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-RESEARCH ARTICLE-

Catch Composition of Bottom Trawl Fisheries in Düzce Coast, southwestern Black Sea

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Abstract

This study was performed to identify the catch composition of Düzce coast (southwestern Black Sea) at depths of 30-110 meters by bottom trawl between September 2014 and August 2015. In the catch compositions of the Düzce coast, the abundance of the first, second and third species were *Merlangius merlangus* with 73.12% (1290.29 kg / km^2), Gobius spp. with 9.30% (164.04 kg/km^2) and *Mullus barbatus* with 9.05% (159.61 kg / km2), respectively. The other 33 species make up 8.53% of total fish biomass. When seasonal distribution was examined, the total catch of fish were 1038.54, 2552.37, 1068.72, 5132.96 kg/km^2, of which economic (target) fish species (*Merlangius merlangus*) constitute 745.72, 1726.14, 724.58, 4910.15 kg/km^2 in autumn, winter, spring and summer respectively. In this study, fishing a very high rate of discard whiting in little sizes draws the attention. Whiting constitutes 56% of discard. Single or sporadic captures were also recorded for *Acipenser stellatus, Trachurus trachurus, Spicara smaris, Lophius piscatorius, Serranus hepatus* and *Hippocampus hippocampus*. Moreover, in this study, red list status for 36 fish species belonging to 27 family in Düzce coasts were considered with the Red List published by the International Union for conservation of Nature and Natural Resources (IUCN). As a result of this comparison, it was determined that 2 species Critically Endangered (CR), 5 species Vulnerable (VU), 22 species Least Concern (LC), 4 species Not Evaluated (NE), 2 species Data Deficient (DD).

Keywords:

Southwestern Black Sea, Düzce coast, Bottom Trawl, Catch Composition, Turkey

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Introduction

Düzce is a prominent segment of Black Sea with its 35 km coast line along the Akçakoca district. It also stands as a major observation point to monitor the general issues of Black Sea. Extreme investment being made in the sector with developed technologies lately makes fish stocks to be exposed to extreme fishing pressure.

Fishing equipments not having selective specification also makes bycatch rates to be high and jeopardize the future of fishery. Determining the changes in production quantity in catch composition and average product lengths, assessing the effect of fishery on storages, specifying the measurements to be taken by authorities in order to reduce this effect, if necessary, collecting and analyzing regional fishing composition and bycatch data regularly is necessary in order fishery data to be used effectively for many years. In the detailed literature analysis made, it was noticed that there is no study that reveals the composition of trawl fishing at Düzce coasts and it was aimed to close this gap in the literature by this planned study.

It is thought that sandy deep structure of Düzce coasts makes other region trawls to prefer this region and this makes Düzce coasts to be the key area for such studies and it is planned that this study reveal important output for intended planning to be done for the future of regional fishery. Thus in the present study, the effects of bottom trawl fishery on the fishes and trawl catch composition and target, by-catch and discard composition and fish stock biomass of bottom trawl fishery were examined for the first time in the Düzce coast, (southwestern Black Sea), Turkey.

Material and Methods

Total biomass, species composition, seasonal distribution and abundance were examined for 12 months (September 2014- August 2015), with trawling on the lines shown on the map (Figure 1) from the Düzce, western Black Sea coast of Turkey. Experiments were carried out on the commercial trawler (21-24 m and 420 hp main engines) during daytime in stable weather and sea conditions. The diamond mesh cod-end size was 40 mm, head-rope length of the trawl net was 24 m and trawling speed was 1.8-2.0 nm/h. In this study, a total of 33 commercial bottom trawl operations were performed with at 50-60 m depth ranges in the Düzce coast. Seasonal distribution of the number of operations were as 6 in autumn, 12 in winter, 11 in spring and 4 in summer. Species were identified according to Turan et al. (2007) and Eschmeyer et al. (2017), and the number of individuals and the total weight of samples were also detected.

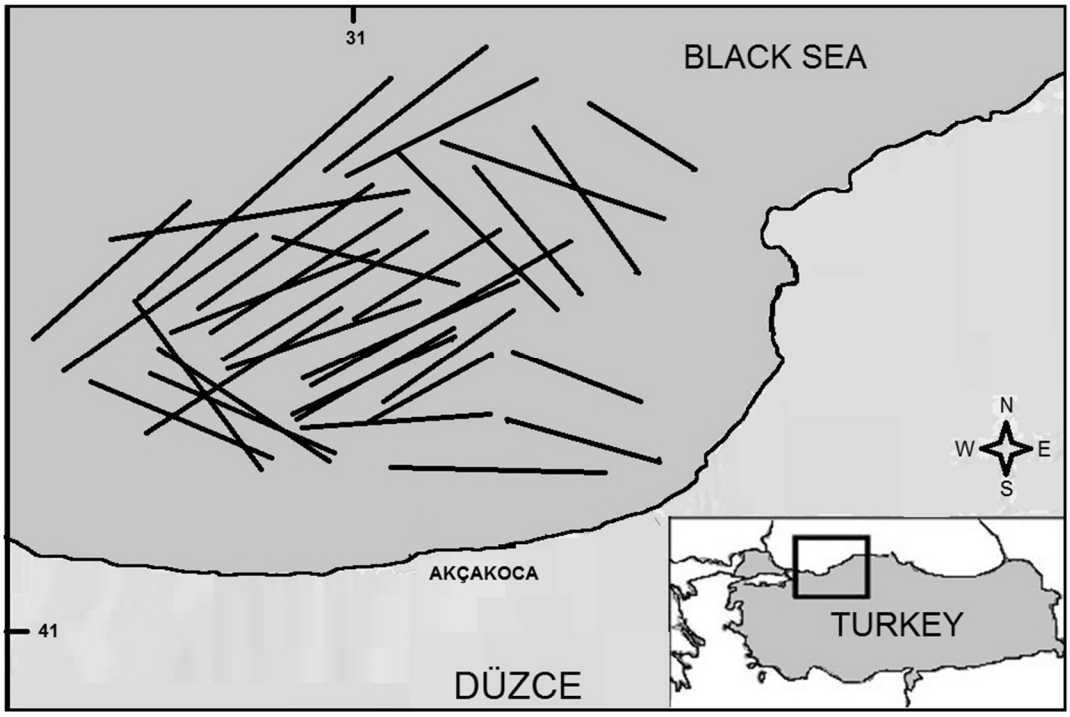

Figure 1. Map of Study area (Düzce Coast) (trawling lines are shown with bars)

The biomass was estimated based on the swept area method (Sparre & Venema, 1998). The catch per unit area was calculated by using the formula given by Pauly (1980) and Sparre & Venema (1998). The total catch amount occurring in each of these areas was determined separately, and areas with different amounts were then combined into a total. In this method, simple and clear mathematical calculations were used in estimating the existing stock.

The estimate of biomass was made by following steps;

The swept area (Sparre & Venema, 1992) for each haul was calculated using the formulas;

$$a = D * h * X2, \qquad D = V * t$$

Fraction of the head rope which is equal to the width of the path swept by the trawl, (x2) was taken as 0.4 following Shindo (1973), Somvanshi et al. (2004). Pauly (1980) have arrived at the value of x2 = 0.5 to be the best compromise for the trawl vessels, and this value has been used for the present study.

Cw/t= CPUE- kg/h (The Catch-Per-Unit Effort); Catch in units of weight per trawling hour

a/t = area swept per trawling.

$$\frac{Cw/t}{a/t} = \frac{Cw}{a}$$

the Catch Per Unit of Swept Area (CPUA-kg/km2);

$$\overline{b} = \frac{(\overline{Cw/a})}{X1} \text{ kg/km}^2$$

In Black Sea waters, value for X1 for *M. merlangus*, 1.0 (Suer, 2016) have been used, with 1.0 possibly being the best compromise.

At the same time a frequency analysis of the frequency of species availability for each season was made (F=Na / N * 100) (Blanchard et al., 2004). As a result of the analysis, the species were grouped according to their frequency in terms of the seasons and the frequency analysis results were visualized on the table.

Result and Discussion

In the study, Düzce coast trawl catch composition were composed of 36 fish species from 27 family. In the previous study on West Black Sea trawl fishery by Baskaya (2012), 27 fish species, two of which being cartilaginous species, were catched in 34 trawling operation. In the other study related to marine fish fauna on the coast of Düzce by Yaglioglu (2016), 76 marine fish species were found. Due to the current sea floor morphology being compatible for trawling and the large number of fresh water input (Melen River, Sakarya River, Cayagzi, Cakbelit, Degirmenagzi creeks), supplying rich nutrients to the region, it is thought that Düzce coast has a higher biodiversity than the other regions of the Black Sea.

In all samplings, whiting (*Merlangius merlangus*), the target species of the study, was obtained along with the by-catch species such as *Mullus barbatus, Chelidonichthys lucerna, Scophthalmus maximus, Scorpaena porcus, Scophthalmus maeoticus, Alosa immaculata, Pomatomus saltatrix, Anguilla anguilla, Symphodus tinca,* and with discard *s*uch as *Merlangius merlangus, Mullus barbatus, Trachurus mediterraneus, Scorpaena notata, Spicara maena, Solea solea, Merluccius merluccius, Spicara smaris, Trachurus trachurus, Scophthalmus maximus, Trachinus draco, Scorpaena porcus, Sardina pilchardus, Scophthalmus maeoticus, Alosa immaculata, Pomatomus saltatrix, Gobius spp., Gobius niger, Raja clavata, Sprattus sprattus, Uranoscopus scaber, Engraulis encrasicolus maeoticus, Gaidropsarus mediterraneus, Arnoglossus laterna, Platichthys flesus, Squalus acanthias, Buglossidium luteum, Syngnathus acus, Parablenniuis sanguinolentus, Acipenser stellatus, Lophius piscatorius, Hippocampus hippocampus, Serranus hepatus.* Crustaceans and jellyfishes were also sampled in study. In Düzce coast trawling composition, the catch is composed of 91.52% bony fishes, 2.20% cartilaginous fishes and 6.28% invertebrates.

In this study, the biomass rates of target by-catch and discard in total catch were compared seasonally (Figure 2). The highest rate between target and discard biomasses is observed during autumn season (discard/target = 4.58). It is believed that this fact is due to excessed number of individuals of species, primarily whiting, under the allowed catch size at the end of summer season which doesn't constitute bottom trawling fishing pressure.

In this study, the biomass and percentage of discard were constantly observed than the biomass of target fishes during winter season on Düzce coast. Although the fish size selectivity of trawling equipment used for trawling in region is being in legal limits, it is believed that the legal limits doesn't affect the selectivity of trawling in region positively. In addition, Main & Sangster (1990) indicated that the selectivity of trawl nets are lower and that the diamond shaped meshes of

trawling nets will close significantly during trawling no matter how much their mesh sizes are (Özdemir, 2006).

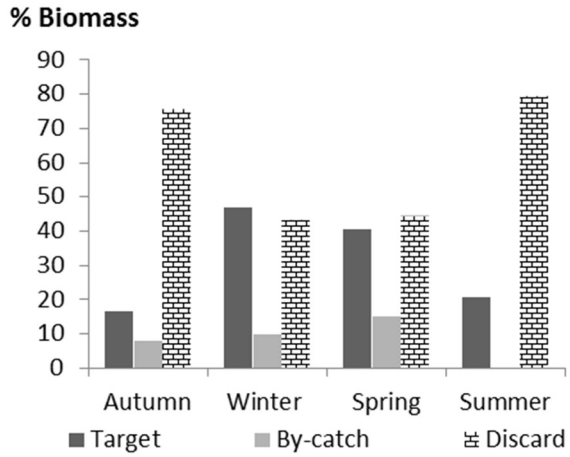

Figure 2. Seasonal distribution of the total target, by-catch and discard fish % biomass in Düzce coast.

In the present study, seasonal distribution was also examined, total catch of fish were 1038.54, 2552.37, 1068.72, 5132.96 kg/km^2 in autumn, winter, spring and summer, respectively. Total viable biomass for Düzce coast was calculated as 1.813,87 kg/km^2. Gonener & Bilgin (2006), in their study on Middle Black Sea, have determined the total fish amount as 10.147,1 kg/km^2 for shallow waters (<75m) and 16.940,0 kg/km^2 for deep waters (>75m). In the present study, these values are calculated as 1.764,51 kg/km^2 for Düzce coast (Table 3.3). Suer (2016), has calculated the biomass amount as 3.173,71 kg/km^2 in eastern Black Sea where is open to trawling and intense catch pressure. Besides, Suer (2016) also has found the amount as 5.806,23 kg/km^2 in areas close to trawling and revealed the effects of fishing pressure on biomass. In our study, whiting biomass was determined as 1.290,29 kg/km^2, and it can be concluded that there are adverse effects, primarily excessive fishing, on fish biomasses for both whiting and other fish species in Düzce coast.

All fishes caught were identified at the species level, but some species of *Gobius* genus was not to be distinguished from others during the survey, therefore the species were described as *Gobius spp*. In this study, species other than *Merlangius merlangus*, *Mullus barbatus, Gobius spp.* were found to be not abundant. However single specimen was captured for *Acipenser stellatus, Anguilla anguilla, Parablenniuis sanguinolentus, Symphodus tinca, Lophius piscatorius, Chelidonichthys lucerna* throughout the study.

Merlangius merlangus was the most abundant species comprising 73.12% (1290.29 kg/km^2) of all fishes, followed by *Gobius spp*. (9.30%, 164.04 kg/km^2) and *Mullus barbatus* (9.052%, 159.61 kg/km^2) and *Raja clavata* (1.98%, 34.93 kg/km^2) as described in Figure 3.

In autumn, the total catch weight of *M. merlangus* was 745.72 kg/km^2, representing 71.8% of the total fish biomass in autumn. In winter, the total catch weight of *M. merlangus* was 1726.14 kg/km^2, comprising 67.62% of the total biomass. In spring, 67.8% of the total fish biomass

(1068.72 kg/km^2) was composed of *M. merlangus*. In summer, *M. merlangus* were determined as 4910.15 kg/km^2, which represent 95.66% of the total biomass (Figure 3, Figure 4).

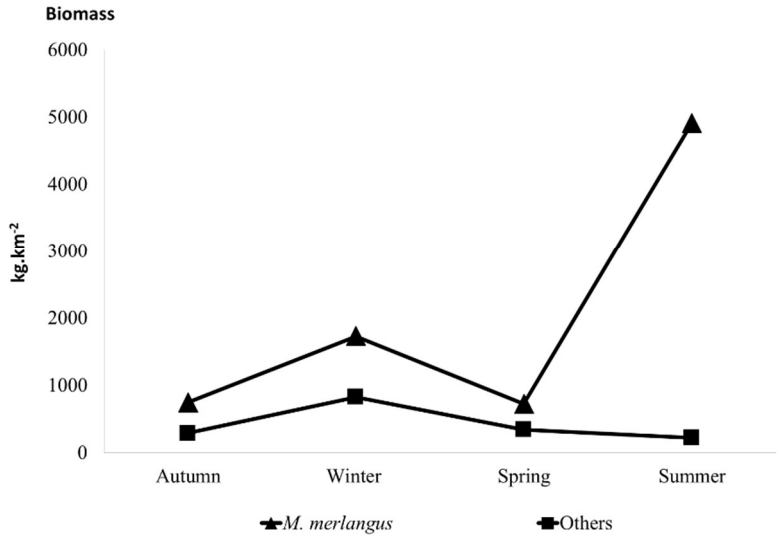

Figure 3. The average biomass index for *M. merlangus* and other species by trawling.

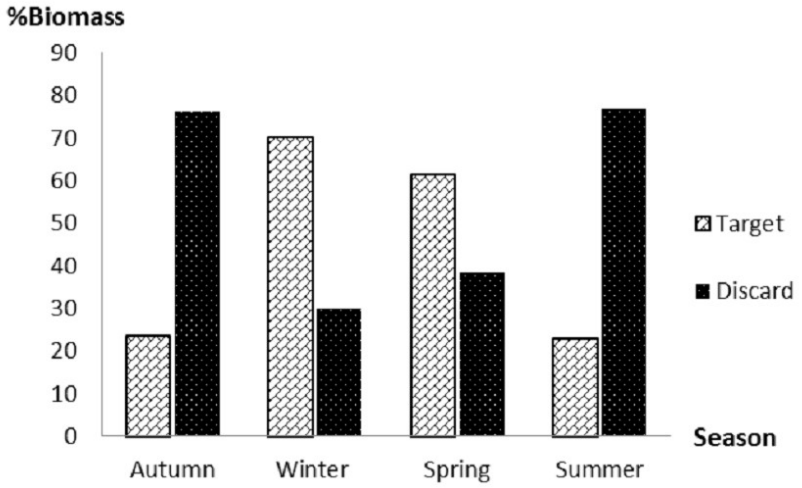

Figure 4. Seasonal distribution of target and discard biomass ratio of *M. merlangus* in Düzce coast by trawling.

In the present study, it was found that the target whiting in winter and spring seasons, and discard whiting in autumn and summer seasons, were excessive (Table 1). Zengin et al. (2017) reported that determined the discard rate of the catch taken onboard was 25-42% by trawling in the Black Sea. In current study, discard and target rates of whiting show a significant change between seasons. The total annual figures of 51.86% for target whiting and 48.14% for discard whiting are very close to figures of the study. Besides, Zengin et al. (2017) determined discard rate of whiting as 41% in 2005-2006 fishing season; 45% in 2008-2009 fishing season; and 31% in 2009-1010 fishing season. While the target fish amount is higher than discard fish amount during winter and spring seasons, target fish is found lower than discard fish during autumn and summer

seasons. Ciloglu et al. (2002) reported that no whiting can be catched in 15 m depth in easten Black Sea during the year, but it is catched in 35 m depth in some months (summer and winter) and in 60 and 80 m depths during the whole year, and that the rate of whiting in total fishing is 65.72% in 60 m, and 71.% in 80 m. Kara et al. (1989) reported the whiting rate in fishing composition between Sinop and Ünye as 78.4% in 1985. In current study, total whiting biomass rate in total fish biomass for Düzce coast is determined as 73.13% for a whole year, similar to other studies (Figure 4).

Table 1. Seasonal Total catch weight, The Catch-Per-Unit Effort (CPUE) and biomass datas of target and discard *M. merlangus*.

	Autumn		**Winter**		**Spring**		**Summer**	
	Target	**Discard**	**Target**	**Discard**	**Target**	**Discard**	**Target**	**Discard**
Total catch weight (kg)	123.14	395.59	1344.70	574.35	715.87	450.00	251.23	840.00
Biomass (kg/km^2)	177.02	568.70	1209.53	516.62	444.91	279.67	1130.45	3779.70
% Whiting	23.74	76.26	70.07	29.93	61.40	38.60	23.02	76.98
Target/Discard	0.31		2.34		1.59		0.30	
CPUE (kg/h)	9.84	31.60	67.20	28.70	24.72	15.54	62.81	210.00

As a result of seasonal frequency analysis of 36 species catched within the study, it was observed that only 4 species (*Merlangius merlangus, Gobius niger, Mullus barbatus, Raja clavata*) were fished in all trawling, and 11 species were catched in all seasons (Table 2).

Table 2. List of fish species observed in this study IUCN red list status and percentage of frequency of occurrence (f) and distributional information by the seasons. The frequency of occurrence index: Rare species 20%, Sparse species 40%, Moderate finding found species 60%, commonly found species 80%, Most Commonly found species 100%. Red list categories are abbreviated as: CR-Critically Endangered; VU-Vulnerable; LC-Least Concern; DD-Data Deficient; NE-Not Evaluated.

Species	**Red List**	**f**	**Autumn**	**f**	**Winter**	**f**	**Spring**	**f**	**Summer**
Merlangius merlangus	LC	100	+	100	+	100	+	100	+
Gobius niger	LC	100	+	100	+	100	+	100	+
Mullus barbatus	LC	100	+	100	+	100	+	100	+
Raja clavata	VU	100	+	100	+	100	+	100	+
Scorpaena porcus	LC	100	+	100	+	60	+	80	+
Scophthalmus maximus	NE	100	+	100	+	60	+	0	-
Gobius spp.	-	100	+	100	+	0	-	0	-
Scophthalmus maeoticus	NE	80	+	100	+	0	-	0	-
Engraulis encrasicolus maeoticus	LC	80	+	80	+	60	+	0	-
Sprattus sprattus	NE	80	+	40	+	0	-	40	+
Trachinus draco	LC	60	+	80	+	80	+	60	+
Syngnathus acus	LC	60	+	40	+	20	+	40	+
Sardina pilchardus	LC	60	+	40	+	60	+	0	-
Scorpaena notata	LC	60	+	0	-	0	-	60	+
Uranoscopus scaber	LC	40	+	60	+	40	+	60	+
Solea solea	DD	40	+	40	+	20	+	20	+
Trachurus trachurus	VU	40	+	0	-	0	-	0	-
Pomatomus saltatrix	VU	40	+	0	-	0	-	0	-
Arnoglossus laterna	LC	40	+	0	-	0	-	0	-

Gaidropsarus mediterraneus	LC	20	+	40	+	20	+	60	+
Hippocampus hippocampus	DD	20	+	40	+	20	+	20	+
Trachurus mediterraneus	LC	20	+	40	+	20	+	0	-
Buglossidium luteum	LC	20	+	20	+	20	+	0	-
Squalus acanthias	VU	20	+	0	-	0	-	0	-
Chelidonichthys lucerna	LC	20	+	0	-	0	-	0	-
Spicara smaris	LC	20	+	0	-	0	-	0	-
Serranus hepatus	LC	20	+	0	-	0	-	0	-
Alosa immaculata	VU	0	-	80	+	20	+	0	-
Merluccius merluccius	NE	0	-	20	+	20	+	0	-
Spicara maena	LC	0	-	20	+	0	-	0	-
Symphodus tinca	LC	0	-	20	+	0	-	0	-
Lophius piscatorius	LC	0	-	20	+	0	-	0	-
Anguilla anguilla	CR	0	-	0	-	20	+	0	-
Platichthys flesus	LC	0	-	0	-	20	+	0	-
Parablenniuis sanguinolentus	LC	0	-	0	-	20	+	0	-
Acipenser stellatus	CR	0	-	0	-	20	+	0	-

In study, it was determined that 22 species those corresponding 63% of identified species in Düzce coast trawling composition was in least concern (LC) level. This rate is different from all Black Sea (26.46%) (Yankova et al., 2014), and similar to Düzce coast marine fish fauna (Yaglioglu, 2016). In this study, of the species within Düzce coast trawling composition, 14% is determined as "Vulnerable" 6% as "Critically Endangered", 6% as "Data Deficient" and 11% as "Not Evaluated" after the review of their red list statuses. Although these 22 species in fishing composition being in Least Concern level is considered as a positive fact, 2 species being critically endangered and 5 species being in sensitive status are important indicators for the pressure caused by trawling in this study (Figure 5).

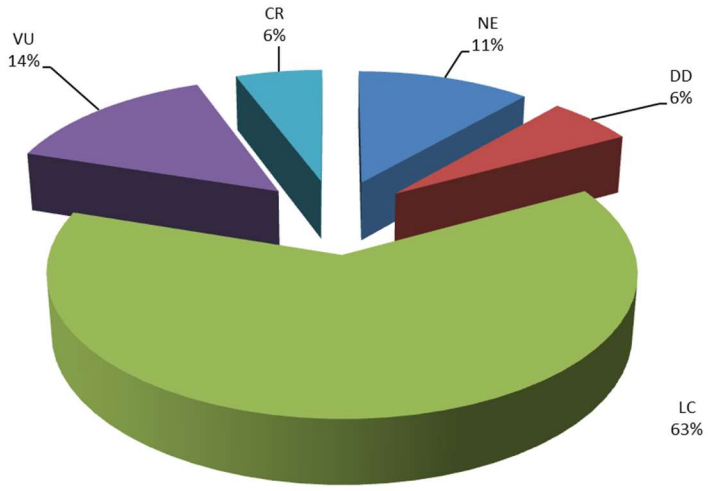

Figure 5. Regional Red List status of trawl fish compositions species in the Düzce coast. Categories are abbreviated as: CR-Critically Endangered; VU-Vulnerable; LC-Least Concern; DD-Data Deficient; NE-Not Evaluated;

When origins of species are examined, it was determined that the species within Düzce coast trawling composition, 72% are of Atlantic origin; 3% are of Atlanto-Mediterranean, in other Atlantic originated Mediterranean species are 11% of Black Sea endemic species; 3% of

Mediterranean endemic species and 11% of cosmopolite species (Table 3). The origin analysis draws attention that the most part of the species are of Atlantic originated cold-water fish species (Figure 6). It is thought that due to its high rate of cold water species, the biodiversity of the Black Sea would likely be affected by water temperature rises as a result of global climate changes in future as reported by Turan et al. (2016).

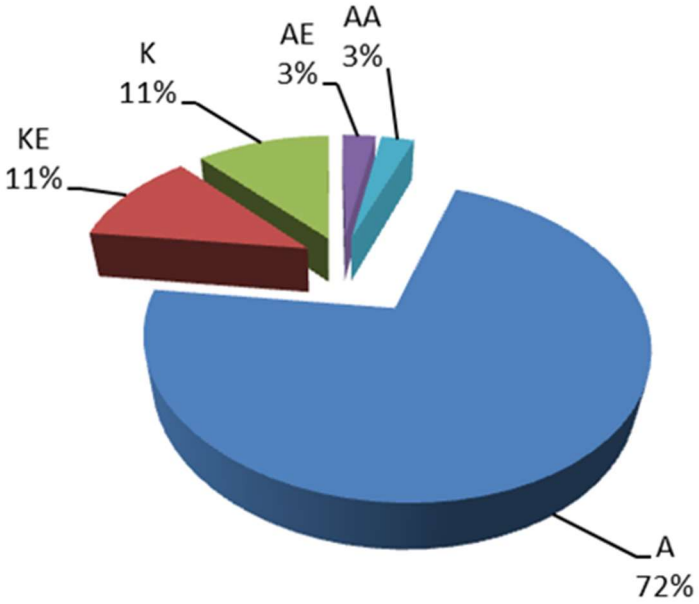

Figure 6. The origin of trawl fish compositions species in the Düzce coast (A-Atlantic, BE-Black Sea-Endemic, C-Cosmopolitan, ME-Mediterranean-Endemic, AA-Atlanto-Mediterranean)

In conclusion, the species caught in demersal trawl fishery in the Düzce coast in September 2014-August 2015 such as catch composition, target and by-catch and discard catch ratios, catch per unit efforts (CPUE) and conservation status and origin distribution of fish species were determined. Present study and future studies are important to reveal and monitor the situation of the trawl catch composition and possible effects of trawl fishery to biodiversity.

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