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# Discards in Bottom-trawl Fishery in the South-Eastern Black Sea, Turkey

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**Abstract:** Seasonal data sampling on the total catch, target catch, bycatch and discard of four commercial bottom trawlers in the south-eastern Black Sea near the coast of Turkey was carried out in the 2016–2017 fishing season. Totally, 217 bottom trawl operations were sampled. *Merlangius merlangus* and *Mullus barbatus* were the target species while eight species were discarded, including trash fish and specimens below the legal size of the target species. A total of 28039.86 kg of biomass was caught during the operations, of which 22.98 % was bycatch. The weighed discard rate was 15.12 %. The highest CPUE values calculated for the whiting and red mullet were 69.36 and 23.00, respectively.

**Key words**: Bycatch, bottom trawl, discard, Black Sea fishery

## Introduction

The amount of research on bycatch fisheries has increased due to the technological development and the impacts of commercial fishing activities on populations of marine birds and mammals (Alverson & Hughes 1996). This is also the reason for research on bycatch fisheries has started gaining ground in 1990s (Tillman 1993). The first discard estimation study was this by Saila (1983). Subsequently, Andrew & Pepperell (1992) examined the bycatch in shrimp and trawl fishery. Alverson et al. (1994) worked out the first global bycatch and discard estimates covering the period 1980–1992. Kennelly (1995) studied the bycatch in Australian demersal trawl fishery. Alverson & Hughes (1996) examined the effect of bycatch fishing on fisheries management. Pascoe (1997) analysed the effect of discards on economy. A comprehensive global discard estimation was proposed by Kelleher (2005). For the Black Sea, detailed discard analyses were proposed by Yildiz & Karakulak (2017, 2018).

The selectivity of the commercial bottom trawl fishery between the target and non-target fish species is notoriously poor, which results in massive bycatch and discards (Hopkins 2015). Discards increase the mortality caused by fishery and constitute an important part of the total mortality exerted on the resources (ICES 2003).

Of the 431,557 t production of fisheries in Turkey in 2019, 80.3 % was from the Black Sea (TÜIK 2020). Seine nets and midwater trawls (targeting anchovies, sprat, mackerel and bonito) are handled to attain a massive part of this yield. However, the share of bottom trawling also comprises important part of the yield (Ceylan et al. 2014). The total trawl fishing fleet on the Black Sea coast of Turkey comprised of 486 fishing vessels (Kaykaç et al. 2014). Current legislation in Turkey concerning the trawl codend defines 40 mm as the minimum mesh size in the Black Sea. Al-

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though Turkish trawl fleets conduct multi-species fishing, statistical data on the bottom trawl fishery, bycatch and discard rates in these regions are scarce. Unfortunately, no target studies have been conducted in order to reduce bycatch by the Black Sea fishery. In addition, there are no investigations aiming to estimate the economical dimensions of bycatch and discards.

The aim of the present study was to determine the target, bycatch and discard rate of traditional bottom trawls used in south-eastern Black Sea. This study is important for further studies in order to propose a reference point for further comparison in this region.

## Materials and Methods

Samplings were performed on commercial fishing boats along the south-eastern coasts of the central Black Sea during the 2016–2017 fishing season. During the 8-month research period, fishing operations were done on roughly 74 days. Totally, 217 bottom trawl operations were performed (Table 1) in 40–80 m depths in the area between Ünye (Ordu) and Terme (Samsun) (37˚13'028.25'' E, 41˚13'11.43'' N). Bottom trawls with rhomboid shape and 40 mm mesh size were used.

The study was conducted by four commercial trawl boats with different capacities (engine power and tonnage). The lengths and engine power of the vessels were 18.50 m and 420 HP, 19.80 m and 450 HP, 23 m and 450 HP, and 26.80 m and 700 HP. The tow duration was 2 h, and the tow speed ranged 2.2–2.8 knots. Following the selection of the commercial species, the catch composition was determined. Target catch, bycatch and discard rate were calculated according to the following formulas (Matsuoka 1999, Sparre & Venema 1998):

$Rh=Dh/C$,

where Rh is the target catch rate, Dh is the target catch amount (g) and C is the total catch (g),

$R_1=D_1/C$,

where $R_1$ is the discard catch rate, $D_1$ is discard catch amount (g) and C is the total catch (g).

The calculation was standardised by taking into account the time between trawl net was released and the codend was decked (Ricker 1975, King 1995). Catch per Unit Effort (CPUE) was calculated for targeted catch using formula CPUE=C/T/N, where C is quantity of catch in each operation (kg), T is active operation time (hour) and N is the operation number.

Mean and standard error calculations were made and graphics were prepared using Microsoft Office Excel.

## Results

During the samplings, 14 species were caught. Only two species, *M. merlangus* and *M. barbatus*, were targeted; these were also the species caught in greatest abundance. Eight species were identified as discards. The total biomass was 28039.86 kg, of which 77 % (21593.20 kg) were identified as the target and 23 % (6446.66 kg) as bycatch; weighted discard rate was 15.12 % (Table 2).

The rate of discard within bycatch was determined as 65.80 %, of which 66.13 % was constituted by *M. merlangus* below commercial size. The most abundant target, incidental catch and discard species caught was *M. merlangus*. Catch compositions and bycatch components are shown in Fig. 1. Monthly amounts and rates of target, incidental and discarded species encountered throughout the research are given in Table 3. Based on monthly catch percentages of whiting, the highest rate was in September 2016 with 24.28% and the lowest rate was in February 2017 with 3.18% (Fig. 2). Based on monthly catch percentages of red mullet (the second most frequently caught species), the highest rate was in February 2016 with 32.2% and the lowest rate was in September 2016 with 0.03% (Fig. 3).

Operational information and CPUE values on whiting and red mullet on research sampling dates are given in Tables 4 and 5. Whiting was caught in all operations, while red mullet was caught in 69 operations. Monthly CPUE values for whiting and red mullet are shown in Figs. 4 and 5.

## Discussion

A great majority of fish species with commercial value are shared in the exclusive economic zones of the countries adjacent to the Black Sea (STECF 2011, 2012, Nicolaev & Radu 2008). For this reason, the Black Sea has an important impact on the economy of neighbouring countries (Eremeev & Zuyev 2007, Radu et al. 2013). Management measures to decrease discard include input controls (regulations aiming to control the amount of total fishing by limiting the time spent for fishing, the amount of fishing tools used and the number and sizes of vessels) as well as output controls (Pope 2002, Condie 2013).

In this study, an amount of 28039.86 kg fish was caught, which included 21593.20 kg (77 %) of target species and 2204.86 kg (7.86 %) of incidental catch; however, an amount of 4241.80 kg (15.12 %) was discarded. Total bycatch (incidental catch plus discarded catch) was found to be 6446.66 kg (23 %).

**Table 1.** Summary of monthly catching operations

| Months | Number of days in operation | Fishing operations number | Depth (m) | Distance to shore (km) | Tow duration (h) |
|---|---|---|---|---|---|
| February 2016 | 14 | 29 | 76-110 | 9-22 | 2 |
| March 2016 | 10 | 19 | 82-110 | 9-18 | 2 |
| September 2016 | 15 | 45 | 91-100 | 9 | 2 |
| October 2016 | 11 | 37 | 72-100 | 7-10 | 2 |
| February 2017 | 3 | 12 | 82-110 | 8-22 | 2 |
| March 2017 | 8 | 32 | 82-110 | 14 | 2 |
| April 2017 | 4 | 16 | 82-127 | 14-32 | 2 |
| September 2017 | 9 | 27 | 91-100 | 9 | 2 |

**Table 2.** Total biomass of species caught in samplings

| | | Species | Kg | % |
|---|---|---|---|---|
| **Targets Red mullet *Mullus barbatus* Linnaeus, 1758** | | **Whiting *Merlangius merlangus* (Linnaeus, 1758)** | **20570.88** | **73.36** |
| | | **1022.32** | **3.65** | |
| Bycatch | Incidental catch | Pontic shad *Alosa immaculata* Bennett, 1835 | 993.70 | 3.54 |
| | | Black goby *Gobius niger* Linnaeus, 1758 | 992.00 | 3.54 |
| | | Turbot *Scophthalmus maximus* (Linnaeus, 1758) | 173.96 | 0.62 |
| | | Bluefish *Pomatomus saltatrix* (Linnaeus, 1766) | 19.00 | 0.07 |
| | | Horse mackerel *Trachurus trachurus* (Linnaeus, 1758) | 17.00 | 0.06 |
| | | Picarel *Spicara smaris* (Linnaeus, 1758) | 5.30 | 0.02 |
| | | Black scorpionfish *Scorpaena porcus* Linnaeus, 1758 | 3.90 | 0.01 |
| | Discard | Whiting *Merlangius merlangus* (Linnaeus, 1758) | 2805.12 | 10.00 |
| | | Red mullet *Mullus barbatus* Linnaeus, 1758 | 139.32 | 0.50 |
| | | Turbot *Scophthalmus maximus* (Linnaeus, 1758) | 22.06 | 0.08 |
| | | Thornback ray *Raja clavata* Linnaeus, 1758 | 1087.00 | 3.88 |
| | | Flounder *Platichthys flesus* (Linnaeus, 1758) | 154.60 | 0.55 |
| | | Spiny dogfish *Squalus acanthias* Linnaeus, 1758 | 9.00 | 0.03 |
| | | Sand sole *Pegusa lascaris* (Risso, 1810) | 3.70 | 0.01 |
| | | Greater weever *Trachinus draco* Linnaeus, 1758 | 21.00 | 0.07 |
| TOTAL | | | 28039.86 | 100 |

**Table 3.** Monthly amounts and rates of target, incidental and discarded species in total catch

| Months | Target | | Incidental Catch | | Discard | |
|---|---|---|---|---|---|---|
| | kg | % | kg | % | kg | % |
| February 2016 | 4190 | 14.94 | 633.5 | 2.26 | 368 | 1.31 |
| March 2016 | 1989 | 7.09 | 505.2 | 1.8 | 925.7 | 3.3 |
| September 2016 | 4654 | 16.6 | 189.9 | 0.68 | 1315 | 4.69 |
| October 2016 | 3387 | 12.08 | 191 | 0.68 | 359.4 | 1.28 |
| February 2017 | 709 | 2.53 | 493 | 1.76 | 206.6 | 0.74 |
| March 2017 | 2203 | 7.86 | 21.8 | 0.08 | 455.8 | 1.63 |
| April 2017 | 1521.7 | 5.43 | 91.3 | 0.33 | 266.9 | 0.95 |
| September 2017 | 2939.5 | 10.48 | 79.2 | 0.28 | 344.8 | 1.23 |

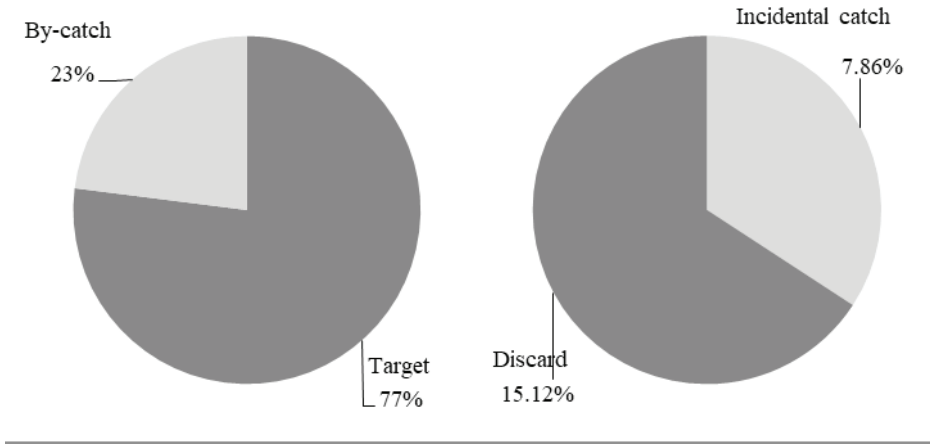


**Fig. 1.** Overall catch composition of the trawl.

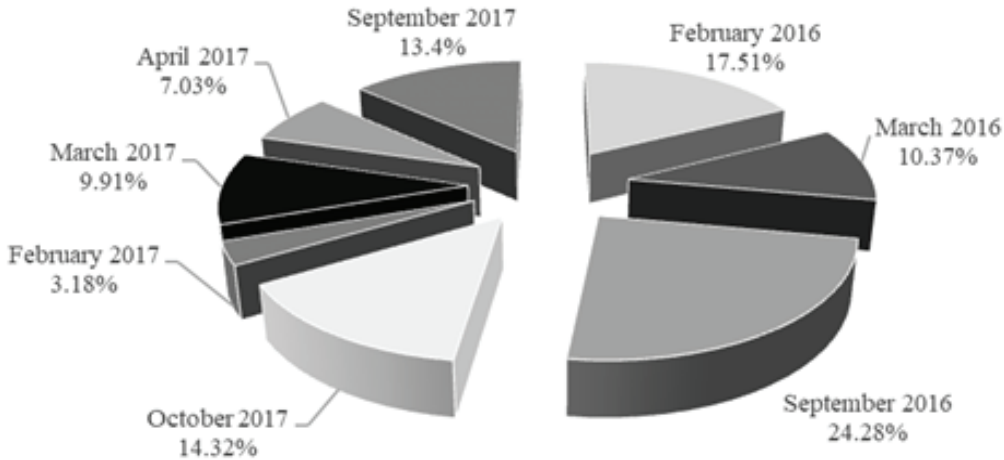


**Fig. 2.** Monthly catch composition of whiting (%).

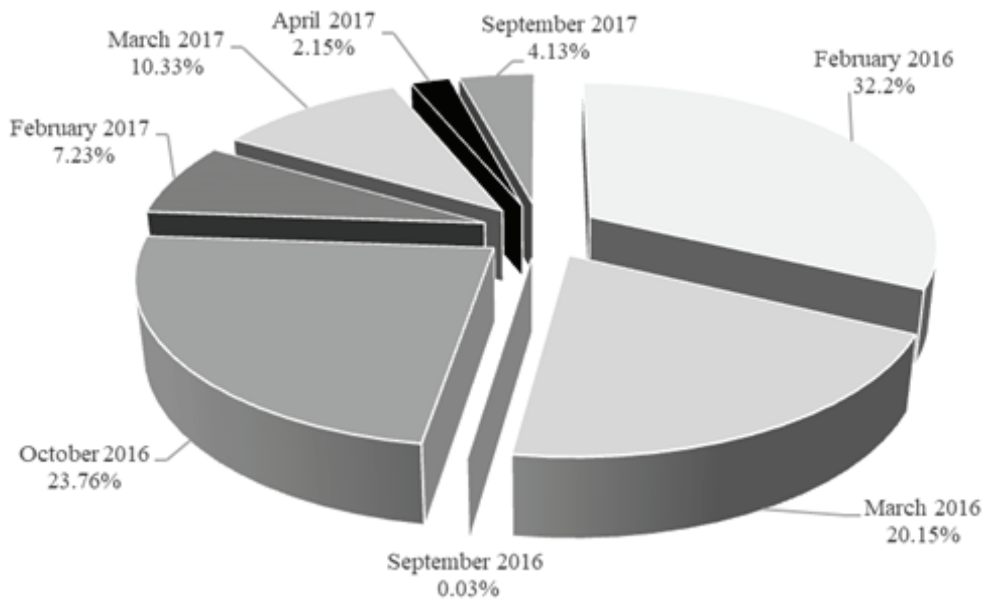


**Fig. 3.** Monthly catch composition of red mullet (%).

**Table 4.** Monthly operational information for whiting and red mullet (Mean ± SE)

| | February 2016 | March 2016 | September 2016 | October 2016 | February 2017 | March 2017 | April 2017 | September 2017 |
|---|---|---|---|---|---|---|---|---|
| Operation number | 29 | 19 | 45 | 37 | 12 | 32 | 16 | 27 |
| Active operation time (hour) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Mean catch amount (kg) | 141.1±30.90 | 127.58±40.17 | 126.13±5.26 | 90.49±6.15 | 62±7.07 | 72.38±4.62 | 102.75±5.48 | 116±8.04 |
| CPUE (kg/h/op. h.) | 69.36 | 63.79 | 65.07 | 45.24 | 31 | 36.19 | 51.38 | 58 |

**Table 5.** Monthly operational information for red mullet (Mean ± SE)

| | February 2016 | March 2016 | September 2016 | October 2016 | February 20117 | March 2017 | April 2017 | September 2017 |
|---|---|---|---|---|---|---|---|---|
| Operation number | 21 | 10 | 6 | 6 | 6 | 10 | 8 | 2 |
| Active operation time (hour) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Mean catch amount (kg) | 17.81±3.02 | 23.4±3.84 | 0.05±0.008 | 46±7.21 | 14±2.00 | 12±0.00 | 3.13±1.94 | 24±0.00 |
| CPUE (kg/h/op. h.) | 8.75 | 11.70 | 0.03 | 23.00 | 7.00 | 6.00 | 1.56 | 12.00 |

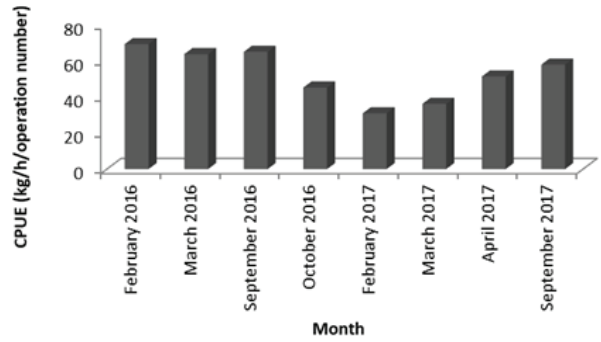


**Fig. 4.** Monthly CPUE values of whiting

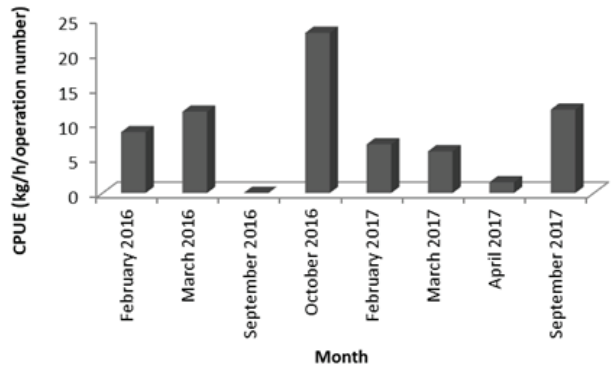


**Fig. 5.** Monthly CPUE values of red mullet

Kelleher (2005) estimated the rate of the bycatch for the Mediterranean Sea and the Black Sea to be 45-50 %. Similarly, Malal (2006) recorded bycatch of 56 % for the Mediterranean. Soykan (2011) measured a bycatch of 38 % for the Aegean Sea. For the Black Sea, Ceylan (2011) and Kasapoğlu (2013) calculated bycatch of 42 % and 62 %, respectively. Therefore, the bycatch and discard amounts for bottom trawl, shrimp trawl, beam trawl, etc., found in studies in the Mediterranean – Black Sea basin mostly vary between 40 % and 60 %. In the present study from the Black Sea, which is characterised with lower species diversity than the Mediterranean, the bycatch rate was determined as 23 %. Among the possible reasons for the lower bycatch rate in the Black Sea than in the other mentioned studies, in addition to the lower species diversity, we can mention the high stock of the target species in the fishing area.

Özdemir et al. (2006) conducted a study in the central Black Sea coast of Turkey using bottom trawls and concluded that the marketed catch was 64 % and the remaining 36 % were discarded. From the Samsun area, Zengin et al. (2017) reported that a commercial bottom-fishing trawler was in the sea between 12 and 14 hours a day and each operation lasted for about 1.5 hours. Yildiz & Karakulak (2018)

observed that the time spent on each haul in bottom trawling in Western Black Sea lasted up to 2.5 hours. Ceylan et al. (2014) recorded that bottom-trawling operations differed between 45 min. and 2 hours. In our study, the average haul time was c. 2 hours.

According to Ceylan (2011), the bottom trawl operations targeting whiting, the mean CPUE value was 69.13±76.851 kg/s; when targeting red mullet, the mean CPUE was 3.903±2.188 kg/s. In the study by Kasaopoğlu (2013), the highest and lowest CPUE values for whiting and red mullet were from Samsun (107.3 kg/s) and Sinop (43.13 kg/s), respectively, among the samples acquired from various Black Sea areas. In present study, whiting CPUE value was found to be the highest (69.36 kg/s) in 2016 and the lowest (31 kg/s) in February 2017. The highest CPUE value for red mullet was in October 2016 (23.00 kg/s).

The main conclusions of the present study are that the targeted fishery in the area is efficiently implemented and the low species diversity in the Black Sea may lead to a high share of the targeted catch of whiting.

Since there is no regional fishing management organization in Black Sea, there is no common fishing management of commonly shared and migrating species; each country in the region organises its own fishing management (Radu et al. 2013). Bottom trawling is not a common fishing method in the Black Sea countries except Turkey (Yildiz & Karakulak 2018). For this reason, with the goal of decreasing discard fishing and protection of the benthic ecosystems from the bottom trawling, it will necessary national management authorities to apply the necessary precaution measures.

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