

Effect of steel wire and claw size on the sea snail (*Rapana venosa*) catch in a Black Sea beam trawl fishery

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Abstract: The effects of the claw size used on the shoes of the traditional sea snail beam trawl and the effect of the steel wire used between the shoes on catching efficiency were investigated on the Samsun coast of the Black Sea. A traditional beam trawl with steel wire and with a claw length of 5.5 cm (T) was compared to modified beam trawls with steel wire (M1) and without steel wire (M2) with a claw size of 0.5 cm. The operations were performed as T-M1 and then T-M2 hauls using the dual parallel towing method. There was no significant difference in the amount of target species in the comparison of T (70.12) and M1 (63.23) according to the average catch per unit effort (CPUE, kg h⁻¹) values obtained (P = 0.399). In the T-M2 comparison, 49% higher CPUE value was achieved with the T (77.37) beam trawl and there was a significant difference in terms of targeted species (P = 0.002). As a result, it was observed by underwater observations that steel wire on the beam trawl had a negative effect on the ground, and it was found that the bycatch ratio with the T beam trawl was higher than that with the modified beam trawl.

Key words: Sea snail, beam trawl, catch per unit effort, Black Sea

1. Introduction

The first record in the Black Sea for the sea snail (*Rapana venosa* Val., 1846), a local species of the Japanese Sea, was made in Russia's Novorossiysk Bay in 1947 (1). It was observed in the eastern Black Sea region for the first time in 1962 in Turkey (2). It has been extremely effective in reducing stocks of mussels, especially on the Anatolian and Caucasian coasts (3,4). It was reported that the sea snail had harmful effects on the demersal ecosystem on the coasts of Zmiinyi Island (Black Sea) (5). Although it is responsible for the collapse of bivalve stocks, it started being caught as an important export species in Turkey in the late 1980s and in Bulgaria in the 1990s (2). While the amount of fishing catch was 235 t according to the first official fishing record in 1983, the catch amounted to 9657 t in 2016, with an increase of about 40 times. Between the years 2003 and 2010, the frozen sea snail meat average annual export amount of Turkey and Bulgaria together was about 3000 t (two-thirds of it from Turkey), and it has obtained an average annual export revenue of 13 million euros (6). In Turkey, with respect to the limitations in relation to the beam trawl used in sea snail fishing, it is not permitted for a boat to haul two beam trawls at the

same time or to carry out sea snail fishing in the summer months with beam trawls (7).

Whereas sea snail fishing can be done with dredges, beam trawl, diving, pots, and traps, almost all of the fishing on the Black Sea coast of Turkey is done by beam trawl (74% in Romania, 90% in Ukraine, and over 95% in Bulgaria and Turkey) (4,8). However, besides the fact that fishing carried out intensely by beam trawl causes destruction of the benthic habitat, it also catches many species as bycatch (9). Almost half (47%) of the sea snail catch of the coasts of Turkey is obtained from the Samsun shelf area with beam trawls. Samsun Province is Turkey's largest rapa whelk producer in terms of area, number of boats, and processing plants (6). The towing fishing gear used in sea snail fishing in the region is known as a sea snail beam trawl because it is unique to the species (10). This active fishing gear changes the physical properties of the sea bed when in contact with the bottom and can cause the death of living beings directly or indirectly at the bottom. Furthermore, due to the physical characteristics of the fishing gear, it can cause the sea bed to be flattened by destruction, activation, and displacement (11,12). After the 2000s, alternative pots and trapping experiments

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were carried out due to the damage caused by the sea snail beam trawl to the benthic ecosystem in the region (13–15). These are more environmentally friendly fishing gears with low ecosystem impact index because they are aimed at the target species and cause minimum damage to the ground (16,17). There are limited studies on beam trawls, the most effective means of fishing for the species (10,18,19). There is an urgent need to make structural changes to the beam trawls and to reduce the benthic effect when it is considered that the average annual production in the last 10 years was about 10,000 t and 90% of the production was provided by this fishing gear. The catch per unit effort (CPUE) quantity is an important index in terms of fisheries management and science. This index is used in a number of areas, such as monitoring the variables in the population size of different habitats (20), and also comparing the productivity of different fishing means (21).

In this study, the effect of steel wire and claw size (ledge height where steel wire is mounted under the shoes) on fishing quantity of the target and bycatch species in the traditional method and with two different modified beam trawls was examined.

2. Materials and methods

The study was carried out in two different localities of the Samsun continental shelf of the Black Sea by two separate commercial boats in July 2014. Experiments were carried out between depths of 7.5 and 11.5 m by the vessel called Remzi Baba (11.30 m in length and 135 HP) at the Dereköy station and at Costal by the vessel called İki Kardeşler-2 (11.6 m in length and 185 HP) (Figure 1). The study area and ground structure were studied in detail in a PhD thesis conducted under the BENTHIS (EU-FP7-312008) project, and they are areas where fishermen extensively carry out snail fishing (22). This fishing gear is composed of a beam head with two shoes and a steel wire stretched between claws of different lengths existing under these shoes, and a frame (max. 300 cm length and 40 cm height) forming the general beam structure and a bag of 1 m in length behind it (min. mesh size 72 mm) (7).

The fishing activity of three different beam trawls in sea snail fishing was examined (Figures 2 and 3). The first of these is the traditional beam trawl type (T1) with steel wire (\varnothing 8) with 8 cm width and about 20–25 cm length with claws at 5.5 cm deep under the shoes, which fishermen

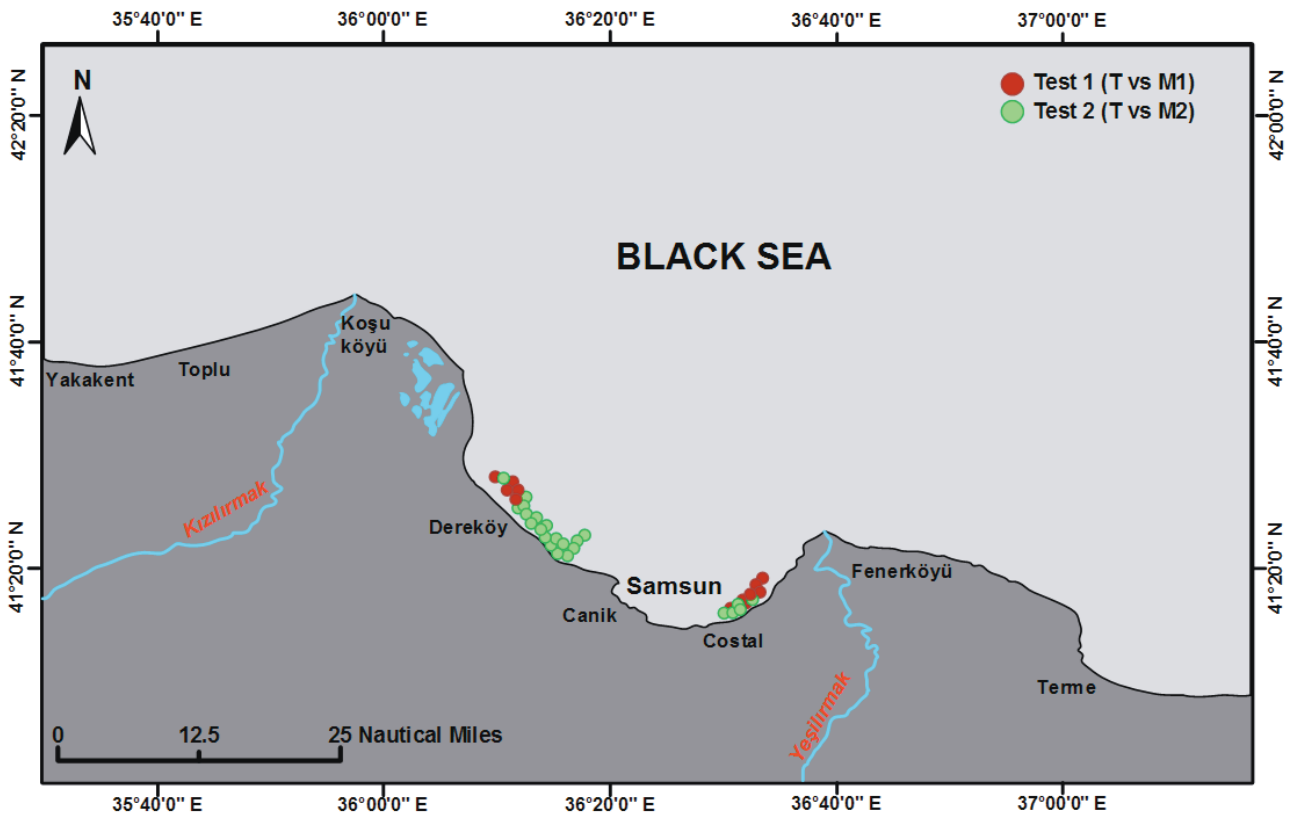


Figure 1. Study area. Dereköy and Costal localities in the Samsun shelf area and the stations for experimental surveys for the trials of modified beam trawls in the summer (July) 2014 period.

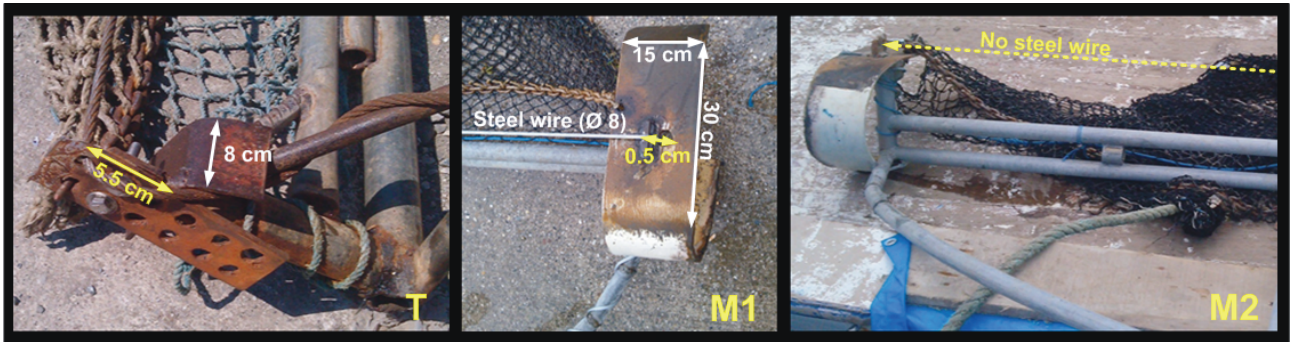


Figure 2. Pictures of beam trawls used in the study.

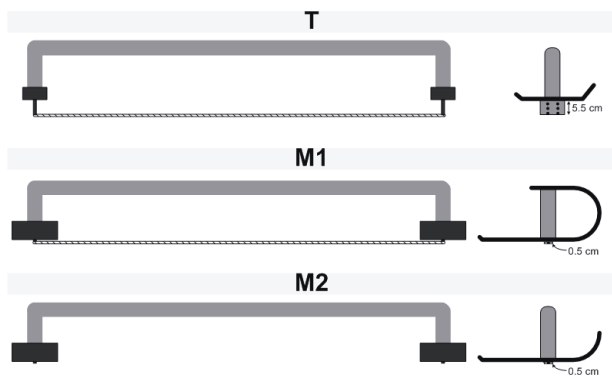


Figure 3. Front and side views of the beam trawls used in the operation.

commonly use. The second, instead of shoes, is a modified beam trawl with sledges 15 cm wide and 30 cm in length considered to have less impact on the ground, and with a steel wire with a claw depth of 0.5 cm under them (M1 - modified steel wire). The last one is M2, identical in terms of its general features to M1, with the most distinct difference that it is a modified beam trawl without a steel wire between the sledges. The weight of all beam trawls in the air (ropes, chain, frame, and bag) is 50–55 kg, the length of the beam is 270–280 cm, and the height is 15–25 cm.

Traditional (T) and modified beam trawls (M1-M2) were tested comparatively at both locations. The comparisons of the fishing gears were performed in 2 stages by making parallel hauls as described below. Test 1 was T versus M1 and Test 2 was T versus M2.

With parallel hauling in each operation, the conditions that could affect the amount of catch likely to stem from boats, from sea conditions (current, ground structure, etc.), and weather conditions (wind, temperature, etc.) were minimized. During the operations, the fishing

duration was generally between 25 and 40 min. The entire product taken out of the bags was separated on the deck as target and bycatch. The amount of target species in each operation was determined as weight. In both modified and traditional fishing operations, the length (mm) of all sea snail individuals was measured in the target catch taken on board in some hauls (a total of 14 hauls). Underwater cameras were used to see in some operations if beam trawl shoes and sledges were working or not.

In the study, all species except for sea snail were recorded as bycatch and discarded. These species were then recorded as numbers for each hauling within 4 groups: Pisces (*Pegusa nasuta*, *Diplecogaster* sp., *Uranoscopus scaber*, *Parablennius tentacularis*, *Hippocampus hippocampus*, *Psetta maxima*, *Arnoglossus kessleri*, *Platichthys flesus*, *Syngnathus* sp., *Scorpaena porcus*, *Callionymus* sp., *Dasyatis pastinaca*), Crustacea (*Diogenes pugilator*, *Liocarcinus depurator*, *Carcinus aestuarii*, *Brachyotus sexdentatus*, *Plimnus hirtellus*, *Palaemon elegans*, *Nerocila* sp., *Eriphia verrucosa*), Mollusca (*Papillicardium papillosum*, *Cyclope neritea*, *Nassarius reticulatus*, *Anadara cornea*, *Mytilus galloprovincialis*, *Chamelea gallina*), and Tunicata (*Ascidia* sp.). For all operations, the towing time was standardized as 1 h, and the amount of catch obtained per hour was calculated as CPUE (kg h^{-1}). CPUE values were compared as T-M1 and T-M2. Whether or not the statistical significance between the two comparison groups was significant was checked by the Student t-test for the target fishing quantity, and the numerical values of the bycatch species were checked by the chi-square test. The Kolmogorov-Smirnov z test was used to determine whether there was a significant difference between the length frequency distributions of the sea snails obtained by modified and traditional beam trawls. For each haul, CPUE for the target catch was calculated by the following equation:

$$\text{CPUE} = (C_i/N_i) \times 60$$

C_i is the amount of catch in each operation (kg) and N_i is the haul duration for each operation.

3. Results

This research is the first study conducted in Turkey about the impact of the structural changes on sea snail beam trawls and benthic ecosystems, and also on the target species. In the study, a total of 52 valid hauls were performed, with 27 in the T vs. M1 trial and 25 in the T vs. M2 trial. During the surveys 6832.92 kg of sea snail was caught. In the T vs. M1 experiment, 53% of the total of 3600.63 kg of target species was obtained from the T beam trawl. On the other hand, this rate was about found to be 60% for T in Test 2. The total durations of the hauls performed were 941 and 650 min for Test 1 and Test 2, respectively. In the second experiment, however, the amount of the target species in the M2 beam trawl was considerably reduced (Table).

It is seen that the target fishing amounts in T-M1 are almost the same, and in some of the hauls, the fishing values

of M1 are higher than those of the T beam trawl (Figure 4). However, in the T vs. M2 experiment, M2 caught more sea snails than the T beam trawl with a slight difference in only one hauling. It was found that there was no significant difference between the T and M1 beam trawls in terms of the target species amount caught per hour ($t = 0.851$, $P = 0.399$); however, in Test 2, the difference between T and M2 was statistically significant ($t = 3.262$; $P = 0.002$). This is also seen in the 95% confidence intervals of the average CPUE values (Figure 5).

In the comparisons of bycatch and discarded catch, the Pisces group produced a statistically significant difference ($\chi^2 = 5.194$; $P < 0.05$) in the T and M1 beam trawls. Similarly, Mollusca groups also have significantly different CPUE values ($\chi^2 = 223.536$; $P < 0.05$) in T and M1. On the other hand, there were no significant differences in T and

Table. Average CPUE values for target species obtained in beam trawl operations.

		Haul number	Total weight (kg)	Min.	Max.	Mean value (kg)	(±SE)	P-value
Test 1	T	27	1893.32	30.00	171.43	70.12	(±6.29)	0.399
	M1	27	1707.31	24.00	133.71	63.23	(±5.11)	
Test 2	T	25	1934.29	36.00	130.00	77.37	(±6.12)	0.002
	M2	25	1298.00	21.00	110.00	51.92	(±4.82)	

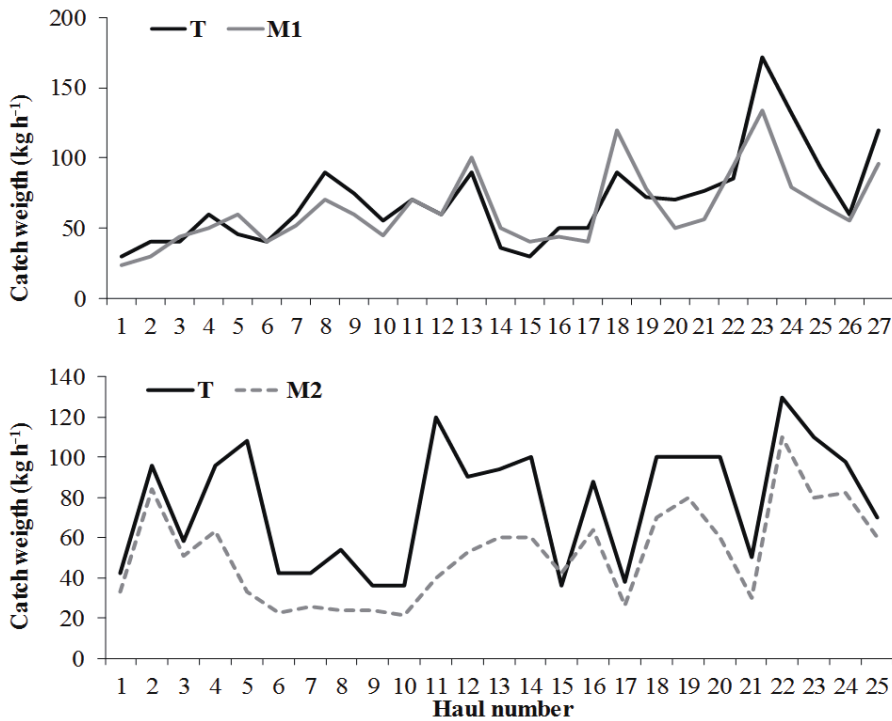


Figure 4. The T-M1 and T-M2 CPUE (kg h^{-1}) values for each haul.

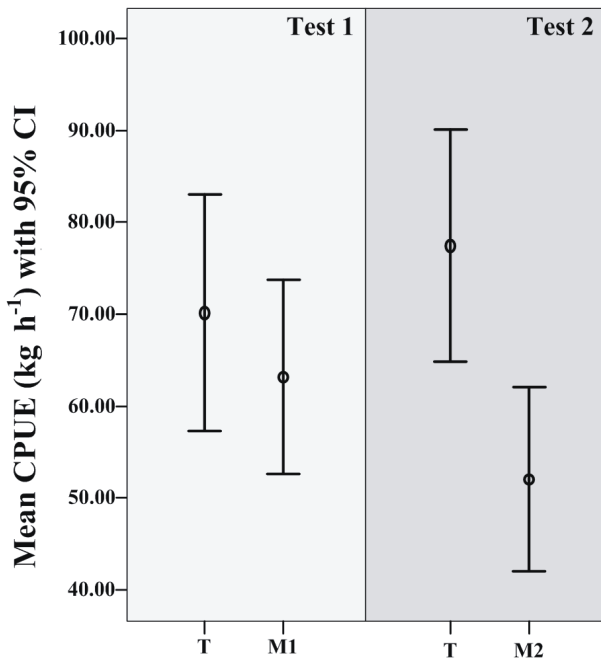


Figure 5. The 95% CI chart of the average CPUE values in Test 1 and 2.

M1 operations in terms of CPUE values for the Crustacea ($\chi^2 = 0.692$; $P > 0.05$) and Tunicata ($\chi^2 = 0.027$; $P > 0.05$) groups. In the comparison of the T and M2 beam trawls, the difference between the CPUE values of bycatch was found to be significant for all groups (Pisces ($\chi^2 = 6.333$; $P < 0.05$); Crustacea ($\chi^2 = 93.545$; $P < 0.05$); Mollusca ($\chi^2 = 31.680$; $P < 0.05$), and Tunicata ($\chi^2 = 99.492$; $P < 0.05$)) (Figure 6).

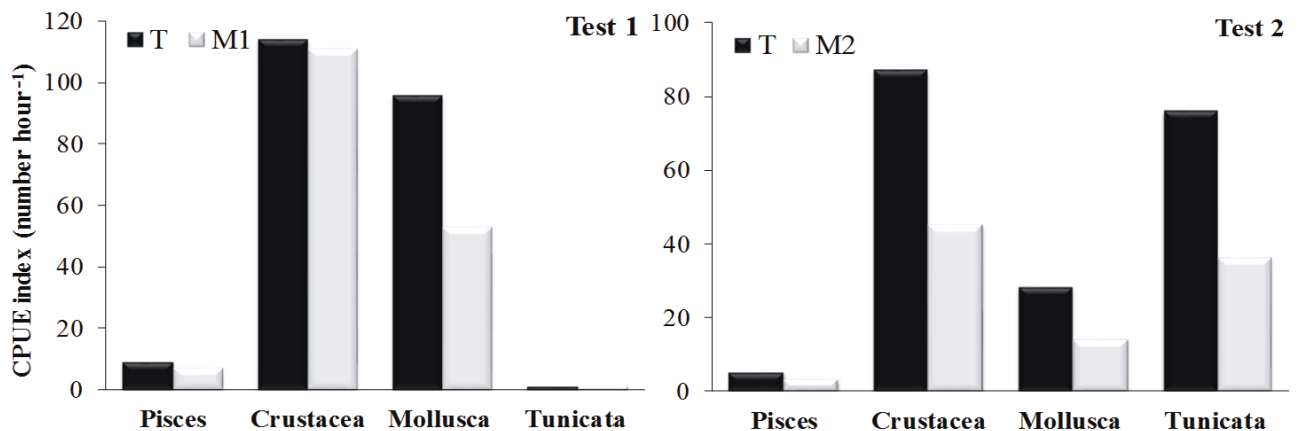


Figure 6. The CPUE index in number estimated for different organism groups of bycatch and discard in Test 1 [traditional gear (T) vs. modified gear (M1: sledges with steel wire)] and Test 2 [traditional gear (T) vs. modified gear (M2: sledges without steel wire)] in the experiments.

The length frequency distributions of a total of 6627 sea snail individuals obtained from the operations on the T, M1, and M2 beam trawls were investigated. The difference was significant for some cases and not for the others. We could not define a clear tendency as to whether any of the beam trawls caught larger or smaller individuals. The size frequency distributions of rapa whelk (pooled for all operations) obtained from modified and traditional gears are presented in Figure 7.

In the T beam trawls, it was observed that the claws under the shoes were buried in the ground and the layout was completely placed on the floor. In addition to this, it was observed that the steel wire remained slightly below the benthic floor due to these claws and lifted an excessive cloud of dust behind it (Figure 8). As seen in Figure 8, the steel wire of M1 is seen more clearly compared to T; sometimes it is hauled by sitting on the ground, and sometimes it is hauled slightly above the floor. In the M2 beam trawl test without the steel wire, it was observed that the sledges were not buried in the ground and came without sinking on the ground. It is seen in Figure 8 that the chain mounted on the net just behind the beam between the shoes is dragged without sinking into the ground. It was also seen that the chain produced less blurriness compared to the steel wire. Underwater observations showed that the beam trawl shoes and steel wire are the parts that have the most important interaction with the ground.

4. Discussion

In this study, which was carried out in two stages, the impact of claw length (T-M1) and then the steel wire (T-M2) on the target species was investigated. The findings revealed that the use of steel wire had a significant effect on the amount of catch of the target species ($P < 0.05$),

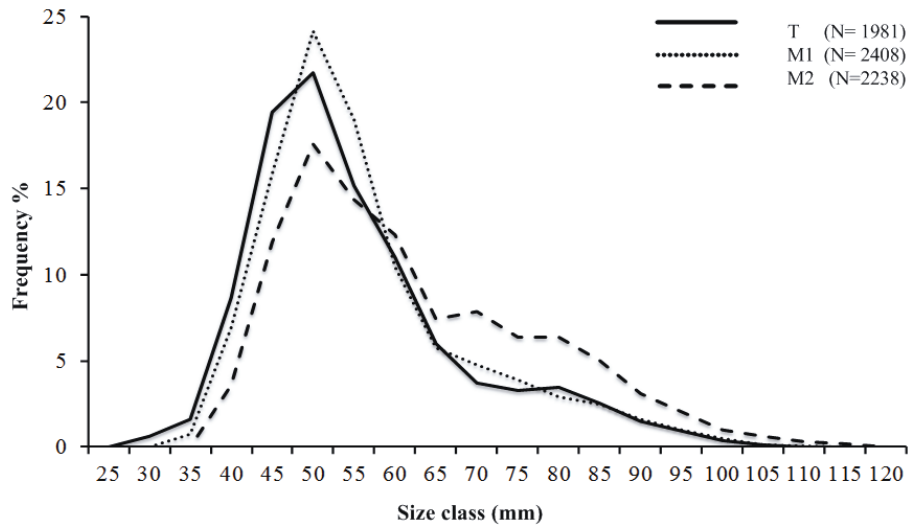


Figure 7. Length-frequency distribution of samples taken with T, M1, and M2 beam trawls.

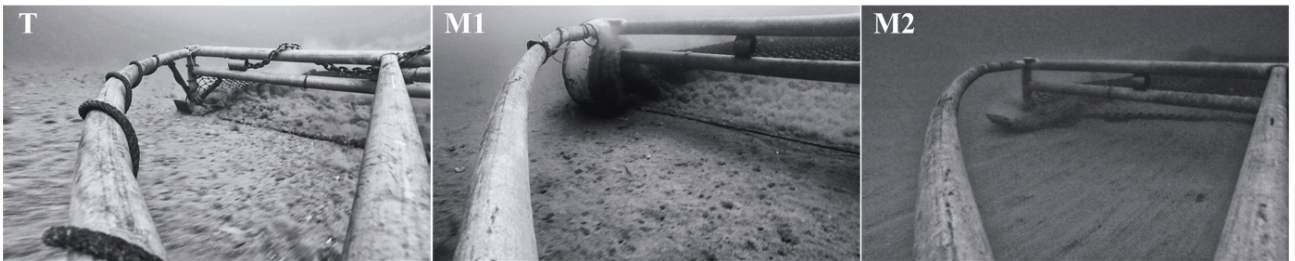


Figure 8. Underwater images of the shoes/sledges and steel wires of the sea snail beam trawls in Tests 1 and 2.

while showing no significant effect of the claw length on the CPUE value ($P > 0.05$). However, the use of beam trawl without steel wire (M2) played an active role in reducing the numbers of Pisces, Crustacea, Mollusca, and Tunicata individuals caught as nontargets ($P < 0.05$). The modified gears and especially the sledges without steel wire lowered the catch rate to nearly 50% of the total. This significant effect became more visible when the bycatch and discard composition was evaluated within organism groups as fishes, crustaceans, molluscs, and tunicates. It is concluded that the modified gear (sledges with and without steel wire) has a significant role in reducing the bycatch species in rapa whelk fishery. This result is very vital with regards to juvenile fish and especially the flat fish species that use this nearshore coastal area as nursery grounds. In addition, in the operations made with M2, it was also determined that larger size groups with higher market prices were caught. In underwater observations, it was seen that T and M1 beam trawls caused a negative effect on the ground compared to M2 due to the steel wire. The weight of the fishing gear ranges from a few hundred kilograms to a few tons, and depending on this weight,

it can penetrate from 1 cm to 8 cm into the ground and create holes (23). The sea snail beam trawls used in the Samsun region is structurally smaller and is a species-specific fishing gear with a weight of about 50–65 kg (10). The smallness of the foot size and the damage created on the floor by the claw and steel wire used under the foot were first displayed in this study with underwater images. The underwater images showed that the damage of the claw and steel wire on the ground is more serious in T beam trawls compared to M1 and M2.

Numerous experimental studies have been carried out on pots and traps, which are alternatives to the beam trawls widely used in sea snail fishing (14,15,18). However, these first attempts on the Southeast Black Sea coast have failed in terms of fishing yield and they have not been adopted by fishermen. Due to the low fishing yield in fishing with pots, fishermen were not satisfied economically (8). In Turkey, the beam trawl fishing method as well as sea snail fishing by diving is free all year round but only 5% of the sea snails caught on the coasts of Turkey are obtained by diving (18). This method is not preferred because of the nonconformity of underwater equipment, lack of a sufficient number of

educated divers, many underwater accidents, and difficult working conditions. Average lengths of sea snails obtained in beam trawl and in fishing by diving were 5.61 and 5.83 cm, respectively (18). In this study, smaller individuals were caught with T beam trawls while larger individuals were caught with M2 beam trawls. While the steel wire enables the entire catch in front of it to move into the bag by moving it from the ground, it is thought that relatively small individuals remain under the chain when there is no steel wire and the bigger ones are directed to the bag by the chain. The best pot in an experiment with 3 different pots was $0.62 \text{ kg pot}^{-1} \text{ day}^{-1}$ (15). It is reported that this value is $379 \text{ kg diver}^{-1} \text{ day}^{-1}$ in fishing by diving; however, in beam trawls, it is $552 \text{ kg dredge}^{-1} \text{ day}^{-1}$ (15). Although M2 captured 48% fewer individuals than T beam trawls, removal of steel wire can be an important structural improvement considering the fact that it gives less damage to the ground and catches larger individuals. Fishermen will use the sea snail beam trawls under all conditions until a more effective and environmentally friendly fishing gear is developed. The greatest proof of this is that fishermen go fishing with the beam trawl in the forbidden period or even use two beam trawls instead of one (6,15). In our study, the T beam trawl's high CPUE values of $70.12\text{--}77.37 \text{ kg h}^{-1}$ also support this. However, underwater observations have shown that the structure of the ground is overly damaged by the use of traditional gear. Such damage can lead to the direct deaths of organisms in regions where the fishing gear is in contact with the ground, and there may be a decrease in the number of large organisms (12). In this study, the fact that T and M1 steel wire had significant impacts on the destruction of large organisms

was observed in these four groups. Fishermen engaged in sea snail fishing emphasized the fact that the steel wire takes out the snails buried in the sand and hence the steel wire is important in terms of fishing. In the T-M2 experiment, the significant difference between the CPUE values also showed the importance of the steel wire in the amount of the catch. However, this does not indicate that the steel wired beam trawl is innocent and harmless, and the underwater images being monitored by the fishermen also enabled them to see the damage.

As a result of this study, it has been found that the steel wire has a significant effect on the amount of catch in the beam trawl, which is the most effective instrument of sea snail fishing. However, underwater images of this fishing gear enabled us to see the negative effects of the steel wire and the whole gear on the ground. It is necessary to make many modifications to the sea snail beam trawls and to continue the research for alternative fishing gears. The applicability will be more effective if the results also satisfy the fishermen who make their living from this species. There is a need for studies to be made from now on as seasonal work, to be undertaken throughout the whole year to determine the damages that fishing devices have inflicted on the infauna and epifauna in more detail.

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