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The catch amount of Mediterranean horse mackerel *Trachurus mediterraneus* (Steindachner, 1868) gillnets in the Sea of Marmara

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Abstract

The small-scale fishermen in the coastal area of the Marmara Sea between April and June caught the Mediterranean horse mackerel Trachurus mediterraneus (Steindachner, 1868) with gillnets. This target species, T.mediterraneus and significant amounts of non-target species are caught in these nets. So, the technical and structural characteristics of the gillnets for a commercial fishermen were determined and the target and non-target species were evaluated in catching operations. The multifilament gillnet mesh size of 18 milimeters polyamid, twine thickness of 210d/2, hanging ratio of 0.33 and the total length of approximately 200 meters. Also, guarding nets were added to gillnets. The total amount was determined as 397.8 kilograms (kg) and 9204 individuals (ind). The weight of T.mediterraneus was constituted 39.3% of the total weight. The in of T.mediterraneus was constituted 43.4% of the total ind. While the catch per unit effort (CPUE) for T.mediterraneus was calculated at 0.026 kg/m.operation^{-1} and 0.7 ind/m.operation^{-1}, the CPUE for the total amount was calculated at 0.066 kg/m.operation^{-1} and 1.5 ind/m.operation^{-1}. The total economic value was calculated at 15814.4 Turkish Liras (TL), which 9390 TL from T.mediterraneus and 6424.4 TL from non-target species. This study is important in terms of revealing for the first time the catch efficiency of gillnets used by commercial fishermen to catch T.mediterraneus in the coastal area of the Marmara Sea, which is an important fishing area. These results will contribute to the creation of management plans and fisheries management for species-specific fishing gear used in a region.

Keywords: *Coastal area, target species, non-target species, fisheries management, economic value*

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Marmara Denizi'nde sarıkuyruk istavrit Trachurus mediterraneus (Steindachner, 1868) uzatma ağlarının av miktarı

Öz

Marmara Denizi'nde Nisan ve Haziran ayları arasında, kıyısal alanda küçük ölçekli balıkçılar uzatma ağları ile sarıkuyruk istavrit Trachurus mediterraneus (Steindachner, 1868) avcılığı gerçekleştirmektedir. Bu avcılıkta hedef türün istavritin yanında, önemli miktarlarda hedefdışı türlerde avlanmaktadır. Bunun için Marmara Denizi'nde ticari bir balıkçının istavrit avcılığında kullandığı uzatma ağlarının teknik özellikleri belirlenerek, avcılık operasyonlarında yakalanan hedef ve hedefdışı türler değerlendirilmiştir. Çalışmada kullanılan multifilament uzatma ağının göz genişliği 18 mm, ip kalınlığı 210d/2, donam faktörü 0,33 ve ağın toplam uzunluğu ise yaklaşık 200 metre olarak belirlenmiştir. Ayrıca, uzatma ağlarının alt kısmına sardon ağı ilave edildiği belirlenmiştir. Avcılık operasyonlarında yakalanan hedef ve hedefdışı türlere ait toplam av miktarının 397,8 kg ve 9204 adet olduğu belirlenmiştir. Hedef tür T.mediterraneus'un ağırlık olarak toplam avın %39,3'unu oluşturduğu belirlenmiştir. Birey sayısı olarak ise T.mediterraneus, toplam avın %43,4'ünü oluşturmaktadır. Birim çabaya düşen av miktarı (CPUE) T.mediterraneus için ağırlık olarak 0,026 kg/m.operasyon^{-1}, adet olarak ise 0,7 adet/m.operasyon^{-1} hesaplanmıştır. Toplam avda ise ağırlık olarak 0,066 kg/m.operasyon^{-1}, birey sayısı olarak 1,5 adet/m.operasyon^{-1} hesaplanmıştır. Uzatma ağları ile T. mediterraneus hedeflenen bu avcılıkta hedef türden 9390 TL, hedefdışı ticari olarak değerlendirilebilen türlerden ise 6424,4 TL olmak üzere toplam 15814,4 TL kazanç sağlanabileceği hesaplanmıştır. Bu çalışma önemli bir balıkçılık alanı olan Marmara Denizi'nin kıyısal alanında ticari balıkçıların T. mediterraneus türünü avlamak için kullandıkları uzatma ağlarının av veriminin ilk kez ortaya konması bakımından önem taşımaktadır. Bu sonuçların türe özgü kullanılan av araçlarının yönetim planlarının oluşturmasına ve balıkçılık yönetimine katkı sağlayacağı düşünülmektedir.

Anahtar kelimeler: *Kıyısal alan, hedef tür, hedef dışı tür, balıkçılık yönetimi, ekonomik değer*

1. Introduction

The total catch consists of the target species and non-target species in a fishing operation. The target species is the species targeted to be caught with the fishing gear. The non-target species consist of "incidental caught species" that are commercial importance and caught completely by accident, "discard species" that are not commercial importance or uneconomic sizes of the target species [1]. It has been reported that catching non-target species is a serious problem in fisheries around the world [2]. Also, approximately 10 million tons of unwanted fishing products are not evaluated and thrown into the sea annually [3]. The non-target species include species that do not have commercial value such as sea mammals, seabirds, small fish that have not reached their first maturity size and some batoid fish species. It has been reported that discard species account for an average of 230 thousand tons per year or 18.6% of the total catch in the Mediterranean [4]. Also, almost all fishing gear catches non-target fish species [5]. Although some studies have shown that discard is a problem in Türkiye fisheries [6-8], the target and discard amounts of species-specific fishing gear are found to be inadequate studies. It is

reported that the gillnets from fishing gear have high impacts on the ecosystem [9]. Therefore, the characteristics and the catch efficiency of the gillnet used to catch *Trachurus mediterraneus* (Steindachner, 1868) must be defined.

The horse mackerel species (*Trachurus* sp.) are the food of many predatory species, so they have a very important role in ecological balance [10]. Some of the *T.mediterraneus* migrate to feed depending on the water temperature from the Aegean Sea to Marmara and from the Marmara Sea to the Black Sea in mid or late April [11, 12]. At the same time, the fishing ban for *T.mediterraneus* on purse seine fishing begins on April 15 in the Marmara Sea. So, small-scale fishermen increase economic gain by effectively using gillnets to catch *T.mediterraneus* in the coastal area with the passive fixed method after April 15. However, Doyuk [13] and Emirbuyuran and Çalık [14] emphasized that the fishing gear characteristics used effectively to catch one species should be identified in a region. The catch efficiency as an index of abundance is based on a fundamental relationship widely used and easily collected in quantitative fisheries analysis. So, the issue of the gillnet characteristics has used by commercial fishermen to catch *T.mediterraneus* in the coastal area of the Marmara Sea were described and their catching efficiency was investigated for the first time.

2. Material and methods

The current study was carried out between 8 May 2023 and 30 Jun 2023 with commercial fisherman in the Kemer Region in the south of the Marmara Sea (Figure 1). This smale scale commercial fishing boat was used in the catching operations with a length of 7.6 meters (m) and engine power of 85 HP located in the Kemer fishing port.

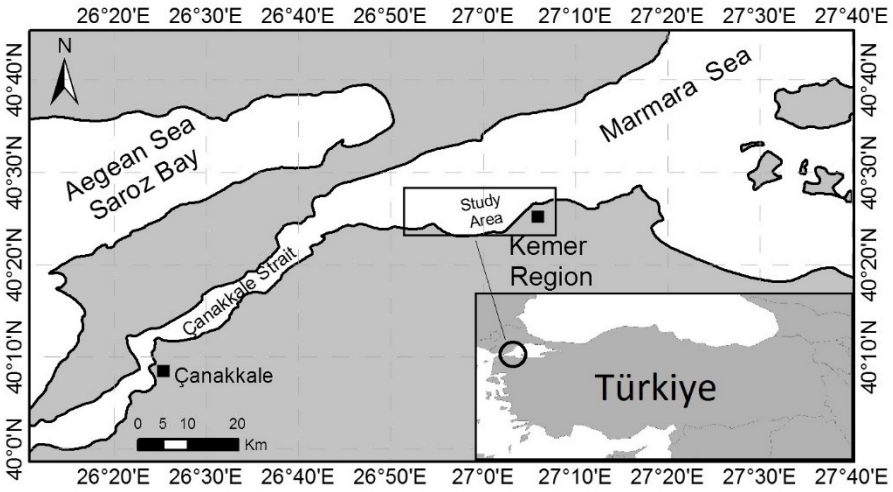

Figure 1. Study area

A total of 30 catching operations were utilized using the gillnets with the passive fixed method and these operations were in the coastal area of maximum 10 meters depth. The gillnets were set in the sea in the evening and collected them from the sea after 2 hours. The technical and structural characteristics of the gillnets were determined by measurement, and their technical plans were drawn to scale according to FAO standards with the use of the MS Visio 10.0 program [15-17].

After fishing operations, the target and non-target species have been removed from the gillnets. The catch composition of species were determined according to Bilecenoğlu et al. [18], Whitehead et al. [19] and Worms [20]. In each operation, the total number of target and non-target species was recorded in individuals (ind) and their weight were recorded with a digital scale in grams (gr). In this study, *T.mediterraneus* was considered as target species, and all other species were considered as non-target species. The non-target species are evaluated as commercial species and discard species depending on they have whether commercial value or not. All evaluations were made in the Microsoft Excel computer program.

To assess the catching efficiency, the catch per unit effort (CPUE) was calculated from the following equation:

$$CPUE = \Sigma \left(\frac{Y}{L}\right)/n \quad (1)$$

(Y: The weight (kg) or individuals (ind) of species in one operation, L: The length of nets (200 m), n: The number of operation (30 operations) [21, 22]. The CPUE value of the total and subtotal target and non-target species is calculated as kg/m.operation^{-1} and ind/m.operation^{-1}.

The economic evaluations were made for the unit price of target species and non-target species that can be evaluated commercially by commercial fishermen. In line with the interviews with fish middlemen, the unit price of the target species *T.mediterraneus* was determined to be 60 Turkish Liras (TL). The unit prices of commercial non-target species were evaluated *Boops boops* 35 TL*, Scomber scombrus* and *Scomber japonicus* 70 TL, *Alosa immaculata* and *Spicara sp.* 10 TL, *Mullus surmuletus* 200 TL. The discard non-target species were not evaluated commercially in line with the interviews conducted with commercial fishermen and fish middlemen. The discard non-target species individuals were determined to be quite small sizes and target of only *T.mediterraneus* in gillnets. The economic value was calculated from the following equation:

$$Economic\ value\ = Amount\ (kg)\ x\ Unit\ price\ of\ species\ (TL) \quad (2)$$

3. Results

In this study, the *T.mediterraneus* gillnet was identified multifilament with mesh sizes (bar length) of 18 mm, twine thickness of 210d/4 polyamide (PA) and orange mesh color. Also, this net has floating material plastic with 2 numbers and sinker material lead with 50 grams. The total length was approximately 200 meters and 200 meshes in height (6.76 m). The hanging ratio of gillnet was E=0.33. In addition, it was determined that a guarding net was added on the sinker part of this gillnet. This net 18 mm mesh size (bar length), black color, 10 meshes (0.34 m) in height and twine thickness of 210d/6 PA. Other technical characteristics of the *T.mediterraneus* gillnet net are shown in Figure 2.

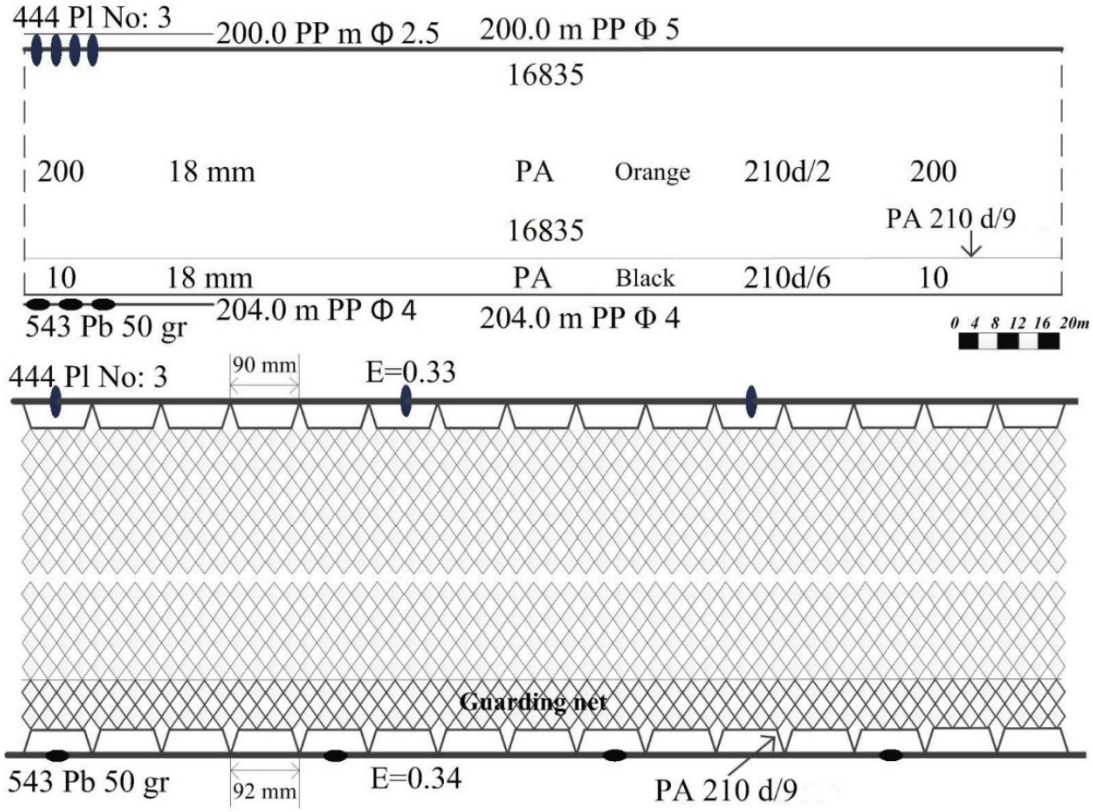

Figure 2. Technical plan and structural characteristics of gillnet

A total of 397.8 kg and 9204 ind belonging to target and non-target species were caught in the fishing operations. While the catch per unit effort (CPUE) for *T.mediterraneus* was calculated at 0.026 kg/m.operation^{-1} and 0.7 ind/m.operation^{-1}, the CPUE for the total amount was calculated at 0.066 kg/m.operation^{-1} and 1.5 ind/m.operation^{-1}. The highest CPUE (kg and ind) of commercial non-target species was detected for *Spicara* sp.. The highest CPUE (kg and ind) of discard non-target species *S. porcus* was determined.

The highest economic value of commercial non-target species was detected for *S.japonicus*. The amount, CPUE and economic value of target and non-target species are shown in Table 1.

Table 1. Amount, CPUE and economic value of caught species

Species	Amount				CPUE				Ecomomic value	
	kg	%	Ind	%	kg	%	Ind	%	TL	%
Target										
Trachurus mediterraneus	156.5	39.3	3997	43.4	0.026	39.3	0.7	43.4	9390	59.4
Subtotal	156.5	39.3	3997	43.4	0.026	39.3	0.7	43.4	9390	59.4
Non-target (Commercial)										
Alosa immaculata	43.9	11.0	833	9.1	0.007	11.0	0.14	9.1	439	2.8
Boops boops	58	14.6	1115	12.1	0.010	14.6	0.2	12.1	2030	12.8
Spicara sp.	68.5	17.2	2298	25.0	0.011	17.2	0.4	25.0	685	4.3
Scomber scombrus	0.52	0.1	2	0.02	0.000	0.1	0.0	0.0	36.4	0.2
Scomber japonicus	43	10.8	245	2.7	0.007	10.8	0.0	2.7	3010	19.0
Mullus surmuletus	1.12	0.3	23	0.2	0.000	0.3	0.0	0.2	224	1.4
Subtotal	215	54.1	4516	49.1	0.036	54.1	0.75	49.1	6424.4	40.6
Non-target (Discard)										
Belone belone	0.43	0.1	2	0.0	0.000	0.1	0.0	0.0	-	-
Merlangius merlangus	0.25	0.1	8	0.1	0.000	0.1	0.0	0.1	-	-
Pomatomus saltatrix	1.27	0.3	14	0.2	0.000	0.3	0.0	0.2	-	-
Chelidonichthys lucerna	0.06	0.0	2	0.0	0.000	0.0	0.0	0.0	-	-
Chromis chromis	0.01	0.0	4	0.0	0.000	0.0	0.0	0.0	-	-
Diplodus annularis	1.19	0.3	33	0.4	0.000	0.3	0.0	0.4	-	-
Diplodus vulgaris	0.15	0.0	4	0.0	0.000	0.0	0.0	0.0	-	-
Engraulis encrasicolus	0.17	0.0	16	0.2	0.000	0.0	0.0	0.2	-	-
Gaidropsarus mediterraneus	0.27	0.1	6	0.1	0.000	0.1	0.0	0.1	-	-
Gaidropsarus vulgaris	0.06	0.0	1	0.0	0.000	0.0	0.0	0.0	-	-
Gobius niger	0.14	0.0	3	0.0	0.000	0.0	0.0	0.0	-	-
Lithognathus mormyrus	0.09	0.0	3	0.0	0.000	0.0	0.0	0.0	-	-
Merluccius merluccius	0.03	0.0	1	0.0	0.000	0.0	0.0	0.0	-	-
Monochirus hispidus	0.03	0.0	2	0.0	0.000	0.0	0.0	0.0	-	-
Ophidion barbatum	1.15	0.3	22	0.2	0.000	0.3	0.0	0.2	-	-
Pagellus acerna	0.12	0.0	3	0.0	0.000	0.0	0.0	0.0	-	-
Pagellus erythrinus	2.14	0.5	43	0.5	0.000	0.5	0.0	0.5	-	-
Scorpaena porcus	7.81	2.0	248	2.7	0.001	2.0	0.0	2.7	-	-
Serranus scriba	4.65	1.2	107	1.2	0.001	1.2	0.0	1.2	-	-
Symphodus sp.	2.69	0.7	99	1.1	0.000	0.7	0.0	1.1	-	-
Symphodus mediterraneus	2.75	0.7	63	0.7	0.000	0.7	0.0	0.7	-	-
Trachinus draco	0.82	0.2	7	0.1	0.000	0.2	0.0	0.1	-	-
Subtotal	26.3	6.6	691	7.5	0.004	6.6	0.12	7.5	0	0
Total	397.8	100.0	9204	100.0	0.066	100.0	1.5	100.0	15814.4	100.0

The target species *T.mediterraneus* was caught with the weight of 156.5 kg. This amount constitutes 39.3% all total weight. Apart from the target species *T.mediterraneus*, a total of 241.3 kg (60.7%) of non-target species, which are non-target species of commercial and discard. Among these commercial non-target species of *A.immaculata* accounts for 43.9 kg (11.0%), *B.boops* for 58 kg (14.6%), *Spicara* sp. for 68.5 kg (17.2%), *S.scombrus* for 0.52 kg (0.1%), *S.japonicus* for 43 kg (10.8%), and *M.surmuletus* for 1.12 kg (0.3%).

However, a total of 26.3 kg (6.6%) from the discard non-target species were determined (Figure 3; Table 1).

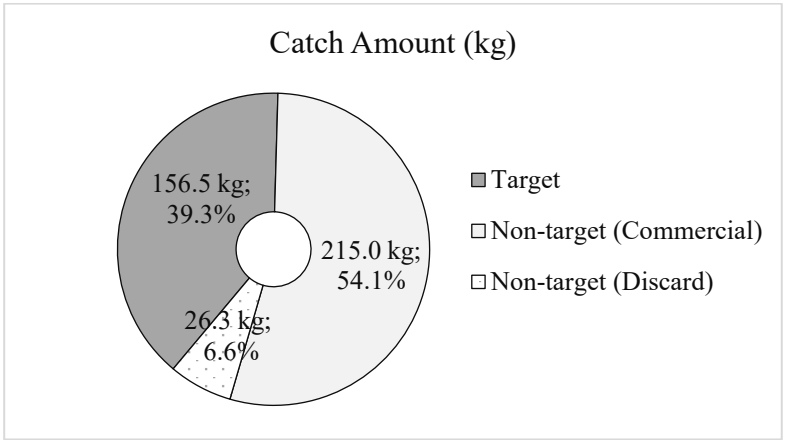

Figure 3. Total weight of target and non-target species

A total of 3997 individuals of the target species *T.mediterraneus* were caught. This amount constitutes 43.4% of all individuals. Apart from the target species *T.mediterraneus*, a total of 5207 individuals (56.6%) of non-target species, which are non-target species of commercial and discard. Among these commercial non-target species of 833 ind (9.1%), 1115 ind (12.1%), 2298 ind (17.2%), 2 ind (0.02%), 245 ind (2.7%) and 23 ind (0.3%) from *A.immaculata*, *B.boops*, *Spicara* sp., *S.scombrus*, *S.japonicus* and *M.surmuletus*, respectively. From the discard non-target species, a total of 691 ind (7.5%) were of determined (Figure 4; Table 1).

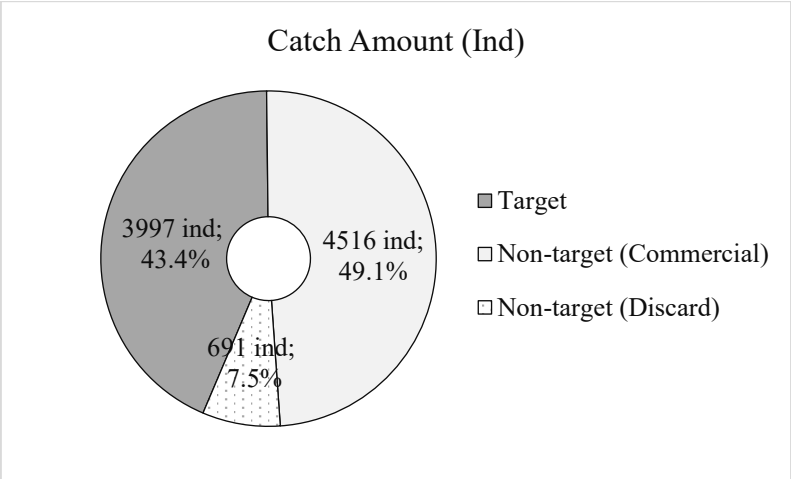

Figure 4. Total individuals of target and non-target species

The total economic value was calculated at 15814.4 TL. The economic value from the caught target species *T.mediterraneu*s has been calculated at 9390 TL. This amount constitutes 59.4% of all economic value. Apart from the target species *T.mediterraneus*, it has been estimated that an economic value of 6424.4 TL (40.6%) can be generated from non-target species. Among these commercial non-target species, it is estimated that can be gained from *A.immaculata* of 439 TL (2.8%), *B.boops* of 2030 TL (12.8%), *Spicara*

sp. of 685 TL (4.3%), *S.scombrus* of 36.4 TL (0.2%), *S.japonicus* of 3010 TL (19%) and *M.surmuletus* of 224 TL (1.4%) (Figure 5; Table 1).

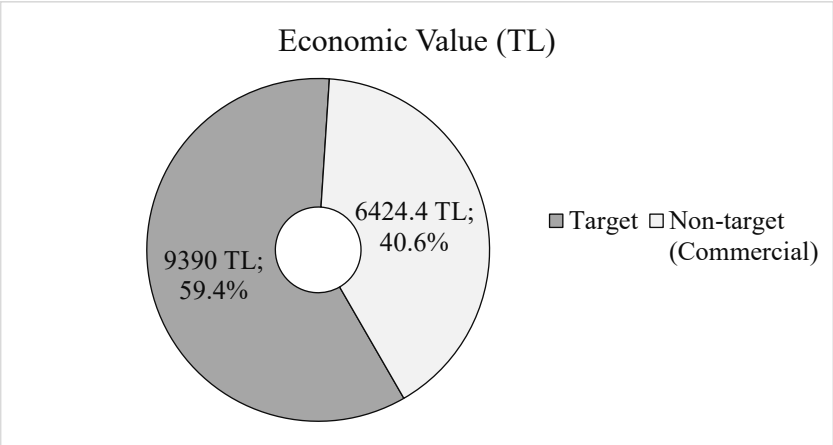

Figure 5. Economic value of target and non-target species

4. Discussion

In this study, firstly the technical characteristics of the gillnets used to catch *T.mediterraneus* in the coastal area of the Marmara Sea was determined. It is seen that commercial fishermen tend to add guarding net in gillnets. This result may be explained by reducing non-target species and preventing unwanted discard species such as Crustacea and Mollusca species from damaging the gillnet. As a matter of fact, all caught non-target individuals consist of teleost fish and were not catch discard of Crustacea, Mollusca species in this study. Previous studies have shown that using guarding net decreases the discard rate [23, 24]. The twine thickness of the guarding net was 2010d/6, whereas the twine thickness of the gillnet was 2010d/2 in this study. Previous studies have shown that twine thickness affects catching efficiency and catch rates [25-27]. However, studies needed to explain comparing gillnet with guarding net and without guarding net twine thickness in detail.

The technical and structural characteristics of gillnets may vary in different areas. Özdemir and Erdem [28] caught 1391 individuals belonging to 13 species at depth of 15 to 50 meters with monofilament and multifilament nets with 18 mm mesh size monofilament and multifilament gillnets and trammel nets in Sinop, Black Sea. They reported that 41.19% of the individuals in multifilament net and 92.67% of the economic value in multifilament net. They stated that *Trachurus trachurus*, *Mullus barbatus ponticus*, *Merlangius merlangus euxinus* species were targeted in their study. In our study, only *T.mediterraneus* was targeted in the coastal area. It is thought that the area where gillnets are used, depth and mesh height are effective in the number of caught individuals and species diversity. Yıldız and Karakulak [29] reported that *Trachurus* sp. gillnet on the coast of Istanbul was the twine thickness of 210d/2-3, the mesh sizes of 17-18 mm, the mesh height of 50-100 and the hanging ratio of 0.68. At the same time, they also stated that *Trachurus* sp. gillnet was used at depth of 3-30 meters, that is, in the coastal area and deep sea. Akyol and Perçin [30] determined the mesh sizes as 16-17 mm, the mesh height as 100-300 and the twine thickness as 210d/3-4 of *Trachurus* sp. gillnet used in May-July on the coast of Tekirdağ. Erdem et al. [31] stated that the mesh

size was 18 mm, the twine thickness was 210d/1, the mesh height was 50-70-100 for *Trachurus* sp. gillnet in the Central Black Sea. Although the same species are targeted, it can be seen that there may be differences in the design of fishing gear depending on the knowledge and experience of the fishermen, environmental conditions and region conditions. Because catching operations carried out in the coastal area and in short time in this study.

In this study, the discard non-target species such as Crustacea and Mollusca were not caught. This situation is thought to be related to the soaking time of the gillnet. The gillnet was soaking time only 2 hours. Dickson [32] and Engas [33] reported that increasing the soaking time of the gillnets would indirectly increase their impact on the ecosystem. While targeting a species in fisheries, it is of course not possible to completely prevent the catch of non-target species. In the study, 29 non-target teleost fish species were caught, while the targeted *T.mediterraneus* was caught. The non-target species were constituted 60.7% of the total weight and 56.6% of the total individuals. Within this amount, it was determined that the commercial non-target species that were present constituted 54.1% of the weight and 49.1% of the individuals. In other words, the discard of non-target species is only 6.6% of the weight and 7.5% of the individuals. In addition to, the high individual and weight of commercial non-target species is a positive result in terms of economic value. As a matter of fact, 40.6% of the total economic value was obtained from commercial non-target species. However, no data on the length distribution of these individuals was presented in the study. In this case, there is a need to investigate the length distribution of the individuals caught. Because catching individuals above the legal catch length and first reproductive length of the species in the gillnets used will contribute to the preservation of stocks. The number of individuals and their length may vary depending on the body shape and length distribution of the species caught in the nets [34, 35]. The species are caught snagged, gilled, wedged in gill nets [36]. In this case, the technical and structural characteristics of fishing gear should be planned according to the biological and morphological features of the target species.

As a result, the technical and structural characteristics of the gillnet used in *T.mediterraneus* target were defined and the target and non-target catch efficiency of these nets were investigated for the first time. There is a need for further studies to reveal how changes in catch efficiency of target and non-target species by making changes these net characteristics. For the sustainability of *T.mediterraneus* stocks, it is necessary to determine the behavior of other species sharing the same environment as the target species and to plan the fishing gear. It is thought that these results further support to the creation of management plans and fisheries management for species-specific fishing gears used in a region.

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