiency (FAO, 2021). There are some CPUE (Bolat et al., 2011; Yüksel and Duman, 2011; Yüksel et al., 2013; Demirol et al., 2017; Cilbiz et al., 2021; Ruokonen et al., 2021) studies conducted on commercial fyke net using in crayfish fishery. Comparable results were found from these studies. On the other hand, It has been reported that the sorting grid system applied to crayfish fyke net significantly improved the size selectivity. This study aimed to compare CPUE and YPUE values of the grid with 18, 20 and 22 mm bar spacing on crayfish with fyke net in Turkey.

Material and methods

The study was carried out between July and October 2020 in Eğirdir Lake, the most productive crayfish area (annually 395.6 t for 2019 by official record) in Turkey. Modified fyke nets, designed based on commercial ones, were used in the experiments. Technical specifications of the net was given in Figure 1-A. The net consisted of 2 sections (one set). Each unit has one D (the first one) and four cylindrical iron frames with two funnels. Iron frames had 3 mm thickness with 44 and 25 cm

diameters for the first (D form) and the rest, respectively. A 34 mm mesh size, used commercially, was used in all parts of the nets.

Sorting grids that have 18, 20 and 22 mm bar spacing were tested in the experiments. Grids frames and bars have iron (Fe) material and are produced by laser cutting. The iron frames have a 3 mm thickness and the grids have 25 mm diameter (R). A precision digital calliper was used for measurements of the bar spacing. The mean values of SG18, SG20 and SG22 were 18.00±0.08, 20.00±0.07 and 22.19±0.07 mm, respectively. No statistical differences were found between bar spacing ($p>0.05$). The grids were rigged on the last circle of the nets. In this way, it prevents the closing of codend meshes. A total of 90 fyke nets, each bar spacing have 30 (15 sets) was used. The nets were connected with a rope that has 1 m lengths and Ø 5 mm Polyamide (PA) material (Fig. 1-B).

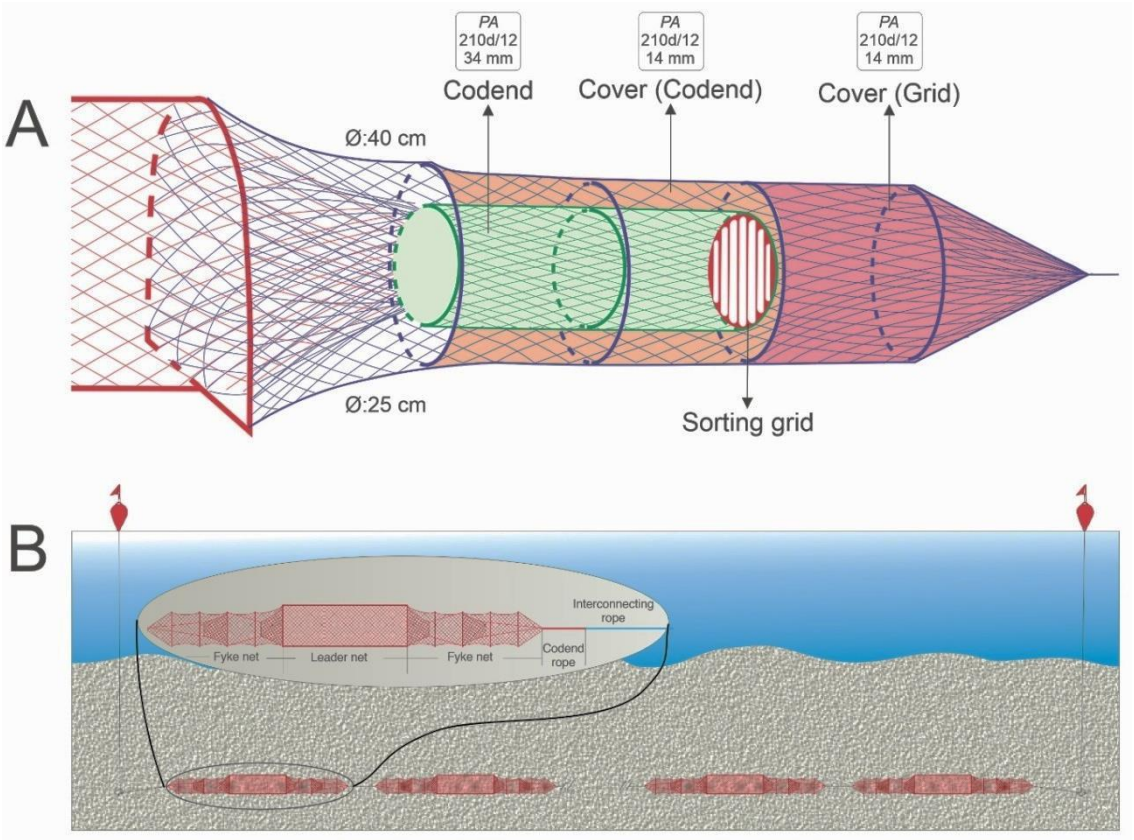

Figure 1: Experimental fyke net design (A) and applied fishing technique.

A covered codend technique was used in the experiments to obtain escapers from grids and nets. The cover was designed according to Wileman et al. (1996). To prevent masking, a cover circle diameter was made 1.5 times bigger (37.5 cm) than fyke net hoops. The covers had three circles attached to the middle of the third and fourth circles of the net (Fig 1-A. The covers had polyamide (PA) materials with 210d/12 no twine thickness and 14 mm mesh size. It was 80 cm in length and 110 meshes on its circumferences and rigged between the 2nd and 3rd circles of the fyke net to keep the net.

The nets were settled in the morning and after 2 days (soak time: ~48 h), hauled up and controlled. After lifting the nets, catches were

separately emptied as codend and cover on the deck, then the crayfish were collected and the others were released the water. The total length of all individuals was measured to the nearest 0.5 cm

CPUE values were calculated according to FAO (2018) using the formula given below. A fisherman and station were used to determine the nominal effort. In the calculations, the total number (n) of caught crayfish for CPUE and total weight (g) of caught crayfish for YPUE were based on the total catch:

CPUE = total catch / nominal effort

Nominal effort (for Fyke Net) = number of traps x fishing days

One-way analysis of variance (ANOVA) with TUKEYHSD post-hoc test was used for comparing the total length of caught by trial codend by using agricolae (v1.3-5) R package (De Mendiburu, 2021). Permutational multivariate analysis of variance (PERMONOVA) was used for non-normal distributed CPUE & YPUE values of trial codends by using vegan (v 2.5-7) R package adonis2 function (Oksanen et al., 2020). All statistical process was computed with R (v4.1.0) based RStudio (v1.4.1717) software.

Results

A totally of 12 fishing operations were done. A total (codends+covers) of 1495 crayfish was caught. While the 619 (%41.4) individuals were belonging to codend catch, 876 (58.6 %) was a cover catch. The total number of crayfish in codend (retained) and cover (escapees from net and grid) were given in Table 1. The codend catch distribution of the SG18, SG20 and SG22 mm for 226 (36.5%), 208 (33.6%) and 185 (29.9%), respectively. The cover catch (grid+codend) distribution of the SG18, SG20 and SG22 mm for 314 (35.8%), 262 (29.9%) and 300 (34.2%), respectively. In SG18, 540 crayfish were caught, while 41.9% (226) of the specimens retained with sizes ranging from 83.63 to 162.10 mm (mean: 109.71 mm), 58.1% (314) of escape ranged from 42.13 to 106.10 mm (mean: 58.0 mm). In SG20, 470 crayfish were caught, while 44.3% (208) of the specimens retained had sizes ranging from 84.87 to 149.84 mm (mean: 108.65 mm), 55.7% (262) of escape ranged from 39.19 to 102.61 mm (mean: 72.07 mm). In SG22, 485 crayfish were caught, while 38.1% (185) of the specimens retained had sizes ranging from 88.57 to 140.65 mm (mean: 108.98 mm), 61.9% (300) of escape ranged from 35.95 to 103.94 mm (mean: 72.35mm). The difference between the mean lengths of codend and cover in the all test groups was found to be statistically significant ($p<0.05$) (Fig. 2).

Table 1: Total length distribution of catch by trial fyke nets (mm).

Bar spacing	Codend type	n	Total length (mm)		Total weight (g)	
			Mean±SE	Min-max	Mean±SE	Min-max
SG18	Codend	226	109.71±0.86	83.63-162.10	38.49±1.11	16.39-142.12
	Cover (Codend)	183	59.92±0.83	42.13-88.94	6.55±0.29	1.75-20.04
	Cover (Grid)	131	86.07±0.64	68.43-106.10	18.02±0.43	8.52-35.64
SG20	Codend	208	108.65±0.87	84.87-149.84	37.15±1.01	17.20-109.95
	Cover (Codend)	163	58.73±0.81	39.19-81.03	6.06±0.25	1.64-14.79
	Cover (Grid)	99	85.41±0.84	67.49-102.61	17.42±0.49	8.14-31.96
SG22	Codend	185	108.98±0.72	88.57-140.65	37.08±0.81	19.06-82.77
	Cover (Codend)	181	59.17±0.74	35.95-79.87	6.12±0.23	1.04-14.11
	Cover (Grid)	119	85.53±0.75	66.86-103.94	17.81±0.47	7.98-29.24

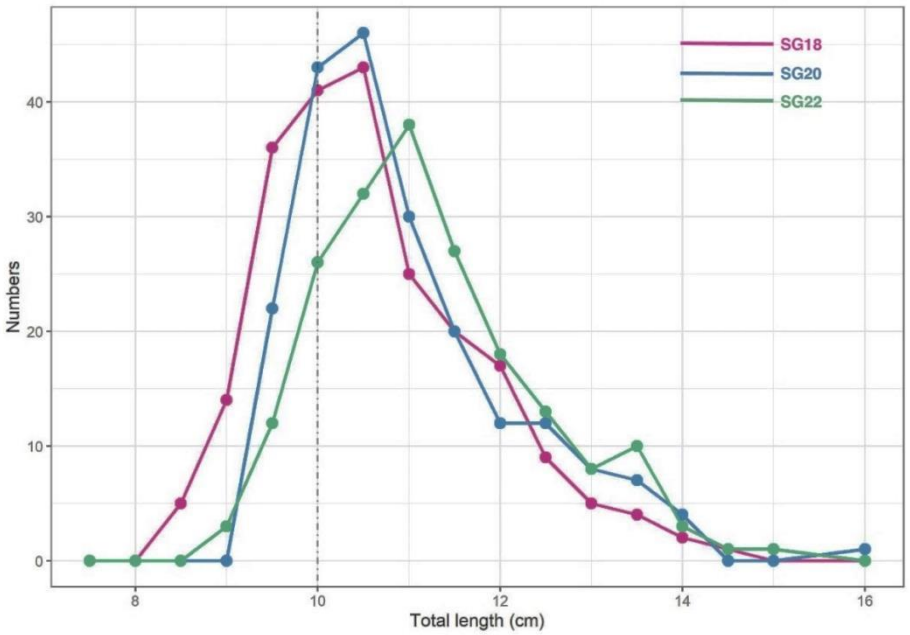

Figure 2: Length frequency distributions of codend catch.

The CPUE and YPUE values obtained from the experiment are given in Table 2. The obtained specimens (codend) CPUE values for SG18, SG20 and SG22 were determined as 0.29±0.05, 0.31±0.04 and 0.28±0.03 (n/fyke net/day), respectively (Fig. 3). YPUE values were calculated as 11.33±2.19, 11.50±1.64 and 10.21±1.34 (g/fyke net/day) (Fig. 4) for SG18, SG20 and SG22, respectively. The difference between the CPUE and YPUE values of the experimental codends were not to be found statistically significant ($p>0.05$).

Table 2: Mean CPUE and YPUE values.

Data source	Bar spacing	Codend type	CPUE (n/fyke net/day)		YPUE ((g/fyke net/day)	
			Mean±SE	Min-Max	Mean±SE	Min-Max
Total catch	*SG18*	Codend	0.29±0.05	0.11-0.72	11.33±2.19	3.95-28.47
		Cover (Codend)	0.24±0.07	0.08-0.95	1.56±0.24	0.55-3.43
		Cover (Grid)	0.17±0.02	0.06-0.34	3.07±0.48	1.12-6.85
	SG20	Codend	0.31±0.04	0.20-0.73	11.50±1.64	6.87-28.39
		Cover (Codend)	0.24±0.07	0.09-0.98	1.47±0.26	0.39-3.53
		Cover (Grid)	0.15±0.01	0.09-0.23	2.57±0.20	1.69-4.03
	SG22	Codend	0.28±0.03	0.16-0.59	10.21±1.34	5.85-23.44
		Cover (Codend)	0.27±0.06	0.13-0.89	1.65±0.19	0.64-3.01
		Cover (Grid)	0.18±0.01	0.09-0.25	3.15±0.23	1.80-4.81

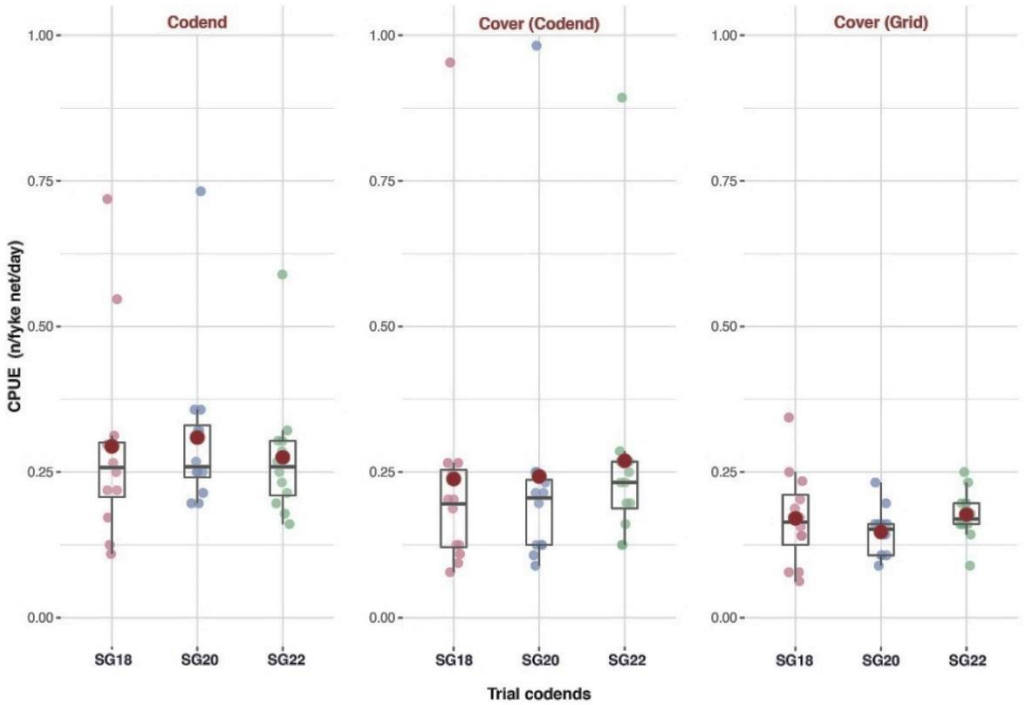

Figure 3: Mean CPUE values of experimental codends.

Codend-cover CPUE values were estimated were 0.24±0.07, 0.24±0.07 and 0.27±0.06 (n/fyke net/day), SG18, SG20 and SG22, respectively. Codend-cover YPUE values also were assessed 1.56±0.24, 1.47±0.26 and 1.65±0.19 (g/fyke net/day) for SG18, SG20 and SG22, respectively. There is no statistical significance between codend-cover CPUE and YPUE of the experimental codend. Cover-grid CPUE values were computed were 0.17±0.02, 0.15±0.01 and 0.18±0.01 (n/fyke net/day), SG18, SG20 and SG22, respectively. Codend- cover YPUE values were determined as 13.07±0.48, 2.57±0.20 and 3.15±0.23 (g/fyke net/day) for SG18, SG20 and SG22, respectively. There is no statistical significance between grid-cover CPUE and YPUE of experimental

SG18, SG20 and SG22 codend ($p>0.05$).

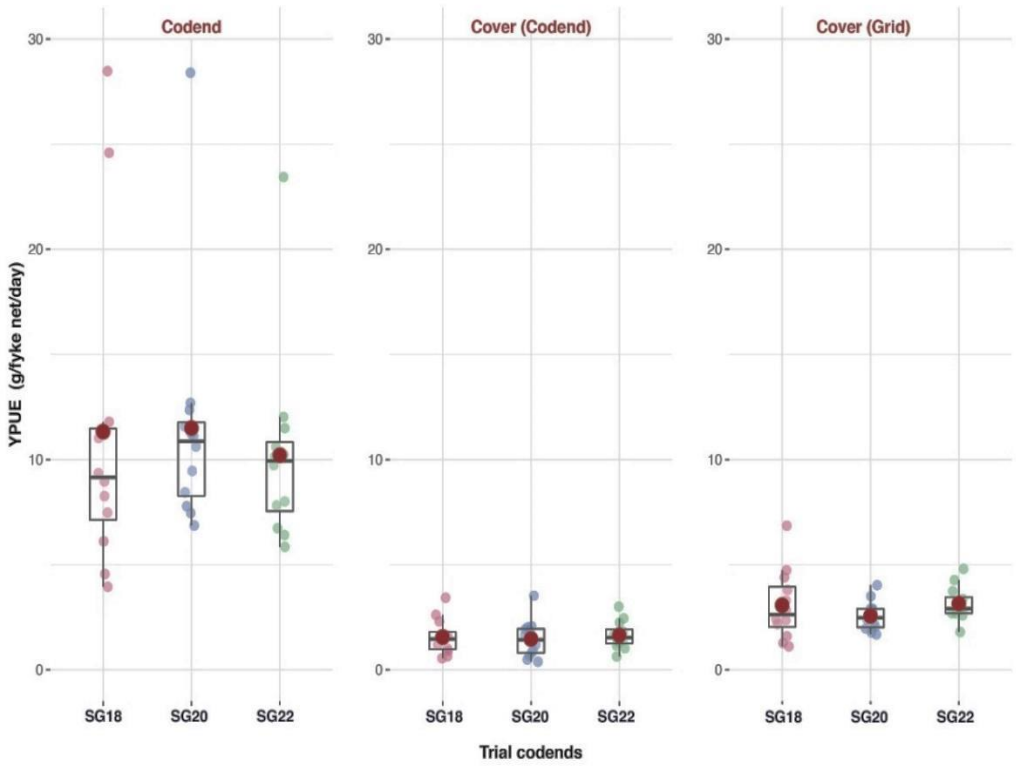

Figure 4: Mean YPUE values of experimental codends.

The total length distributions of crayfish caught (codend) in experiments are given in Fig 2. When considering under and below specimens, most specimens in codends for all test designs are above MLS (10 cm total lengths). Under MLS specimens can escape through meshes and grid bars. Besides, under MLS specimens, cover codend amounts are higher than grid codend. Under and above MLS specimens, CPUE and YPUE values are given in Table 3. The SG18, SG20 and SG22 mm showed the same values as 0.23±0.04 considering the above MLS specimens CPUE. The highest values in the SG18 codend were 9.68 (g/fyke net/day).

Table 3: CPUE and YPUE values of trial codends by MLS.

Above MLS	**SG18**	**Codend**	**0.23±0.04**	**0.06-0.56**	**9.68±2.03**	**2.77-24.60**
		Cover (Codend)	0.00±0.00	0.00-0.00	0.00±0.00	0.00-0.00
		Cover (Grid)	0.01±0.00	0.00-0.03	0.21±0.12	0.00-1.09
	SG20	Codend	0.23±0.04	0.13-0.57	9.44±1.48	5.19-24.31
		Cover (Codend)	0.00±0.00	0.00-0.00	0.00±0.00	0.00-0.00
		Cover (Grid)	0.01±0.00	0.00-0.04	0.21±0.11	0.00-1.04
	SG22	Codend	0.23±0.03	0.13-0.48	9.05±1.21	4.95-20.91
		Cover (Codend)	0.00±0.00	0.00-0.00	0.00±0.00	0.00-0.00
		Cover (Grid)	0.00±0.00	0.00-0.02	0.08±0.06	0.00-0.51

Below MLS	SG18	Codend	0.07±0.01	0.02-0.16	1.65±0.34	0.31-3.87
		Cover (Codend)	0.24±0.07	0.08-0.95	1.56±0.24	0.55-3.43
		Cover (Grid)	0.16±0.02	0.06-0.34	2.86±0.45	1.12-6.85
	SG20	Codend	0.08±0.01	0.04-0.16	2.06±0.33	0.84-4.08
		Cover (Codend)	0.24±0.07	0.09-0.98	1.47±0.26	0.39-3.53
		Cover (Grid)	0.14±0.01	0.05-0.21	2.36±0.24	1.08-3.56
	SG22	Codend	0.05±0.01	0.02-0.11	1.16±0.18	0.38-2.53
		Cover (Codend)	0.27±0.06	0.13-0.89	1.65±0.19	0.64-3.01
		Cover (Grid)	0.17±0.01	0.09-0.25	3.07±0.23	1.80-4.81

Discussion

In this study, CPUE and YPUE compare sorting grids with 18, 20 and 22 mm bar spacing on crayfish fishing with fyke net in Turkey. The obtained CPUE and YPUE values are very close to each other between the grids. While the highest CPUE and YPUE were obtained with SG20, the lowest was SG22 (Table 2). Our results are also comparable with other studies which were carried out on crayfish CPUE. Demirol et al. (2017) found that 0.08-0.22 (n/fyke-net/day) CPUE and 3.14 -8.95 (g/fyke -net/day) YPUE values in Keban Lake with fyke net. CPUE values are also determined as 2.74-6.35 (kg/100 fyke nets/week) based on fishing statistics in Keban Lake by Yüksel et al. (2013). These values are lower than our results. Yüksel and Duman (2011) found that CPUE values were 0.93 (n/fyke net/7 day). And besides, the CPUE value of fyke net with bait was found to be 0.80 (n/fyke net/) and 0.40 (n/fyke net/) for fyke net without bait in Eğirdir Lake by Bolat et al. (2011).

On the other hand, Cilbiz et al. (2021) reported 98.34 (g/fyke net/day) YPUE values from Hirfanlı Lake. These differences might be due to the reasons; (I) Differences between sampling net; they use traditional fyke net with 34 mm mesh codend. It is well known that the conventional fyke net is too low and they can catch all specimens. (II) Fishing pressure on crayfish population; there are almost 500 fishermen in Eğirdir Lake, where the study was carried out, while only 150 registered fishers in Hirfanlı Lake (Anonymus, 2018). (III) Sampling period; Cilbiz et al. (2021) carried out the studies for 8 months during the 2017-2018 fishing season. While this study was conducted for only two months (IV) Experimental period, Crayfish must be caught between July 01 and October 31 by Turkish fisheries circular. It is well known that fishing on an exploited stock can lead to a low catch yield. Low CPUE was reported during the September and October example period by Cilbiz et al. (2021).

The maximum and minimum total length range of crayfish was found to be 35.95 - 162.10 mm in the study. In some related studies conducted in the same study area, these values were reported as 66.00–168.00 mm (Bolat and Kaya, 2016); and 102.00 – 162.00 mm (Bök et al., 2013). These slight differences in minimum lengths might be due to the mesh size using codend. We use 14 mm in cover while they use 34 mm mesh size in commercial fyke net.

Naturally, the maximum lengths of the specimens were obtained in codend (in front of the grid) followed by grid cover and cover codend, respectively. It is thought that individuals large enough to escape from the

grid can easily pass through between the smooth grids. But when trying to escape from mesh size, crayfish, which has a large number of extremities, chelipeds, pleopod and abdomens segments, can be attached/tangled meshes and this can be prevented from escaping. However, crayfish behaviour against grid and meshes in fyke net should be investigated to get the precision result.

This study could be conducted in a limited time due to covid-19 restrictions. The absolute results can be obtained when experiments are carried out within a period to cover the entire fishing season. However, CPUE and YPUE results are comparable with other studies concocted on crayfish with traditional fyke net. On the other hand, traditional fyke net selectivity is too low (Bolat et al. 2010; Cilbiz, 2019). For sustainability of crayfish fishery, selectivity parameters of SG18, SG20 and SG22 should be evaluated.

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