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RESEARCH PAPER

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New Approach for Codend Selectivity: a Case Study of Coastal Beach Seine for Big-Scale Sand Smelt (*Atherina boyeri*) Fishery in İznik Lake

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Abstract

Sand smelt (*Atherina boyeri* Risso, 1810), which is an exotic species with invasive character, is the third most caught species in the small-scale fisheries among the inland fisheries in Turkey. The fact that it has become an important source of income for the fishermen with low income due to its export potential has led to the maintenance of its stock recently. In this study, the selectivity of coastal beach seine used in the fishing of the species was investigated. A specially designed coastal beach seine with 10 m codend consisting of 4 different compartments was used in the study. Among the compartments of the codend, which was surrounded by a 6 mm mesh cover, in the codend panels mesh with 9, 12 and 14 mm were used. Field studies were carried out on a monthly basis in 4 different stations of İznik Lake in 2014. Selectivity data were collected by the covered codend method and analyzed by means of a logistic equation with the maximum likelihood method. A totally 3053 individuals were caught length ranged from 2.6-11.2 cm and weight ranged from 0.11-11.02 g. The mean L_{50} values of 14, 12- and 9-mm panels were determined as 6.71, 5.62 and 4.51 cm total length, respectively. It is concluded that 12 mm mesh size panel is suitable for sustainable *A. boyeri* fishery by beach seine net when considered given by length at first maturity size.

Introduction

Actually, marine origin species big scale sand smelt (*Atherina boyeri* Risso, 1810) has rapid spread to isolated inland water thanks to adaptability. It was first reported in 1940 from Sapanca Lake in Turkey (Battalgil, 1941; Ekmekçi *et al.*, 2013). After 1988, when first observation year in İznik Lake, *A. boyeri* is one of the first commercial fish species of the lake and its production has shown increase trend year by year (Dogan, 2009). Production was started from 60 t/year in 1989 (Dogan, 2009), and increasing approximately 1350 t in 2017.

During the *A. boyeri* adaptation periods to the lake ecosystem fishermen were investigated the suitable fishing methods and gears. In the first years, fishermen used small beach seine (maximum length approximately 50-60 m) with manpower. Following years, gears are developed with the giant ones (length range 200-400 m) and also engine power began to be used instead of manpower. Portable net drum (with tractor) has been utilized for hauling of very big seine from the lake. In 2007, annual gross income of a fisherman was reported as 27 788 $USD based on *A. boyeri* fishing in İznik Lake (Dogan, 2009).

According to the 2017 data, *A. boyeri* was the third caught species in Turkey inland fisheries. Their economic value of 4892 t of *A. boyeri* production was almost 2 065 150 $*USD* (TUIK, 2019). ¼ of total Turkey's production has been provided from İznik Lake. Almost all individuals are proceeding as a crisps and export to some European county such as Italy, England, France and Spain. Due to hardening of scale and spine of larger individuals (larger than 6-7 cm total length) not preferred for crisps production, this circumstance is causes abnormal fishing pressure on young individuals.

İznik Lake is the fifth larger lake of Turkey with 300 km^2 surface area. A total 180 licensed fishermen work as commercially in four fishing area. Besides *A. boyeri*, Cyprinus *carpio, Carassius gibelio, Rutilus frisii, Siluris glanis* and *Astacus leptodactylus* have been caught in the lake. Fishing operation for sand smelt is made by beach seine with 4-5 fishers (a team). According to the 2018 data, there are 42 teams in the lake. Beach seines with smaller than 9 mm mesh size (stretched) were commonly used for *A. boyeri* fishing.

There are some studies conducted on *A. boyeri* fishing; Rodríguez-Climent *et al.* (2012) presented gillnet selectivity of *A. boyeri* in Ebro Delta Lagoon (North-East, Spain) by using *SELECT* method. Catch composition, *CPUE*, bycatch and discard rate studies were carried out on beach seine fishing (Broadhurst *et al.,* 2008; Akyol, 2003; Cabral *et al.*, 2003; El-Mor *et al.*, 2002; Gray & Kennelly, 2003; Vanderklift *et al.*, 1998; Hutchings & Lamberth, 2002a; Hutchings & Lamberth, 2002b). However, there are very limited beach seine selectivity studies both in the sea and inland water; Tosunoğlu (2003), determined *Mullus barbatus, Pagellus erythrinus* and *Diplodus annularis* selectivity parameters in Turkey's Aegean Sea by using covered codend method. The other study was conducted by Tesfaye, Wolff and Taylor. (2016) for investigated *O. niloticus, C. gariepinus* and *C. carpio* selectivities in Lake Koka (central Ethiopia).

Brčić *et al.* (2018) investigated the selectivity of the commercial creels with 41mm mesh, which were used in fishing *Nephrops norvegicus* in the Mediterranean, using the control creel with 41mm mesh and he found the l50 value as 31.82 for 1 soak time. In another study, Deval *et al.* (2016) investigated the selectivity of *T0* and *T90* codends with 50 mm mesh on commercial shrimp species in Turkish deepwater trawl fishery, Eastern Mediterranean; it was found that there was an increase in the escape rates of *Aristaeomorpha foliacea, Aristeus antennatus, Parapenaeus longirostris and Plesionika martia* in case the codend was transformed from *T0* to *T90*. Sala, Brčić, Herrmann, Lucchetti, & Virgili (2016) investigated the selectivity of a grid system, which was designed for grading of striped venus clam (*Chamelea gallina*) after fishing with hydraulic dredge. The grid system with 5 different sequential holes spacing (Filter: 32.5 mm, Grid 1: 21.5 mm, Grid 2: 21.1 mm and Grid 3: 20.3 mm and Filter:10.5 mm) was used in the study. L_{50} sizes for Grid 1, Grid 2 and Grid 3 were found to be 25.01, 24.29 and 22.84 mm. A similar approach to our study was demonstrated in pooling the data used in the calculations. However, there are not any study conducted on beach seine selectivity for *A. boyeri* fishing.

In this study, our goal is to determine the selectivity characteristics of coastal beach seine, which was designed to determine the selectivity of codends with different meshes (9, 12- and 14-mm nominal stretched mesh size) in the same hauling simultaneously, in sand smelt fishing.

Material and Method

Study Area

The study was conducted in İznik Lake that is one of most important *A. boyeri* producer (Figure 1). As a tectonic origin, Lake İznik locate southeastern part of the Marmara region in Turkey. Altitude is 85 m and maximum depths was determined as a little bit more than 70 m at near south coast. Lake's surface area is 285 km^2 and length is 32 km (Ceribasi, 2018). Lake located between 40°23' - 40°30'N latitudes and 29°20' - 29°42' E longitudes (Yağci & Ustaoğlu, 2012).

Sampling Process

Experiments were carried out 4 different station of lake in 2014 with monthly period. Only one hauling

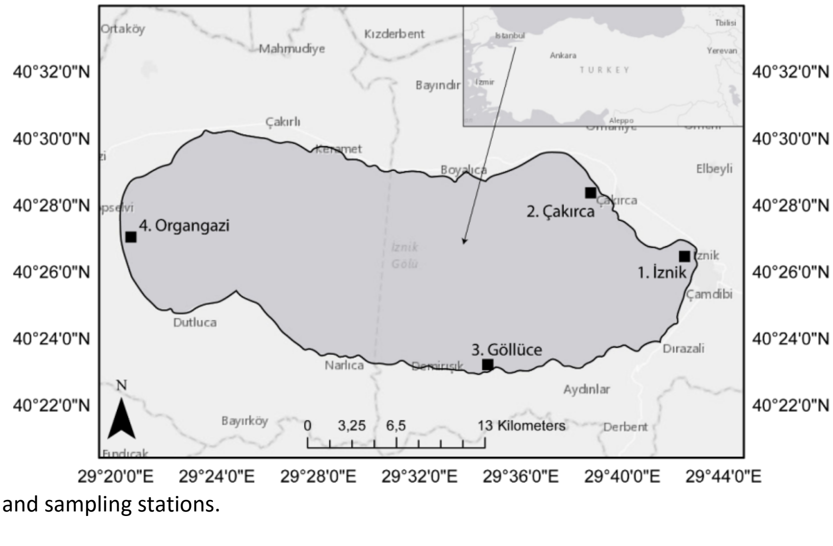

Figure 1. Study area and sampling stations.

applied each station. A beach sine used in hauling which was specially designed and rigged to determine multi codend mesh selectivity parameters at same hauling operation. More information about the geometry and characteristics of the used beach seine given Figure 2.

Multimesh codend model was generated from four different codend compartment by connected with each other using touch & close tape. First compartment's tag-end rigged codend mesh with 14 mm and it surrounded with cover mesh (6 mm); second compartment's tag-end rigged codend mesh with 12 mm and it surrounded with cover mesh (6 mm); third compartment's tag-end rigged codend mesh with 9 mm and it surrounded with cover mesh (6 mm) and finally all of last compartment covered by 6 mm cover mesh (Figure 3).

A unique data pooled model was used in the study due to the possibility that the length distributions of the haul obtained from different stations in the same period could be different. Due to the possibility that the schools of different length distributions will be evaluated each time during the sampling, it was expected to see that there were inconsistencies in the estimated L_{50} values at the classic single codend & cover application, which stemmed from the diverse size distributions of the schools. For this reason, a model, where the size selectivities of different codends for each school could be tried simultaneously, was necessary. Within this framework, a beach seine, on which the part that remained in the front part of each panel was taken as the codend and the back parts were taken as the cover, was used in the study, displayed in detail in Figure 3.

Data Analysis

Caught fish were classified by codend type and measured total length with 0.1 cm precision and gaged total weight with 0.01 g precision. Covered codend techniques was utilized estimation of selectivity parameters (Wileman *et al.*, 1996). The data were analyzed using a logistic equation with the maximum likelihood method (Wileman *et al.*, 1996). The mean selectivity of the individual hauls was calculated by taking into account between-haul variation according to Fryer (1991) using the *ECModeller* software (ConStat, 1995) which adopts the *REML* method (residual maximum likelihood). The choice of the model which best describes the data was based on the lowest value for Akaike's Information Criterion-AIC (Fryer &

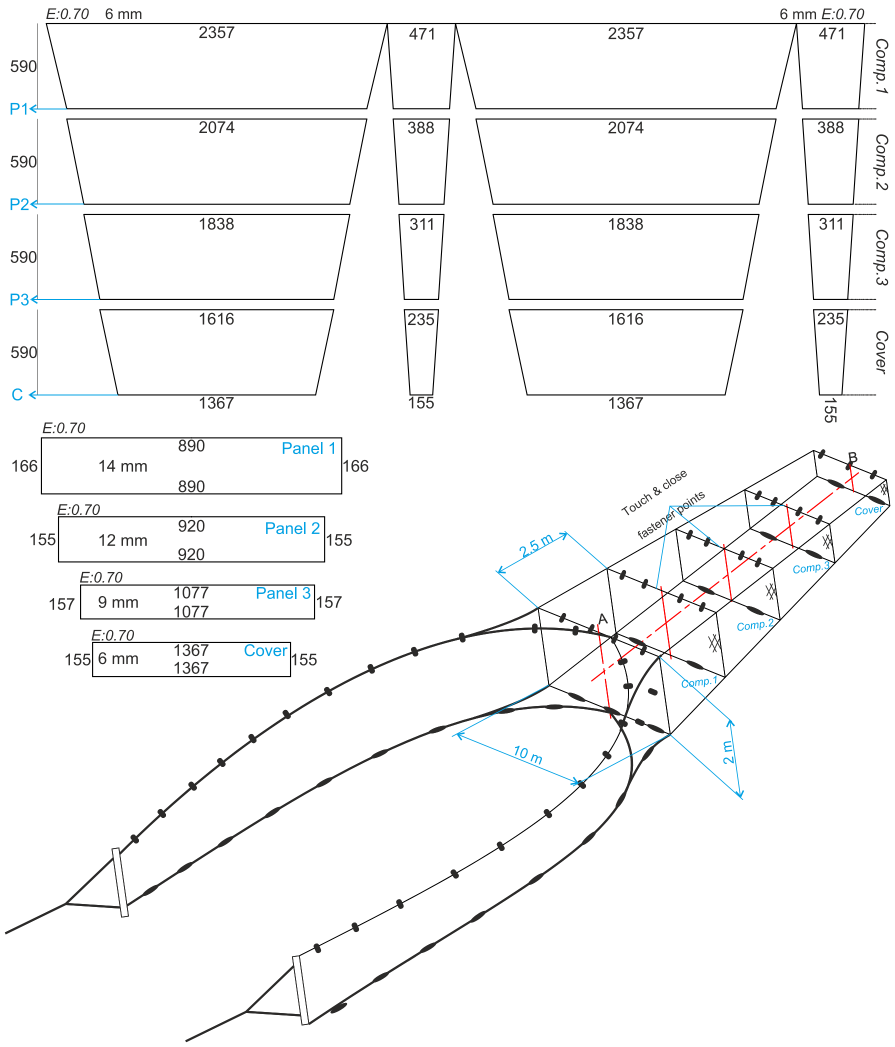

Figure 2. General view (not in scale) and net cutting plan of modified beach seine.

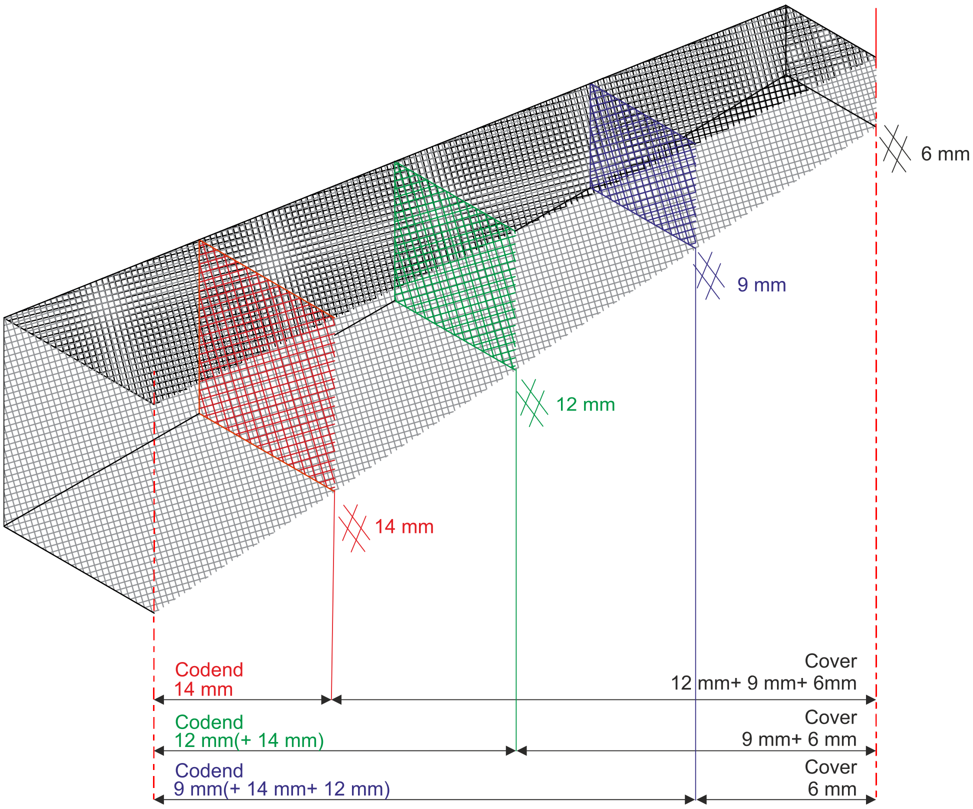

Figure 3. Data pooling process for estimating the multimesh codend selectivity (A-B sectioning which shown in Figure 2).

Shepherd, 1996). *t-test* and o*ne-way ANOVA* with *Tukey*^{HSD} were used for statistical comparing of normal disturbed data evaluations process for catch total length and weight by month. Also, Fulton's condition factor (K) was calculated using K=(W/TL^3) ×100 formula. Kolmogorov-Smirnov (*K-S*) test was used to determine differences between size frequency distributions of fish caught by different codend. We used the "mgcv" package (Wood, 2019) in RStudio (v11.2.5019) to model the relationships between total length and influencing factors (sampling month, sampling station, codend type) in Generalized Additive Models (*GAMs*) evaluating process. The *GAMs* is given by:

$$\text{Model: } tl \sim \text{s}(sm)+\text{s}(ss)+\text{s}(tc)$$

Where, tl: total length, *sm:* sampling month, *ss*: sampling station, *ct*: test codend, s(.) is a spline smoothing function. RStudio (v11.2.5019) computer software was used all statistical analysis.

Result

Catch Composition

A total of 13 valid/successful hauls were carried out for estimating selectivity parameters. End of fishing trial, a total of 3053 *A. boyeri* were caught total length range between 2.6-11.2 cm and total weight between 0.11-11.02 g. Mean total length and total weight are shown statistical differences by sampling month (Table 1) (P<0.05).

Statistical differences were found mean total length and weight values (P<0.05) between codends. There are no statistical differences in 6 and 12 mm codends between male and female total length of *A. boyeri* (P>0.05), while differences were found in 9 and 14 mm codends between male and female individuals (P<0.05). The highest mean total length was observed in Göllüce station, while lowest was İznik station. Statistical differences were found between mean total lengths of sampling stations (P<0.05). Mean total lengths of catch are shown statistical differences between stations for same sampling period (P<0.05)

Used *GAMs* model parameters to compare catch total length and other response (sampling, month, sampling station, test codend) given Table 2 and scatter plot matrix for predictors given Figure 4. Model residual *d.f.* and residual deviation were found as 3042.0 and 1480.6 respectively. All response shown statistical difference by fish total lengths.

The effects of sampling month, sampling station and test codend variables on total length was modeled through *GAMs* and the results were given in Figure 5. It can be stated that the sampling from İznik station negatively affected the total length, the total length as affected negatively from the summer months towards the winter months, and that the increase of mesh size used in codend affected total length positively.

From the *K-S* test results (Table 3), in the all paired compare, statistical differences were found length frequency distribution of *A. boyeri* from different codend.

Table 1. Length-weight distribution and condition factor of captured A. boyeri by sampling month

Month	N	(%)	Total Length (cm)			Total Weight (g)			K
			Mean±SE	*Min.*	*Max.*	*Mean±SE*	*Min.*	*Max.*	
March	165	5.4	5.95±0.09^{c}	3.4	10.3	1.44±0.09^{bc}	0.26	8.24	0.584
April	642	21.0	6.33±0.06^{d}	3.1	11.2	2.14±0.07^{d}	0.14	11.02	0.679
May	502	16.4	6.00±0.06^{c}	3.5	9.8	1.58±0.05^{c}	0.19	6.74	0.623
June	431	14.1	5.86±0.10^{c}	2.6	10.6	1.87±0.09^{d}	0.11	9.25	0.660
July	573	18.8	5.16±0.05^{a}	2.6	9.7	1.11±0.03^{a}	0.12	5.65	0.713
August	400	13.1	5.51±0.07^{b}	2.8	9.5	1.42±0.05^{bc}	0.22	4.53	0.738
September	340	11.1	5.32±0.07^{ab}	3.1	8.9	1.23±0.05^{ab}	0.20	4.86	0.699

Different letters within columns show significant differences between month (P<0.05).

Table 2. Comparison of models for total length using *ANOVA* nonparametric effects

Response	df	*F*	p
Sampling month	3	66.670	P<0.001
Sampling station	2	42.448	P<0.001
Test codend	2	108.082	P<0.001

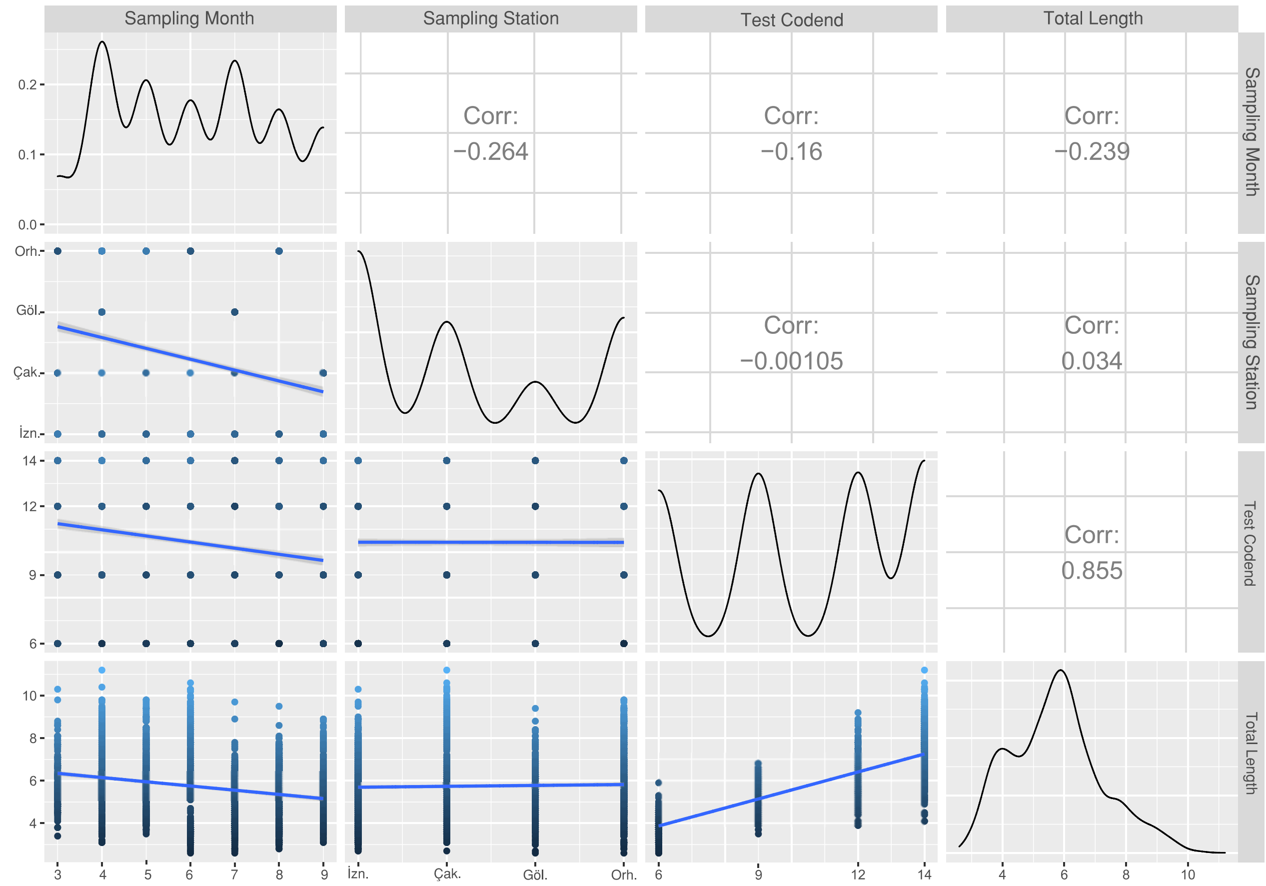

Figure 4. Scatter plot matrix for predictors used *GAMs* analysis.

Table 3. *K-S* test result of *A. boyeri* captured from different codend

Net 1		Net 2		Kolmogorov-Smirnov Test		
Mesh Size	N	Mesh Size	N	D max	Critical Values (α=0.05)	Decision
14	824	12	771	0,3288	0,0681	H_0 Reject
14	824	9	767	0,3138	0,6820	H_0 Reject
14	824	6	691	0,3741	0,0702	H_0 Reject
12	771	9	767	0,2805	0,0694	H_0 Reject
12	711	6	771	0,4123	0,0712	H_0 Reject
9	767	6	691	0,3569	0,0713	H_0 Reject

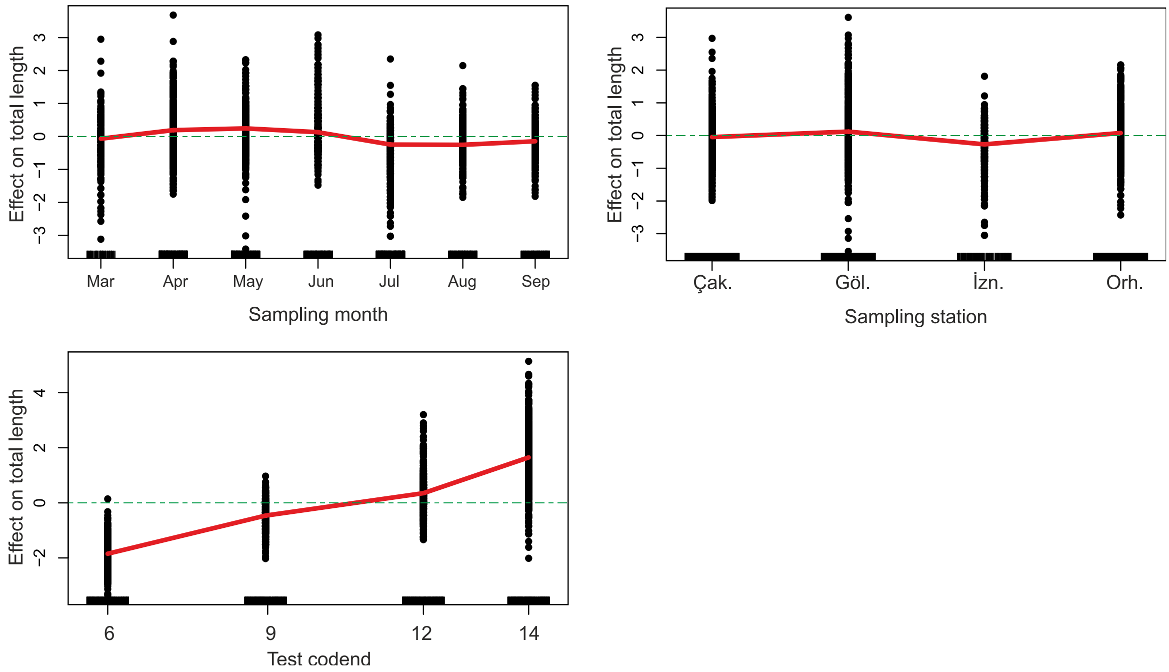

Figure 5. The relationships between total length and other factors from fitted *GAMs.*

Data by pooling process are given in Table 4 and explain in Figure 3. From the data, statistical differences were found ($P<0.05$) mean total length of fish that obtained from both codend and cover of beach seine.

Selectivity Parameters

Catch ratio, retrieved from codend were founded as 26.36(%), 51.76(%) and 77.14(%) for 14, 12 and 9 mm codend respectively (Figure 6). Selectivity parameters of experimental codend's are given Table 5, 6, 7. L_{50} lengths and *SR* values were determined as 6.71 (0.76), 5.62 (0.59) and 4.51 (0.35) cm for 14, 12 and 9 mm codends, respectively. Statistical differences were found between L_{50} values of the codends ($P<0.05$). There are no statistical differences between 12 and 14 mm codends *SR* values. However, statistical difference was estimated ($P<0.05$). When comparing to this value with 9 mm, Selectivity curves and normalized frequency plots are given Figure 4. Estimated L_{50} and *SR* values are given Figure 5, in addition length at first maturity of *A. boyeri* reported by Anonymus (2015) are shown same graph for male (4.52 cm) and female (4.96 cm) separately.

Estimated L_{50} vs *SR* values and its standard errors shown in Figure 7. Codend with 12 mm mesh size is suitable for sustainable *A. boyeri* fishery with beach seine net by length at first maturity size of species.

Discussion

It is first time presented beach seine selectivity for *A. boyeri* in the study. 13 successfully hauls were utilized for estimating selectivity parameters. However, totally 48 fishing operations were performed. Due to the not obtained, 35 hauls not including the data for estimated selectivity parameters. *A. boyeri* schools migrating to deeper water in conjunction with decreasing the water temperature in Fall and Winter seasons, so it could not be caught in these months except September.

Most of samples were obtained in April, while least were in March (Table 1). Production shown decreasing trend towards fall season and there are no individuals in late fall and winter season. This circumstance associated with bio-ecological properties of *A. boyeri.* In general, as a species originated from mild climate marine system, *A. boyeri* migrate to deeper areas for protect itself in cold water temperature. This case directly connected with water temperature by Işıklıkaya (2017), although *A. boyeri* is a species that can be adapted very hard conditions, if water temperature is decreasing below 8^{o}C feeding of species comes to halt; moreover, water temperature below the 4^{o}C is cause deadly effect on *A. boyeri*. Whereupon it is seeing that *A. boyeri* migrate to marine from freshwater system if there is a connection between both of them; otherwise flocks are clustering relatively hotter deeper locations of lake's in winter. It is impossible catching of this fish with beach seine in this circumstance.

Naturally mean total length were increase in keeping with mesh size increasing used in codend (Figure 5). Similar observations are seen L_{50} values (Figure 7). These results shown similarity to other selectivity studies based on logistic model (Bolat, Demirci & Mazlum, 2010; Dereli *et al.*, 2016; İlkyaz et al, 2017; Nguyen & Larsen, 2013; Reeves *et al.*, 1992). Risk of selectivity modal used in this study was pilling probability of the school front of codend panel. In this situation, smaller fish would not pass from one compartment to others. *A. boyeri* scholl has a specifically spiral circle movement and this habit was

Table 4. Pooled data and mean length

Codend Mesh Size (mm)	Total Length (cm) Codend			Cover			P
	Pooled Codend	*N*	*Mean±SE*	*Pooled Codend*	*N*	*Mean±SE*	
14	14	824	$7.43±0.04^{c}$	12+9+6	2229	$5.12±0.02^{c}$	0.000
12	14+12	1595	$6.79±0.03^{b}$	9+6	1458	$4.61±0.02^{b}$	0.000
9	14+12+9	2362	$6.30±0.02^{a}$	6	691	$3.87±0.02^{a}$	0.000

Different letters within columns show significant differences between codends (P<0.05).

Table 5. Selectivity parameters of *A. boyeri* for codend with 14 mm

Parameters		Op1	Op2	Op3	Op4	Op5	Op6	Op7	Op8	Op9	Op10	Op11	Op12	Op13	P	*F*
L_{50}		7.03	6.78	6.56	6.77	7.21	6.85	7.01	7.82	6.27	6.18	6.65	6.53	6.48	6.69	6.71
L_{50} (*SE*)		1.05	1.00	1.00	1.04	1.03	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.11
L_{50}		-6.36/	-5.98/	-6.17/	-6.50/	-5.94/	-5.87/	-5.74/	-5.00/	-6.50/	-6.56/	-6.13/	-6.20/	-6.24/	-6.02/	6.47/
(*%95 CI*)		20.42	19.54	19.29	20.04	20.37	19.58	19.76	20.65	19.05	18.93	19.45	19.27	19.22	19.41	6.95
SR		1.75	0.69	0.75	0.58	1.49	0.48	0.69	0.75	1.05	0.97	1.12	0.45	0.49	1.00	0.76
SR (*SE*)		1.09	1.00	1.00	1.02	1.05	1.00	1.00	1.01	1.01	1.00	1.01	1.00	1.00	1.00	0.07
SR		-12.12/	-12.08/	-12.00/	-12.44/	-11.96/	-12.25/	-12.08/	-12.12/	-11.83/	-11.82/	-11.79/	-12.29/	-12.25/	-11.72/	0.61/
(*%95 CI*)		15.63	13.46	13.50	13.61	14.95	13.21	13.47	13.63	13.94	13.77	14.03	13.20	13.24	13.74	0.92
R_1		1.111	1.009	1.004	1.091	1.072	1.003	1.008	1.019	1.011	1.006	1.013	1.004	1.006	1.002	0.013
R_2		0.117	0.001	0.001	0.035	0.067	0.001	0.003	-0.007	0.007	0.004	0.007	0.000	0.002	0.001	-0.000
R_3		1.193	1.010	1.007	1.051	1.122	1.004	1.011	1.027	1.028	1.014	1.033	1.006	1.006	1.004	0.005
a		-8.82	-21.59	-19.21	-25.64	-10.63	-31.35	-22.32	-22.91	-13.12	-13.99	-13.04	-31.88	-29.05	-14.56	-19.39
b		1.25	3.18	2.92	3.78	1.47	4.57	3.18	2.92	2.09	2.26	1.96	4.88	4.48	2.17	2.89
Deviance		8.81	6.96	4.99	1.95	15.27	1.78	13.15	3.32	2.71	10.29	3,54	3.99	5.07	44.66	-
Df.		10	12	12	9	8	12	12	15	7	12	10	10	11	16	-
Weight	Cod.	48.68	397.4	267.28	266.25	40.19	333.6	134.16	330.76	93.05	143.87	123.17	129.83	177.22	2485.46	
	Cov.	100.96	118.5	293.87	28.69	112.98	305.87	202.6	137.35	152.84	248.57	164.49	149.03	241.01	2256.76	
	Tot.	149.64	515.9	561.15	294.94	153.17	639.47	336.76	468.11	245.89	392.44	287.66	278.86	418.23	4742.22	
Number	Cod.	26	100	100	50	20	100	48	61	50	77	50	50	62	794	
	Cov.	109	99	271	22	113	269	219	103	150	296	150	150	278	2229	
	Tot.	134	199	371	72	133	369	267	164	200	373	200	200	340	3023	

Table 6. Selectivity parameters of *A. boyeri* for codend with 12 mm

Parameters		Op1	Op2	Op3	Op4	Op5	Op6	Op7	Op8	Op9	Op10	Op11	Op12	Op13	P	*F*
L_{50}		5.59	5.71	5.64	4.43	5.67	5.87	5.88	6.14	5.38	5.17	5.63	5.52	5.46	5.58	5.62
L_{50} (*SE*)		1.00	1.00	1.00	1.29	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.07
L_{50}		-7.15/	-7.01/	-7.07/	-12.05/	-7.09/	-6.84/	-6.86/	-6.61/	-7.33/	-7.58/	-7.10/	-7.20/	-7.25/	-7.11/	5.48/
(*%95 CI*)		18.33	18.45	18.36	20.93	18.43	18.59	18.62	18.90	18.10	17.92	18.37	18.26	18.18	18.29	5.77
SR		0.73	0.49	0.66	1.33	0.80	0.60	0.81	0.51	0.31	0.79	0.62	0.55	0.42	0.74	0.59
SR (*SE*)		1.00	1.00	1.00	1.32	1.00	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.04
SR		-12.08/	-12.26/	-12.07/	-15.55/	-12.02/	-12.12/	-12.00/	-12.35/	-12.41/	-11.98/	-12.15/	-12.19/	-12.26/	-11.96/	0.49/
(*%95 CI*)		13.55	13.26	13.41	18.22	13.62	13.34	13.62	13.37	13.03	13.58	13.39	13.31	13.19	13.46	0.69
R_1		1.005	1.004	1.002	1.685	1.009	1.002	1.006	1.008	1.002	1.007	1.005	1.005	1.002	1.000	0.005
R_2		0.000	-0.000	-0.000	-0.640	0.001	-0.000	-0.002	-0.000	-0.000	-0.000	-0.001	-0.000	0.000	-0.000	0.000
R_3		1.017	1.009	1.006	1.766	1.018	1.005	1.016	1.024	1.003	1.012	1.010	1.007	1.003	1.000	0.002
a		-16.82	-25.60	-18.77	-7.31	-15.57	-21.49	-15.95	-26.45	-38.13	-14.37	-19.95	-22.05	-26.08	-16.56	-20.92
b		3,00	4.48	3.32	1.65	2.74	3.66	2.71	4.30	7.08	2.78	3.54	3.99	4.77	2.96	3.72
Deviance		4.60	1.39	7.38	0.37	6.48	3.37	9.90	1.04	1.29	24.38	7.46	3.88	2.66	17.27	-
Df.		10	12	12	9	8	12	12	14	7	12	10	10	11	16	-
Weight	Cod.	102.72	483.4	431.51	291.71	103.66	492.92	244.63	427.11	177	272.59	216.66	207.19	280.34	3731.44	
	Cov.	49.87	32.5	129.64	3.23	49.51	146.55	92.13	41	68.89	119.85	71	71.67	137.89	1013.73	
	Tot.	152.59	515.9	561.15	294.94	153.17	639.47	336.76	468.11	245.89	392.44	287.66	278.86	418.23	4745.17	
Number	Cod.	66	147	200	69	61	200	115	96	100	173	100	100	138	1565	
	Cov.	69	52	171	3	72	169	152	68	100	200	100	100	202	1458	
	Tot.	135	199	371	72	133	369	267	164	200	373	200	200	340	3023	

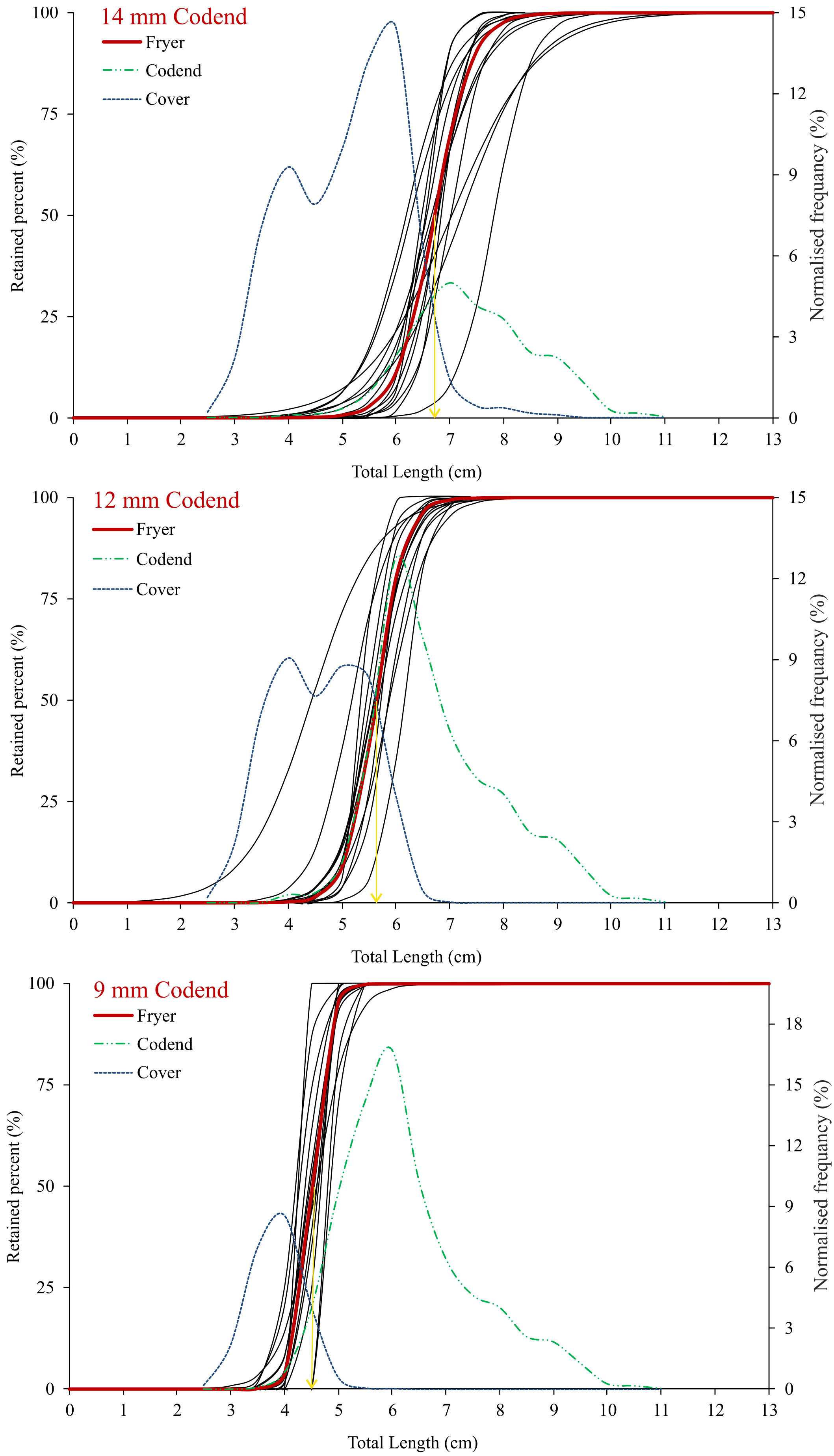

Figure 6. Selection curves and length distribution of *A. boyeri* for different codend.

Table 7. Selectivity parameters of *A. boyeri* for codend with 9 mm

Parameters		Op1	Op2	Op3	Op4	Op5	Op6	Op7	Op8	Op9	Op10	Op11	Op12	Op13	P	*F*
L_{50}		4.58	4.21	4.56	*NA*	4.42	4.93	4.55	4.96	4.59	4.18	4.28	4.53	4.46	4.48	4.51
L_{50} (*SE*)		1.00	1.05	1.00	*NA*	1.00	1.00	1.03	1.52	1.00	1.00	1.00	1.00	1.00	1.00	0.06
L_{50} (*%95 CI*)		-8.22/ 17.38	-9.22/ 17.64	-8.16/ 17.28	*NA*	-12.44/ 13.07	-7.86/ 17.74	-8.59/ 17.69	-62.89/ 72.82	-8.13/ 17.32	-8.53/ 16.90	-8.46/ 17.02	-8.19/ 17.26	-8.24/ 17.18	-8.22/ 17.19	4.38/ 4.64
SR		0.71	0.10	0.30	*NA*	0.31	0.10	0.10	0.10	0.32	0.37	0.46	0.33	0.42	0.44	0.35
SR (*SE*)		1.01	1.01	1.00		1.00	1.01	1.12	1.52	1.00	1.00	1.00	1.00	1.00	1.00	0.02
SR (*%95 CI*)		-12.13/ 13.57	-12.78/ 12.98	-12.42/ 13.03	*NA*	-12.44/ 13.07	-12.85/ 13.05	-14.22/ 14.42	-19.32/ 19.52	-12.40/ 13.05	-12.34/ 13.09	-12.29/ 13.23	-12.40/ 13.08	-12.30/ 13.15	-12.26/ 13.15	0.30/ 0.40
R_1		1.015	1.117	1.002	*NA*	1.004	1.015	1.070	28.52	1.003	1.001	1.006	1.003	1.002	1.000	0.0037
R_2		-0.011	-0.010	-0.000	*NA*	-0.001	-0.024	0.135	-0.489	-0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.0003
R_3		1.023	1.028	1.003	*NA*	1.008	1.040	1.271	2.336	1.003	1.002	1.009	1.005	1.003	1.000	0.0005
a		-14.17	-92.50	-33.39	*NA*	-31.32	-108.3	-99.97	-108.9	-31.51	-24.82	-20.44	-30.16	-23.33	-22.37	-28.31
b		3.09	21.97	7.32	*NA*	7.08	21.97	21.97	21.97	6.86	5.93	4.77	6.65	5.23	4.99	6.27
Deviance		2.29	0.04	0.75	*NA*	1.16	0.01	0.00	0.00	6.09	2.73	6.42	1.71	3.56	4.41	-
Df.		10	12	12	*NA*	8	12	12	14	7	12	10	10	11	16	-
Weight	Cod.	141.95	514.28	538.11	294.94	145.33	607.24	306.82	451.56	221.95	356.38	268.61	256.29	373.89	4477.35	
	Cov.	10.64	1.62	23.04	.	7.84	32.23	29.94	16.55	23.94	36.06	19.05	22.57	44.34	267.82	
	Tot.	152.59	515.9	561.15	294.94	153.17	639.47	336.76	468.11	245.89	392.44	287.66	278.86	418.23	4745.17	
Number	Cod.	115	192	300	72	111	300	164	115	150	273	150	150	240	2332	
	Cov.	20	7	71	0	22	69	103	49	50	100	50	50	100	691	
	Tot.	135	199	371	72	133	369	267	164	200	373	200	200	340	3023	

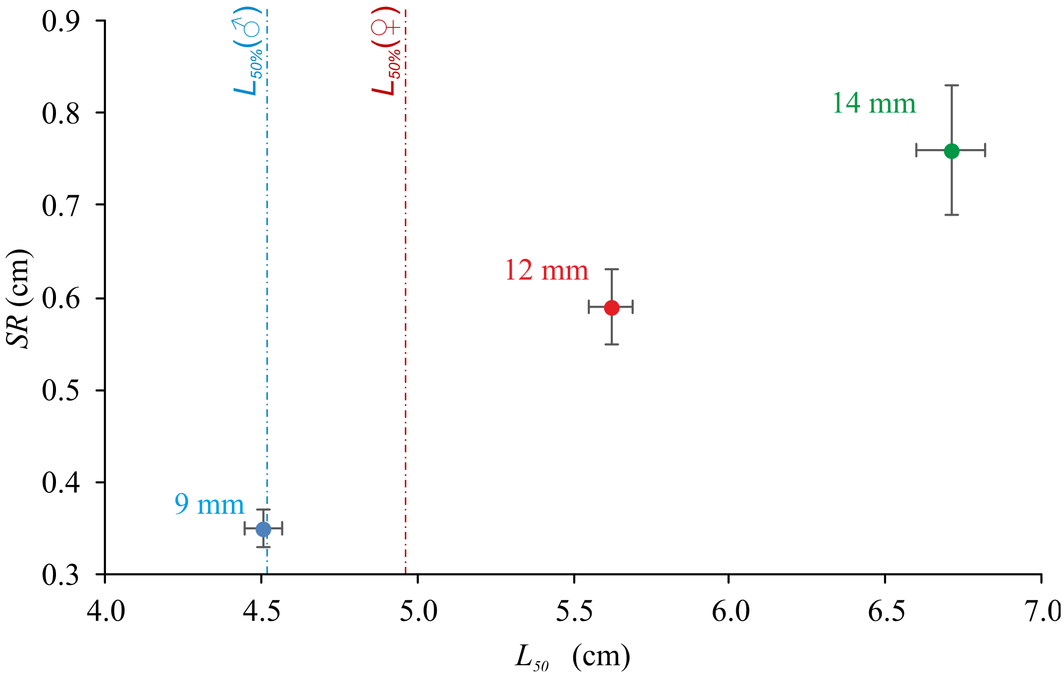

Figure 7. Estimated L_{50} vs *SR* values and error bars.

going on in seine compartment. The fish which would not pass other codend no waited front of the compartment, they continued circle movement. So, we could not see pilling observation in front of codend mesh. The beach seine compartments used in trial was divided of catch by lengths, this idea supported as scientifically with both mean total length differences and length frequency distribution differences that is revealed by *K-S* test result (Table 3). This result show that applied trial modal has given successfully for selectivity analysis. Cover codend is specified as a properly method for measured selectivity by Pope, Margetts, Hamley and Akyüz (1975) due to no effect escaped all length group of fish from codend. As a disadvantage masking effect expressed by Tosunoğlu and Tokaç (1997) that arising from reposing of cover on codend mesh may be cause preventing effect of fish escaping.

Any masking effect was not observed between codend panels in this study in that each codend panel had 2.5 m free field front of compartment. Occurred hauling with manpower and very slowly positive effected on this circumstance. Other beach seine selectivity study in which used covered codend method was carried out by Tosunoğlu (2003) in Aegean shore of Turkey. The study was conducted based on classically one codend (36 mm) and one cover net model (24 mm). Similar study was carried out by (Tesfaye *et al.*, 2016) in Lake Koka (Ethiopia).

Increasing water temperature parallelly increase food web in environment and fish metabolism speed. Therefore, fish condition is also increase. Highest fish condition was founded in August as 0.738, while lowest was 0.584 in March (Table 1). This circumstance caused on seasonal length frequency differences. Highest condition was reported by Lorenzoni *et al.* (2015) (Lake Trasimeno, Italy) and Gençoğlu and Ekmekçi (2016) (Hirfanlı Dam Lake, Turkey) for *A. boyeri* in July.

It was found that there are differences between mean total length of stations ($P<0.05$) which caught by hauling same time. This result might be stem from the ecological properties food abundance of fishing areas. Also, this finding supports to the assumption that flocks length frequency may be different from each other. İznik area is shallower than other locations for this reason water temperature is little higher, so it has relatively rich plankton abundance and this cause to positive effect on feeding regime of fish. In addition, many streams (such as, İtimat, Göksu, Karasu, Kavaklık, Sölöz and Kıran Stream) entered in İznik lake, they are also direct and indirectly positive effected on water quality and lake productivity as well.

It is clearly revealed that multimesh codend selectivity model approach is very useful for presented mean lengths differences of fish at same time in different stations. If study had conducted classically one codend – one cover mesh approach, same codend's L_{50} values would be founded different from each other, based on probability of surrounded stocks have different length distribution. In this context, it is thought that selectivity method used in the study can be utilized similar other selectivity studies, if there are no any masking effect front of the codend.

14 mm codend produce higher 19% and 49% L_{50} values than 12 mm and 9 mm codend. 9 mm codend mesh size is commonly use in *A. boyeri* fishery in İznik Lake, L_{50} values of 9 mm codend (5.62 cm) lower from first maturity length (4.52 cm for male and 4.96 cm for female) given by Anonymous (2015). Rodríguez-Climent *et al.* (2012) researched gillnet selectivity for *A. boyeri* using *SELECT* method in Ebro Delta (North-East of Spain) lagoon. Authors reported catch of gillnet with 10 mm mesh size were mostly below the first maturity length (5.22 cm). But, almost all of the caught fish lengths were above first maturity, when mesh size was increased to 12.5 mm. Although used selectivity method is different result are shown similarity with us.

When this species, which is defined as a species with invasive potential by Ekmekçi *et al.* (2013) and which cannot be completely removed from the Iznik Lake, is considered in terms of its contributions both to the fishermen and the national economy, it is believed that it would be more advantageous to maintain its stock bio-economically. The most important method to prevent overpopulation of this species in the Iznik Lake is the fishing pressure since it does not have an effective predator. In summary, fishermen should continue to catch this species in order to prevent excessive reproduction of the species in the lake. In order the fishermen to continue fishing, the members of the stock should grow in a certain range of length (5-6 cm) in terms of marketability.

There are very few studies on the selectivity of beach seine, which is widely used in small scale fisheries in many regions of the world. In addition to the selectivity of these sets, which are generally equipped with fine-meshed nets, there is a need for studies on their impact on the coastal ecosystem. In particular, it is necessary to determine the non-target ratios of other species on larvae and juvenile. In some areas, fishermen remove the structures such as stones, rocks, etc. from the environment in order to avoid the lead to be stuck during hauling; and this causes the destruction in the natural structure of the ground. In line with the current findings, it is believed that the method we used to reveal the selectivity of more than one codend simultaneously through the logistic model was very successful and could be used easily in studies of similar cases.

It is thought that logistic model is successfully for estimating multimesh codend selectivity. So current model can be adapted and use for similar other locations and different fish species. One important point that should not forget is selectivity not only related with net mesh size but also fish behavior (Tokai *et al.*, 1995; Wileman *et al.*, 1996; Fonseca *et al.*, 2005). Hence, determining of beach seine codend selectivity with classical method (one codend – one cover) may be helpful for comparing of gained result in study.

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