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Hakan Aksu, Yakup Erdem, Süleyman Özdemir

THE EFFECTS ON TARGET CATCH, BYCATCH AND DISCARD OF USING MULTIFILAMENT AND MONOFILAMENT SARDON ON THE TRAMMEL NETS IN THE BLACK SEA SMALL SCALE FISHERIES

***Hakan AKSU[1], Yakup ERDEM[2], Süleyman ÖZDEMİR[2]**

[1]Vocational School, Fisheries Department, Sinop University, Sinop - Türkiye

[2] Fishing Technology Department of Fisheries Faculty, Sinop University, Sinop – Türkiye

*Correspondence: Dr. Hakan AKSU, Meslek Yüksekokulu, Su Ürünleri Bölümü, Sinop Üniversitesi, Merkez 57000 Sinop, Turkey Phone: +90 368 271 57 38, e-mail: (HA) haksu@sinop.edu.tr, (YE) yerdem@sinop.edu.tr, (SÖ) sozdemir@sinop.edu.tr. ORCID: (HA) 0000-0002-3712-8564, (YE) 0000-0003-4754-0963, (SÖ) 0000-0002-2247-0703.

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Background. In the Sinop region, many species are caught as non-targets during the target species catching with gill nets. Sardon was used to prevent the bottom creatures (crabs, snails, etc.) climbing these nets used on the ground from climbing. This study was carried out in 13 fishing operations in the inner harbor area of Sinop, from September through November of 2004. Trammel nets were used, which has 32 mm mesh size and target fish species of the fishing gear is red mullet (Mullus barbatus) in the study.

Materials and methods. Three net groups were used in the experiments, without sardon (A0) for the control net, multifilament with sardon (A1) and monofilament with sardon (A2) respectively.

Results. 65.3% Osteichthyes fish (696 specimens), 16.8% Mollusca (179 specimens), 16.4% was arthropoda (175 specimens) and 1.5% was Chondrichthyes fish (16 specimens) of catch obtained from the operations were form. A total 124 specimens as the target species (red mullet), 398 specimens as bycatch species, and 544 specimens as discarded species were captured sea trials. Catch ratio of A0, A1 and A2 nets were determined 51.88%, 21.58% and 26.55% respectively. 48.38% of the target species, 30.40% of the bycatches and 57.53% of the discarded catch were caught by the A0 net. 25.81% of the target species, 45.23% of the bycatches, and 18.57% of the discard catch were caught with A1 net. 25.81% of the target species, 24.37% of the bycatch and 24.37% of the discarded catch were caught by the A2 net.

Conclusions. The results showed that the use of sardon on trammel nets in the Black Sea coastal fisheries caused a slight decrease in target fish catch, but significantly decreased the amount of discarded catch.

Keywords: Coastal fisheries, Trammel net, Bycatch, Discard, Black Sea

INTRODUCTION

The prevention of bycatch and discarded species in active and passive fishing gear remains up-to-date all over the world (Alverson et al. 1994; Clucas 1997; Kelleher 2005; Kenelly 2007; FAO 2011; FAO 2019). Set nets are one of the most common fishing gear used in fishing since it is easy use and produce such as gillnets and trammel nets (Karlsen and Bjarnason 1987; Sainsbury 1996; Purbayanto et al. 2008). The target species of gillnets, which are used extensively for fishing in Black Sea are red mullet and whiting, which have a very high commercial value (Özdemir and Erdem 2006; Aydın et al. 2006; Aksu 2006; Erdem et al. 2019; Erdem et al. 2020). The fishing areas are not homogeneous and host many different species. Studies have shown that using gillnets and trammel nets in fishery has caused the decline in many fish populations and the near extinction of a few fish species (Syrja and Valkeaja 2010). This negative effect is not only limited to fish, but also covers many other marine species and poses a great threat to coastal ecosystems (Regular et al. 2013). Gillnets have low selectivity and high mortality rates for bycatch (Saila 1983; Alverson et al. 1994; Pascoe 1997).

Other species have been caught as non-target species in gill nets that equipped for catching target species (Aydın et al. 2015). Even though some of these species are thrown back the sea as discarded, many species are considered as bycatch and create significant economic benefits (Özdemir et al. 2005). The most significant discards are the crabs, due to the damage to gillnet and the caught products (Aydın et al. 2015; Kasapoğlu and Düzgüneş 2017).

These species can cut the nets and the net may be damaged during their extraction as well. As a result, the discards catch has negative effect on fishery, as it create damage on other catch products and also increase the time and effort on the cleaning, repair and maintenance of the net (Aksu 2006; Özdemir and Erdem 2007).

In addition to the listed side effects, it is important for today's fisheries managements, that are sensitive to the environment and consider the ecosystem as a whole, to prevent the destruction of these discard species, that are the food of other commercially important species, even though they cannot be valued as commercial themselves. While it is not possible to completely prevent the catching of non-targeted species, some measures can be taken to minimize the side effects of fisheries on fish stocks. The measures to be taken in this regard are examined in different categories by different scientists. These can be classified as technical, administrative and economic measures (Pascoe 1997); measures based on technology and training; measures based on fishing gear and legal regulations (Saila 1983; Alverson et al. 1994; Godoy et al 2000; Aksu 2006; Erdem et al. 2020). By using sardon, norsel ropes and fabrics on the lead side of nets, changing the color, material or hanging ratio of the net, it has been seen in studies related to species selectivity to prevent the catching of unwanted species, that the catching of discards can actually be reduced (Godoy et al. 2003; Gökçe 2004; Aksu 2006; Favaro 2013; Özdemir et al. 2017; Eryaşar et al. 2021).

The aim of the study is the effect on the amount of target catch and bycatch has been analysed when sardon aplication and different net materials being used on trammel nets in small scale fisheries of Black Sea coasts.

MATERIALS AND METHODS

The study was carried out with trammel nets at depths between 10 and 35 m in Sinop inner harbour region in September-October-November 2004. Sinop region is important fisheries center of the Black Sea. In addition to trawler and purse seine fishing, coastal fishing also has an important place in the region. Sinop region is an important upwelling area and an important transit point especially for migrating fish (Figure 1). Although bonito fishing attracts attention in the coastal fisheries in the region, especially turbot, red mullet and whiting are widely fished.

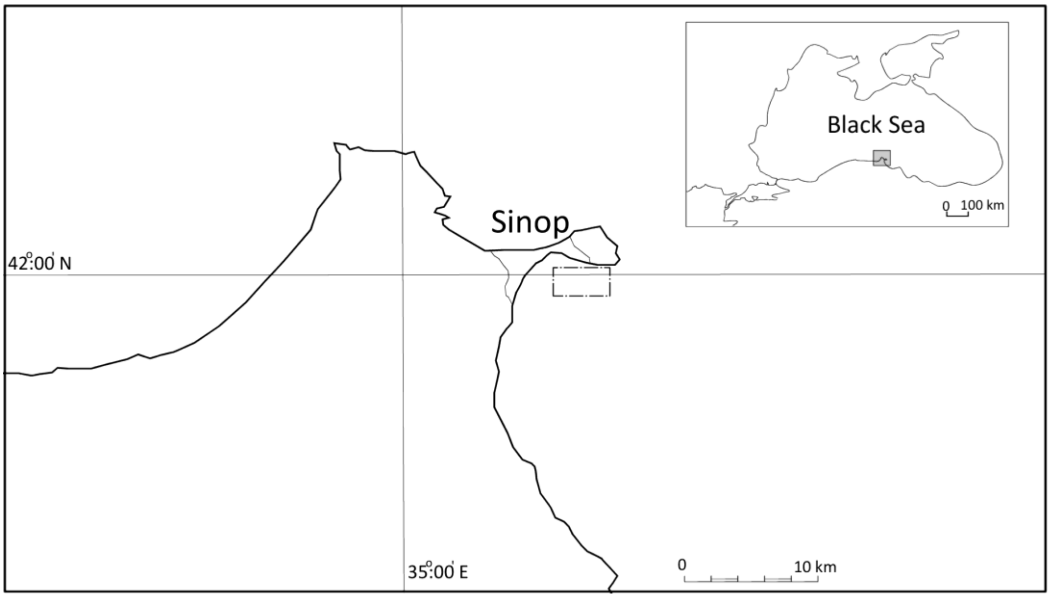

Figure 1. Nautical chart of the study area (dotted line)

The inner nets which used in the study was made of PA material monofilament rope with 32 mm mesh opening, a height of 66 mesh, a length of 200 m, a rope thickness of Ø 0.12 mm. The outer nets are made of PA material with a mesh opening of 220 mm, a depth of 6.5 mesh, a length of 150 m, using PA material fishing line (monofilament) trammel nets with a rope thickness of 210D/6. The outer net hanging ratio (E) was 0.67 and the outer/inner net ratio was applied as 2/3 (Figure 2).

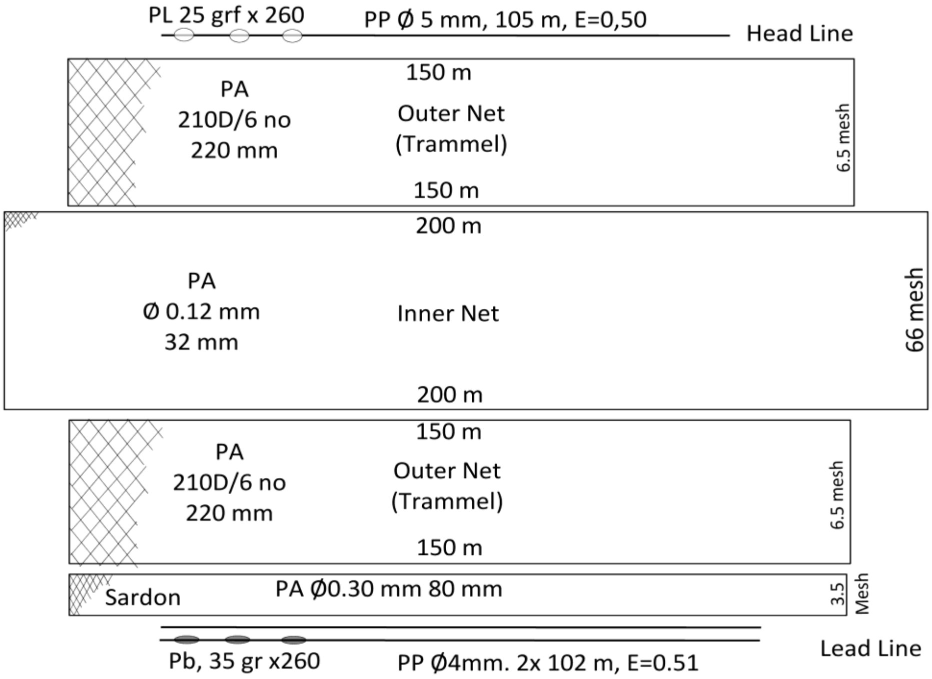

Figure 2. Technical features of the trammel nets used in the study

Experimental (A1 and A2) nets were added sardon. A1 nets have sardon with multifilament material and A2 nets have sardon with monofilament. Three nets (A0, A1 and A2) prepared for this purpose were added to each other to form a set net and total 13 fishing operations were carried out.The nets are placed on the deck in such a way that the head and lead line do not interfere with each other in order to facilitate their launch into the sea. Ropes (2 meters) were attached to the head and lead line at both ends of the nets. These ropes are attached to the ropes to which buoys and anchors are attached. The nets were laid into the sea parallel to the shore in the sun set time and they were collected out of sea in the dawn time. Whether the difference between the nets used depending on the amount of prey is significant or not was determined by the Chi-Square test using the Microsoft Excel and MiniTab 13.0 package program.

RESULTS

In 13 fishing operations, a total of 1066 (42962 g) individuals from 25 species belonging to 4 different groups were caught with all nets. The distribution of the captured species according to the number of individuals have been identified as; 696 osteichthyes, 179 mollusca, 175 arthropoda and 16 chondrichthyes. 14 species from the group of osteichtyes, mainly horse mackerel, red mullet, whiting and picarel were fished. Although red mullet is the target species, the most caught fish is horse mackerel. The most of the bycatch species were the sea snail. The distribution of other species by groups is given in the Table 1.

Table 1. Distribution of captured species with all nets in the study

Groups	Species	N	%
Osteichthyes	Horse mackerel (*Trachurus mediterraneus* Steindachner, 1868)	163	15.29
	Red mullet (*Mullus barbatus ponticus* Essipov, 1927)	124	11.63
	Whiting (*Merlangius merlangus euxinus* Nordman, 1940)	102	9.57
	Picarel (*Spicara smaris* Linnaeus, 1758)	116	10.88
	Anchovy (*Engraulis encrasicolus* Linnaeus, 1758)	11	1.03
	Bluefish (*Pomatomus saltatrix* Linnaeus, 1766)	3	0.28
	Turbot (*Scophthalmus maximus* Linnaeus, 1758)	1	0.09
	Tub gurnard (*Chelidonichthys lucerna* Linnaeus, 1758)	2	0.19
	Scorpion (*Scorpaena porcus* Linnaeus, 1758)	47	4.41
	Stargazer (*Uranoscobus scaber* Linnaeus, 1758)	39	3.66
	Ling (*Gaidropsarus mediterraneus* Linnaeus, 1758)	58	5.44
	Labrus (*Labrus* sp.)	16	1.50
	Goby fish (*Gobius* spp)	7	0.66
	Greater weever (*Trahinus draco* Linnaeus, 1758)	7	0.66
Chondrichthyes	Spiny dogfish (*Squalus acanthias* Linnaeus, 1758)	12	1.13
	Thornback ray (*Raja clavata* Linnaeus, 1758)	3	0.28
	Common stingray (*Dasyatis pastinaca* Linnaeus, 1758)	1	0.09
Arthropods	Warty crab (*Eriphia verrucosa* Forskål, 1775)	8	0.75
	Blue-leg swimcrab (*Liocarcinus depurator* Linnaeus, 1758)	163	15.29
	Baltic prawn (*Palaemon adspersus* Rathke, 1837)	4	0.38
Mollusca	Rapa whelk (*Rapana venosa* Valenciennes, 1846)	166	15.57
	Others (*Gibbula* sp.)	13	1.22
Total	**25 Species**	**1066**	**100**

Distribution of Total Catch by Nets of Different Type

A total 553 individuals (51.88%) were caught with the A0 (control net), 230 (21.58%) with the A1 (multifilament with sardon) and 283 (26.55%) with the A2 (monofilamnet with sardon) during the sea trials. The highest catch efficiency (191824 g) was obtained with A0 net. Catch amount of the other nets (A1 and A2) were determined 9872 and 13908.11 g respectively. Also, Osteichthyes, mollusca, arthropoda and chondrichthyes were captured by A0, A1 and A2 nets 322, 171, 203; 132, 26, 21; 97, 30, 48 and 2, 3, 11 speciemens respectively (Table 2).

Table 2. Distribution of total catch of the nets

Groups	Osteichthyes		Mollusca		Arthropod		Chondrichtyes		Total			
Net Type	N	%	N	%	N	%	N	%	N	%	W	%
A0	322	58.23	132	23.87	97	17.54	2	0.36	553	51.88	19182	44.7
A1	171	74.35	26	11.30	30	13.04	3	1.30	230	21.57	9872	22.9
A2	203	71.73	21	7.42	48	16.96	11	3.88	283	26.55	13908	32.4
Total	696	65.29	179	16.79	175	16.42	16	1.50	1066	100	42962	100

While most of the osteichthyes, molluscs and arthropods caught were caught with the A0 net, only chondrichtyes were caught more with the A2 net. When the ratios of the caught species according to the net type analyzed, osteichthyes with a rate of 58.23 % were caught A0 net, the rate of the osteichthyes were reached higher in the A2 net and A1 net 71.73% and 74.35% respectively.

Among the 322 osteichtyes caught with A0 net, whiting, red mullet, horse mackerel and picarel took the first four places with the number of 66, 60, 59 and 44, respectively. The ratio of these species in the total prey caught with A0 net was calculated as 11.93%, 10.85%, 10.67% and 7.96%, respectively. Rapa whelk (123 specimens) and blue-leg swimcrab (92 specimens) were the most caught species from mollusca and arthropoda. However, few fish were captured from chondrichtyes group. Captured fish number were 1 thornback ray and 1 spiny dogfish (Table 3).

Table 3 Catch composition of nets used in the study

Net Type		**A0**		**A1**		**A2**	
Groups	**Species**	**N**	**%**	**N**	**%**	**N**	**%**
Osteichtyes	Horse mackerel	59	10.67	42	18.26	62	21.91
	Red mullet	60	10.85	32	13.91	32	11.31
	Whiting	66	11.93	13	5.65	23	8.13
	Picarel	44	7.96	39	16.96	33	11.66
	Anchovy	8	1.45	2	0.87	1	0.35
	Turbot	1	0.18	0	0	0	0
	Bluefish	0	0	1	0.43	2	0.71
	Tub gurnard	2	0.36	0	0	0	0
	Scorpion	30	5.42	9	3.91	7	2.47
	Stargazer	19	3.44	13	5.65	19	6.71
	Ling	26	4.70	13	5.65	10	3.53
	Labrus	1	0.18	5	2.17	2	0.71
	Goby fish	3	0.54	2	0.87	4	1.41
	Greater weever	3	0.54	0	0	7	2.47
Chondrichtyes	Spiny dogfish	1	0.18	3	1.30	8	2.83
	Thornback ray	1	0.18	0	0	2	0.71
	Common stingray	0	0	0	0	1	0.35
Arthropods	Warty crab	5	0.90	27	11.74	44	15.55
	Blue-leg swimcrab	92	16.64	1	0.43	2	0.71
	Baltic prawn	0	0	2	0.87	2	0.71
Mollusca	Rapa whelk	123	22.24	26	11.30	17	6.01
	Gibbula	9	1.63	0	0	4	1.41
TOTAL		**553**	**100**	**230**	**100**	**283**	**100**

Comparison of catch amounts in the fishing operations of nets

A total of 696 osteichthyes fish were caught by the A0, A1 and A2 nets in the 13 fishing operations 322, 171 and 203 respectively. The mean was 24.77 ± 5.51 with A0 net, 13.15 ± 2.84 with A1 net, and 15.62 ± 3.23 with A2 net. As a result of the Chi-Square test, the difference between the osteichthyes fish catches among the nets was found to be statistically significant ($P<0.001$). During the study, 179 individuals from the mollusca group were caught, of them with A0, A1 A2 nets 132, 26, 21 respectively. The average number of mollusca caught per operation was calculated as 10.15 ± 2.80 in A0 net, 2.00 ± 0.75 in A1 net, 1.62 ± 0.57 in A2 net and 13.77 ± 3.70 in total. As a result of the Chi-Square test, the difference between the amount of mollusks caught with each net type was found to be statistically significant. ($P<0.05$). It was seen that the difference between the mollusc catches in Sardon nets was insignificant, and the use of sardon prevented the net from catching snails. In addition, the difference between mollusc catches with sardon nets and non-sardon nets was found to be statistically significant. ($P<0.05$). A total of 175 individuals from the arthropod group were caught, 171 of which were crabs and 4 of them were shrimps. The average number of individuals was 13.46 ± 5.65. The number of catched arthropods is 97 with A0 net, 30 with A1 net and 48 with A2 net. One of the most important data of the study and the most important discard species for gillnets is arthropod species. According to the nets, the average arthropod catch amount was calculated as 7.46 ± 3.81 with A0 net, 2.31 ± 1.09 with A1 net and 3.69 ± 1.12 with A2 net. As a result of the Chi-Square test, the difference between the amount of arthropod prey caught with each net type was found to be statistically significant ($P<0.01$). The outcome has demonstrated importance of using sardon and the effect of sardon material on the arthropod catch amount. (Table 4).

Table 4. Catch amount distrubition in the nets of captured groups in the fishing operations

Fishing Operations	Osteichthyes			Mollusca			Arthropoda		
	A0	A1	A2	A0	A1	A2	A0	A1	A2
1	4	11	14	28	2	0	1	1	2
2	6	4	3	7	0	1	0	1	1
3	46	30	30	12	1	0	1	0	3
4	28	5	4	6	3	1	4	0	1
5	36	26	18	31	10	6	6	2	6
6	50	4	6	2	0	0	8	2	2
7	20	11	21	0	0	0	2	0	1
8	14	13	28	12	1	5	3	1	9
9	2	2	2	0	0	0	2	0	0
10	7	7	10	13	2	2	3	0	1
11	63	23	39	16	2	3	52	11	13
12	11	6	8	3	1	0	4	1	1
13	35	29	20	2	4	3	11	11	8
Total (N)	**322**	**171**	**203**	132	26	21	97	30	48
Avarage	**24.8**	**13.2**	**15.6**	**10.2**	**2.0**	**1.6**	**7.5**	**2.31**	**3.69**

Comparison of different net types of the target fish species

A total 124 target fish species (red mullet) were caught, of which 60 were caught with A0 net, 32 with A1 net and 32 with A1 net. Of the 3208.81 g red mullet fish catch, 1610.46 g were caught with A0, 808.52 g with A1 and 789.83 g with A2 net. The average of 9.54 ± 1.15 red mullet fish were caught per operation and the averages according to the nets were calculated as 4.62 ± 1.89 in A0 net, 2.46 ± 2.27 in A1 net and 2.46 ± 2.07 in A2 net (Table 5). As a result of the Chi-Square test, the difference between the amounts of the target species caught per each net and the operation was found to be statistically significant ($P<0.01$).

Table 5. Distribution of target fish species (red mullet) caught by nets

Fishing Operations	A0	A1	A2	Toplam
1	0	3	1	4
2	1	0	0	1
3	6	2	1	9
4	16	0	0	16
5	21	19	14	54
6	0	0	0	0
7	0	0	0	0
8	0	0	1	1
9	0	0	0	0
10	0	0	0	0
11	8	2	6	16
12	3	2	1	6
13	5	4	8	17
Total (N)	**60**	**32**	**32**	**124**
Avarage	**4.62**	**2.46**	**2.46**	**9.5**

A total of 398 fish were caught from 7 fish species constituting the bycatch and 45.23% (n=180) of them were caught by A0, 24.37% (n=121) by A1 and 30.4% (n=97) by A2 net. The fish species most captured by the nets were horse mackerel, picarel and whiting Considering the distribution of bycatch species, which are caught commercially, according to the nets; 36.2% of horse mackerel were caught with A0, 25.77% with A1 and 38.04% with A2 net. Bycatch rate distrubution in the A1 and A2 nets of the other two fish species were showed in Table 6.

Table 6. Distribution of economical bycatch fish species caught by nets

Fish Species		Net Type						Total
		A0		A1		A2		
H. Mackarel	**N**	59	% 36.2	42	% 25.77	62	% 38.04	163
	W (g)	1195.2	%34.45	1041.8	%30.03	1232.4	%35.52	3469.4
Whiting	**N**	66	%64.71	13	%12.75	23	%22.55	102
	W (g)	2340.5	%65.08	411.6	%11.45	844.3	%23.48	3596.4
Picarel	**N**	44	%37.93	39	%33.62	33	%28.45	116
	W (g)	1393.3	%39.12	1182.2	%33.20	985.8	%27.68	3561.3

As a result of the trials, the average amount of by-catch, consisting of 398 individuals caught, per operation was found to be 30.62 ± 7.77. According to different types of net, the averages were calculated as 13.85 ± 4.27 in A0 net, 7.46 ± 2.11 in A1 net and 9.31 ± 2.88 in A2 net. As a result of the Chi-Square test, the difference between the average catches caught per net and per operation was significant($P<0.001$).

Among the discarded species, 30 scorpion fish were caught in A0 net, 9 in A1 net and 8 in A2 net. 26, 13 and 19 ling were caught with A0, A1 and A2 nets, respectively. 19, 13 and 7 stargazer were caught with A0, A1 and A2 nets, respectively. 97, 28 and 46 crabs were caught with A0, A1 and A2 nets, respectively. Sea snails were caught 132, 26 and 21 with A0, A1 and A2 nets, respectively. When the species are considered individually or collectively, it is seen that the unwanted species are caught more with the A0 net. This result was supported by the Chi-Square test. The average of 544 discarded fish caught per operation was 41.85 ± 9.29. Of this amount, 24.08 ± 5.98 were caught with A0, 7.77 ± 1.87 with A1 and 10.00 ± 2.09 with A2 net (Table 7). As a result of the Chi-Square test, the difference between each net and the average discard catch amounts per operation was found to be statistically significant ($P<0.05$).

Table 7. Distribution of discard catch caught by nets

Fishing Operations	A0	A1	A2	Toplam
1	31	5	13	49
2	8	4	4	16
3	34	9	13	56
4	22	8	5	35
5	50	18	16	84
6	14	3	5	23
7	4	3	1	8
8	15	4	18	37
9	2	1	0	3
10	20	4	11	35
11	81	19	24	124
12	11	3	3	17
13	21	20	17	58
Total (N)	313	101	130	544
Avarage	**24.08**	**7.77**	**10.00**	**41.85**

DISCUSSION AND CONCLUSION

In this study, the effect of sardon and sardon material used in the trammel nets used in red mullet fishing has been tried to be revealed. For the study, a set of nets were created with non-sardon (commercially used) net (A0) as well as experimental nets with multifilament sardon (A1) and monofilament sardon (A2).

A total of 1066 individuals were caught, of which 124 were target species, 398 bycatch and 544 discarded species. Together with the target species of red mullet, bycatch species represented 49% of the total catch, and discarded species represented 51%. It was recorded that the amount of osteichthyes fish caught with the nets using sardon was lower than the nets without sardon. The difference observed in terms of the number of mollusca catch between nets was found to be statistically significant (P<0.05). It was determined that this difference was caused by the use of sardon, and the effect of sardon being multifilament or monofilament had been insignificant on catching mollusks which are damaging the nets. This leads to the conclusion that the use of sardon prevents snails from being caught as discarded. This outcome proved that the expected result had been obtained from the use of sardon in the nets and that sardon prevented the crabs from climbing into the net.

Gökçe (2004) stated that the catch obtained in his study with sardon nets equipped with different hanging ratios and nets without sardon, consisted of arthropods, molluscs, osteichthyes fish and chondrichthyes fish groups, and reported that there were significant reductions in the number of both groups and species with the use of sardon. The results obtained from different studies conducted in Turkish seas show the diversity of species in fishing with gillnets. Ayaz (2003) caught 392 individuals belonging to 26 species in his study with gillnets in the Aegean Sea. Fish made up 76% of the total catch, crustaceans 24% and arthropods 0.02%.

A total of 124 red mullet fish were caught, of which 60 were caught with A0 net, 32 with A1 net and 32 with A1 net. Avarages were calculated as 4.62±1.89 in A0 net, 2.46±2.271 in A1 net and 2.46±2.07 in A2 net. It was seen that the difference between the nets in terms of catch amount of red mullet was statistically significant ($P<0.05$). This outcome revealed that the use of sardon in the net decreased the amount of target species caught. It was seen that the amount of bycatch decreased with the use of sardon in the nets. According to the results obtained, it was determined that the difference between the nets in terms of discard amount was statistically significant ($P<0.05$).

If a general assessment regarding the species is made, considering intended outcome of the fishery and its economical evaluation, the amount of discards decreases significantly with the use of sardons. However, there is a decrease in the amount of prey of commercial species. Although these results are interpreted as negative in terms of fisheries, considering the disadvantages such as the damage caused by undesirable species to the nets and the catch product, the cost of fishing, the time spent during fishing, as well as the unnecessary removal of discarded species, which is caught undesirably and unnecessary and has devastating effects on the ecosystem, all in all it can be assessed that a significant gain has been achieved, not a loss. For example, in cases where crabs, which are the most important discarded species, are caught in the net in large quantities, the fishing gear can be damaged so much that it cannot be used after a few catching operations. Considering the difficulty and economic cost of repairing a net set, it is thought that all fishermen will prefer to catch less discards, even if the amount of the commercial species decreases. In addition, the commercial species caught in the fishing tool are eaten by the crabs and lose their economic value. Crabs and other predatory species harm commercial species at any rate. However, the use of sardon reduces this rate considerably. All in all, discards reduces the economic return of the products caught without sardon net and brought it to the level when using sardon nets. For these reasons, it can be determined by looking at the results of the research that the use of sardon is very important in the bottom trammel nets. However, while using sardon, factors such as the number of mesh, mesh size, hanging ratio, material made from and rope thickness should be determined well, and consequently, it should be tried to increase the productivity of fishery. In similar studies (Gökçe 2004; Metin et al. 2009; Özdemir and Erdem 2019), it has been reported that nets using sardon catch less undesired prey of shrimp, crabs, mantis shrimp (*Squilla mantis*, L.), and madya species than nets without sardon, and that the height of the sardon used is an

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important criterion for reducing bycatch. Likewise, Godoy et al. (2003) and Kara et al. (1991) reported that the norsel ropes and sardons net attached to the lead line of the net reduced the catching of bycatch species. Eryaşar et al. (2021) aims to prevent non-target species from climbing into the net with the tarpaulin they have equipped on the lead line of the trammel net and they tried to get the target species to ascend from the ground and got trapped in the net, as a result, they reported that there was a decrease in the amount of discards as well as target species.

While it is not possible to completely prevent the catching of non-targeted species, some measures can be taken to minimize the effects of fisheries on stocks. The measures to be taken in this regard are examined in different categories by different researchers. These are classified as technical, administrative and economic measures (Pascoe 1997), measures based on technology and education, legal regulations (Saila 1983) or measures based on fishing gear, and measures based on legal regulations (Alverson et al. 1994). In the light of the results of these and other researches and generally accepted scientific facts, it is evident that how important the reduction of bycatch is, for more efficient and environmental friendly fisheries. Although different methods are used for different fishing gears, it is a fact that various modifications should be made in fishing gears in order to reduce the amount of bycatch, not to endanger the future of the stocks and to keep the fishery under control (Kınacıgil et al. 1999). With this research, it was revealed that the use of sardon in gillnets reduces the amount of bycatch. For the nets used in the fishing of different species, varying applications should be determined to reduce the undesired catch, and additional techniques other than sardon should definitely be tried.

In conclusison, improvements in a fisheries bycatch profile can be accomplished by fishing less, by managing and making use of non-target species caught in fishing gear, or by improving the selectivity of fishing gear (Kelleher 2005; Hall et al. 2007; Favaro 2013). Reducing the catch of non-target and unwanted species has many advantages such as reducing the fishing pressure on the species, ensuring sustainable fisheries, and preventing time, labor and fuel losses (Brewer et al. 1998).

The findings obtained as a result of this study give us the opportunity to say that the cost of fishing and the amount of catch of unwanted creatures can be reduced without sacrificing the actual product by using sardon in the trammel nets used in red mullet fishing. Therefore, the necessity of using sardon on the trammel nets and gillnets used on costal fisheries have been understood from the perspective of sustainable fishing and environmental awareness.

References

Aksu H. 2006. The Effect of Using Sardon in Trammel Nets on Prevent Catching of Discarded Species, Master Thesis, Ondokuz Mayıs University, Graduate School of Natural and Applied Sciences, Samsun, 90 p.

Alverson, D. L., Freeberg, M. H., Pope, J. G., Murawski, S. A. 1994. A Global Assessment On Fisheries Bycatch and Discards. FAO Fisheries Technical Paper, No: 339, 136 p.

Ayaz A. 2003. Investigations on Ghost Fishing Gear. Ege Üniversity, Department of Fishing and Seafood Processing Technology, Department No:504.06.01 PhD Thesis, 83p.

Aydın İ., Metin C., Gökçe G. 2006. The Effects of Monoflament and Multiflament PA Netting Twine on Catch Composition of the Red Mullet Gillnets. Ege University Journal of Fisheries & Aquatic Sciences. Volume 23, Issue (3-4): 285–289.

Aydın M., Karadurmuş U. Kontaş S. 2015. Ecosystem effects of the commercial scorpion fish nets used in Ordu region. Turkish Journal of Maritime and Marine Sciences 1(1): 56-63. Retrieved from https://dergipark.org.tr/en/pub/trjmms/issue/40133/477462.

Clucas I. 1997. A study of the options for utilization of bycatch and discards from marine capture fisheries. FAO Fisheries Technical Report, Circular No. 928: 59. https://www.fao.org/3/W6602E/w6602E00.htm

Erdem Y., Özdemir S., Özsandıkçı U., Büyükdeveci F. 2020. Technical plans of fishing gears used in the central Black Sea coastal fisheries (Sinop-Samsun) Marine and Life Sciences, 2(2): 85-96. Retrieved from https://dergipark.org.tr/en/pub/marlife/issue/58361/796825.

Eryaşar A.R., Ceylan Y., Özbilgin H., Bozaoğlu A.S. 2021. Are Cloth Tarpaulin Mounted Nets Effective for Discard Reduction in Trammel Nets? Turkish Journal of Fisheries & Aquatic Sciences. 21(2): 63-71. http://doi.org/10.4194/1303-2712-v21_2_02

Favaro B. 2013. Can fishing gear protect non-target fish? Design and evaluation of bycatch reduction technology for commercial fisheries. PhD Thesis, Simon Fraser University, Department of Biological Sciences Faculty of Science, Canada, 121 p.

FAO 2011. International Guidelines on Bycatch Management and Reduction of Discards. Rome. ISBN 978-92-5-006952-4. 73 p.

FAO 2019. Monitoring discards in Mediterranean and Black Sea fisheries: Methodology for data collection. FAO Fisheries and Aquaculture Technical Paper No: 639. ISBN: 978-92-5-131538-5. 96 p.

Godoy H., Furevik D. Lokkeborg S. 2000. Reduced Bycatch of Red King Crab (Paralithodes camtschatica) in the Cod Gillnet Fisheries in Northern Norway. “International Council for the Exploration of the sea (ICES)”, Efficiency, Selectivity and Impacts of Passive Fishing

Gears, C.M. 2000/5-05:1-7. https://imr.brage.unit.no/imrxmlui/bitstream/handle/11250/100447/J0500.pdf?sequence=1

Godoy H., Furevik D. Lokkeborg S., 2003. Reduced bycatch of red king crab (*Paralithodes camtschaticus*) in the gillnet fishery for cod (*Gadus morhua*) in northern Norway. Fisheries Research, 62(3): 377-384.

Gökçe G. 2004. Research on Reduction of Non-Target Species in Shrimp Trammel Net. Ege University, PhD Thesis, İzmir, Türkiye, 112 p.

Hall M.A., Nakano H., Clarke S., Thomas S., Molloy J., Peckham S.H., Laudino-Santillán J., Nichols W.J., Gilman E., Cook J., Martin, S., Croxall J.P., Rivera K., Moreno C.A., Hall S.J. 2007. Working with Fishers to Reduce By-catches. Pages 235-288 in S. Kennelly, Editor. By-catch Reduction in the World's Fisheries. Springer Netherlands

Kara A., Hoşsucu H. Çıra E. 1991. To Reduce Crab Intake Trying to Used Trammel Net with Sardon Added Lead line.. E. Ü. Fisheries Vocational School, Bornova İzmir. Fisheries Symposium in the Tenth Year of Education. 675-679 p.

Karlsen L. Bjarnason B.A. 1987. Small-scale fishing with driftnets. FAO Fisheries Technical paper, No: 284, 64 p.

Kasapoğlu N., Düzgüneş E. 2017. The common problem in the Black Sea fisheries: By-catch and its effects on the fisheries economy. Turkish Journal of Fisheries and Aquatic Sciences 17: 387-394. ISSN 1303-2712. DOI: 10.4194/1303-2712-v17_2_18

Kennelly S. J. 2007. By-catch reduction in the world's fisheries. In: Reviews: Methods and technologies in fish biology and fisheries. Volume 7. (Ed. J.L. Nielsen), Springer, 288 p. The Netherlands. ISBN 978-1-4020-6077-9.

Kınacıgil H.T., Çıra E. İlkyaz A.T. 1999. The Problem of Unwanted Species in Fisheries. Ege Journal of Fisheries and Aquatic Sciences, 16 (3-4): 437-444. https://www.academia.edu/22191885/Bal%C4%B1k%C3%A7%C4%B1l%C4%B1kta_Hedeflenmeden_Avlanan_T%C3%BCrler_Sorunu

Metin C., Gökçe G., Aydın İ., Bayramiç İ., 2009. Bycatch Reduction in Trammel Net Fishery for Prawn (Melicertus kerathurus) by Using Guarding Net in Izmir Bay on Aegean Coast of Turkey. Turkish Journal of Fisheries and Aquatic Sciences 9(2): 133-136. DOI: 10.4194/trjfas.2009.0202

Özdemir S., Erdem Y. Sümer Ç. 2005. Catch efficiency and catch composition of the gillnets having different structure and material. Fırat Üniversity, Journal of Science and Engineering, 17(4), 621 - 627. https://www.acarindex.com/firat-universitesi-fen-ve-muhendislik-bilimleri-dergisi/farkli-yapi-ve-materyale-sahip-uzatma-aglarinin-av-verimi-ve-av-kompozisyonu-653584.

Özdemir S., Erdem Y. 2006. Effect on Catchability of Species and Species Selectivity of Structure Properties and Net Material of Gillnets. E.U. Journal of Fisheries and Aquatic Sciences 23(3-4):429-433. ISSN 1300 – 1590.

Özdemir S., Erdem Y. 2007. Comparison of catch location on trammel nets of different fish species. Turkish Journal of Aquatic Life, 3-5(3-4): 387-394.

Özdemir S., Özsandıkçı U., Erdem Y., Büyükdeveci F. 2017. Catch composition of crab species that as bycatch captured by trammel nets used on Sinop coasts. Turkish Journal of Maritime and Marine Sciences. 3(2): 55-62. https://dergipark.org.tr/en/download/article-file/565824

Özdemir S., Erdem Y. 2019. Distribution on the nets of bycatch fishes caught by multifilament and monofilament trammel nets. Marine and Life Sciences, 1(1): 25-31. https://dergipark.org.tr/tr/download/article-file/912228. 7 p.

Pascoe S. 1997. Bycatch Management and the Economics of Discarding; FAO Technical Paper, Rome, Italy, 137 p. http://www.fao.org/docrep/010/w6929e/w6929e00.htm

Purbayanto A., Imron M., Baskoro S. M., Pramono B. 2008. Mesh Selectivity of Sweeping Trammel Nets for Dominant Nontarget Species (Amoy Croaker and Moustached Thryssa) in the Northern Coast of Central Java. American Fisheries Society Symposium, 49: 1293-1302. https://www.academia.edu/24141217/Mesh_Selectivity_of_Sweeping_Trammel_Nets_for_Dominant_Nontarget_Species_Amoy_Croaker_and_Moustached_Thryssa_in_the_Northern_Coast_of_Central_Java

Regular P., Montevecchi W., Hedd A., Robertson G., Wilhelm S. 2013. 'Canadian fishery closures provide a largescale test of the impact of gillnet bycatch on seabird populations', doi: 10.1098/rsbl.2013.0088. Journal List Biol Lett v.9(4); 2013 Aug 23 PMC3730620.

Saila S. 1983. Importance and assessment of discards in commercial fisheries. UN/FAO Technical paper, Rome, Circular no: 765.

Syrja J., Valkeaja P. 2010. 'Gillnet fishing drives lake-migrating brown trout to near extinction in the Lake Paijanne region , Finland', Fisheries Management and Ecology, Volume 17, Issuse 2: p 199–208. https://doi.org/10.1111/j.1365-2400.2010.00738.x.