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The Effect of Bait and Soaking Times on Catch Efficiency and Species Composition of Trammel Nets

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Abstract

Trammel nets are used with long soaking times to increase catching efficiency in Türkiye commercial fisheries. In the present study aim to examine the effects of the baited alternative trammel nets instead of the long soaking times with non-baited trammel nets. A total of 405 individuals from 37 species were caught, including 143 from 9 target species, 93 from 18 non-target species and 169 from 10 other species. 98 non-damage individuals of target species comprised only 24.2% of total catch. The baited trammel nets were found as 1.56,1.6,1.2 times more efficient than non-baited nets for 3,5,7 days soaking times in the non-damage individuals of target species. The non-baited nets for only 1 day were determined as 1.5 times more efficient than baited nets. 109 damaged individuals (46.2%) were identified from the total target and non-target species in the baited and non-baited nets. As the soaking times increased, the number of damaged individuals in target and non-target, also other species increased. The addition bait affected number of individuals, whereas statistically insignificant. Consequently, the baited alternative method of trammel nets with 3 days soaking time can be recommended instead of the long soaking times considering negative effects on species for Turkish trammel net fisheries.

Introduction

Some trammel nets are used for catching generally various kinds of demersal fish from December to May in Türkiye commercial fisheries (Altınağaç et al., 2008; Şen & Özekinci, 2022). Şen and Özekinci (2022) reported that some of these nets are used an average 5 days, minimum 1 day and maximum 14 days soaking time. So, these nets can be used in the depth waters with long soaking times to catch demersal fish such as cuttlefish, shark, stingray, sole, scorpion, flounder and lobster, so these nets are known as marya nets in the Türkiye fisheries. The main purpose of commercial fisher's trammel nets with long soaking times is to increase catching efficiency by attracting high-economic value, carnivorous, scavenger and slow-moving species such as cuttlefish, angler fish, lobster etc. (Şen & Özekinci, 2022). Also some species are caught passively during long soaking tines. As a result of the long soaking time of these nets, they cause deterioration, damage or discard of the caught species regardless of their economic value in the early days, and this happens again and again until they are removed from the sea. This situation may emerge ecologically undesirable catching method in Turkish commercial fisheries.

Cochrane (2002) reported that trammel nets have poor size and species selective properties, resulting in high negative effects on the ecosystem. So, alternative fishing methods are necessary to not damage marine species and ecosystems, considering the negative effects of fishing gear and reductions in fish stocks (Pontecorvo, 2008; Palkovacs, 2011; Hilborn et al., 2020; Palomares et al., 2020). Several studies have suggested that the long soaking time method of the gillnets should be short and the soaking time should not be longer than 24 hours so that the quality of the caught species should not be damaged (Dickson, 1989; Engas & Lokkeborg, 1994; Cilasın et al., 2015). However, there is no regulation regarding the soaking times of trammel nets in the Regulation of Turkish Commercial Fisheries (GDFA, 2020).

Some studies were focused on the effects of attracting fish species to different fishing gear by taking advantage of the odor caused by the bait on catching efficiency (Engas et al., 2000; Özdemir & Erdem, 2006; Dartay & Duman, 2016). The basic principle in the fishing of non-baited trammel nets that fish are caught by being snagged, gilled, wedged or entangled, when actively moving fish have tried to pass through the mesh (Millner, 1985; Karslen & Bjarnason, 1986). Increasing the chance of fish encountering in trammel net is possible by increasing the fish's desire to head toward this net (Engas et al., 2000; Kallayil et al., 2003). For this purpose, bait types are used to attract fish to fishing gear by making use of their feeding behavior with chemical stimuli (Atema, 1980; Løkkeborg, 1990; Kallayil et al., 2003). Baited fishing gear has the feature of attracting fish thanks to the chemical stimulants that affect the fish. After the bait odor disperses and reaches the fish, it shows search behavior by using its sense of smell to find the bait (Fernö et al., 1986; Furevik & Løkkeborg, 1994). The bait-seeking behavior of fish indirectly increases the probability of encountering baited nets and being caught in these nets. Also, the fish stay around the nets longer in baited nets (Kallayil et al., 2003).

Many researchers argued that the effects of different bait types and soaking times on catch efficiency and species composition in various fishing gear such as gillnets, longlines and traps (De Rozarieux, 2014; Løkkeborg et al., 2014; Gilman et al., 2020; Spoors et al., 2021; Demirkıran & Özekinci, 2022; Cullen & Stevens, 2017; Olsen et al., 2019; Naimullah et al., 2022). Also, commercial fisher declared that trammel nets were used by adding fish as bait to catch some species like lobsters in 1980-1990 in Çanakkale, Türkiye. But, no study with trammel nets has been investigated with the addition of bait instead of the long soaking time used especially for caught demersal fish in Türkiye fisheries until now. Therefore, the aim of this study was to evaluate on species the baited alternative trammel nets instead of the long soaking times and non-baited trammel nets.

Materials & Methods

The present study was carried out in the Kemer Region of the Marmara Sea, Türkiye (Figure 1). A total of 10 catch operations with 3 repetitions of trammel nets were conducted in the winter and spring seasons of 2022, each with 5 catch operations because of mostly used in these months to catch demersal species in commercial fisheries. Baited (B) and non-baited (NB) multifilament trammel nets with 46 millimeter (mm) nominal mesh size and outer panel with 180 mm mesh size (bar length) were used in fishing operations. Each

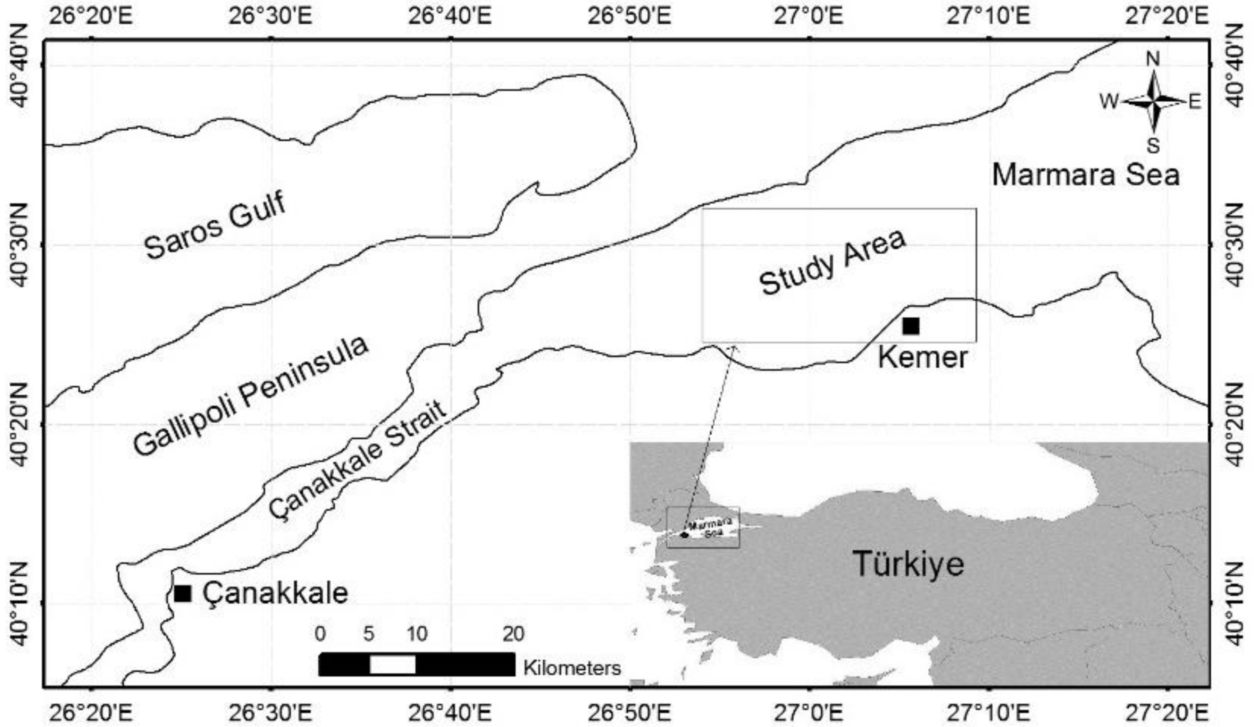

Figure 1. Study area.

trammel net set was 33 meters long, 33 mesh depth, 0.50 hanging ratio and 210d/6 mesh thickness. Other characteristics of baited and non-baited trammel nets are presented in Figure 2.

The only difference between baited and non-baited trammel nets was the use of bait. Waste and parts of consumed fish as bait with 100 grams (g) were put into bags and added to the leadline part of these nets, with 2 bags in each baited trammel net set. The bait type consisted of a mixture of *Trachurus* sp., and *Spicara* sp., were used in half. This bait was placed in polyamide bags with mesh size of 30 microns.

The baited and non-baited trammel nets (total of 800 meters) with four soaking times (1, 3, 5, 7 days) were prepared with three repetitions. Baited and non-baited trammel nets were operated simultaneously. For each trammel net, one of the baited and non-baited was joined together end-to-end. A passive fixed method was used. These nets were set in the early morning and retrieved the following 1, 3, 5 and 7 days soaking times early in the morning. The adding bait was made on the first day, and no extra bait was made on the next day. Since these nets were removed from the sea at different soaking times, one operation was completed in four days. The fishing operations were carried out at the depth of 20-70 meters.

The species were classified as target (T), non-target (NT) and other (O) species from baited or non-baited trammel nets for soaking times. The identification of these was determined by Alverson et al. (1994) as reference.

Target species (T): The lobster, cuttlefish, flounder, sole, angler fish, gurnard species, black scorpionfish, octopus and whiting species have targeted by commercial fisher.

Non-target species (NT): Osteichthyes and chondrichthyes groups cannot be commercially evaluated.

Other species (O): Macrobenthic organisms which arthropoda, mollusca, echinodermata and cnidaria groups cannot be commercially evaluated.

After being landed, these species were identified according to Whitehead et al. (1986), Kaya et al. (2011), Bilecenoğlu et al. (2014) and WoRMS (2023). On the basis of knowledge and observations from earlier retrieval cruises two stages were identified from caught target and non-target species. These stages adapted according to Humborstad et al. (2003);

Non-damage (F); the fish is alive or dead and shows no sign of morphological damaged, no faded gills noted, glossy eyes, rigor might occur.

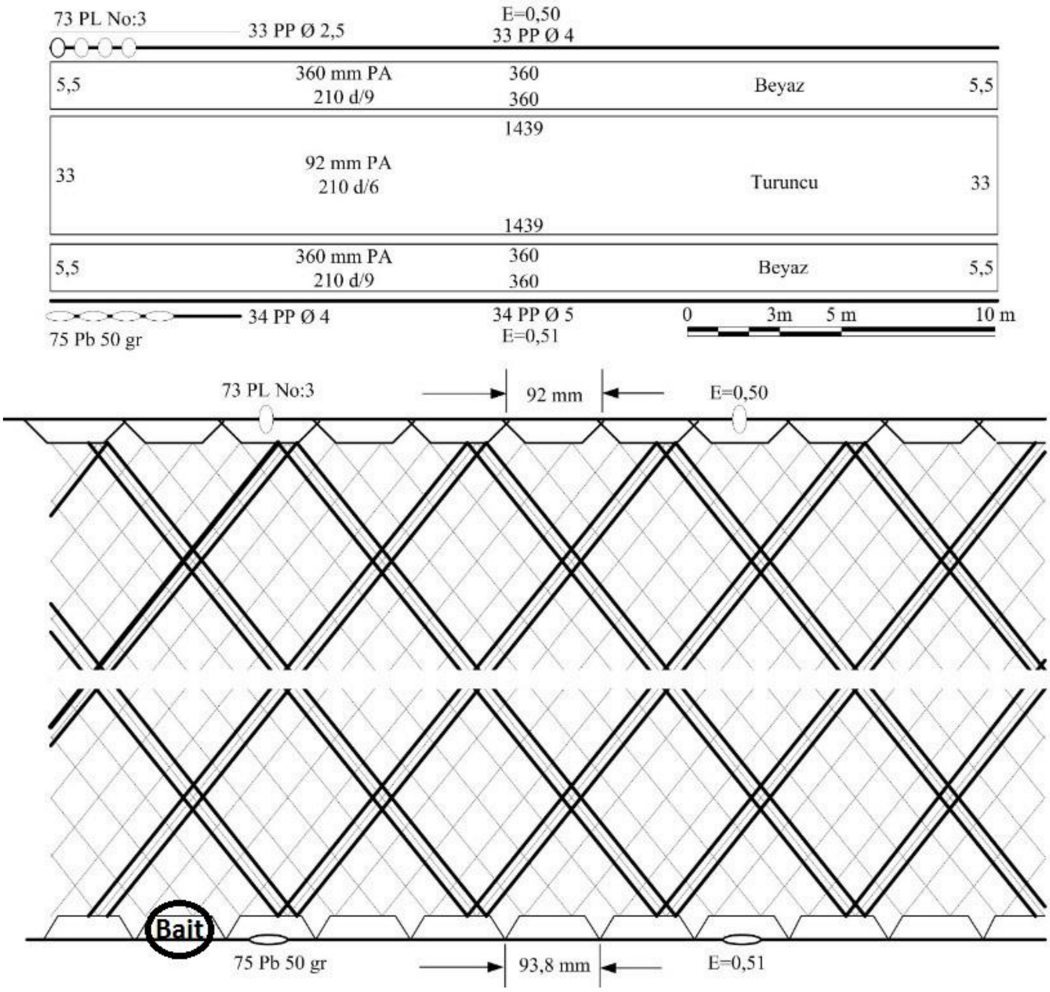

Figure 2. Scaled (top) and detailed (below) technical plans of trammel nets.

Damaged (D); damaged indicators as above, but this stage is characterized by small holes in the flesh caused by scavengers (amphipods and isopods). Also, bones partially exposed, intestines missing. Bacterial decay is included and only skeleton or parts of it remaining.

These species were evaluated as non-damage of target, damaged of target, non-damage of non-target, damaged of non-target, other species for soaking times and bait status. The non-damage of target species in bait status was compared according to soaking times. The weight of non-damage target and non-target species were measured by the nearest 1 g digital scale. The weight of the target and non-target species in bait status were compared according to soaking times.

To assess the catching efficiency, the catch per unit effort (CPUE) was calculated from the following equation: CPUE $=\Sigma(Y/L)/n$, where Y is the catch in weight (kg) or individuals of fish (n) of a given species in one operation, L is the length of nets (33 m) and n is the number of operations (Hyvärinen & Salojärvi, 1991; Balık & Çubuk, 2001). In the calculation of CPUE, the individuals (ind) of non-damage and their weight of target and non-target species were used.

The IBM SPSS 25 (IBM Corp, 2017) program was used for statistical analyses. Independent Two-Sample T-test (a) or Mann Whitney U test (c) taking into account normality was used to test the differences firstly in the non-damage and damaged individuals of target and non-target species; secondly in the individuals of target, non-target and other species at the bait status; thirdly in the non-damage and damaged individuals of target and non-target species at the bait status; fourthly in the weight of target and non-target species at the bait status. Friedman test (b) was used to test the differences firstly in the individuals of target, non-target and other species; secondly in the non-damage and damaged individuals of target and non-target species; thirdly in the weight of target and non-target species at the different soaking times.

Results

A total of 405 individuals from 37 species were caught in the fishing operations, including 143 individuals (35.3%) from 9 in the target species, 93 individuals (23%) from 18 in the non-target species, and 169 individuals (41.7%) from 10 in the other species. The target species composition with non-damage and damaged individuals in the bait status, depending on soaking times are provided in Table 1. *Sepia officinalis* was the most caught among the target species. The F and D individuals of *S. officinalis* increased with the soaking times. 43 individuals of *S. officinalis* were caught in B, while 36 individuals of *S. officinalis* in NB. 35 non-damage individuals caught in B and 29 non-damage individuals caught in NB. The detailed individual of *S. officinalis* according to soaking times and bait status can be seen from Table 1 and Figure 3. The mean total length of *S. officinalis* was higher in the baited net than the non-baited net, whereas the mean weight of *S. officinalis* was higher in the non-baited net than in the baited net. There was no statistically significant difference with independent Two-Sample T-test among baited and non-baited nets for *S. officinalis* of total length and weight ($p>0.05$) (Table 2).

Solea solea was the highest caught fish species with 25 individuals. While 10 individuals caught in NB and 15 individuals in B. Also, only 13 individuals were non-damage. *Homarus gammarus* one of the main targets of trammel nets caught with 1 individual in B for 5 days, while 2 individuals in B for 7 days and 1 individual in NB for 7 days. Although 1 individual of *Chelidonichthys lucerna* was identified, 6 individuals of (*Chelidonichthys* sp.) could not be identified due to damaged. 19 individuals of *Lophius* sp. caught. 12 individuals of these in B and 7 individuals in NB. While 15 F individuals of *Lophius* sp. and 4 D individuals of *Lophius* sp. were detected. Although 2 individuals of *Merluccius* sp. caught in NB and 4 in B, all of these individuals were evaluated as damaged. While, 1 individuals for each of

Table 1. The F and D individuals of T in the bait status, depending on soaking times (T: Target species, F: Non-damage, D: Damaged, B: Baited, NB: Non-baited, TT: Total)

T	1 day				3 days				5 days				7 days				F	D	TT
	NB		B		NB		B		NB		B		NB		B				
	F	D	F	D	F	D	F	D	F	D	F	D	F	D	F	D			
Mollusca																			
Sepia officinalis	2	0	2	0	6	1	7	1	6	3	8	2	15	3	18	5	64	15	79
Arthropoda																			
Homarus gammarus										0	1	0	0	1	1	1	2	2	4
Osteichthyes																			
Solea solea	1	0	0	2	1	2	2	2	2	1	3	0	2	1	2	4	13	12	25
Chelidonichthys lucerna															1	0	1	0	1
Chelidonichthys sp.					0	1			0	2	0	1	0	1	0	1	0	6	6
Lophius sp.					2	0	4	0	2	0	3	1	2	1	2	2	15	4	19
Merluccius sp.							0	1	0	1	0	2	0	1	0	1	0	6	6
Scorpaena scrofa							1	0			1	0					2	0	2
Platichthys flesus													1	0			1	0	1
TT	**3**	**0**	**2**	**2**	**9**	**4**	**14**	**4**	**10**	**7**	**16**	**6**	**20**	**8**	**24**	**14**	**98**	**45**	**143**

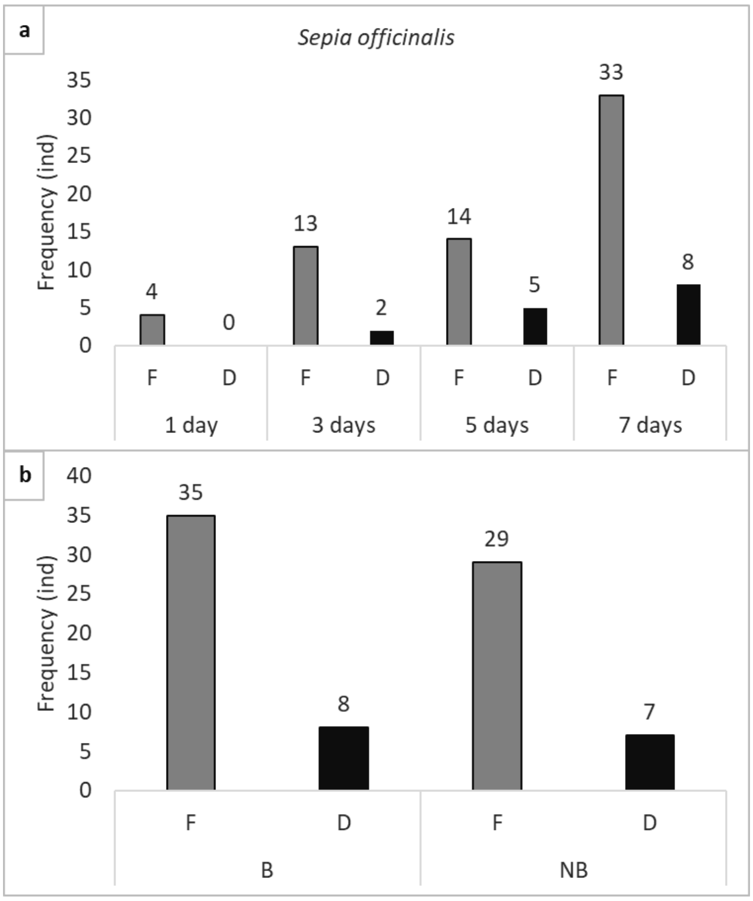

Figure 3. The non-damage (F) and damaged (D) individuals of *S. officinalis* in soaking times (a) and baited (B) and non-baited (NB) trammel nets (b).

Table 2. The total length and weight, minimum (min), maximum (max) and mean ± standard error (Se) of most caught *S. officinalis* among the target species

S. officinalis	Number of individuals	Total length (cm) Min–Max (Mean±Se)	Weight (cm) Min–Max (Mean±Se)
Baited net	35	25.3-44 (34.4±4.7)	348-2164 (952.2±384.4)
Non-baited net	29	22-40.3 (33±5.2)	318-1680 (994±400.8)

Scorpaena scrofa caught in B for 3 days and 5 days. 1 individual of *Platichthys flesus* caught in NB for 1 day (Table 1).

The non-target species composition with F and D individuals of in the bait status, depending on soaking times are given in Table 3. Although *Trachinus* sp., *Diplodus annularis*, *Mullus barbatus*, *Mullus surmuletus*, *Pomatomus saltatrix*, *Scomber scombrus*, *Scyliorhinus canicula*, *Dasyatis pastinaca* were determined as damaged individuals; *Chelidonichthys lastoviza* and *Myliobatis aquila* were determined non-damage individuals. *Trachurus* sp. was the highest caught among the non-target species with 19 individuals. The individuals of NT according to soaking times and bait status are shown in Table 3. *Scyliorhinus stellaris*, *S. canicula*, *Mustelus mustelus* and *Squalus acanthias* of shark species, *Torpodo marmorata*, *M. aquila*, *Raja clavata* and *D. pastinaca* of stingray species caught with 50 individuals as NT. Among these chondrichthyes caught, the critically endangered *M. aquila* and the endangered *M. mustelus* are especially notable. *M. aquila* detected only in B and F. While 25 individuals chondrichthyes were caught in B, 25 individuals of them were caught in NB. While 23 individuals of chondrichthyes were F, 27 individuals were D. 14 D individuals in B and 13 D individuals in NB were determined. *T. marmorata* was the highest caught among the chondrichthyes fish with 17 individuals (Table 3).

The non-damage individuals of target species in the non-baited trammel nets was determined to be 1.5 times more efficient than the baited trammel nets for 1 day. But, the non-damage individuals of target species in the baited trammel nets was determined to be 1.56, 1.6, 1.2 times more efficient than the non-baited trammel nets for 3 days, 5 days and 7 days, respectively.

The other species composition with F and D individuals of in the bait status, depending on soaking times are provided in Table 4. *Astropecten irregularis* and *Liocarcinus depurator* occurred only in the baited nets. *Bolinus brandaris* was the highest caught among the other species with 55 individuals on soaking times.

Table 3. The F and D individuals of NT in the bait status, depending on soaking times (NT: Non-target species, F: Non-damage, D: Damaged, B: Baited, NB: Non-baited, TT: Total)

NT	1 day				3 days				5 days				7 days				F	D	TT
	NB		B		NB		B		NB		B		NB		B				
	F	D	F	D	F	D	F	D	F	D	F	D	F	D	F	D			
Osteichthyes																			
Chelidonichthys lastoviza					1	0	1	0									2	0	2
Trachinus sp.							0	1							0	1	0	2	2
Diplodus annularis									0	1							0	1	1
Trachurus sp.	0	1	0	1	0	1	0	3			0	2	2	2	0	7	2	17	19
Engraulis encrasicolus					1	0	0	1	0	2	0	1	0	2	0	1	1	7	8
Mullus barbatus							0	1									0	1	1
Mullus surmuletus					0	1											0	1	1
Scorpaena porcus			1	0							0	1					1	1	2
Pomatomus saltatrix													0	1			0	1	1
Scomber scombrus					0	1	0	1	0	1	0	2	0	1			0	6	6
Chondrichthyes																			
Scyliorhinus stellaris													1	1	0	1	1	2	3
Scyliorhinus canicula							0	1	0	1	0	1					0	3	3
Mustelus mustelus													0	1	1	0	1	1	2
Squalus acanthias					0	2	0	1	1	0	0	1	0	1	0	2	1	7	8
Torpedo marmorata	1	0			2	0	1	1	2	0	2	1	2	1	2	2	12	5	17
Myliobatis aquila			1	0													1	0	1
Raja clavata	1	0			1	0	1	0	1	1	2	0	0	1	1	0	7	2	9
Dasyatis pastinaca					0	1			0	2	0	2	0	1	0	1	0	7	7
TT	**2**	**1**	**2**	**1**	**5**	**6**	**3**	**10**	**4**	**8**	**4**	**11**	**5**	**12**	**4**	**15**	**29**	**64**	**93**

Table 4. The F and D individuals of O in the bait status, depending on soaking times (O: Other species, F: Non-damage, D: Damaged, B: Baited, NB: Non-baited, TT: Total)

O	1 day		3 days		5 days		7 days		TT
	NB	B	NB	B	NB	B	NB	B	
Arthropoda									
Squilla mantis	0	1	1	2	2	3	4	3	16
Goneplax rhomboides	1	1	2	0	1	2			7
Liocarcinus depurator			0	1					1
Medorippe lanata			0	1	1	1			3
Mollusca									
Tonna galea					0	2			2
Bolinus brandaris	1	0	8	4	6	9	13	14	55
Cnidaria									
Alcyonium sp.			2	0	1	0	0	2	5
Echinodermata									
Astropecten irregularis	1	1	0	1	2	1	4	3	13
Parastichopus regalis			6	8	7	10	7	9	47
Marthasterias glcialis			2	1	3	2	4	8	20
TT	**3**	**3**	**21**	**18**	**23**	**25**	**32**	**39**	**169**

The more individuals caught in B for 5 days and 7 days of soaking times than on the other days. The more individuals caught in NB than in B for 3 days. The highest *B. brandaris* with 14 individuals caught in B for 7 days (Table 4).

The individuals of T, NT and O according to bait status and soaking times, and also F and D individuals are shown in Table 5. No significant difference determined between the individuals of T, NT and O in B and NB ($p>0.05$). The difference of T was caused by the soaking times of 1 day to 5 days (p:0.01) and 7 days (p:0.00), 3 days to 7 days (p:0.014). The difference of NT was caused by the soaking times of 1 day to 5 days (p:0.012) and 7 days (p:0.019). The difference in O was caused by the soaking times of 1 day to 3 days (p:0.03), 5 days (p:0.00) and 7 days (p:0.00). 109 individuals D (46.2%) from total of 236 individuals were detected in T and NT. The significant difference was found between T and NT in the soaking times ($p<0.05$). 127 F individuals (53.8%) and 109 D individuals (46.2%) were determined in T and NT. But, the significant difference found between the F and D individuals ($p<0.05$) (Table 5).

The F and D individuals in bait status and soaking times of target species are presented in Table 6. No significant difference determined between the F individuals in bait status ($p>0.05$). But, the significant difference detected between the D individuals in bait status (p<0.05). The F and D individuals were determined in the lowest 1 day and the highest in 7 days. The significant differences found between F individuals in soaking times (p<0.05), due to 1 day to 7 days (p:0.00). Also, the significant difference was detected between the D individuals in soaking times (p<0.05), due to 1 day and 3 days (p:0.00); 1 day and 7 days (p:0.00); 3 days and 5 days (p:0.00); 5 days and 7 days (p:0.00) (Table 6).

The F and D individuals in the bait status and soaking times of non-target species are shown in Table 7. No significant difference defined between the F and D individuals in bait status (p>0.05). The F and D individuals were detected in the lowest 1 day and the highest in 7 days. There significant differences found between F individuals of NT caught in soaking times. Also, the significant difference determined between the D individuals of NT in soaking times (p<0.05), due to 1 day and 5 days (p:0.016); 1 day and 7 days (p:0.014) (Table 7).

The total weight of F determined as 122.7 kg. 92.7 kg of the weight of T and 30 kg of the weight of NT. The weight of T determined 55.7 kg in B and 37 kg in NB, whereas the weight of NT determined 15.6 kg in B and 14.4 kg in NB. No significant difference determined the weight of T and NT in the bait status (p>0.05). No significant difference found between the weight of NT in the soaking times (p>0.05). The significant difference was determined between the weight of T in the soaking times (p<0.05) due to the difference between 1 day and 7 days (p:0.01) (Table 8).

Table 5. The individuals of T, NT and O in bait status and soaking times, and F and D individuals in T and NT (T: Target species, NT: Non-target species, O: Other species, F: Non-damage, D: Damaged, B: Baited, NB: Non-baited)

	T	%	p	NT	%	p	O	%	p
Number of ind	**143**	**35.3**		**93**	**23**		**169**	**41.7**	
F	98	68.5	**0.00**(a)	29	31.2	**0.003**(a)	-	-	-
D	45	31.5		64	68.8				
Bait status									
B	82	57.3	0.325(a)	43	46.2	0.641(a)	90	53.3	0.694(a)
NB	61	42.7		50	53.8		79	46.7	
Soaking time (days)									
1	7	4.9	**0.00**(b)	6	6.5	**0.00**(b)	6	3.6	**0.00**(b)
3	31	21.7		24	25.8		39	23.1	
5	39	27.3		27	29.0		53	31.3	
7	66	46.1		36	38.7		71	42.0	

p<0.05 significant difference, p>0.05 insignificant difference

Table 6. The F and D individuals in bait status and soaking times for T (T: Target species, F: Non-damage, D: Damaged, B: Baited, NB: Non-baited)

T	F	%	p	D	%	p
Bait status	**98**	**31.5**		**45**	**68.5**	
B	56	57.1	0.215(a)	26	57.8	**0.00**(a)
NB	42	42.9		19	42.2	
Soaking time (days)						
1	5	5.1	**0.00**(b)	2	4.4	**0.00**(b)
3	23	23.5		8	17.8	
5	26	26.5		13	28.9	
7	44	44.9		22	48.9	

Table 7. The F and D individuals in bait status and soaking times for NT (NT: Non-target species, F: Non-damage, D: Damaged, B: Baited, NB: Non-baited)

NT	F	%	p	D	%	p
Bait status	**29**	**31.2**		**64**	**68.8**	
B	13	44.8	0.716(a)	37	57.8	0.515(c)
NB	16	55.2		27	42.2	
Soaking time (days)						
1	4	13.8	0.648(b)	2	3.1	**0.003**(b)
3	8	27.6		16	25.0	
5	8	27.6		19	29.7	
7	9	31.0		27	42.2	

CPUE value of non-damage individuals for T and NT in bait status according to number of individuals and weight is given in Table 9. The highest individuals and weight of CPUE for T was determined in 7 days, while the lowest CPUE for T was determined in 1 day. The highest individuals of CPUE for NT was determined in 7 days, while the lowest CPUE for T was determined in 1 day. The highest weight of CPUE for NT was determined in 5 days, while the lowest CPUE of T was determined in 1 day. The more efficient the individuals of CPUE for T was determined 1.3 times and the weight of CPUE for T was determined 1.6 times in B than in NB (Table 9).

Discussion

The present study was tested with the hypothesis that some species of high commercial value can be attracted to trammel nets in shorter soaking times with the addition of bait. From earlier retrieval cruises, commercial fisher of trammel nets in the Çanakkale, Türkiye stated that they caught species such as lobsters by adding bait to trammel nets in 1980-1990. Afterwards, commercial fisher stated that the method of adding bait was forgotten by itself, the new commercial fisher used long soaking times instead of adding bait to the trammel nets. So, this study focused on the baited alternative trammel nets instead of the long soaking times and non-baited trammel nets.

The addition of bait affected the individuals of T, NT and O, whereas this effect was statistically insignificant ($p>0.05$). The individuals of T, NT and O were affected by soaking time and this effect was significant ($p<0.05$). While the addition of bait caused significantly increase in the non-damage individuals of the target species ($p<0.05$), it is also caused significantly increase in the damaged individuals of non-target species ($p<0.05$). But, 98 non-damage ind of target species were only 24.2% of the total catch in the current study. 109 damaged individuals of target and non-target species constituted 46.2% of the total target and non-target individuals in baited and non-baited trammel nets. Nearly half of the individuals were damaged. The main reason for the deterioration in the current study is that some parasitic species attacked and damaged caught species in the trammel nets. Scientific researches revealed that some species of isopods could pose a threat to Türkiye fisheries (Kirkim et al., 2019; Öndeş, 2019; Mülayim et al., 2022).

The most intensively caught species was *S. officinalis* in baited and non-baited nets among the target species in this study. The alternative baited nets were 1.21 times more catch in terms of the non-damage individuals of *S. officinalis*. *H. gammarus* is the target species with the highest commercial value in the long soaking time of trammel net fishing. But, 2 individuals of *H. gammarus* were damaged in baited and non-baited nets for 7 days, indicating that these individuals were adversely affected by long soaking times. As a result, the adding bait and long soaking times for this species did not important. The individuals of target species can be increased by shortening the soaking times with the different bait types. Gilman et al. (2022) reported that

Table 8. Distribution of the weight (kg) of the F individuals of T and NT according to the bait status and soaking times (T: Target species, NT: Non-target species, B: Baited, NB: Non-baited)

	T	%	p	NT	%	p
Bait status	**92.7**	**75.6**		**30**	**24.4**	
B	55.7	60.1	0.299 [(c)]	15.6	52.0	0.603 [(c)]
NB	37	39.9		14.4	48.0	
Soaking time (days)						
1	3.8	4.1	**0.00**[(b)]	3.4	11.3	0.410[(b)]
3	23.5	25.4		7.1	23.7	
5	21.4	23.1		11.6	38.7	
7	44	47.4		7.9	26.3	

Table 9. CPUE of non-damage individuals of T and NT (T: Target species, NT: Non-target species, B: Baited, NB: Non-baited, TT: Total)

Bait status	Ind of CPUE			Weight of CPUE		
	T	NT	TT	T	NT	TT
B	0.014	0.003	0.017	0.014	0.004	0.018
NB	0.011	0.004	0.015	0.009	0.004	0.013
TT	0.025	0.007	0.032	0.023	0.008	0.031
Soaking time (days)						
1	0.003	0.002	0.005	0.002	0.002	0.004
3	0.012	0.004	0.016	0.012	0.003	0.015
5	0.013	0.004	0.017	0.010	0.006	0.016
7	0.022	0.005	0.027	0.022	0.004	0.026
TT	0.048	0.015	0.064	0.046	0.015	0.061

various baits are used to control the selectivity of species. De Rozarieux (2014) emphasized that discard species and fish waste can be used as bait. The "waste and parts of consumed fish" bait increased individuals of the other target species in this study. *S. solea*, *Lophius* sp., *Merluccius* sp. and *S. scrofa* more caught in baited nets in this study. Hickford and Schiel (1997) presented that the baited nets can be done earlier in catching. The individuals of the target species did not increase for 1 day in the baited nets, but increased for 3, 5 and 7 days.

According to Hamley (1975) different characteristics fishing nets were preferred to catch different species. Although the modification of fishing gear increases the amount of catch, it is inevitable to increase the amount of bycatch (Bayse & Grant, 2020). In the present study, *C. lucerna*, *P. flesus*, *Trachinus* sp., *M. barbatus*, *M. aquila*, *Tonna galea*, *L. depurator* caught only in baited nets. The more species and individuals of target, non-target and other species caught in baited nets.

Dulvy et al. (2017) declared that cartilaginous fish were especially slow growing, late maturing, long reproduction and life cycle, low fertility, protected by many contracts and significant reductions in catch amounts. 50 individuals chondrichthyes from 8 species were caught in baited and non-baited nets in the present study. These chondrichthyes fish increased depending on the increase in soaking times. For this reason, fisheries managers should consider the issue carefully in order not to reveal potential problems with non-target species while increasing the target catch rate (Bayse & Grant, 2020). Erzini et al. (2006) reported that reducing the soaking time is one of the methods for reducing the problem of bycatch in the gillnet fisheries. The half of the chondrichthyes fish caught in the baited nets shows that adding bait to the trammel nets has no effect on the chondrichthyes species in this study. But, it should not be ignored that the amount of catch for the chondrichthyes species increased depending on soaking times.

Miller (1979) declared that the amount of catch is not constant in passive fishing gear, but the amount of catch does not increase over time, which does not coincide with the results of this study. In the present study, the soaking times increased, the total amount of target, non-target and other species caught in baited and non-baited increased slightly, but it did not increase when evaluated on the basis of species composition. This situation may be related to the catching of the species in the trammel nets by snagged, gilled, wedged or entangled.

In previous studies with gillnets, Engas et al. (2000) stated that baited net was 3 times more efficient than non-baited for some species. They declared that *Gadus morhua* 61%, *Molva molva* 23%, *Reinhardtius hippoglossoides* 36% of the more catch in baited nets. Kallayil et al. (2003) stated that baited nets caught more, but the catch ratio was not higher. Bayse and Grant (2020) stated that by adding different bait types to gill nets, the catch efficiency for *R. hippoglossoides* species increased by 253.8% and 149.7%. In the present study with baited trammel nets were determined to be 1.56, 1.6, 1.2 times more efficient than non-baited nets for 3 days, 5 days and 7 days in non-damage individuals of the target species. Only non-baited nets for 1 day were determined to be 1.5 times more efficient than baited nets. Bayse and Grant (2020) declared that baited nets increase the catch efficiency of target species; these will cause a decrease in soaking times or the number of nets, which may reduce the rate of bycatch, but it may also pose a threat to the populations of some non-target species.

According to the results of CPUE value evaluations, it is necessary to switch to baited nets instead of non-baited nets and long soaking times. But, the faster and higher amount of catch was not provided in baited nets for 1 day. It is thought that no damaged individuals of target species in non-baited nets for 1 day are due to the absence of bait, whereas the presence of damaged individuals of target species in baited nets is due to the effect of the bait. It has been determined that there is no difference in individuals, weight, and catch efficiency between 3 days and 5 days of baited nets. Although baited nets for 7 days compared to 3 days were revealed to catch more in terms of individual catch efficiency, weight, and catch efficiency, baited nets for 7 days have negative effects on damaged species of target, non-target species and other species. So, trammel nets with 3 days soaking time set twice a week and baited could provide more efficiency and lower negative effects of catching than 7 days soaking time. It is thought that the effect of the bait may attract more parasitic organisms especially in baited nets as the soaking time increases and causing damage to target and non-target species.

Şen and Özekinci (2022) declared length of average 5150 meters and soaking time of average 5 days of trammel nets used in Çanakkale, Türkiye. They reported that this situation could have negative consequences for this region and also Türkiye commercial fisheries. However, there is no regulation regarding the soaking times of trammel nets in Türkiye commercial fisheries regulations (GDFA, 2020). Considering all the present study results and the negative effects of soaking times on species, baited alternative trammel nets and 3 days soaking time can be recommended for Türkiye trammel net fisheries. The effects of long soaking times for trammel nets on the ecosystem definitely should not be ignored and regulations must be made. Consequently, the catching efficiency of the target species can be increased by shortening the soaking times with species-specific bait types by taking into account the feeding characteristics of the target species. A lot of mixed target, non-target and other species can be caught with the long soaking time of trammel nets. But, no statistically significant difference among baited and non-baited nets of main target species *S. officinalis* for the total length and weight. So, further comprehensive studies with the various baited nets should be carried out, considering the length distributions of taking into account the minimum landing size and first reproductive size of the target species.

Ethical Statement

All triploidy process and experimental protocols have been approved by Veterinary Control and Research Institute, Animal Experiments Local Ethics Committee (No; 2020/11-06) under the General Directorate of Agricultural Research and Policy surveillance.

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Author Contribution

Yusuf Şen: Conceptualization, Writing, Formal Analysis, Investigation, Methodology; Uğur Özekinci: Review and Editing

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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