



RESEARCH ARTICLE

## Evaluation of Illegal, Unreported and Unregulated (IUU) Trawl Infringements Committed by Turkish Fishing Vessels

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**Key words:**

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Turkish Waters  
Illegal fishing  
Trawl violation

**Abstract:** This study analyses a highly damaging and prevalent fishing practice of trawl infringements, which is one of the crucial components of IUU fishing in Turkish waters. The raw data gathered from the Turkish Coast Guard Command (TURCG), covered 2012 – 2014 period. Data covered a total of 1040 trawl infringements, with considerable differences in trawling violations among the seas surrounding Türkiye; the Black Sea, the Sea of Marmara, the Aegean Sea, and the Mediterranean Sea. With respect to trawling infringements, the Sea of Marmara (37%) and Istanbul Strait (15%) were the hot points. The most common infringement type was trawling in a closed area (43%) and when combined with the rate of infringements on trawling during the closed season (10%), these violations accounted for 53% of spatio-temporal infringements. Regarding illegal trawling by vessel type, trawl vessels had a 44% share and non-trawlers had a share of 56%, of which included infringements by other type of fishing vessels (46%) and non-fishing vessels (10%). It was also found that infringement by vessels smaller than 12 meters in length had a share of 46%. These vessels (known as "şebeke" in Turkish), trawl illegally using small types of nets and gears in coastal waters without giving any obvious indication of fishing activity. The results of this study will be useful to policy-makers, practitioners and scientists to successfully combat trawling infringements by providing information on distribution, intensity and methods of trawl violations.

**Anahtar kelimeler:**

Trol balıkçılığı  
Türk Denizleri  
Yasadışı avcılık  
Trol ihlalleri

### Türk Balıkçı Gemileri Tarafından İşlenen Yasa Dışı, Kayıt Dışı, Kural Dışı (YKK) Trol İhlallerinin Değerlendirilmesi

**Öz:** Bu çalışma, Türkiye Denizlerinde YKK (Yasa Dışı, Kayıt Dışı, Kural Dışı) balıkçılığın en zararlı ve yaygın bileşenlerinden biri olan trol ihlallerini analiz etmektedir. Çalışmaya ait ham veriler, Sahil Güvenlik Komutanlığı'ndan 2012-2014 döneminde temin edilmiştir. Toplam 1040 trol ihlaline ait veriler incelendiğinde, Türkiye'yi çevreleyen Karadeniz, Marmara Denizi, Ege Denizi ve Akdeniz arasında trol ihlalleri bakımından dikkate değer farklılıklar olduğu tespit edilmiştir. Trol ihlalleri bakımından Marmara Denizi (%37) ve İstanbul Boğazı (%15) kendi ölçeklerinde en sıcak noktalar olarak bulunmuştur. En yaygın ihlal türü %43 ile yasak sahada trol çekmek olup, yasak zamanda trol çekme ihlalleri ilave edildiğinde zamansal-mekansal ihlallerin %53'e ulaştığı gözlemlenmiştir. Yasadışı trol avcılığı gemi türü bakımından incelendiğinde ise trol gemileri %44'lük bir paya sahipken, diğer balıkçı gemileri (%46) ve balıkçılık ruhsatına sahip olmayan gemilerin (%10) oluşturduğu trol ruhsatına sahip olmayan gemiler %56 paya sahip olmuştur. Ayrıca boyu 12 metreden küçük olan gemilerin ihlaller içinde %46 gibi önemli bir paya sahip olduğu tespit edilmiştir. Bu gemiler (Türkçede "şebeke" olarak adlandırılmaktadır), dışarıya hiçbir emare vermeden küçük boyuttaki ağlar ve takımlarla kıyı sularında gizlice trol çekebilmektedir. Bu çalışmanın sonuçları, trol ihlallerinin dağılımı, yoğunluğu ve metotları hakkında bilgi vererek, trol ihlalleriyle etkin mücadele kapsamında uygulayıcılara, politika yapıcılara ve bilim insanlarına faydalı olacaktır.

### Introduction

The widely accepted and adopted definition of IUU fishing has three distinct dimensions: illegal, unreported, and unregulated activities. Illegal fishing is conducted by vessels of countries that are party to a fisheries organization. Unregulated fishing is normally conducted by vessels flying the flag of countries that are not parties

of or participants in relevant fisheries organizations implementing such activities as fishing without a license, fishing in a closed area or marine protected area (MPA), fishing with prohibited gear, fishing over a quota, or the fishing of prohibited species. Unreported fishing refers to fishing activities, which have not been reported, or have

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been misreported, to the relevant national authority, in contravention of national laws and regulations, or similar lack of reporting or misreporting to regional fisheries management organizations (FAO, 2001; Sumaila et al., 2006; Hosch, 2006; Polacheck, 2012; Phelps Bondaroff et al., 2015). In this study, the criteria mentioned above will be dealt with to assess situations of trawl infringements in Turkish Waters due to IUU fishing.

Türkiye is by far the largest producer accounting for 27.5% of the total fishing in the Black Sea, with 81.6% of capture fisheries coming from the Black Sea, and has the greatest fishing capacity (17.4%) in the GFCM area of application (FAO, 2022). With regard to IUU fishing, Türkiye has an index of 2.34, which is close to the world average (2.29), and ranks 54<sup>th</sup> place among 152 countries. Türkiye also ranks 8<sup>th</sup> in the GFCM area among 28 countries (Macfadyen et al., 2019). Data suggests that Türkiye does not make significant contribution to the IUU fishing, when compared to its proportionately great fishing capacity. Nevertheless, Türkiye's marine capture production decreased by 30% in the last decade (GDFA 2022). It is strongly considered that Türkiye's large-scale fishery could be responsible for this decline. As one of the main gear types of large-scale fisheries, trawl fishery (bottom and mid-water trawls) constitutes 32% of total marine capture production (Anonymous 2018) and represents 5.7% of the fishing fleet with 786 trawl-licensed vessels (TURKSTAT, 2020). Therefore, trawling infringements in Turkish waters have substantial significance to combat IUU fishing with respect to developing solutions and updating regulations (GFCM, 2017; EU, 2017).

The present study has two major goals; i) the analysis of infringements by fishing vessels in Turkish Waters with or without a bottom or mid-water trawl permit as the primary or secondary fishing gear (LOA  $\geq$ 12 m) (6 m < LOA <12 m), ii) providing information and giving recommendations to fisheries policymakers, and scientists in order to combat trawl infringements.

## Material and Methods

Data for a total of 29 303 fishery infringements were collected from the Regional Commands (n: 10 079) and Central Database (n: 19 224) of TURCG. The raw data sets which include "all fisheries infringements", "multiple duplications " and "separate records for each person involved in the same infringement incidence" were subjected to a detailed examination process. Two worksheets (1: Fleet segments based on gear type and length classes, Table 1 and 2: Type of infringements, Table 2) were prepared by analysing 1040 incidences within the scope of this study using the method described below:

### Fishing vessels and fleet segments

The vessels that committed the infringements were classified according to their equipment, commercial fishing or commercial trawling licenses, and length

segments modified from Appendix B (GFCM, 2018) (Table 1).

### Place and time data

Location data were based on the sea, province, district and geographical positioning, and time data were based on the year and month in which the infringements occurred.

### Types of infringement

Infringement types were examined in 3 main groups (illegal, unreported, and illegal beyond the EEZ) and 12 subgroups and have been detailed and presented in Table 2. Although rarely occurred, each infringement of the vessel that was found to have been committed more than one infringement at the same time was considered a separate incidence.

### Fine data

In this section, administrative fines imposed on vessels were assessed based on infringement incidences. That is, fines imposed on more than one person on board in the same infringement were collected and the total amount of fines for the infringement was used. The fines imposed in Turkish Liras were converted to USD by using the parity of 1.80 TL = 1 USD.

### Confiscation data

One of the legal actions that were imposed on the vessels for violating the fisheries legislation was the seizure of catch, gear or vessel.

### Applicable legislation

In this study, the legal basis of the reported infringements included: *i*) Fisheries Law No. 1380 (Anonymous, 1971) *ii*) Fisheries Regulation No. 22223 (Anonymous, 1995), and *iii*) Communiqué 2012/65 no 3/1 regulating commercial fishing (Anonymous, 2012). Due to protection of personal information, no data were given on the identities of the fishermen and vessels that violated the national fisheries regulations as well as the coast guard boats that had reported the incidences.

## Results

In total, 1040 trawl infringements were reported during three years from 2012 to 2014 in the Black Sea, the Sea of Marmara, the Aegean Sea, and the Mediterranean Sea and were evaluated under six different titles.

### Place and time

The shares of 1040 trawl infringements according to the seas over a period of three years were 424, 350 and 266, respectively (Figure 1). In addition, 36.6% of these infringements took place in the Sea of Marmara (including Istanbul and Çanakkale Straits), where all kinds of trawling were prohibited throughout the year.

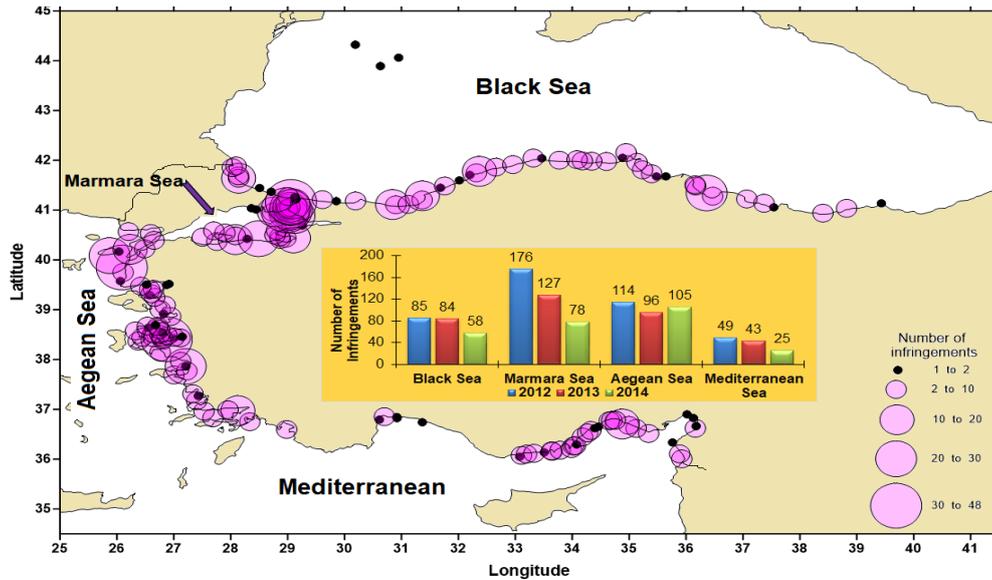
30.3% of infringements took place in the Aegean Sea, along with 21.8% in the Black Sea and 11.3% in the Mediterranean Sea (Figure 1).

**Table 1.** The codes of reported fleet segments according to gear type and length classes (modified from GFCM (2018)). (LL: Longlines, GEN: Gillnets and entangling nets, GTR: Trammel nets, GNC: Encircling gillnets, DRB: Boat dredges)

		Fleet segments							
		Vessel groups			Gear code	Length classes (LOA)			
						6<12 m	12-24 m	>24 m	
Commercial fishing licensed (CFL)	1	Polyvalent <sub>Small</sub> (P <sub>S</sub> ) : The small-scale vessels that use passive or active gears			LL, GEN, GTR, GNC, DRB	P <sub>S</sub> -01	P <sub>S</sub> -02	P <sub>S</sub> -03	
		Seiner (S)			PSS (Purse seines)		S-02	S-03	
	3	Trawler (T)			TB (Bottom trawl) PTM (Mid-water pair trawl)		T-02	T-03	
		Polyvalent <sub>Big</sub> (P <sub>B</sub> ) : The vessels that trawl and/or purse seine fishing licensed using a secondary or a tertiary gear.			TB/PSS TB/PTM PTM/PSS TB/PTM/PSS		T-04	T-05	
No CFL	5	Other	Y	: Carrier vessels			Y-01	Y-02	Y-03
			O	: Diving, service, shipping, pleasure, excursion boats etc.			O-01	O-02	O-03
			Prv	: Private boats			Prv -01	Prv -02	Prv-03

**Table 2.** Type of infringements

<b>Infringements</b>			<b>Description of the infringements</b>
<b>Main group</b>	<b>Codes</b>	<b>Sub-groups</b>	
Illegal	1.1	Fishing in a closed area	: Fishing in a closed area, regardless of whether the vessel has the appropriate license.
	1.2	Fishing during a closed season	: Fishing in a closed season, regardless of whether the vessel has the appropriate license.
	1.3	Fishing beyond a closed depth	: Using a mid-water pair trawl in shallow waters less than 24 m, although it has the appropriate license.
	2	Possessing improperly stowed trawling equipment on the deck when transiting a closed area or during seasonal closure	
	3	Inappropriate gear features	: Minimum mesh size, mesh shape, etc...
	4.1	Lack of Fisheries license (Vessels)	
	4.2	Lack of Fisheries license (Fisherman)	
	4.3	Lack of License plate of the Vessels	
	4.4	Lack of Fishing permit for the Mid-water pair trawl fishing	
	5	Minimum landing sizes	
Unreported	6	No logbook or no product registration	
Illegal (Beyond EEZ)	7	Illegal Fishing in Foreign States Exclusive Economic Zones (EEZ)	



**Figure 1.** The distribution of trawl infringements in Turkish Waters (2012-2014)

Provinces with high infringement rates were Istanbul (27%), Izmir (14%), Çanakkale (10%), Mersin (7%), Balıkesir (5%), Samsun (5%), and Bursa (4%). Lower infringement rates were observed in Artvin, Rize, Trabzon with a near-zero rate and Ordu, Giresun, Kocaeli, Düzce, Edirne, and Antalya below 1%. Although the violator’s vessels were registered in 59 different ports, 23% of the infringements were committed by the vessels registered in Istanbul, 14% were from Bandırma and 11% were from İzmir ports. Istanbul Strait is the primary hotspot with respect to violated areas in the Sea of Marmara (41%) and in all of the Turkish Waters (15%). The second hotspot in the Sea of Marmara was the Adalar-Kadıköy region (12.6%) near the Istanbul Strait. Except for the Eastern Black Sea, which is closed to trawling, trawl infringements were encountered on all other coasts of the Black Sea; Samsun (22%) in the Central Black Sea and Kırklareli (13%) in the Western Black Sea were determined as hotspots in the Turkish Coasts of the Black Sea. Izmir Bay (34%) and the vicinity of Çanakkale Strait (26%) were two significant violated areas on the Turkish coasts of the Aegean Sea. Mersin Bay, where 63% of infringements on the Turkish Coasts of the Mediterranean Sea occurred, was another hot spot. It seems that trawl infringements occurred mostly in January (17%), followed by February (13%) and March (11%). With respect to seasons, most were determined in the winter (41%) and autumn (28%). While the proportion of the trawl infringements was 10% during the closed season, which was between April 15<sup>th</sup> and September 15<sup>th</sup>, cases related to engaging in illegal trawling activity had a 22% share, consisting of 80% by non-trawlers in the same period.

**Fishing vessels and fleet segments**

The LOA of the violator’s vessels varied between 6.30 and 40.85 m with an average of 15.1 ±5.8 m. The lowest average length was in the Sea of Marmara (12.8 ±5.3 m) and the largest in the Black Sea (18.1 ±5.7 m). While 57%

of all infringements were committed by the vessels with a commercial trawl license (T and PB), small vessels and unlicensed vessels (LOA < 12 m; PS-01, Y-01, O-01, and Prv-01) were responsible for 36% of the infringements.

Although the rate of infringements by vessels without a trawl license and are smaller than 12 m was 56% in the Sea of Marmara, it was only 17% in the Black Sea. The fleet segments with the highest infringement rates were T-01 (25%), Ps-01 (20.6%), and PB-02 (16.6%), respectively (Table 3, Figure 2).

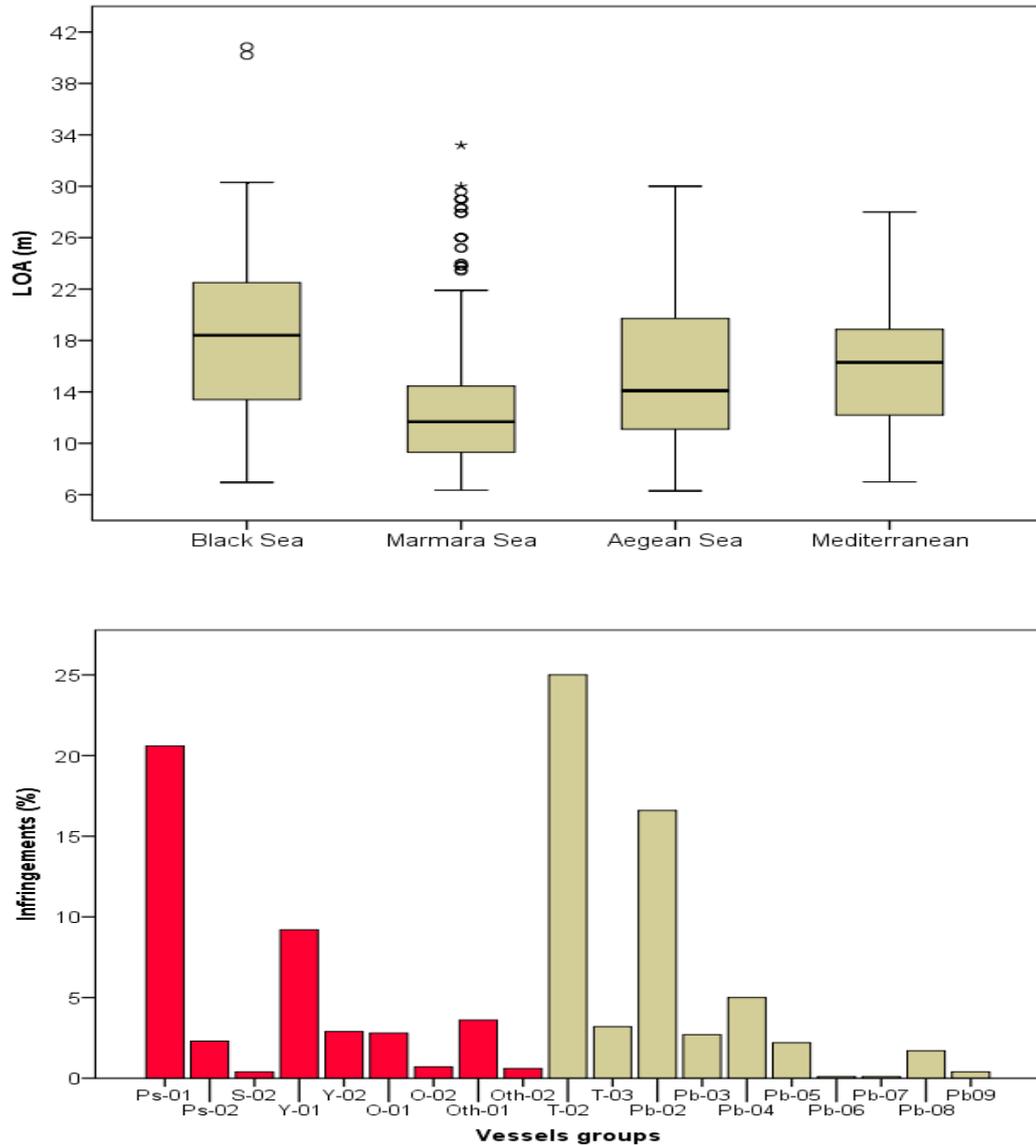
**Infringements**

The vast majority of infringements determined was "fishing in a closed area" and had a share of 42.7% of total infringements. Other reasons for infringements were "possessing improperly stowed trawling equipment on the deck when transiting a closed area or during seasonal closure" (15.3%), "lack of fishing license" (11.4%), "trawling during closed season" (10%), "unreported catch" (8%), "minimum landing size" (7%), and "use of prohibited fishing gear/equipment" (2%) (Figure 3e). In Polyvalent (Ps) (Figure 3a) and Other (Y, O, and Prv) vessels (Figure 3d) that did not have commercial trawl fishing licenses, 97% and 93% of infringements consisted of these three infringements, respectively. Spatio-temporal infringement’s share was determined as 52.7% and the infringements related to gear were found to be 17,3% in total.

Although fishing in a closed area was the most common infringement (33.4%) for trawlers (T), these vessels also committed 10 other types of infringements (Figure 3b). "Employing unlicensed fishermen" and "unreported catch" were other common infringements. The three most common infringements in Polyvalent (Ps) vessels with a commercial trawl fishing license were identical to those of the trawlers group and had a share of 70% (Figure 3c).

**Table 3.** The distribution of the infringements according to seas, vessel groups, and length segments (see descriptions of vessel groups and gear codes in Table 1)

Vessel groups	Gear code	Sea of Marmara			Black Sea			Aegean Sea			Mediterranean			All Seas		
		LOA (m)														
		6-<12	12-24	≥24	6- <12	12-24	≥24	6- <12	12-24	≥24	6- <12	12-24	≥24	6- <12	12-24	≥24
P <sub>B</sub>	P <sub>s</sub>	94	13		23	1		83	9		14	1	-	214	24	
	S		1			1			1			1	-		4	
	T		37	14		43	3		103	14		77	2		260	33
	TB/PS		59	7		62	7		42	10		10	4		173	28
	TB/PTM		1	2		45	19		4	2		2			52	23
	PTM/PS		1				1								1	1
Oth.	TB/PTM/PS		3	1		14	2		1	1				18	4	
	Y	93	21		1	4		2	5		-			96	30	
	O	17	4			1		8	2		4			29	7	
	Pr	11	2					24	4		2			37	6	
Σ=		215	142	24	24	171	32	117	171	27	20	92	6	376	575	89
			381			227			315			117			1040	



**Figure 2.** a: Total length (LOA) distribution of vessels in four different seas (n), b: infringement distributions (%) according to vessel segments (Red bars: Not licensed for trawl fishing)

Mid-water trawl infringements had a share of 3.5% of all infringements committed by mid-water trawlers (PTM) and consisted of “fishing in shallower waters” (39%), “documental infringement” (33%), and “minimum landing size” (28%).

### Fines

During the study period, 96.1% of the total amount of fines (5.97 million USD) for IUU trawl fishing was issued due to illegal fishing infringements, whereas 85.5% of the fines were issued for “fishing in a closed area and fishing during a closed season”. Nearly half of the fines (46.4%) were issued to vessels without a trawling licence that were engaged in trawling activities. The highest total fines were issued on the groups of **P<sub>B</sub>** (30.2%) and vessels in the other segments (26.1%), without a commercial fishing license.

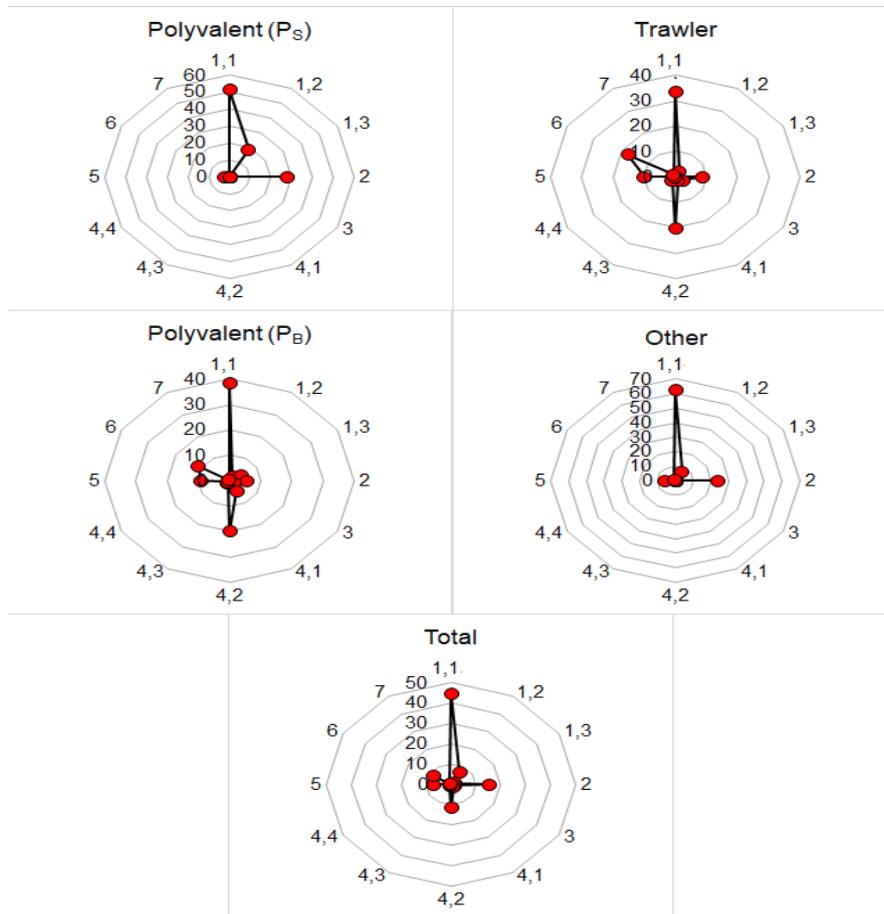
### Confiscation

In addition to fines issued to fishing vessels, confiscation was used as a means of penalty. The proportion of seized vessels with a commercial trawl license was only 17%. Interestingly, 156 of 157 seized boats were in the Sea of Marmara and the remaining one was in the Black Sea. With respect to vessel size, 105 of them were 6-12 m, 46 were 12-24 m, and 6 were larger than 24 m. (Fig. 4)

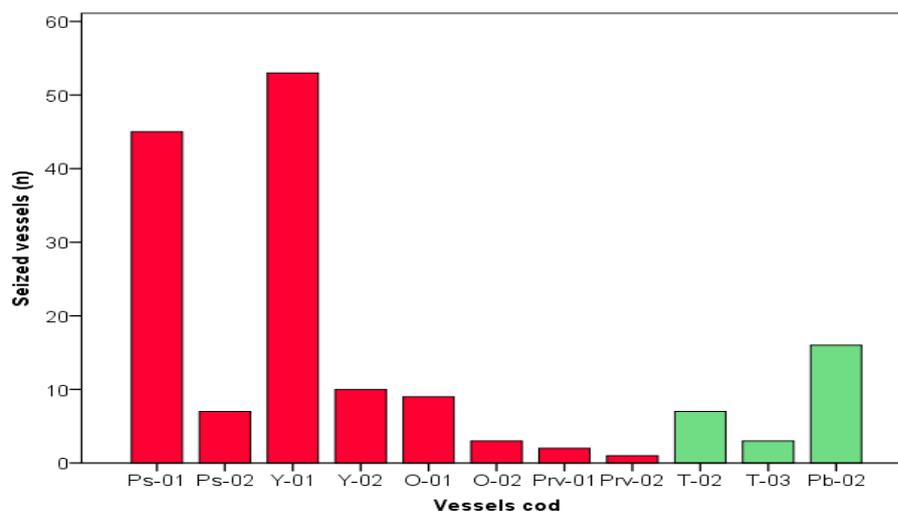
i). Of the 238 infringements committed by the **P<sub>S</sub>** group vessels, 51 were imposed as seizure of fishing vessel, 21 were imposed as seizure of the trawl net, and one infringement was imposed as seizure of both the vessel and trawl net; ii) Out of 293 infringements committed by the vessels in the Trawler group, 8 were imposed as seizure of the vessels, 68 were imposed as seizure of the trawl net and 2 of the infringements were imposed as

seizure of both the vessel and trawl net; iii) Out of the 300 infringements committed by the vessels with P<sub>B</sub> license 16 were imposed as seizure of the vessels and 35 were imposed as seizure of the trawl net; iv) Out of 205 infringements committed by vessels in the Other group, 74 were issued as seizure of the vessel, 19 were issued as

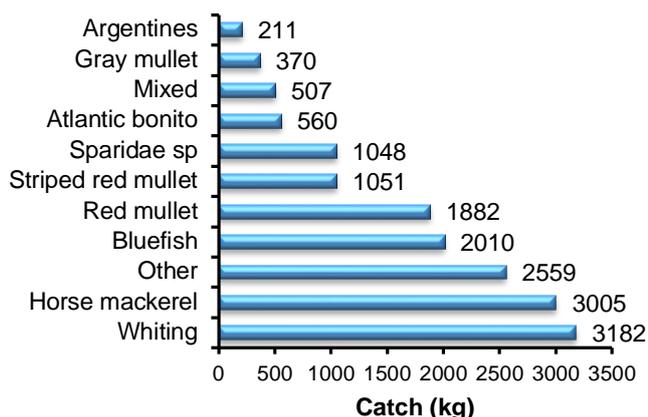
seizure of the trawl net and 5 infringements were imposed as confiscation of both the vessel and trawl net. With respect to species composition of the 16.4 tons of catch that was seized, the majority of the pelagic species were horse mackerel and bluefish whereas the majority of the benthic species were whiting and red mullets (Fig. 5).



**Figure 3.** The distribution (%) of trawl infringements according to vessel segments (a: Polyvalent, P<sub>S</sub>; b: Trawler, T; c: Polyvalent, P<sub>B</sub>; d: Other; e: Total)



**Figure 4.** Seized vessel distribution (n) according to the vessel segments (red bars: Not licensed for trawl fishing)



**Figure 5.** Confiscated species and quantities (kg)

### Fisheries in the foreign state's exclusive economic zones (EEZ)

Among 19 cases reported in foreign EEZ, fishing infringements committed by three vessels were in the T-02 segment. One in each Pb-02, Y-02, and Oth-02 segment in the Ukrainian and Romanian Territorial Waters was included in the Black Sea in calculations by trawl vessels.

### Discussion

The findings of this study indicated that illegal and unreported trawl fishing is prevalent in Turkish waters. Trawling infringements, which were examined in detail, had different characteristics in different regions of Turkish waters. Therefore, precautions to combat trawling infringements should be considered based on the geographic and socio-economic characteristics of each region as described below.

#### The Black Sea

In the Black Sea, trawling infringements were highest in Samsun followed by Kırklareli. Tanış (2013) studied the Black Sea coasts of Türkiye from Sakarya to the east during the period of September 2008-August 2012. According to this, trawlers committed 238 infringements (60 per year) which were mostly spatial (55%), documental (21%), and temporal (12%). In addition, trawling infringements were highest in Samsun (29%), followed by Kastamonu (17%), Bartın (13%) and Ordu (12%), and reached to near-zero levels towards the east such as in Trabzon, Rize and Artvin provinces. In the present study, 151 infringements by trawlers and 25 cases by non-trawlers were committed. Trawling infringements were mostly spatial (57%), documental (26%), and minimum landing size (14%). The regions with high rates of infringements were Samsun (29%), Bartın (25%), Kastamonu (23%), and Sinop (19%) respectively. Juxtaposing that study with ours, there seems to be a decrease (17%) in trawler infringements during 2012-2014. Infringements were concentrated in the Central Black Sea (Samsun, Kastamonu, and Bartın), with almost no cases in the eastern region (Trabzon, Rize, and Artvin). Besides, a substantial decrease in Ordu and Giresun was

also noticed. Ayaz and Mazlum (2019) examined the fishery violations at the Black Sea coasts of Türkiye from Giresun to the east during the period of 2009-2014. A total of 11 illegal trawling (around 2 per year) were reported in this region, mostly observed in Giresun (80%) in May and September (80%). Our results in the same region during 2012-2014 were similar to those reported by Ayaz and Mazlum (2019). A total of 7 illegal trawling cases were reported, all practiced by non-trawlers, accounting for 2 per year, mostly in Giresun (86%) and in May, August, and September (in total 86%). Hence, it can be concluded that a minor decrease was observed in trawl infringements between 2012 and 2014. Furthermore, non-trawler's contribution to trawling violations is remarkable. Since trawling in the eastern Black Sea is banned in all seasons, violations are decreasing and presumably, legal trawlers are being converted to non-trawler vessels, which are harder to detect. However, in the rest of the Black Sea coasts of Türkiye, trawling ban within 3-miles from the coast has led to comparatively higher infringement rates as it is practically almost impossible to control illegal trawling activities due to the lack of strong MCS Systems. Therefore, not only is it essential to reconsider range restriction regulations for the Black Sea, but the use of small vessels for illegal fishing activities should be monitored in all regions within the fishing zone of Turkish Waters.

Beyond the Turkish EEZ in the Black Sea, Öztürk (2013) reported 65 illegal fishing cases committed by Turkish vessels in the Black Sea between 1992 -2012, accounting for 3.1 incidents per year. In our study, a relative increase was observed with 19 cases (4 cases belonging to trawlers) during 2012-2014, corresponding to 6,3 cases annually. However, Türkiye, which has the greatest fleet capacity and ranked 8<sup>th</sup> given the IUU fishing index in the GFCM area of application (Macfadyen et al., 2019), in comparison, appears to make only a limited contribution to IUU fishing.

#### The Sea of Marmara

Although the Sea of Marmara has a much smaller area than other seas, fishery infringements are relatively high. The Sea of Marmara and Istanbul Strait are hot spots for trawling infringements. The other provinces that have high infringement rates are Çanakkale, Balıkesir, and Bursa. Interestingly, a majority of trawl infringements (51%) were from Istanbul, Izmir, and Çanakkale. This may be due to the high demand for seafood and heavy maritime traffic in this region.

The present study reveals that the percentage of small-size vessels (<12 m) is the highest in the Sea of Marmara (56%), followed by the Aegean Sea, the Mediterranean, and the Black Sea. Besides, the confiscation rate of small-size vessels (67%) was much higher than that of other types of fishing vessels. In practice, small-size vessels are notorious with respect to a specific type of mini-trawl gear towed from the stern or sides of the boat, which is commonly known as "şebeke" in Turkish. Even boats with 6-7 meters in length can tow a trawl net without any visual

sign of the trawling activity. In addition, when a suspicious activity is detected by the coast guards and engaged, “şebeke” can easily be cut loose by the fishermen. This also explains lower confiscation rates of trawl nets which account for only 10% of all illegal trawling activities. The “şebeke” can later be retrieved from the bottom and used again for illegal near-shore trawl operations for high-value demersal species. For this reason, it is very important that these small-size “şebeke” trawl vessels should be effectively monitored.

### The Aegean Sea

Findings of the present study have shown that the Aegean Sea ranks second with respect to trawling infringement rate and İzmir has the second highest rate of trawling violations. İzmir Bay and the vicinity of Çanakkale Strait had high infringement rates. Small-size vessels engaged in illegal trawling activity were also common in this region. Moutopoulos et al. (2016) stated in their study conducted in Greek waters of the Aegean Sea between 1999-2013 that trawl infringements were more common in the winter, in bays and gulfs, and in areas where fishing is prohibited. In addition, trawlers turned off their VMS devices when fishing illegally within a protected area leading to a relatively higher number of fishing violations in prohibited areas compared to those committed during closed periods. Similarly, in Turkish waters, trawling infringements were common in the winter period (41%) and the number of violations (43%) in bays and gulfs were higher than those committed during closed seasons (10%). In Greek Waters most common types of trawl infringements were spatio-temporal (45.5%), prohibited fishing gear (37.7%), and minimum landing size (2%), whereas, in Turkish Waters, spatio-temporal (53.2%), infringements related to gear (17.3%), and minimum landing size (7.1%) were more common. In both countries, spatio-temporal infringements were the most common type of trawling infringements.

### The Mediterranean Sea

Our findings showed that the Mediterranean coasts of Türkiye had the lowest rate of trawl infringement. Trawl fisheries are more common on the eastern coasts and Mersin Bay is by far the most prevalent region for trawling infringements. Yağcılar (2009) reported 33 illegal trawling cases per year, mostly in October, November, and January with a rate of 71% in total, between 2008 -2012. In our study, in the same region in 2012-2014, the mean number of annual cases was 30, and more cases were reported in November, December, and January (47% in total) during 2012-2014, in the same region a 10% reduction in illegal cases were observed during 2012-2014 compared to 2008-2012.

### General issues

Although spatially based fisheries management is crucial to sustainability, its implementation is challenging due to conceptual and technical difficulties (Russo et al., 2014). Lack of surveillance and control systems (MCS) together with VMS (Vessel Monitoring System) and AIS

(Automatic Identification System) present difficulties in combatting illegal trawling particularly when small-size vessels are used extensively for trawling. Therefore, instead of establishing a distance restriction of 3 miles in the coastal zone for trawl fishing, establishing MPA (Marine Protected Area), or NFZ (No-Fishing Zone) zones will be a better monitoring approach in combatting trawling until effective MCS measures are implemented. In this regard, studies carried out in Sicily, Italy and Gökova Bay, Türkiye are successful examples (Pipitone et al, 2000; Ünal and Kızılkaya, 2019).

Temporal management of trawl fisheries seems more effective than spatial management as it contains only 10% of total infringements. Moreover, for specific infringement types, engagement in illegal trawling cases (related to fishing methods, catch, and gear infringements) was observed with a share of 22%, which is mostly caused by non-trawlers (80%). In infringements concerning time-closure for trawl fisheries, the majority of violations were due to small-size (<12m) illegal trawlers without valid licenses. Likewise, while the percentage of the vessels without a trawl license was 43%, the share of trawl infringements by vessels smaller than 12 meters was 37%. When engaged in illegal trawling, infringement rates surged up to 56%, and 47% respectively, so it can be concluded that in Turkish Waters, most of the infringements were related to engaging in illegal trawling by non-trawlers, and 84% of the non-trawlers consisted of vessels <12 meters. These non-trawlers without a trawl license consisted of fishing or auxiliary fishing vessels (81%) and non-fishing vessels (19%) such as private vessels (11%) and other types of vessels including diving, service, excursion, and tug boats (8%).

The share of trawling infringements on minimum landing size and unreported catch had a share of 7% and 8%, respectively. Since small-size vessels are not required to register, it is expected that when adequate enforcements are implemented, the share of unreported catch will likely increase. In addition, although mid-water trawl infringements had a share of 3.5% of all infringements, higher rates of violations such as “fishing in shallower waters” (39%) and “minimum landing size” (28%) are critical considering their negative effect on fish stocks (Göktürk & Deniz 2017). With respect to confiscated species, whiting, horse mackerel, bluefish and red mullet accounted for 62% of the total and indicated that the economic value of the target fish is an important factor for trawling violations.

### Recommendation

Gallic and Cox (2006) suggested that permanently reducing fishing capacities or preventing further development of capacities are alternative and less costly measures for preventing IUU fishing. The size of the Turkish fishing fleet should be reduced as the capacity of the Turkish fishing fleet and the potential of fish stocks is not balanced (Anonymous, 2014). Despite five different decommissioning programs between 2013-2018, there is no significant change in the fishing power of the large-

scale Turkish fleet. (Yılmaz et al., 2017). For example, from a total of 15352 powered vessels in 2008, a 13% reduction was achieved in 2018, but large-size vessels still accounted for 10.2% of the total capacity (Ünal & Gönçüoğlu-Bodur., 2018). Therefore, in order to ensure sustainable fishing, the total capacity of the Turkish fishing fleet should be reduced by 50% by means of an effective buyback program.

Since most of the IUU vessels engaging in illegal trawling (e.g. *şebeke*) have lower running costs (inexpensive to buy, fewer personnel, low fare, no licenses, no documents, etc.) than registered vessels, it is important to propose harsher penalties for combating IUU fishing activities. It is expected that increasing fines and deploying MCS systems could directly affect IUU fishing activities. Strict monitoring of IUU fisherman, also serves as a deterrent (Phelps Bondaroff et al., 2015) and the countries that have strong fisheries management use effective MCS. Despite being expensive, it can be observed that fish stocks are recovered by tighter inspection and control measures performed by competent authorities both on the land and at the sea. Trade measures and sanctions are also very important to combat IUU fishing, i.e. strict inspections on landing ports, local markets, and even restaurants to prevent the consumption of undersized, prohibited, and illegally caught species. Supporting legitimate fishermen as “guardians of the sea” and collaborating with related fishery management units will also contribute to increasing costs for combating illegal activities. However, it is important to protect legitimate fishermen from unfair competition with illegal fishermen so that they can remain legitimate, and refrain from IUU activities.

As mentioned in the EU (2017) and GFCM (2017) related to having taken measures by coastal states to eliminate IUU fishing mainly include conducting effective MCS systems, not undertaking fishing activities without valid authorization and maintaining a logbook while fishing. In addition, preventing trading or importing the illegally caught catch, developing a national control and sanctioning system, improving fisheries by declaring restricted or marine protected areas are the other crucial precautions on this issue. The regulations put into force in 2020 in Türkiye are an important step in preventing IUU fishing in Turkish Waters, and they serve to harmonize EU rules consisting of critical confiscation, punishment, and jail sentence regulations against violator fishers and vessels. Moreover, the MCS system, which is an ongoing project called “coast surveillance radar system” includes radar, electro-optic, thermal, and data link systems surrounding all seas and including relevant partner authorities for information sharing, and it is expected to run completely within a few years which can be another major development. Locally used drones are an alternative and effective solution in the extent of MCS for combatting illegal fishery since air vessels have a significant advantage of speed and secrecy.

## Conclusion

As experienced historically, Mediterranean community-based fishery management was particularly effective in fostering not only social cohesion but also sustainable utilization of coastal resources (Raicevic et al 2018). Similarly in Türkiye, community-based solutions together with ecosystem-based and species-based solutions should be preferred principally in fishery management, which can also contribute to reducing trawl infringements and IUU fishing at the same time. Effective measures such as declaring NFZ and/or MPA in overexploited or extensively violated areas and defining quotas for high-value species or overexploited stocks are significant measures in the fight against IUU. Within this scope, strengthened regulations and the implementation of the MCS system will be a significant milestone in controlling IUU fishing. In this context, reliable field data and case studies on IUU fishing are critical to defining priorities and developing effective solutions for sustainable fisheries.

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## Conflict of Interest

The authors declare that they have no conflict of interest.

## Author Contributions

G.S. Karabacak: Conceptualization, data curation, review and editing, investigation, resources. M.C. Deval: Conceptualization, data curation, methodology, visualization, and writing -original draft.

## Ethics Approval

No ethical permissions are required.

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