RESEARCH ARTICLE　　　　　　　　　　　　　　　　　　　　　　　　**ARAŞTIRMA MAKALESİ**

Effects of depth and season on catch volume of bottom gillnets employed along the Fatsa coasts of the South-eastern Black Sea

Güneydoğu Karadeniz'in Fatsa kıyılarında kullanılan dip uzatma ağlarıyla yakalanan avın miktarı üzerine derinlik ve mevsimin etkileri

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Abstract: The study was conducted along the Fatsa coasts of the South-eastern Black Sea, to investigate the effects of depth and season on catch volume of the bottom gillnet fishery. During the study, fishing was carried out using multifilament gillnets with mesh sizes of 32, 34, 36 and 38 mm in each of the four different depth strata (0-14 m, 15-29 m, 30-49 m and ≥50 m) three times per month between March 2013 and February 2014 (except for July and August), with a total of 30 gillnet hauls performed. The results of the study revealed that in all seasons whiting (*Merlangius merlangus*) was caught most in the 30 m and deeper water layers. However, whiting catch increased with increasing water depth. Most red mullets (*Mullus barbatus*) were caught in the 0-14 m depth waters during spring, winter and autumn periods, while its catch was the greatest in the 15-29 m during the summer period. Catch of this species decreased gradually with increasing water depth. Another fish species was pontic shad (*Alosa immaculata*) which was caught least in the shallow waters. However, during all seasons its catch increased gradually with increasing water depth up to the 30-49 m depth strata. Nevertheless, it was determined that catch volume for this species decreased in the ≥50 m level again. On the other hand, Mediterranean horse mackerel (*Trachurus mediterraneus*) was mostly caught in the shallow waters (0-14 m and 15-29 m) during all seasons. Especially in the ≥50 m waters, no Mediterranean horse mackerel was sampled during the study. This study presents that amounts of catch for the fish species sampled were affected especially by water depth and seasons.

Keywords: Black Sea, depth, season, Catch Per Unit Effort, gillnet fishery

Öz: Bu araştırma, dip uzatma ağlarıyla avcılıkta derinlik ve mevsimin av miktarı üzerine etkisini araştırmak için Güneydoğu Karadeniz'in Fatsa kıyılarında yürütülmüştür. Araştırmada, dört farklı derinlik katmanında (0-14 m, 15-29 m, 30-49 m ve ≥50 m) 32, 34, 36 ve 38 mm göz açıklığında multifilament uzatma ağları ile avcılık denemesi yapılmıştır. Avcılık denemeleri, Mart 2013 ile Şubat 2014 arasında ayda üç kez (Temmuz ve Ağustos hariç) tekrarlanmıştır. Araştırmanın sonuçları en fazla mezgit balığı (*Merlangius merlangus*)' nın yıl boyunca 30 m ve daha derin su katmanlarında yakalandığını ortaya koymuştur. Artan su derinliğiyle mezgit av miktarı da artmıştır. En fazla barbunya balığı (*Mullus barbatus*) ise ilkbahar, kış ve sonbahar mevsimlerinde 0-14 m derinlikte yakalanırken, yaz mevsiminde ise 15-29 m derinlik katmanında yakalanmıştır. Bu türün av miktarı, artan su derinliği ile kademeli olarak azalmıştır. Diğer balık türlerinden tirsi (*Alosa immaculata*) en az sığ sularda yakalanmıştır. Bu türün av miktarı yıl boyunca, sığ sulardan 30-49 m derinlik tabakasına kadar artan su derinliği ile kademeli olarak artmıştır. Bununla birlikte, bu türün av miktarı 50 m daha derin sularda tekrar azalmıştır. Diğer taraftan, yıl boyunca en fazla istavrit balığı (*Trachurus mediterraneus*) sığ sularda (0-14 m ve 15-29 m) avlanmıştır. Özellikle 50 m ve daha derin sularda bu türe rastlanmamıştır. Bu araştırmanın sonuçları, avlanan balık türleri için av miktarlarının su derinliği ve mevsimlerden etkilendiğini ortaya koymuştur.

Anahtar kelimeler: Karadeniz, Derinlik, Mevsim, Birim Çaba Av Miktarı, Uzatma ağı balıkçılığı

INTRODUCTION

The Black Sea is characterized by a relatively low species diversity, high productivity and biomass, and anoxic conditions below 150-200 m depth (Knudsen et al., 2010). Especially over the last 50 years, the Black Sea ichthyofauna has undergone major changes concerning its qualitative and quantitative structure and the response of various fish populations to environmental changes.

Although the Black Sea is inhabited by approximately 187 species (Yankova et al., 2014), a few fish species are mainly caught in the commercial fishery. As indicated by Knudsen et al. (2010), whiting (*Merlangius merlangus*) is a dominant species in the littoral zone of the South-eastern Black Sea.

According to Zengin (2000), Kara et al. (1991) and Bingel et al. (1995), 65-70% of the benthic and bentho-pelagic fish biomass consisted of whiting in this part of the Black Sea. Since the whiting reaches reproductive maturity at two years age (İşmen, 1995; Genç, 2000), it spawns almost throughout the whole year, having the potential for rapid growth, while the stock regenerates quickly. The whiting stock is, therefore, more resilient to fishing pressure than many other species which have longer life spans and mature later (Knudsen et al., 2010). In addition, the prevalence of a cold intermediate layer (CIL, thermocline) is one of the main reasons that the biomass of whiting already mentioned is much greater in the Black Sea than in the Mediterranean (Knudsen et al., 2010). Although red

mullet (*Mullus barbatus*) is common in all Turkish waters (i.e. the Sea of Marmara, the Aegean Sea, and the Southern coasts of Turkey), subspecies *Mullus barbatus* ponticus inhabits in the Black Sea and the Sea of Azov. *Mullus barbatus* ponticus is a very commercial fish species along the coasts of Black Sea and it is mainly caught by trawls and gillnets along the Turkish coasts of the Black Sea (Yılmaz et al., 2019). The Pontic shad (*Alosa immaculata*) is anadromous fish species, belonging to the family Clupeidae. The species is native for Bulgaria, Georgia, Moldova, Romania, Russia, Serbia, Turkey and Ukraine. It occurs in Black sea and Sea of Azov and for spawning, migrates in Danube, Dnepr, Dniester, Don, Bug etc. (Rozdina et al., 2013). Since 2001, the species is established in the Sea of Marmara (Eryılmaz, 2001). Mediterranean horse mackerel (*Trachurus mediterraneus*) is a schooling species, widely distributed in Turkish waters. It is one of the most important fishery stocks, together with horse mackerel and small pelagics such as anchovy, sprat and sardine in Turkey. Despite the fact that Black Sea represents the most significant part in Turkish fishery, the main fishing area of this species is the Sea of Marmara (Demirel and Yüksek, 2013). According to Ivanov and Beverton (1985), Mediterranean horse mackerel is a migratory species distributed in the whole Black Sea basin. The main prey of the species are small fishes and zooplankton.

Continental shelf along the Turkish Black sea coast is very narrow. This situation restricts fish stocks and fishing activities. In addition, the trawl fishery has been prohibited in the South-eastern coasts of the Black Sea (Anonymous, 2016). Pelagic fish species such as anchovy (*Engraulis encrasicolus*), Mediterranean horse mackerel (*Trachurus mediterraneus*) and bonito (*Sarda sarda*) have been caught using purse seine in the Black Sea (Şahin et al., 2015), while benthic or bentho-pelajic fish species such as red mullet and whiting in the South-eastern Black Sea have been caught only with bottom trawls, gillnets and trammel nets in recent years. Gillnets are the most widely used net type in the small-scale fisheries, while concentrating in recent years on whiting, red mullet and Mediterranean horse mackerel using the same gillnets (Özdemir et. al., 2005). Essentially, these fish species are known to live in different depths. Mediterranean horse mackerel is a pelagic fish species, although whiting is a bentho-pelagic and red mullet is a benthic species (Genç, 2001).

Factors affecting fishing by gillnets and trammel nets which are the most important net types for small-scale fisheries should be well known for both commercial fishing and fisheries management. Therefore, the main objective of this study was to determine the effects of different water depths and seasons on catch efficiency of this specific gillnet fishery.

MATERIAL AND METHODS

The study was conducted in the Fatsa coasts (41°01'42.67"- 41°07'42.45" N, 37°31'01.43"- 37°40'11.94" E) situated on the South-eastern Black Sea (Figure 1).

Figure 1. Map of Black Sea and study area (Google Earth, 2020)

Fishing experiments were carried out using multifilament gillnets with mesh sizes of 32, 34, 36 and 38 mm (stretched mesh) in four different depth strata (0-14 m, 15-29 m, 30-49 m and ≥ 50 m) from March 2013 to February 2014. Designs and characteristics of the nets were similar to commercial gillnets used by local fishermen. Their general characteristics are given in Table 1.

The experimental multifilament gillnets with a combination of four different mesh sizes were tied together to compose a set for each of four different depth strata. The fishing was conducted three times for each month except for July and August. In July and August, fishing could not be conducted due to maintenance requirement for fishing boats. The nets were randomly fastened each other and they were set in the afternoon and hauled the following morning. At the end of each fishing trial, all specimens were classified according to species, with or without economic value and depth. Weight of each individual (whiting, red mullet, pontic shad and Mediterranean horse mackerel) was determined to the nearest gram [total weight (W)]. All individuals belonging to the four fish species were determined by number and by biomass for each fishing experiment.

To determine the effects of water depths and seasons on catch efficiency in the gillnet fisheries, Catch Per Unit Effort (CPUE) were separately calculated for each species and each depth strata as well as for each season. For a standard series of gillnets in this study, mean CPUE was defined as the mass of fish caught during about 12 hours (one night) of fishing with a panel length of 1 m gillnet. In the calculations the height differences of gillnets (32 mm = 175 cm, 34 mm = 198 cm, 36 mm = 197 cm and 38 mm = 226 cm) were ignored. The catch data were not normally distributed (Shapiro–Wilk's test $p < 0.05$); therefore, we applied The Kruskal-Wallis test to evaluate differences among depth strata and between seasons. Mann-Whitney U test was used to compare pairwise among depth strata and seasons. Besides, in terms of CPUE of fish species relationships among depth strata and seasons were employed a Correspondence Analysis. All analyses were performed using SPSS statistical software (version 21).

Table 1. Technical characteristics of experimental gillnets by mesh sizes [Common characteristics of all mesh sizes: Diameter of the net twine = 210 d/2; panel height (70 meshes), net colour = white, PVC floats; float size = 2 no (3.1 cm diameter and 1.9 cm width) and lead ropes are made of PP; diameter of the main rope 2.5 mm; diameter of the auxiliary = 1.5 mm; lead weight 50 g]

Net yarn Stretched mesh sizes (mm) Material	32 Multiflament	34 Multiflament	36 Multiflament	38 Multiflament
Diameter (Denier)	210 d/2	210 d/2	210 d/2	210 d/2
Panel height (mesh number)	70	70	70	70
Panel length (mesh number)	6250	5882	5555	5263
Colour	White	White	white	White
Bolsh twin				
Material	PA	PA	PA	PA
Diameter (Denier)	210 d/9	210 d/9	210 d/9	210 d/9
Float rope				
Material	PP	PP	PP	PP
Diameter (main rope, mm)	3.5	3.5	3.5	3.5
Diameter (auxiliary rope, mm)	1.5	1.5	1.5	1.5
Length (m)	125	112	125	105
Number bolshes	1250	1178	1389	1312
Bolsh sizes (cm)	10	9.5	9	8
N. meshes per bolsh	5	5	4	4
Hanging ratio (E)	0.625	0.56	0.625	0.526
Floats				
Material	PVC	PVC	PVC	PVC
Size	2	2	2	2
N. floats	178	168	198	188
Lead rope				
Material	PP	PP	PP	PP
Diameter (main rope, mm)	2.5	2.5	2.5	2.5
Diameter (auxiliary, mm)	1.5	1.5	1.5	1.5
Length (m)	125	112	125	105
Number bolshes	1250	1178	1389	1312
Bolsh sizes (cm)	10	9.5	9	8
N. meshes per bolsh	5	5	4	4
Lead weight (g)	50	50	50	50
N. leads	178	168	198	188
Hanging ratio (E)	0.625	0.56	0.625	0.526
Height of gillnet (cm)	**175**	**198**	**197**	**226**

RESULTS

Throughout the study, a total of 2254 individuals belonging to the whiting, red mullet, pontic shad and Mediterranean horse mackerel were caught. Numbers and total biomass of each fish species for all depth strata and seasons are summarized in Table 2.

Most catches were obtained in the 30-49 m depth strata, followed by ≥50 m, 15-29 m and 0-14 m depth strata, respectively. The catch of whiting caught in the 0-14 m depth strata was very small. It increased clearly in the 15-29 m depth strata and reached a maximum value in the 30-49 m depth strata. However, in the ≥ 50 m depth waters catches were similar to 30-40 m. Catches during the summer period was lower than in other seasons. Since no samples were taken during July and August, the summer catch volume consisted of data only from June. Most fish was caught in autumn. This season was followed by spring and winter, respectively.

Catch volume by depth and season

CPUE for whiting was only 0.08 g m^{-1} for the 0-14 m depth strata, but increased with depth to 0.6 g m^{-1} (15-29 m) and 1.21

g m^{-1} (30-49 m). Catch volume increased about eight fold from 0-14 m to 15-29 m and two fold from 15-29 m to 30-49 m, remaining stable in greater depth. Differences between 30-49 m and ≥ 50 m strata were not statistically significant ($p > 0.05$), while those of others were $p < 0.05$.

Red mullet and Mediterranean horse mackerel were mostly caught in the shallow waters (0-14 m). As seen in Table 3, catches of both species decreased with increasing water depth. Catches of these fish species were greater in the 15-29 m than those of deeper waters. However, red mullet CPUE there were no differences ($p > 0.05$) between the 0-14 m and 15-29 m and between the 30-49 m and ≥ 50 m, while all other depth strata comparisons were significant ($p < 0.05$). For Mediterranean horse mackerel, only the 15-29 m and 30-49 m depth strata were significantly different ($p > 0.05$). Pontic shad was caught least in the shallow waters. However, catches increased gradually with increasing depth down to 30-49 m depth strata, and they decreased in the ≥ 50 m again. For this species, differences of CPUEs between the 0-14 m and 30-49 m depth strata and between the 15-29 m and 30-49 m depth strata were statistically significant ($p < 0.05$).

Table 2. Catch of four species captured by test gillnet fishing in the Fatsa area of the Southern Black Sea listed by number and biomass in relation to seasons (spring, summer, autumn and winter) and by depth strata (0-14, 15-29, 30-49 and ≥50 m). Data were obtained by monthly sampling (three fishing trials per month; March 2013 to February 2014) except for July and August. N = number of fish; TB = total biomass

Species	Depth (m)	Spring		Summer		Autumn		Winter		Total	
		N	TB	N	TB	N	TB	N	TB	N	TB
	0-14	25	964	0	0	9	309	0	0	34	1273
	15-29	67	3482	4	168	109	4071	62	2212	242	9933
Whiting	30-49	96	3967	37	1265	193	6872	167	6054	493	18159
	≥ 50	111	4377	37	1390	224	7977	118	4185	490	17928
	Total	299	12790	78	2823	535	19229	347	12451	1259	47293
	0-14	102	4883	24	971	57	2092	78	2955	261	10900
	15-29	51	2136	32	1312	18	661	32	1194	133	5303
Red mullet	30-49	20	826	0	0	4	151	11	410	35	1387
	≥ 50	6	234	0	0	5	175	0	0	11	409
	Total	179	8079	56	2282	84	3079	121	4558	440	17999
	0-14	10	1277	0	0	14	1748	0	0	24	3025
	15-29	30	3930	0	0	26	3213	21	2460	77	9602
Pontic shad	30-49	36	3804	5	757	57	7248	30	3767	128	15577
	50≥	30	3586	3	362	35	4501	17	2164	85	10613
	Total	106	12596	8	1120	132	16711	68	8391	314	38817
	0-14	38	1305	9	290	91	3175	34	1165	172	5935
	15-29	10	322	3	95	7	224	33	1126	53	1766
Mediterranean horse mackerel	30-49	1	35	3	363	4	130	8	269	16	796
	≥ 50	0	0	0	0	0	0	0	0	0	0
	Total	49	1662	15	748	102	3529	75	2560	241	8498
	0-14	175	8428	33	1261	171	7324	112	4120	491	21133
	15-29	158	9870	39	1575	160	8168	148	6992	505	26604
All species	30-49	153	8632	45	2385	258	14402	216	10500	672	35919
	≥ 50	147	8197	40	1753	264	12653	135	6349	586	28951
	Total	633	35127	157	6974	853	42548	611	27960	2254	112608

Table 3. CPUEs of four species captured by test gillnet fishing in the Fatsa area of the Southern Black Sea listed by biomass in relation to seasons (spring, summer, autumn and winter) and by depth strata (0-14, 15-29, 30-49 and ≥50 m) (g m^{-1}.night^{-1}). Data were obtained by monthly sampling (three fishing trials per month; March 2013 to February 2014) except for July and August

Species	Depth (m)	Spring	Summer	Autumn	Winter	Mean
Whiting	0-14	0.23	0.00	0.07	0.00	0.08
	15-29	0.81	0.12	0.95	0.52	0.60
	30-49	0.93	0.89	1.60	1.41	1.21
	≥ 50	1.02	0.96	1.86	0.97	1.20
	Mean	0.75	0.49	1.12	0.72	0.77
Red mullet	0-14	1.14	0.67	0.49	0.69	0.75
	15-29	0.49	0.93	0.15	0.28	0.46
	30-49	0.19	0.00	0.03	0.09	0.08
	≥ 50	0.05	0.00	0.04	0.00	0.02
	Mean	0.47	0.40	0.18	0.27	0.33
Pontic shad	0-14	0.31	0.00	0.44	0.00	0.19
	15-29	0.97	0.00	0.78	0.58	0.58
	30-49	0.92	0.55	1.79	0.90	1.04
	50≥	0.87	0.24	1.12	0.52	0.69
	Mean	0.77	0.20	1.03	0.50	0.62
Mediterranean horse mackerel	0-14	0.30	0.20	0.75	0.27	0.38
	15-29	0.07	0.06	0.05	0.26	0.11
	30-49	0.01	0.29	0.03	0.06	0.10
	≥ 50	0.00	0.00	0.00	0.00	0.00
	Mean	0.10	0.14	0.21	0.15	0.15
All species	0-14	0.50	0.22	0.44	0.24	0.35
	15-29	0.59	0.28	0.48	0.41	0.44
	30-49	0.51	0.43	0.86	0.61	0.61
	≥ 50	0.48	0.30	0.76	0.37	0.48
	Mean	0.52	0.31	0.63	0.41	0.47

Considering the CPUE, for all four species combined (whiting, red mullet, pontic shad and Mediterranean horse mackerel) the yield was greater in autumn than in other seasons. However, for whiting and pontic shad spring, winter and summer were most effective. For Mediterranean horse mackerel yields were greatest in winter followed by summer and spring. However, differences among seasons were not significant (p>0.05) for CPUEs of whiting and Mediterranean horse mackerel. It was different (p<0.05) between the autumn and summer seasons and between the autumn and winter seasons for pontic shad. On the other hand, most red mullets were caught during spring, followed by summer, winter and autumn. For red mullet, differences of CPUEs were significant (p<0.05) for comparisons between summer and other seasons.

The Correspondence Analysis showed that during all seasons whiting was caught the most in the 30 m and deeper waters (Figure 2). In shallow waters (15-29 m), relatively more whiting were caught during spring, autumn and winter, but littoral zone of 0-14 m almost no whiting caught except for spring. According to the chi-square test (χ^2 (9) = 175.630,

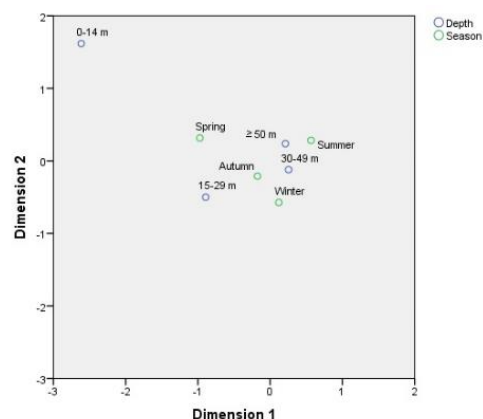p<0.05), however, water depths and seasons are not totally independent from each other.
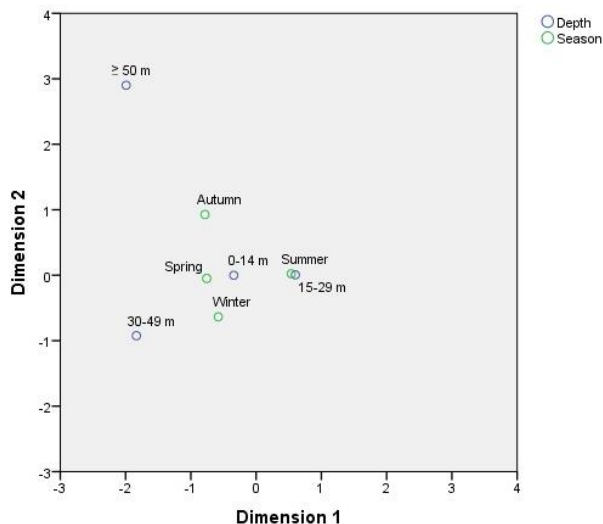

Figure 2. Correspondence Analysis executed with data from a monthly test fishing survey (March 2013- February 2014 (except July and August), using gillnets at different depth strata and seasons to determine catch biomass when fishing for whiting

During the spring, winter and autumn periods, red mullet were mostly caught in the 0-14 m depth strata, while during summer catch was the highest in the 15-29 m depth zone (Figure 3). In deeper waters especially in the ≥ 50 m zone a few red mullets were caught. Chi-square test showed that the total inertia was different from 0 ($\chi2$ (9) = 140.962, p<0.05), indicating that red mullet catch is also affected by the relationship between water depths and seasons.

As seen in Figure 4, pontic shad were mostly caught in the 30-49 m depth strata and deeper waters during all seasons, while in the 0-14 m depth zone pontic shad catch was very small. Also here the Chi-square test ($\chi2$ (9) = 168.536, p<0.05) indicated that the pontic shad catch was greatly affected by interactions between water depths and seasons.

It is understood from Figure 5 that in all seasons Mediterranean horse mackerel were mostly caught in the littoral zone of 0-14 m and in the 15-29 m depth strata. Especially in deeper the ≥ 50 m waters, no Mediterranean horse mackerel was caught. Total inertia value was also different from 0 ($\chi2$ (9) = 136.857, p<0.05) for this species. Therefore, catch volume was also affected by the changes in water depths and seasons.

Figure 3. Correspondence Analysis executed with data from a monthly test fishing survey (March 2013- February 2014 (except July and August), using gillnets at different depth strata and seasons to determine catch biomass when fishing for red mullet
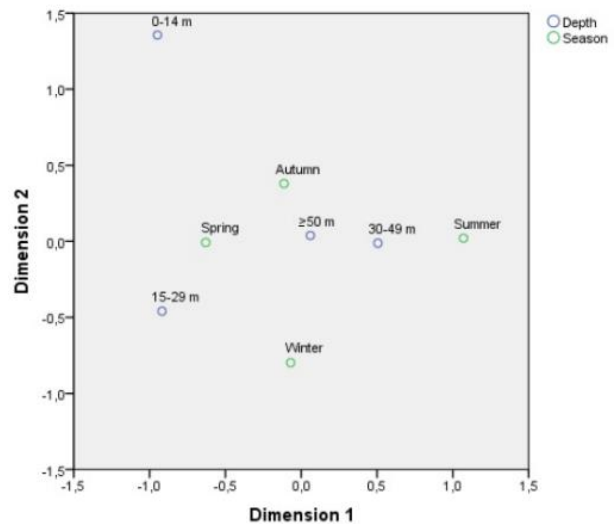

Figure 4. Correspondence Analysis executed with data from a monthly test fishing survey (March 2013- February 2014 (except July and August), using gill nets at different depth strata and seasons to determine catch biomass when fishing for pontic shad
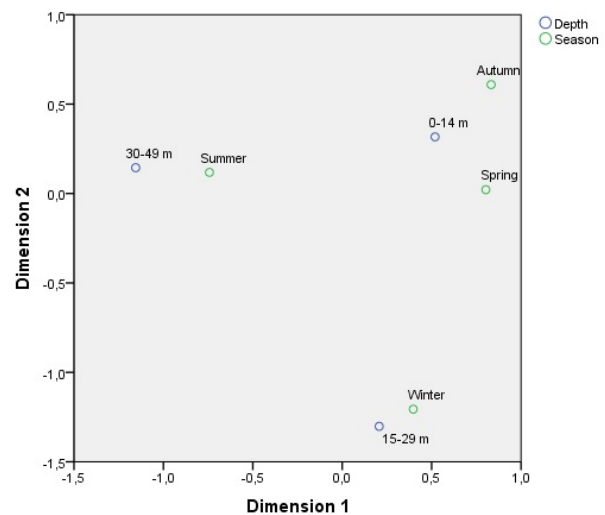

Figure 5. Correspondence Analysis executed with data from a monthly test fishing survey (March 2013- February 2014 (except July and August), using gillnets at different depth strata and seasons to determine catch biomass when fishing for Mediterranean horse mackerel

DISCUSSION

Gillnet and trammel net fisheries are very important in the South-eastern Black Sea coast of Turkey. Importance of these nets has increased particularly because of prohibition of fishing by trawl nets in this region.

The results of our study revealed that catch volume of whiting was less in waters shallower than 15 m, gradually increasing from 0-14 m to 30-49 m, and remaining stable in waters depth of ≥50 m. Daskalov and Rätz (2011) emphasized that whiting occurs all along the shelf, with dense concentrations formed by 1-3 year classes down to 150 m depth, but most often within a depth of 60-120 m. The maximum fishing depth in our study, however, was 70 m only. Catch volume estimate in deeper waters was not possible. Kalaycı and Yeşilçiçek (2014) found a linear correlation between the whiting catch volume and water depth. Erdem et al. (2007) reported that whiting catch was greater in the waters deeper than 50 m in the coasts of Samsun. Çiloğlu et al. (2002) reported no catches in waters of 15 m depth in the Trabzon coastal area. Thus, all studies show that whiting prefers waters deeper than 15 m.

Seasonality of whiting catch shows some trends, however firm conclusion can not be drawn because of missing data for July and August. Kalaycı and Yeşilçiçek (2014) reported different results from the Rize coasts of the South-eastern Black Sea reaching, the highest CPUE in spring. As indicated by Knudsen et al. (2010), excluding the summer period in the South-eastern Black Sea whiting yields abundant catch throughout the year. As a cold-water fish, its seasonal vertical distribution depends on the sea water temperature and during summer the fish stays mainly below the thermocline (30-40 m; ca 7.5-8.5 °C). Contrary to results of Kalaycı and Yeşilçiçek (2014), the results of our study agree with these informations.

Both annual catch statistics and observations on fisheries in this region showed that in recent years the small-scale fishery depends mainly on whiting, red mullet and Mediterranean horse mackerel. Öztaş and Balık (2012) found in 2010 in the same area a mean CPUE for the 32, 34 and 36 mm mesh-sized gillnets of 16.7 g m^{-1}. In this study, mean CPUE was 1.005 g m^{-1} for the same mesh-sized gillnets. This difference clearly shows the decrease in the whiting stock population in the Fatsa coasts.

Red mullet was mostly caught in the shallow waters, with catches decreasing with increasing water depth. However, this is contrasted by Kalaycı and Yeşilçiçek (2014) finding along the Rize coasts (South-eastern Black Sea) the highest red mullet CPUE in the 55-74 m depth strata. Apparently, the depth distribution of this species may depend on the fluctuations in water temperature. From late spring and throughout the summer red mullets prefer shallow coastal waters where they reproduce. During our study, the most red mullet was caught in the spring, followed by summer, winter and autumn, respectively, whereas, Kalaycı and Yeşilçiçek (2014) reported the highest CPUE during the winter period. According to Genç

et al. (2002), red mullets migrate into shallow waters toward spring and they are caught by gillnets in this season. Aydın and Karadurmus (2013) found that summer is the spawning season for this species in shallow waters of the South-eastern Black Sea. Most CPUE values for pontic shad were obtained in the depths of 30-49 m. Even, it was never caught in the depth of 0-14 m in the summer and winter periods and in the depth of 15-29 m in the summer period. Ak et al. (2008) reported catches in water depths between 40 and 60 m in the Trabzon area during winter and spring. Pontic shad migrate seasonally around the Black sea coastal waters but also to brackish waters and rivers to spawn (Polat and Ergün, 2008) and they are found in large schools around the river mouth and in the middle waters. In our study region, there are several rivers and two of them (Bolaman and Elekçi rivers) flow into our study area. Catch of pontic shad may be positively affected by the river flow especially during the spawning season.

Mediterranean horse mackerel is a pelagic migratory species distributed within the entire Black Sea (Ivanov and Beverton, 1985) throwing in surface waters. This species was mostly caught in waters of 0-14 m depth, catches decreasing with increasing water depth, and it was never caught in waters deeper than 50 m, preferably staying in the shelf waters above the seasonal thermocline seasonal catches were the greatest in autumn. During spring, this species migrates to the north for reproduction and feeding.

Whiting is a dominant species in the littoral zone of the South-eastern Black Sea (Kara et al., 1991; Knudsen et al., 2010). The results of the study showed that small scale fisheries depend almost entirely on whiting and red mullet in the South-eastern Turkish coast of the Black Sea.

In conclusion, it was clearly shown that catch efficiency of the four species studied are related to water depth and season when fished by gillnets in the Fatsa coasts of the South-eastern Black Sea. During the year, whiting can be fished by gillnets mainly in the 30 m and deeper waters, while most red mullets can be caught in the shallow waters (0-14 m) during spring, winter and autumn periods, and during the summer in waters depth of 15-29 m. Most pontic shad can be fished in waters depth of 30-49 m throughout the year, while Mediterranean horse mackerel can be fished in waters shallower than 30 m.

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