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## Towards Cross-Border Fisheries Management: An Analysis of Fleet Structures and Species-Specific Regulatory Measures in the Aegean Sea

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### Abstract

Intrinsic differences in the applied management measures of shared stocks in transboundary waters inhibit the ability of either state to benefit from such measures, as one state may benefit in lieu of the other, thus reducing the efficacy of both. This study compares for the first time the fleet structure, specific management measures applied to species-specific regulations for commercial fishing, species listed in official monitoring schemes, and protected taxa between Greece and Türkiye for the Aegean Sea. A comparative analysis utilizing the official data was sourced from both countries. Large-scale Greek and Turkish fishing fleets have been modernized within the last 30 years (1991-2021). Greek and Turkish large-scale fishing fleets included smaller trawlers with lower tonnage and slightly higher engine horsepower, while purse seines of both states included larger vessels with higher horsepower and tonnage. This indicates that the fishing pressure on the demersal resources in the Aegean Sea has partially decreased, but the fishing pressure on pelagic resources has increased despite the decrease in the number of vessels. Only 11 out of 74 minimum conservation reference sizes (MCRS) are sufficiently set above the  $L_{m_{50}}$  sizes they should be based on, whereas 18 species need reproductive studies, and 22 are set below the  $L_{m_{50}}$ , and could benefit from an increase. The application of specific closed seasons for commercial species was used by both states with the intent to protect the reproductive periods of some stocks. However, several of these closure periods did not fully or even partially cover the spawning periods of the respective species. Species-specific closures were applied to 13 species in Greece and 23 species in Türkiye, with only two fish species (*Xiphias gladius* and *Thunnus thynnus*) listed for both countries. Only 14 species (out of 34 protected by Greece and 46 by Türkiye) are protected by both states, most of which are listed as critically endangered by the International Union for Conservation of Nature and Natural Resources (IUCN). Harmonization of fisheries management measures currently does not align between the two neighbouring states, and the General Fisheries Commission of the Mediterranean is the competent authority that would be able to restructure such measures, especially as Türkiye has been aligning their measures with that of the EU for the accession process. This contribution highlights the clear differences between Greece and Türkiye, and provides advice for developing a unified management regime for the Aegean Sea.

**Keywords:** Transboundary management; MCRS; closed seasons; protected species; non-EU member states.

### Introduction

Current stock assessments for the Mediterranean and Black Sea fisheries resources indicate that 58 percent of stocks are overexploited and that exploitation levels vary amongst subregions (FAO, 2023). Stock assessments from the Central and Western parts of the Mediterranean are well documented, whereas most stocks in the eastern

part lack coherent fisheries data imperiling the ability to provide management advice on sustainable targets (Manini & Simmonds, 2021). Such issues are exacerbated by illegal, unreported, and unregulated (IUU) fishing (Sumaila *et al.*, 2020). The situation becomes even more complex for transboundary shared stocks that cross the political boundaries of two bordering coastal states that apply heterogeneous data monitoring and fisheries man-

agement measures (Palacios-Abrantes *et al.*, 2020).

Transboundary fisheries that target shared common resources complicate fisheries management and potentially reduce the effectiveness of policies to achieve their stated objectives (Miller & Munro, 2002; Englander, 2019). Moreover, fish stocks shared between two states have a 9% higher chance of being overfished and are 19% more likely to be depleted than stocks fished by only one country (McWhinnie, 2009), adding fuel to the already declining state of fisheries resources. An accurate understanding of the fishing fleet, distribution and scale of transboundary fish stocks, as well as their associated fisheries, is important for establishing effective fisheries management, including detecting and stopping IUU fishing. In the Mediterranean Sea, important transboundary shared stocks that cross political boundaries exist in the Aegean Sea between Greece and Türkiye. Greek-Turkish fisheries in the Aegean Sea are characterized as multispecies fisheries using multiple gear types targeting both demersal and pelagic fish stocks, as in most other Mediterranean states (Ünal & Göncüoğlu, 2012). However, commercial catch-per-unit-efforts (CPUE) have also been consistently declining in both Greece and Türkiye, demonstrating the declining resources (Tsikliras *et al.*, 2015; Ulman & Pauly, 2016; GFCM, 2021).

Currently, the main fisheries management strategy adopted by Greece and Türkiye applied to the Aegean Sea fisheries in the Eastern Mediterranean is the control of fishing effort combined with specific technical measures. A recent study (Dereli *et al.*, 2022) has shown that there are many differences between Greek and Turkish fisheries management regulations regarding some of the technical measures, such as gear regulations and closed areas.

The present study aims to provide a first basis for discussion of future harmonization possibilities of fisheries management measures applied by Greece and Türkiye towards fleet structure and species-specific fisheries management in the Aegean Sea. These results will help to understand where the differences lie between both regulatory frameworks, which may be used as a reference for future co-management initiatives in the Aegean Sea to be used by decision-makers, stakeholders and the scientific community. More specifically, we compared the species-specific differences related to the minimum conservation reference size (MCRS) and species-specific closed seasons along with some recommendations for unifying and/or improving these measures for Greece and Türkiye in the Aegean Sea. In addition, given that there is the need to gather, analyze, and exchange information about the status of fisheries in transboundary waters, we evaluated the long-term trends of the technical characteristics of the fishing fleet between the two neighbouring states per fishery component. Furthermore, all high trophic level taxa, such as sharks and marine mammals, are currently depleted to very alarming levels across the Mediterranean (Ferretti *et al.*, 2008; Piroddi *et al.*, 2020; Dulvy *et al.*, 2021; Walls & Dulvy, 2021; Fernández-Corredor *et al.*, 2024); hence we highlight which species should be protected by both states here by comparing the prohibited catch lists of each.

## Materials and Methods

### *Study Area and Fishing Gear Types*

The study covers the Aegean Sea, shared by Greece and Türkiye and identified as GSA 22 by the GFCM. Greek marine fisheries use a high diversity of gears operating in the Aegean Sea (GSA 22), representing the focus of this study, as well as in the Ionian (GSA 20) and Cretan (GSA 23) Seas, with most of their vessels being polyvalent (Fig. 1). Fishing gear types were categorised as otter bottom trawlers (OTB), and purse seiners with encircling nets (PS) for the large-scale fleet, and the small-scale fleet including trammel and gill netters, drifters, long-liners, traps, etc., operating along the coasts.

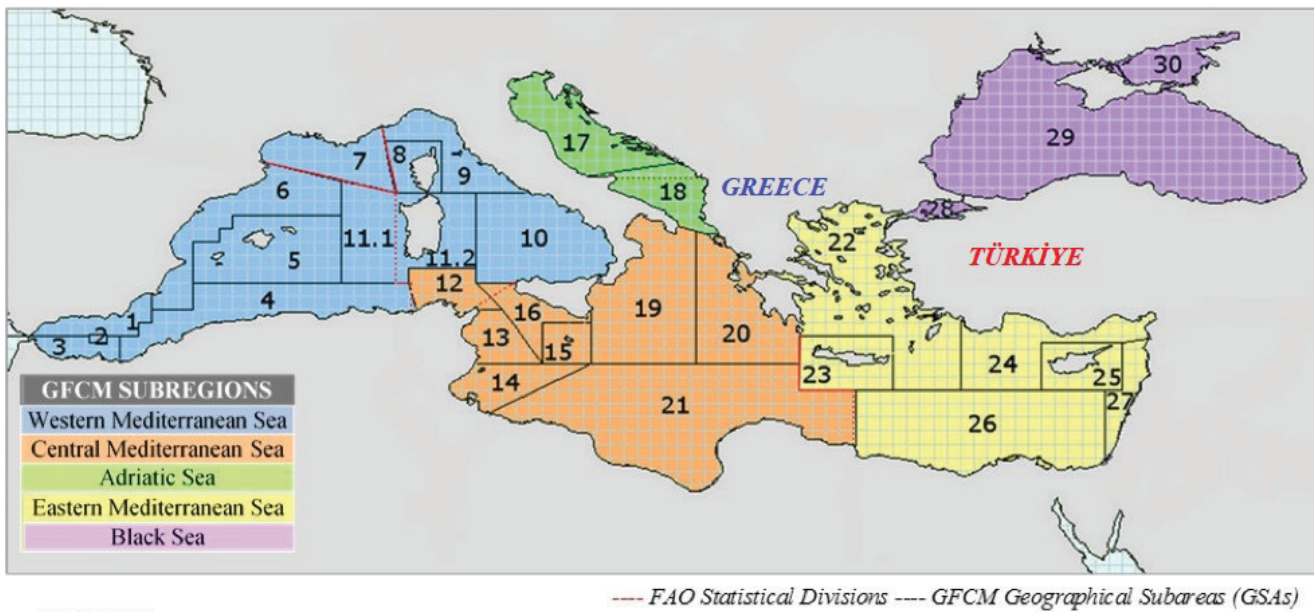
Turkish marine fisheries use a variety of fishing gears in the Black Sea (GSA 29), Marmara Sea (GSA 28), North Levant (GSA 24), and Aegean Sea (GSA 22). Large-scale fishing vessels are usually comprised of sheet metal, using otter bottom trawlers (OTB), and purse seiners with encircling nets (PS), with small-scale fishing vessels, most of which are wooden, including trammel and gill netters, long-liners, traps, beam trawls, etc., operate along all the coasts.

### *Data Sources*

Data on national fisheries landings in GSA 22 were obtained from official statistical institutions (HELSTAT: Hellenic Statistical Authority and TURKSTAT: Turkish Statistical Institute) of both states (HELSTAT, 2022; TURKSTAT, 2022).

With respect to Greek official fisheries landings data, since 2016 HELSTAT began to incorporate landings from professional licensed fishing vessels with engine power less than 19 HP with information on spatially allocated taxa. As a result, from 2016 onwards, the catch data from HELSTAT are the total reported landings (Moutopoulos, 2020). Every month, a questionnaire with the quantities of catches, employment indicators and vessel characteristics (one statistical unit) is submitted by the professional fisher at the local Customs Authorities of HELSTAT. Thereafter, the questionnaires are sent to the Regional Statistical Services of HELSTAT, which, after initial checks, are carried forward to the Directorate of Agriculture, Livestock, Fisheries and Environment Statistics of HELSTAT for a final check and then incorporation into the digitized system of HELSTAT.

Turkish fisheries landing data has been collected by TURKSTAT through surveys with professional fishers once a year from January to May since 1967, and since 2000, catch data by species are available online (TURKSTAT, 2022). In 2011, the “National Fisheries Data Collection Program” was initiated. Since 2014, landings data have been collected in cooperation with the Ministry of Agriculture and Forestry (MAF) and TURKSTAT through monthly surveys for large-scale fishers and seasonally for small-scale fishers (vessel length <10 m) per taxon (i.e., 78 species or taxonomic groupings: Table S1)



--- FAO Statistical Divisions --- GFCM Geographical Subareas (GSAs)

GFCM GSAs				
01 - Northern Alboran Sea	07 - Gulf of Lion	13 - Gulf of Hammamet	19 - Western Ionian Sea	25 - Cyprus
02 - Alboran Island	08 - Corsica	14 - Gulf of Gabes	20 - Eastern Ionian Sea	26 - South Levant Sea
03 - Southern Alboran Sea	09 - Ligurian Sea and Northern Tyrrhenian Sea	15 - Malta	21 - Southern Ionian Sea	27 - Eastern Levant Sea
04 - Algeria	10 - South and Central Tyrrhenian Sea	16 - Southern Sicily	22 - Aegean Sea	28 - Marmara Sea
05 - Balearic Islands	11.1 - Sardinia (west) 11.2 - Sardinia (east)	17 - Northern Adriatic Sea	23 - Crete	29 - Black Sea
06 - Northern Spain	12 - Northern Tunisia	18 - Southern Adriatic Sea	24 - North Levant Sea	30 - Azov Sea

**Fig. 1:** GFCM geographical subareas (GSAs) and study area (Aegean Sea-GSA 22).

and subarea (5 Turkish subareas). Since 2016, the data were digitized using tablets in survey studies and are published electronically by TURKSTAT at the end of each year (GDFA, 2022; TURKSTAT, 2022).

For fishing effort (fishing vessel numbers) data in GSA 22, obtained from the Common Fleet Register (CFR) (CFR, 2022; STECF, 2024) and TURKSTAT (TURKSTAT, 2022) for Greece and Türkiye, respectively. In addition, data on vessel age, tonnage (GRT), length and engine power (HP) of large-scale fishing vessels (trawl and purse seine) available for Greece since 1991 and for Türkiye since 2011 were obtained from the CFR (CFR, 2022; STECF, 2024) and the SUBIS systems (GDFA, 2022), respectively.

Legislations relating to technical fisheries management measures applied to commercial marine taxa in Greece and Türkiye were compiled through a literature review. The measures specifically applied to various taxa in the Aegean Sea fisheries were collected by examining the EU (EU, 2019), Greek (National Legislations: Royal and Presidential Decrees (RP and PD, respectively)) and Turkish (last Fishing Notification 5/1 published in 2020) Fisheries Legislations (Papaconstantinou *et al.*, 2007; EU, 2019; Anonymous, 2020).

Minimum conservation reference sizes (MCRS) are regulated by the EU (EU Regulation 2019/1241; Annex IX-Part A), Greek (National legislations) and Turkish (Notification 5/1) Legislations (Papaconstantinou *et al.*, 2007; EU, 2019; Anonymous, 2020).

### Interpreting and Presenting Data

The historical evolution of fleets registered in the Aegean Sea ports of both countries were revealed by determining the changes in the number of fishing vessels (SSF: small-scale fishing, LSF: large scale fishing- OTB and PS) and the age, tonnage, length and engine power of OTB and PS.

The methodology and historical evolution of obtaining landings data of Greece and Türkiye were analyzed. Species reported were categorised to the following families; Fish, Cephalopods, Crustaceans and Molluscs. The top ten landed commercial species were determined for each country and their percentage share of the total landings of country was calculated.

The current regulations of both states regarding their MCRS, closed seasons for the species and protected species in the Aegean Sea were compared. Species were grouped as Fish, Crustaceans, Mollusc bivalves, Cephalopods, Gastropods, Holothuroidea, and Florideae according to MCRS, and specific closed season comparisons were examined. Common names for marine taxa were taken from [www.fishbase.de](http://www.fishbase.de) and [www.sealifebase.de](http://www.sealifebase.de) (Froese & Pauly, 2020; Palomares & Pauly, 2020). Where scientific names have been updated and differ from EU or national legislations, the currently accepted name is presented here, with a footnote of the change.

All available data on the length at 50% maturity ( $L_{m_{50}}$ ) of each species from the Aegean Sea, if any, or from the adjacent region were extracted from peer-reviewed published sources. Thus, the differences between the  $L_{m_{50}}$  and MCRS were determined based on the cur-

rent MCRS listings of the species for both states, and recommendations are provided to improve the capabilities of this measure. The specific closure seasons were also compared for the spawning seasons of each species, where data were available, to determine if the closures are sufficient or need improving on.

Lists of protected species were compared from the Greek, EU and Turkish measures. The International Union for Conservation of Nature and Natural Resources (IUCN) Red List Categories of species were used by IUCN (2021) to classify threat levels. The nine threat indices of the IUCN Red List are: Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW), and Extinct (EX).

## Results

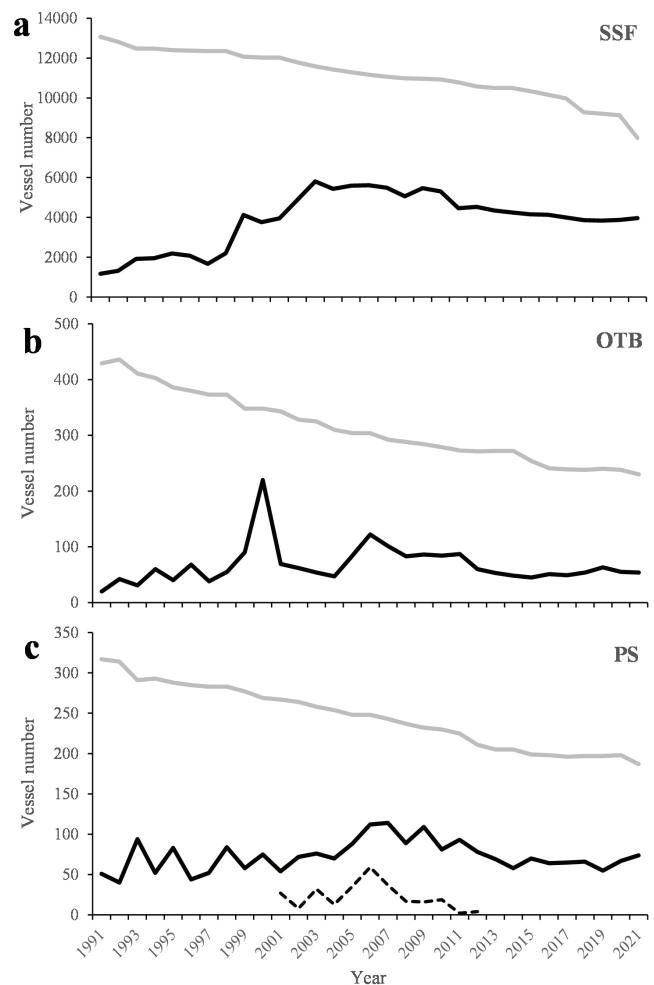
### *Fleet Structure in the Aegean Sea*

In 2021, 8,404 Greek vessels and 4,117 Turkish vessels were registered in the Aegean Sea ports. Of those, 95.0% of the Greek vessels and 96.1% of the Turkish vessels were of a small-scale nature (STECF, 2024; TURKSTAT, 2022), far greater than the 82% Mediterranean average for the entire small-scale fleet (FAO, 2023). Greece exhibited a remarkable reduction by almost 39% of its small-scale fleet reaching 7987 vessels in 2021 (Fig. 2a). In Türkiye, the number of registered small-scale fisheries (SSF) vessels increased from 3,762 in 2000, to peak at 5,806 in 2003, and in 2021 was 3957 (Fig. 2a).

The other Turkish commercial vessels registered in the Aegean Sea aside from SSF consist of PS (1.8%), OTB (1.3%) and carrier vessels (0.8%) (TURKSTAT, 2022), while in Greece they are comprised of bottom trawls (2.7%) and purse seine vessels (2.2%), representing 84.9% of the total Greek OTB and 83.5% of the PS fleet (STECF, 2024) (Fig. 2, 3).

The number of large-scale fishing vessels in the Greek fleet exhibited a considerable decline over the last 30 years with the numbers of OTB and PS decreasing by 46.3% and 41.0% up to 230 and 187 vessels, respectively between 1991 and 2021 (Fig. 2b, c). On the other hand, the number of OTB in the Turkish fleet, which was 20 in 1991, increased to 220 in 2000 and then decreased to 54 in 2021, exhibiting a downward trend, aside from a peak in 2006 (Fig. 2b). The number of PS in the Turkish fleet fluctuated considerably, increasing from 51 in 1991 to 114 in 2007, then decreased to 55 in 2019, before increasing again to 74 in the last two years (Fig. 2c). OTB and PS licensed vessels in the Turkish fleet (shown by the black dashed line in Fig. 2c) both peaked at 59 in 2006 and dropped to two in 2012 between 2001-2012.

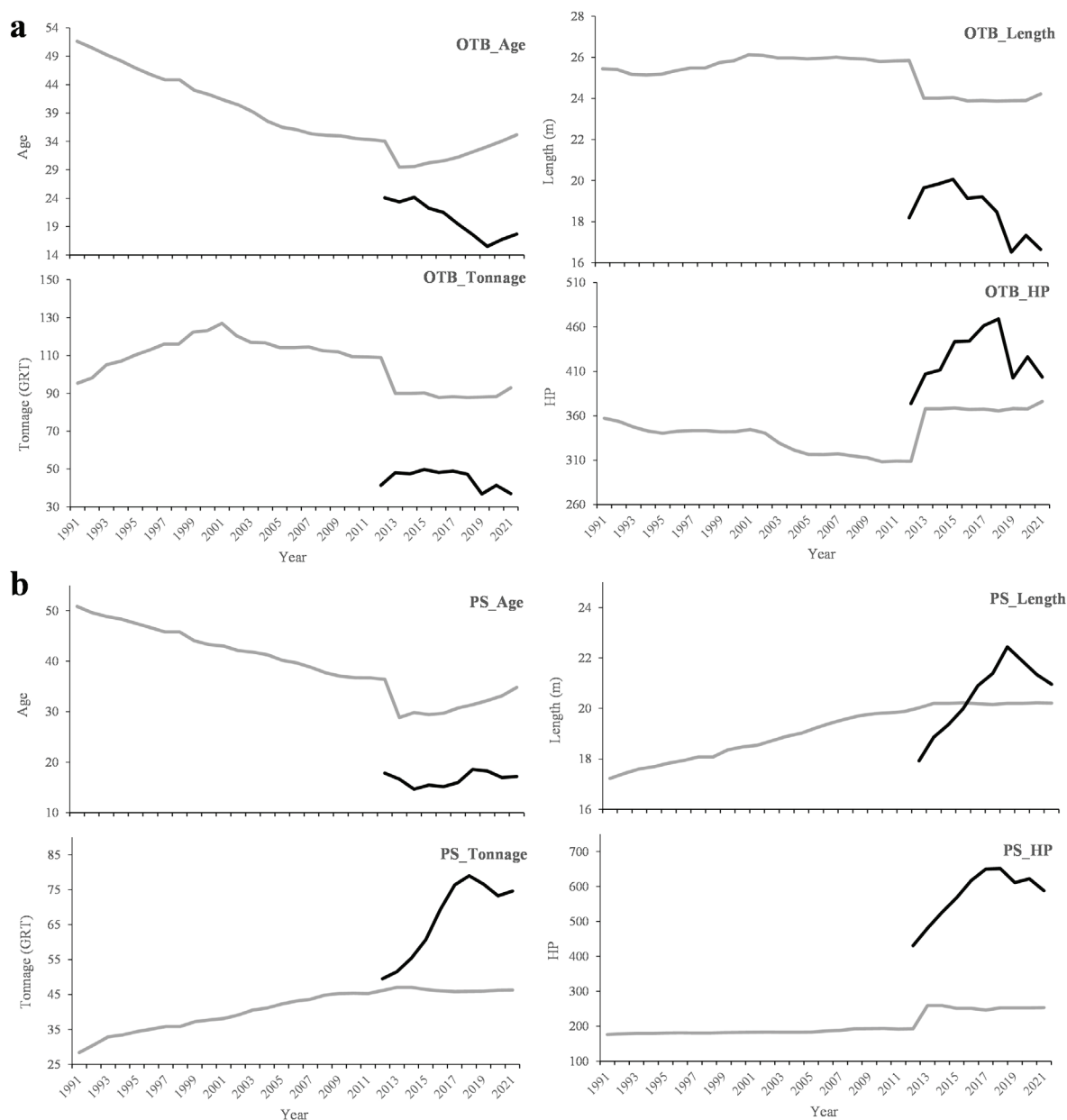
The Greek OTB fleet has historically progressed to using newer but smaller vessels with lower tonnage and slightly higher engine horsepower (grey line in Fig. 3a). Similarly, the Turkish OTB fleet has progressed to using newer, and smaller vessels, with HP and tonnage val-



**Fig. 2:** Temporal variation of Greek (grey line) and Turkish (black line) commercial fishing fleets registered in Aegean Sea ports: (a) small-scale fishing vessels (SSF), (b) single boat bottom otter trawler (OTB), and (c) purse seine (PS). Vessels with both OTB and PS licenses in the Aegean Sea Turkish fleet between 2001 and 2012 are shown with a black dashed line.

ues increasing at first, before decreasing in recent years (black line in Fig. 3a). Although both fleets have become newer over time, the Greek OTB fleet has always been older than the Turkish OTB fleet and is almost twice as old as of 2021 (Fig. 3a). From 2011 to 2021, the Greek OTB fleet had higher values in tonnage and length than the Turkish OTB fleet, while the Turkish fleet had higher HP (Fig. 3a).

The Greek PS fleet has historically progressed to using vessels with a lower age, higher average length and slightly higher horsepower and tonnage (grey line in Fig. 3b). Similarly, the Turkish PS fleet has also started to use vessels with larger and higher HP and tonnage in the last ten years (black line in Fig. 3b). The Turkish purse seine fleet had higher tonnage values from 2011-2021, but had over three times higher HP values from 2012-2021, while the Greek purse seine fleet is almost twice the age of the Turkish purse seine fleet. In terms of length, the Greek purse seine fleet has not changed much over the last decade (21 m average length), while the Turkish purse seine fleet has increased its average vessel length from 18 to 21 m from 2012 to 2021 (Fig. 3b).

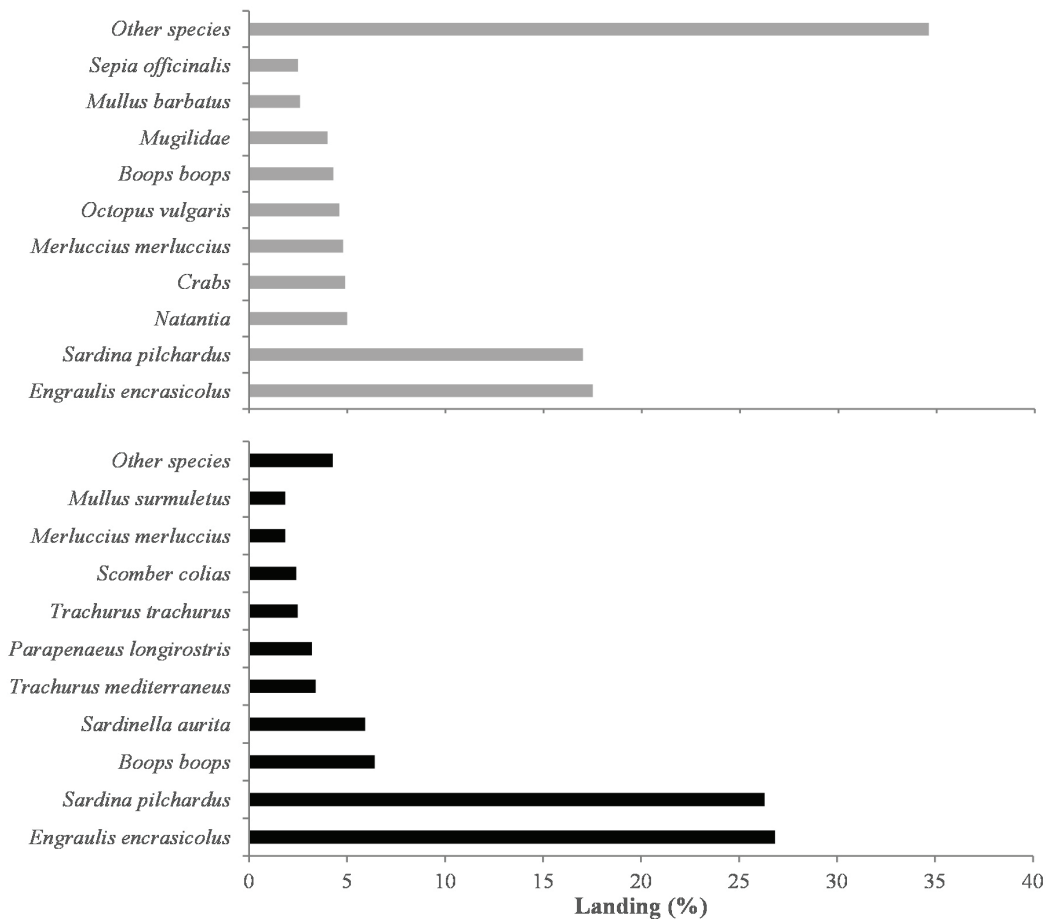


**Fig. 3:** Annual evolution of the mean age, vessel length, vessel tonnage and engine horsepower (HP) of the single boat bottom otter trawl (OTB) (a) and the purse seine (PS) (b) fishing fleet operating in the Aegean Sea of Greece (grey line) and Turkish (black line).

### Reporting Species

In Greece, landing records in 2021 are available for 73 species, including 57 fish, five cephalopods, six crustaceans and five molluscs (Table S1). The top 10 commercial taxa (*Engraulis encrasicolus*, *Sardina pilchardus*, *Natantia*, crabs, *Merluccius merluccius*, *Octopus vulgaris*, *Boops boops*, *Mugilidae*, *Mullus barbatus*, *Sepia officinalis*) with the highest landings provided 65.4% of total landing from the Aegean Sea in 2021, and none of these taxa had specific closed seasons applied to them (Fig. 4). In Türkiye, landing records in 2021 are available for 78 species from the Aegean Sea, including 59 fish, three cephalopods, eight crustaceans, and eight molluscs (Table S1). The top 10 commercial species (*Engraulis encrasicolus*, *Sardina pilchardus*, *Boops boops*, *Sardinella aurita*, *Trachurus mediterraneus*, *Parapenaeus*

*longirostris*, *Trachurus trachurus*, *Scomber colias*, *Merluccius merluccius*, *Mullus surmuletus*) with the highest landings provided 80.7% of Türkiye's 37,077 tons total landing from the Aegean Sea in 2021, and interestingly, as in Greece, none of these species had specified closed seasons applied to them. The total catch amount of 24 species with applied closed seasons was 1,582 tons, representing 4.3% of the total catch amount of the Aegean Sea (Fig. 4). The comparison of the species reported by the official authorities between the two neighbouring states showed that (Table S1) 50 out of 73 species reported for Greece were also reported for Türkiye. In contrast, 28 species were not reported by Greek authorities and 23 species reported in Greece were not reported in the Turkish statistics (Table S1).



**Fig. 4:** Greek (upper-grey columns) and Turkish (down-black columns) landings from the Aegean Sea based on the highest 10 landed commercial taxa (for Greece) and species (for Türkiye) and other species (other species in Turkish landings represents the 24 species with closed season) (TURKSTAT, 2022; HELSTAT, 2022).

### Minimum Conservation Reference Size (MCRS)

Under the MCRS for the listed species, these are protected from being caught, held onboard, transhipped, landed, transported, stored, sold, displayed or offered for sale. MCRS's were determined in Turkish legislation for 33 of 56 fish species (Table 1), two of eight crustacean species, one of two mollusc bivalves, and one of three cephalopod species, which are landed from the Aegean Sea.

Greek and EU MCRS overlap for 10 species. For 6 taxa (*Dicentrarchus labrax*, *Diplodus sargus*, *Pagellus erythrinus*, *Trachurus* spp., *Homarus gammarus*, *Palinuridae*), Greece has to apply the EU MCRS limits, which are of larger sizes than their national legislations (Table 1). Also, for three species (*Diplodus annularis*, *Epinephelus marginatus*, *Venus* spp.), the national MCRSs are more sensitive than EU MCRSs and are applied. In addition, MCRS's in Greek national legislation are valid for 46 species (28 fish, 13 mollusc bivalves, one cephalopod and four gastropods), which are not represented under EU legislation (Table 1). Moreover, for the commercial species not covered under EU regulations (e.g. *Dentex dentex*, *Oblada melanura*, *Serranus cabrilla* and *Spondyllosoma cantharus*), MCRS was arbitrarily set 68 years ago (National Royal Degree FEK 25A/26-1-1954) at 10 cm for *B. boops* and 8 cm for the other twenty species

which have no biological basis (Table 1).

When the EU and NL are evaluated together, Greece applies MCRS for a total of 53 species, (excluding the very outdated 20- 8 cm MCRS's) 28 fish, 4 crustaceans, 16 mollusc bivalves, one cephalopod and four gastropods. In contrast, Türkiye applies a total of 49 MCRSs, 39 fish, three crustaceans, six mollusc bivalves, and one cephalopod. Türkiye has a higher number of MCRS applications only in fish, with this trend reversing in Greece for other groups, except cephalopods, which have *Octopus vulgaris* listed for both states (Table 1).

When the MCRSs of Greece and Türkiye (Table 1) are compared, from a total of 74 species with MCRS limits, 25 species are listed only in Greek legislation and one species (*Callinectes sapidus*) only in Turkish legislation. MCRS is determined for 48 species in both states and 10 of them (*D. labrax*, *Diplodus vulgaris*, *Engraulis encrasicolus*, *Epinephelus* spp., *Merluccius merluccius*, *P. erythrinus*, *Sardina pilchardus*, *Solea vulgaris*, *Sparus aurata*, *Thunnus thynnus*) have the same minimum limits applied. Greece has higher (more sensitive) MCRS values for nine species (*Chamelea gallina*, *D. sargus*, *Donax trunculus*, *H. gammarus*, *Ostrea edulis*, *Ruditapes decussatus*, *Trachurus* spp., *Veneridae* and *Venus* spp.), while Türkiye has higher MCRS values for 29 species (*Lichia amia*, *Mugil cephalus*, *O. vulgaris*, *Sardinella aurita*, *S. colias*, *X. gladius* and the fish species with 8 cm MCRS

**Table 1.** Minimum conservation reference sizes (MCRS) in legislations of EU, Greece (Gr) and Türkiye (Tr) (The valid sizes in EU and Greece National Legislation (NL) are shown in bold). Length at 50% maturity ( $L_{m_{50}}$ ) from the Aegean Sea or adjacent region found in the literature (m: male; f: female; c: combined; NA: Not available) and recommendation for MLS according to  $L_{m_{50}}$  (+: should be increased; S: should be set; ND: Need  $L_{m_{50}}$  data). (MCRS and  $L_{m_{50}}$  values are given as total length. In case of different size, information is provided below the table)

Scientific name	Common name	MCRS			$L_{m_{50}}$			Reference	Recommendation	
		EU	NL	Tr	Aegean Sea	Adjacent region	Gr		Tr	
<i>Argyrosomus regius</i>	Meagre	-	8 cm	25 cm	13.37 cm (m) 12.96 cm (f)	48 cm (m) 58 cm (f)	Abou Shabana <i>et al.</i> (2012)	+ 50 cm	+ 33 cm	
<i>Boops boops</i>	Bogue	-	10 cm	-	9.35 cm (m) 12.96 cm (f)		Soykan <i>et al.</i> (2015)	+ 3 cm	S	
<i>Chelidonichthys lucerna</i>	Tub gurnard	-	8 cm	18 cm		18 cm (m) 20 cm (f)	İşmen <i>et al.</i> (2004)	+ 12 cm	+ 2 cm	
<i>Chelon labrosus</i>	Thicklip grey mullet	-	8 cm	20 cm		25 cm (m) 29.5 cm (f)	Campillo (1992)	+ 11.5 cm	+ 9.5 cm	
<i>Dentex dentex</i>	Common dentex	-	8 cm	35 cm		52 cm (m) 34.6 cm (f)	Morales-Nin and Moranta (1997)	+ 26.6 cm		
<i>Dicentrarchus labrax</i>	European seabass	<b>25 cm</b>	23 cm	25 cm		20 cm (m) 29 cm (f)	Wassef and El Emary (1989)	+ 4 cm	+ 4 cm	
<i>Diplodus annularis</i>	Annular seabream	12 cm	<b>15 cm</b>	-	10.53 cm (m) 10.02 cm (f)		İlkyaz <i>et al.</i> (2018)		S	
<i>Diplodus puntazzo</i>	Sharpsnout seabream	18 cm	-	-		21.5 cm (c)	Mouine <i>et al.</i> (2012)	+ 3.5 cm	S	
<i>Diplodus sargus</i>	White seabream	<b>23 cm</b>	15 cm	21 cm		20.4 cm (m) 21.2 cm (f)	Mouine <i>et al.</i> (2012)			
<i>Diplodus vulgaris</i>	Two-banded seabream	18 cm	-	18 cm	13.37 cm (m) 12.87 cm (f)		Soykan <i>et al.</i> (2015)			
<i>Engraulis encrasicolus</i>	European anchovy	9 cm <sup>(1)</sup>	9 cm	9 cm <sup>(2)</sup>		7.5 cm (m) 8.17 cm (f)	Ferri <i>et al.</i> (2021)			
<i>Epinephelus</i> spp.	Groupers	45 cm	<b>50 cm</b> <sup>(3)</sup>	50 cm <sup>(4)</sup>		49.1 cm (f) <sup>(3)</sup>	Renones <i>et al.</i> (2006)			
<i>Euthynnus alletteratus</i>	Little tunny	-	8 cm	45 cm		44.8 cm (c) <sup>(5)</sup>	Mohamed <i>et al.</i> (2014)	+ 36.8 cm		
<i>Lichia amia</i>	Leerfish	-	14 cm	40 cm		NA		ND	ND	
<i>Lithognathus mormyrus</i>	Sand steenbras	20 cm	-	-	16.21 cm (m) 19.04 cm (f)		Kallianiotis <i>et al.</i> (2005)		S	
<i>Liza aurata</i>	Golden grey mullet	-	8 cm	30 cm		26.2 cm (m) 24.1 cm (f)	Kesiktaş <i>et al.</i> (2020)	+ 16 cm		
<i>Liza ramada</i>	Thinlip grey mullet	-	8 cm	20 cm	33 cm (m) <sup>(6)</sup> 31.8 cm (f) <sup>(6)</sup>		Koutrakis (2011)	+ 24 cm	+ 12 cm	
<i>Liza saliens</i>	Leaping mullet	-	8 cm	20 cm	22.6 cm (m) <sup>(6)</sup> 23.8 cm (f) <sup>(6)</sup>		Koutrakis (2011)	+ 15.8 cm	+ 3.8 cm	
<i>Lophius</i> spp.	Anglerfish	-	30 cm	-	42.5 cm (m) <sup>(7)</sup> 58.8 cm (f) <sup>(7)</sup>		Yigin <i>et al.</i> (2015)	+ 28.8 cm	S	

Continued



Table 1 continued

Taxa		MCRS			Lm <sub>50</sub>			Recommendation	
		EU	Gr	Tr	Adjacent region	Reference	Gr	Tr	
<i>Merlangius merlangus</i>	Whiting	-	8 cm	13 cm	13.9 cm (m) 14.6 cm (f)	Bilgin <i>et al.</i> (2012)	+ 6.6 cm	+ 1.6 cm	
<i>Merluccius merluccius</i>	European hake	20 cm	-	20 cm	29.4 cm (m) 38.9 cm (f)	Apostologamvrou <i>et al.</i> (2023)	+ 9.4 cm	+ 9.4 cm	
<i>Mugil cephalus</i>	Flathead grey mullet	-	16 cm	30 cm	42 cm (m) 47.5 cm (f)	Brusle and Brusle (1977)	+ 31.5 cm	+ 17.5 cm	
<i>Mugil soiauy</i>	So-iuy mullet	-	8 cm	35 cm	NA		ND	ND	
<i>Mullus</i> spp.	Red mullets	11 cm	11 cm	11 cm <sup>(6)</sup> ; 13 cm <sup>(6)</sup>	13.7 cm (m) <sup>(8)</sup> 13.2 cm (f) <sup>(6)</sup> 11.56 cm (m) <sup>(9)</sup> 12.33 cm (f) <sup>(9)</sup>	Arslan and İşmen (2013) <sup>(8)</sup> Ilkyaz <i>et al.</i> (2018) <sup>(9)</sup>	+ 2.2 cm	+ 2.2 cm <sup>(8)</sup>	
<i>Oedalechilus labeo</i>	Boxlip mullet	-	8 cm	20 cm	12.9 cm (m) 12.8 cm (f)	Matić -Skoko <i>et al.</i> (2012)	+ 4.8 cm		
<i>Pagellus acarne</i>	Axillary seabream	17 cm	-	-	13.91 cm (m) 14.45 cm (f)	Soykan <i>et al.</i> (2015)		S	
<i>Pagellus bogaraveo</i>	Blackspot seabream	33 cm	-	-	26.4 cm (m) 32.3 cm (f)	Krug (1998)		S	
<i>Pagellus erythrinus</i>	Common pandora	15 cm	12 cm	15 cm	14.52 cm (m) 11.90 cm (f)	Yapıcı and Filiz (2019)			
<i>Pagrus pagrus</i>	Red porgy	18 cm	18 cm	-	35.6 cm (f) <sup>(10)</sup>	Vassilopoulou and Papaconstantinou (1992)	+ 17.6 cm	S	
<i>Pleuronectes</i> spp.	Right-eye flounders	-	8 cm	20 cm	14 cm (m) <sup>(11)</sup> 15 cm (f) <sup>(11)</sup>	Cengiz <i>et al.</i> (2014)	+ 7 cm		
<i>Polyprion americanus</i>	Wreckfish	45 cm	45 cm	-	90 cm (c)	Carbonara <i>et al.</i> (2003)	+ 45 cm	S	
<i>Pomatomus saltatrix</i>	Bluefish	-	8 cm	18 cm	27.7 cm (f) <sup>(12)</sup>	Ceyhan <i>et al.</i> (2007)	+ 19.7 cm	+ 9.7 cm	
<i>Sarda sarda</i>	Atlantic bonito	-	8 cm	25 cm	36.8 cm (m) 42.5 cm (f)	Kahraman <i>et al.</i> (2014)	+ 34.5 cm	+ 17.5 cm	
<i>Sardina pilchardus</i>	European pilchard	11 cm <sup>(13)(14)</sup>	-	11 cm <sup>(2)(15)</sup>	11.37 cm (m) 11.65 cm (f); 12.1 cm (c)	Tsikliras and Koutrakis (2013); Akyol <i>et al.</i> (1996)	+ 0.6 cm	+ 0.6 cm	
<i>Sardinella aurita</i>	Round sardinella	-	10 cm	11 cm	16.8 cm (m) 15.6 cm (f)	Tsikliras and Antonopoulou (2006)	+ 5.6 cm	+ 4.6 cm	
<i>Sciaena umbra</i>	Brown meagre	-	8 cm	35 cm	19.5 cm (m) 21.97 cm (f)	Engin and Seyhan (2009)	+ 14 cm		
<i>Scomber colias</i>	Chub mackerel	-	12 cm	18 cm	18 cm (c)	Cengiz (2012)	+ 6 cm		
<i>Scomber</i> spp.	Mackerels	18 cm	18 cm	20 cm <sup>(16)</sup>	23.2 cm (m) <sup>(11)</sup> 23.4 cm (f) <sup>(11)</sup>	AO El-Aiatt (2020)	+ 5.4 cm	+ 3.4 cm	

Continued

Table 1 continued

Scientific name	Common name	MCRS				Ln <sub>50</sub>			Recommendation	
		Gr		Tr	Aegean Sea	Adjacent region	Reference	Gr	Tr	
		EU	NL							
<i>Scophthalmus maximus</i>	Turbot	-	8 cm	45 cm		24.68 cm (m) 20.38 cm (f)	Eryılmaz and Dalyan (2015)	+ 12.4 cm		
<i>Scorpaena scrofa</i>	Red scorpionfish	-	8 cm	15 cm		24.9 cm (m) 29 cm (f)	Matić-Skoko et al. (2015)	+ 21 cm	+ 14 cm	
<i>Seriola dumerili</i>	Greater amberjack	-	8 cm	30 cm		93.7 cm (m) 95.3 cm (f)	Sley et al. (2014)	+ 87.3 cm	+ 65.3 cm	
<i>Solea vulgaris</i>	Common sole	20 cm	20 cm	20 cm <sup>(17)</sup>	15.4 cm (f) <sup>(17)</sup>		Cerim and Ateş (2019)			
<i>Sparus aurata</i>	Gilthead seabream	20 cm	20 cm	20 cm		29.1 cm (m) 34.8 cm (f)	Četinić et al. (2002)	+ 14.8 cm	+ 14.8 cm	
<i>Thunnus thynnus</i>	Atlantic bluefin tuna	-	115 cm <sup>(18)</sup> - 30 kg <sup>(19)</sup>	115 cm <sup>(18)</sup> - 30 kg <sup>(19)</sup>		103.6 cm (f) <sup>(18)</sup>	Corriero et al. (2005)			
<i>Trachurus</i> spp.	Horse mackerels	15 cm	12 cm	13 cm <sup>(20)(2)</sup>	17 cm (m) 17 cm (f)		Abaunza et al. (2003)	+ 2 cm	+ 4 cm	
<i>Umbrina cirrosa</i>	Shi drum	-	8 cm	45 cm		NA		ND	ND	
<i>Upeneus moluccensis</i>	Goldband goatfish	-	8 cm	10 cm		11 cm (m) 11.4 cm (f)	Özyurt et al. (2014)	+ 3.4 cm	+ 1.4 cm	
<i>Xiphias gladius</i>	Swordfish	-	120 cm <sup>(21)</sup>	125 cm <sup>(18)</sup>		140 cm (f) <sup>(18)</sup>	Macias et al. (2005)	+ 20 cm	+ 15 cm	
<b>Crustaceans</b>										
<i>Callinectes sapidus</i>	Atlantic blue crab	-	85 mm CL- 420 g	13 cm		11.85 cm (f)	Sumer et al. (2013)	S		
<i>Homarus gammarus</i>	European lobster	105 mm CL <sup>(22)</sup>	240 mm TL-420 g	25 cm TL		NA		ND	ND	
		300 mm TL <sup>(22)</sup>								
<i>Nephrops norvegicus</i>	Norway lobster	20 mm CL <sup>(22)</sup>	20 mm CL	-	33 mm (f)		Relini et al. (1998)	+ 13 mm	S	
		70 mm TL <sup>(22)</sup>	70 mm TL	-	119 mm (f) <sup>(23)</sup>		Relini et al. (1998)	+ 49 mm	S	
<i>Palinuridae</i>	Spiny lobsters	90 mm CL <sup>(22)</sup>	240 mm TL	25 cm TL <sup>(24)</sup>		86 mm CL (f) <sup>(24)</sup> 24.6 cm TL (f) <sup>(24)(25)</sup>	Hunter (1999)			
<i>Parapanaeus longirostris</i>	Deep-water rose shrimp	20 mm CL	-	-	24.6 mm CL (f)		Dereci and Erdem (2011)	+ 4.6 mm	S	
<b>Mollusc bivalves</b>										
<i>Aequipecten opercularis</i>	Queen scallop	-	5 cm	-		NA		ND	S	
<i>Arca noae</i>	Noah's ark	-	5 cm	-		NA		ND	S	
<i>Barbatia barbata</i>	Hairy ark	-	5 cm	-		NA		ND	S	
<i>Callista chione</i>	Brown venus	-	4.5 cm	-		3.03 cm (c)	Galimany et al. (2015)		S	

Continued

Table 1 continued

Taxa		MCRS			Lm <sub>50</sub>			Recommendation	
		EU	Gr	Tr	Adjacent region	Reference	Gr	Tr	
Scientific name	Common name		NL						
<i>Cerastoderma glaucum</i>	Olive green cockle	-	4 cm	-	1.51 cm (m) 1.68 cm (f)	Derbali <i>et al.</i> (2009)		S	
<i>Chamelea gallina</i>	Striped venus clam	-	3.5 cm	1.7 cm	1.15 cm (m) 1.1 cm (f)	Bargione <i>et al.</i> (2021)			
<i>Dontax trunculus</i>	Truncate donax	-	3 cm	2.5 cm	1.91 cm (c)	Deval (2009)			
<i>Dosinia exoleta</i>	Mature dosinia	-	4 cm	-	NA		ND	S	
<i>Flexopecten glaber</i>	Smooth scallop	-	4.5 cm	-	NA		ND	S	
<i>Gari depressa</i>	Depressed sunset clam	-	4 cm	-	NA		ND	S	
<i>Modiolus barbatus</i>	Bearded horse mussel	-	5 cm	-	NA		ND	S	
<i>Ostrea edulis</i>	Edible oyster	-	7 cm	6 cm	NA		ND	ND	
<i>Pecten jacobaeus</i>	Great Mediterranean scallop	10 cm	10 cm	-	NA		ND	S	
<i>Ruditapes decussatus</i>	Grooved carpet shell	-	4.5 cm	24 mm	NA		ND	ND	
<i>Veneridae</i>	Carpet shells	25 mm	25 mm	24 mm <sup>(26)</sup>	NA		ND	ND	
<i>Venus</i> spp.	Venus clams	25 mm	4.5 cm	30 mm <sup>(27)</sup>	2.58 cm (c)	Popović <i>et al.</i> (2013)			
<b>Cephalopods</b>									
<i>Octopus vulgaris</i>	Common octopus	-	500 g	750 g	250 g (m) 580 g (f)	Silva <i>et al.</i> (2002)	+ 80 g		
<b>Gastropods</b>									
<i>Bolinus brandaris</i>	Purple dye murex	-	6 cm	-	5.46 cm (m) 5.64 cm (f)	Elhasni <i>et al.</i> (2013)		S	
<i>Haliotis tuberculata</i>	Tuberculate abalone	-	6 cm	-	NA		ND	S	
<i>Phyllonotus trunculus</i>	Banded dye-murex	-	5 cm	-	NA		ND	S	
<i>Stramonita haemastoma</i>	Red-mouthed rock shell	-	5 cm	-	NA		ND	S	

(1) EU Member States may convert the minimum conservation reference size into 110 specimens per kg.  
(2) Small sizes are permitted, provided that they are less than 15% of the product by weight. This rate is 5% in seafood other than European anchovy, European sardine and horse mackerel.  
(3) For dusky grouper (*Epinephelus marginatus*)  
(4) For white grouper (*Epinephelus aeneus*)  
(5) Total length was calculated from fork length according to Allaya *et al.* (2017)  
(6) Total length was calculated from standard length according to Kara *et al.* (2020)  
(7) For blackbelled angler (*Lophius budegassa*)  
(8) For striped red mullet (*Mullus surmuletus*)  
(9) For red mullet (*Mullus barbatus*)  
(10) Total length was calculated from fork length according to Moutopoulos and Stergrou (2002)  
(11) For spotted flounder (*Citharus linguatula*)  
(12) Total length was calculated from standard length according to Özpiçak *et al.* (2017)  
(13) EU Member States may convert the minimum conservation reference size into 55 specimens per kg.  
(14) This minimum conservation reference size shall not apply to fries of sardine landed for human consumption if caught by boat seines or shore seines and authorised in accordance with national provisions established in a management plan as referred to in Article 19 of Regulation (EC) No 1967/2006, provided that the stock of sardine concerned is within safe biological limits.  
(15) For European pilchard (*Sardina pilchardus*) and round sardinella (*Sardinella aurita*)  
(16) For Atlantic mackerel (*Scomber scombrus*)  
(17) For common sole (*Solea solea*, synonym of *Solea vulgaris*)  
(18) Fork length  
(19) Bluefin tuna between 8-30 kg or 75-115 cm are allowed in maximum 5% as numerical.  
(20) For Atlantic horse mackerel (*Trachurus trachurus*) and Mediterranean horse mackerel (*Trachurus mediterraneus*)  
(21) Swordfish fish less than 11.4 kg (whole weight) or 10.2 kg (gilled and gutted weight) or less than 100 cm in length are allowed in maximum of 5% as a number or weight.  
(22) CL - carapace length; TL - total length.  
(23) Total length was calculated from carapace length according to Aydın and Aydın (2011)  
(24) For European spiny lobster (*Palinurus elephas*)  
(25) Total length was calculated from carapace length according to Queiglas *et al.* (2004)  
(26) For Japanese carpet shell (*Tapes philippinarum*)  
(27) For warty venus (*Venus verrucosa*)

applied by Greece long ago- see Table 1). See Supplementary Material in Yildiz & Ulman (2020) for the development of Turkish MLS regulation sizes for details on each species by publication notification period.

While some MCRS values have been prescribed at the genus level (*Mullus* spp. at 11 cm, and *Scomber* spp. at 18 cm) under Greek legislation, the MCRS values were assigned to these taxa at species level in Türkiye. *Mullus barbatus* is slightly higher at 13 cm, while *Mullus surmuletus* (11 cm) is the same as in Greece. *Scomber scombrus* with 20 cm is slightly higher compared to the 18 cm that is applied for *Scomber* spp. in Greece. *S. japonicus* is the same in both states. Also, MCRS values are provided for *Palinuridae* as carapace length (CL) in EU legislation, but use a similar total length (TL) in Greece and Türkiye.

When comparing the  $Lm_{50}$  values reported from the Aegean Sea, where available, or from the nearest region in the literature, only 11 out of 74 species have MCRS values equal to or higher than the  $Lm_{50}$  values of both states.  $Lm_{50}$  information could not be found in the literature for 18 species (three fish, one crustacean, 11 mollusc bivalves and three gastropods), and hence, no evaluation could be made for these species. For 22 fish species, MCRS values of both states were found to be below  $Lm_{50}$ . Türkiye's MCRS values were found to be sufficient for seven fish species (*Euthynus alletteratus*, *Liza aurata*, *Oedalechilus labeo*, *Pleuronectes* spp., *Scophthalmus maximus*, *Sciaena umbra*, *S. japonicus*) and *O. vulgaris*. On the other hand, the findings showed that Türkiye has no MCRS limits in its legislation for 26 commercial species, while Greece was only lacking this for one species (Table 1).

### Closed Seasons

Closed seasons are applied to specific species in the Aegean Sea fisheries by Greece and Türkiye (Notification 5/1) under national legislation (Papaconstantinou *et al.*, 2007; Anonymous, 2020). Greece only has a closed season for *X. gladius* and *T. thynnus* for fish, and for *H. gammarus* and *Palinurus elephas* for crustaceans (PD 237/1996). For *X. gladius*, fishing is not allowed between 1<sup>st</sup> of January and 31<sup>st</sup> of March each year in Greece (in Annex ID of Regulation (EU) 2023/194 of 30 January 2023 and in Art. 10(1) of Regulation (EU) 2019/1154). In Türkiye *X. gladius* fishery is closed for a total of three months but from 15 February - 15 March and 1 October - 30 November, with only half the period overlapping (Anonymous, 2020). For *H. gammarus* and *P. elephas* fishing is prohibited from 1 September - 31 December (4 months) in Greece and on 1 September - 15 April (7.5 months) in Türkiye. In addition to these species, closed seasons were assigned for seven fish and three crustacean species only under Turkish legislation (Table S2) (Anonymous, 2020).

Closed seasons were determined for seven mollusc bivalve species in both states with similar prohibition periods from about 1 April - 31 October in Greece and a shorter period in Türkiye (15 April - 31 August) (Anonymous,

2020). *Callista chione* has a closed season (1 April – 30 June) only in Greece, and *Gracilaria* spp. and seven fish species (moss) have closed seasons only in Türkiye (Table 2 and Table S2) (Anonymous, 2020). For cephalopods, a species-specific closed season is issued for Türkiye for *O. vulgaris* (April to October) (Anonymous, 2020), whereas for Greece there is a closed season for the primary fishing gear used to target this species (fishing pots) (July to September). *Holothuria* spp. and *Rapana venosa* fishing are prohibited between 1 April and 31 October (7 months) in Greece, and their closed seasons in Türkiye are between two to 2.5 months shorter (Anonymous, 2020).

The species-specific closed seasons of Greece and Türkiye are compared to the spawning periods for those species with available spawning season data (Table 2). Both states have specific closed seasonal fisheries for three species (i.e., *D. trunculus*, *Rapana venosa*, *Holothuria* spp.) based on their spawning periods. Furthermore, Türkiye also has closed seasons for *Epinephelus aeneus*, *Sarda sarda* and *C. sapidus* based on their spawning periods. However, closed-season regulations for 11 species do not cover their entire spawning periods; Four of which (i.e., *R. decussatus*, *Venus verrucosa*, *O. vulgaris*, *O. edulis*) are under the legislations of both states, one (i.e., *C. chione*) is under Greek legislation, and four (i.e., *Coryphaena hippurus*, *Platichthys flesus*, *Solea solea*, *Palinurus elephas*) are under Turkish legislation. Surprisingly, the closed season applied to *X. gladius* does not include the spawning period (between May and September) of the species in both states. Although the spawning periods are not yet known for many species, four species (i.e., *H. gammarus*, *C. gallina*, *Mytilus galloprovincialis*, *Pecten jacobaeus*) are hypothesized to be managed by closed season regulations of both states. Nonetheless, Türkiye applies a closed season for the *Lichia amia* and *Gracilaria* spp., although no data could be found to support the spawning periods for these species (Table 2).

### Protected Species

Protected species in the Aegean Sea fisheries are regulated by the EU (EU Regulation 2019/1241; Annex I) and the Presidential Decree no 67/1981 “On the protection of native flora and fauna” and Türkiye (Notification 5/1) Legislations (EU, 2019; Anonymous, 2020). Lists of protected species are compared for Greece and Türkiye including their associated IUCN Red List Categories in Table 3. Only 14 taxa (*Acipenser naccarii*, *Acipenser sturio*, *Caretta caretta*, *Chelonia mydas*, *Cetaceans*, *Cetorhinus maximus*, *Corallium rubrum*, *Dermodochelys coriacea*, *Mobula japonica*, *Mobula mobular*, *Monachus monachus*, *Pinna nobilis*, *Posidonia oceanica* and *Squatina squatina*) are protected in both states (34 protected by Greece and 46 by Türkiye) (Table 3). Thirty-two species (two of them in DD, two of LC, three of NT, 11 of VU, one of EN and six of CR categories of IUCN Red List) are protected only under Turkish legislation. Twenty species (one of them in LC, four of VU, nine of EN, three

**Table 2.** Closed seasons for species in Greece (blue line) and Türkiye (red line) and spawning seasons shown (grey fill) by month.

Scientific name	Common name	Spawning and closed season												Reference			
		J	F	M	A	M	J	J	A	S	O	N	D				
<b>Fish</b>																	
<i>Coryphaena hippurus</i>	Common dolphinfish																Gatt <i>et al.</i> (2015)
<i>Epinephelus aeneus</i>	White grouper																Gökçe <i>et al.</i> (2003)
<i>Lichia amia</i>	Leerfish																-
<i>Platichthys flesus</i>	European flounder																Çiiloğlu (2005)
<i>Sarda sarda</i>	Atlantic bonito*																Güneş <i>et al.</i> (2011)
<i>Solea solea</i>	Common sole																Kahraman <i>et al.</i> (2014)
<i>Thunnus thynnus</i>	Atlantic bluefin tuna																Cerim and Ateş (2019)
<i>Xiphias gladius</i>	Swordfish																Türkmen (2003)
																	Karakulak <i>et al.</i> (2004)
																	Nakamura (1986)
																	Tserpes <i>et al.</i> (2001)
<b>Crustaceans</b>																	
<i>Callinectes sapidus</i>	Atlantic blue crab																Sumer <i>et al.</i> (2013)
<i>Homarus gammarus</i>	European lobster																-
<i>Palinurus elephas</i>	European spiny lobster																Göfi <i>et al.</i> (2003)
<i>Scyllarides latus</i>	Mediterranean slipper lobster																-
<b>Mollusc- Bivalves</b>																	
<i>Callista chione</i>	Brown venus																Metaxatos (2004)
<i>Chamelea gallina</i>	Striped Venus clam																Galimany <i>et al.</i> (2015)
<i>Donax trunculus</i>	Truncate donax																-
<i>Mytilus galloprovincialis</i>	Mediterranean mussel																Deval (2009)
<i>Ostrea edulis</i>	Edible oyster																-
<i>Pecten jacobaeus</i>	Scallop																Acarli <i>et al.</i> (2015)
<i>Ruditapes decussatus</i>	Clam																-
<i>Venus verrucosa</i>	Warty venus																Serdar and Lök (2010)
<b>Mollusc-Gastropod</b>																	
<i>Rapana venosa</i>	Rapa whelk																Çolakoğlu and Palaz (2015)
<b>Cephalopods</b>																	
<i>Octopus vulgaris</i>	Octopus																Saglam <i>et al.</i> (2009)
<b>Holothuroidea</b>																	
<i>Holothuria</i> spp.	Sea cucumbers																Sánchez and Obarti (1993)
																	Dereli <i>et al.</i> (2016)**
																	Kazanidis <i>et al.</i> (2014)**
<b>Florideae</b>																	
<i>Gracilaria</i> spp.	Moss																-

\* Set longline fishing is allowed from 15 to 31 August in Türkiye \*\* for *Holothuria tubulosa*

**Table 3.** Protected species under Greek (from EU and National Legislations) and Turkish Legislations, with the accompanying IUCN Red List Categories (DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered) (+: Indicates that the taxa is protected; -: Indicates that the taxa is not protected).

Scientific Name	Taxa		Greece	Türkiye	IUCN Red List Categories
	Common name				
<i>Acipenser naccarii</i>	Adriatic sturgeon		+	+(1)	CR
<i>Acipenser sturio</i>	Common sturgeon		+	+(1)	CR
<i>Alopias superciliosus</i>	Bigeye thresher		-	+	VU
<i>Alopias vulpinus</i>	Thresher		-	+	VU
<i>Anoxypristis cuspidata</i>	Narrow sawfish		+	-	EN
<i>Asterina pancerii</i>	Cushion star		-	+	-
<i>Caretta caretta</i>	Loggerhead turtle		+	+	VU
<i>Carcharhinus falciformis</i>	Silky shark		-	+	VU
<i>Carcharhinus longimanus</i>	Oceanic whitetip shark		-	+	CR
<i>Carcharhinus plumbeus</i>	Sandbark shark		-	+	VU
<i>Carcharodon carcharias</i>	White shark		+	-	VU
<i>Cetaceans</i>			+	+	-
<i>Centrostephanus longispinus</i>	Hatpin urchin		+	-	-
<i>Cerithium vulgatum</i>	Common cerithe		-	+	-
<i>Cetorhinus maximus</i>	Basking shark		+	+	EN
<i>Chelonia mydas</i>	Green sea turtle		+	+	EN
<i>Corallium rubrum</i>	Sardinia coral		+	+	EN
<i>Dermochelys coriacea</i>	Leatherback turtle		+	+	VU
<i>Epinephelus marginatus</i>	Dusky grouper		-	+	VU
<i>Galeorhinus galeus</i>	Tope shark		-	+	CR
<i>Gourmya yulgata</i>			-	+	-
<i>Haliotis tuberculata lamellosa</i>	Ormer		-	+	-
<i>Hippocampus hippocampus</i>	Short snouted seahorse		-	+	DD
<i>Homarus gammarus</i>	European lobster		+(2)	-	LC
<i>Huso huso</i>	Beluga		-	+	CR
<i>Isurus oxyrinchus</i>	Shortfin mako		-	+	EN
<i>Lamellaridae</i>			-	+	-
<i>Lamna nasus</i>	Porbeagle		-	+	VU
<i>Lithophaga lithophaga</i>	European date mussel		+	-	-
<i>Maja squinado</i>	Spinous spider crab		-	+	-
<i>Manta alfredi</i> <sup>(3)</sup>	Alfred manta		+	-	VU
<i>Manta birostris</i>	Giant manta		+	-	EN
<i>Mobula eregoodootenkee</i> <sup>(3)</sup>	Longhorned mobula		+	-	EN
<i>Mobula hypostoma</i> <sup>(3)</sup>	Lesser devil ray		+	-	EN
<i>Mobula japonica</i> <sup>(3)</sup>	Spinetail mobula		+	+	-
<i>Mobula kuhlii</i> <sup>(3)</sup>	Shortfin devil ray		+	-	EN
<i>Mobula mobular</i>	Devil fish		+	+	EN
<i>Mobula munkiana</i> <sup>(3)</sup>	Munk's devil ray		+	-	VU
<i>Mobula rochebrunei</i> <sup>(3)</sup>	Lesser Guinean devil ray		+	-	EN
<i>Mobula tarapacana</i>	Chilean devil ray		+	-	EN
<i>Mobula thurstoni</i>	Smoothtail mobula		+	-	EN
<i>Mola mola</i>	Ocean sunfish			+	VU
<i>Monachus monachus</i>	Mediterranean monk seal		+	+	EN
<i>Oxynotus centrina</i>	Angular roughshark		-	+	VU

*Continued*

Table 3 continued

Scientific Name	Taxa		Greece	Türkiye	IUCN Red List Categories
	Common name				
<i>Palinurus</i> spp.	Spiny lobsters		+( <sup>2</sup> )	-	VU( <sup>4</sup> )
<i>Pholas dactylus</i>	Common piddock		+	-	-
<i>Pinna nobilis</i>	Noble pen shell		+	+	CR
<i>Posidonia oceanica</i>	Mediterranean tapeweed		+	+	LC
<i>Prionace glauca</i>	Blue shark		-	+	NT
<i>Pristis clavata</i>	Dwarf sawfish		+	-	EN
<i>Pristis pectinate</i>	Smalltooth sawfish		+	-	CR
<i>Pristis pristis</i>	Common sawfish		+	-	CR
<i>Pristis zijsron</i>	Longcomb sawfish		+	-	CR
<i>Raja clavata</i>	Thornback ray		-	+	NT
<i>Rhinobatos cemiculus</i>	Blackchin guitarfish		-	+	CR
<i>Rhinobatos rhinobatos</i>	Common guitarfish		-	+	-
<i>Salmo trutta labrax</i>	Black Sea salmon		-	+	LC
<i>Savalia savaglia</i>	Gold coral		-	+	NT
<i>Sphyrna zygaena</i>	Smooth hammerhead		-	+	VU
<i>Squalus acanthias</i>	Piked dogfish		-	+	VU
<i>Squalus blainville</i>	Longnose spurdog		-	+	DD
<i>Squatina aculeata</i>	Sawback angelshark		-	+	CR
<i>Squatina oculata</i>	Smoothback angelshark		-	+	CR
<i>Squatina squatina</i>	Angel shark		+	+	CR
<i>Trionyx triunguis</i>	Nile softshell turtle		-	+	VU
<i>Zostera nolti</i>	Dwarf eel-grass		-	+	LC

(<sup>1</sup>) *Acipenser* spp.

(<sup>2</sup>) Except when used for direct restocking or transplantation purposes

(<sup>3</sup>) Not present in European or Mediterranean waters

(<sup>4</sup>) for *Palinurus elephas*

of CR categories of IUCN Red List) are protected only under Greek (EU) legislation. Sixteen shark species are protected only in Türkiye and five sawfish species are protected only in Greece show some key differences, although sawfish are extinct in the eastern Mediterranean Sea. Two lobster taxa, *H. gammarus* and *Palinurus* spp., of high commercial value are protected only in Greece. In addition, many ecosystem-important taxa (i.e., *Hippocampus hippocampus*, *Myliobatidae*, *Trionyx triunguis*, *Savalia savaglia*, *Zostera nolti*) are protected only in Türkiye (Table 3).

The fishing of all pufferfish taxa (*Tetraodontidae*, *Diodontidae* and *Canthigasteridae*) are prohibited under Greek Regulations (EC 853/2004 and EC 854/2004). Similarly, under Turkish legislation, the fishing and landing of pufferfish species were completely prohibited in the previous legal regulation (Notification 4/1) from 2016 onwards due to the high toxicities of some species. However, in order to combat their abundances, all pufferfish species: *Lagocephalus sceleratus*, *Lagocephalus spadiceus*, *Lagocephalus suezensis*, *Lagocephalus guentheri*, *Lagocephalus lagocephalus*, *Sphoeroides pachygaster*, *Tylerius spinosissimus*, *Torquigener flavimaculosus* in the current Notification 5/1, can now be fished with special permissions granted from the Ministry of Agriculture and Forestry of Türkiye, the competent authority, and collect-

ed tails can now be returned to the government as an economic incentive.

## Discussion

The present study for the first time details the existing differences for technical measures applied to commercial and protected species for shared stocks in the Mediterranean Sea. The study provides a comparison of fleet structure and three important traditional fisheries management measures in transboundary waters for Greece and Türkiye; minimum conservation reference sizes (MCRS), commercial species, seasonal closures and protected species. Despite that fisheries management measures in the Aegean Sea have undergone a harmonization process for the corresponding states (i.e., logbook system, VMS data; more details are provided below) in order to close loopholes and improve their overall effectiveness, this study demonstrates that many loopholes still exist, which seriously undermines regional management effectiveness.

The Greek fleet has gradually been reducing its number of SSF vessels since 1991. Turkish SSF similarly decreased since 2003 due to the impact of national buy-back programs which mostly retired small-scale rather than large-scale fishing vessels (Ekmekci & Ünal, 2019;

Ünal & Göncüoğlu-Bodur, 2020a, b). Both states exhibited similar percentages of their total fleet as small-scale vessels in the Aegean Sea (more than 90%). Likewise, Greek large-scale fisheries (OTB and PS) have declined over the years, like the SSF, whereas the Turkish large-scale fisheries initially declined from 2003, but later increased back to the same amount as in 1991. The renewed Greek large-scale fishing fleet included slightly smaller trawlers with lower tonnages and slightly higher HP and purse seines with higher HP and tonnages, while Turkish trawls were smaller, with lower tonnages and Turkish purse seines became larger with more HP and higher tonnages. This indicates that the fishing pressure on the demersal resources in the Aegean Sea (species percentage contribution of the total trawl reported catches in Greek Aegean Sea: *Trachurus mediterraneus* (12.0%), *M. merluccius* (7.5%), and *M. barbatus* (6.0%): Moutopoulos, 2020) has partially decreased, but the fishing pressure on the pelagic resources has increased in effort despite the decrease in the number of vessels. Tsikliras *et al.* (2015) reported that 87% of the fisheries resources in the Aegean Sea have problems in terms of sustainability (25% in fully exploited, 40% in overexploited and 22% in collapsed). The declining catches of the Aegean Sea correlate to the recent decline of fishing effort, as reported by Ulman and Pauly (2016), as it was approximately  $15 \text{ kW} \cdot \text{day} \cdot 10^{-6}$  in the 1990s, approached  $70 \text{ kW} \cdot \text{day} \cdot 10^{-6}$  in the early 2000s and then decreased to  $40 \text{ kW} \cdot \text{day} \cdot 10^{-6}$  in the 2010s, although we know that the purse seine fleet has increased in effort with other sectors responsible for the overall decline. Tunca *et al.* (2021) reported the high associated costs of technological inputs, including gross tonnage, engine power, total generator power, lamp vessel generator power for the Turkish Aegean PS fleet. Similarly, Tsitsika *et al.* (2008) reported that the Greek purse seine fisheries in the Aegean Sea show similar trends in overcapacity with the higher technological inputs and a proportional reduction in fleet size is required to achieve desired exploitation levels in the Aegean Sea.

Due to the increase in total effort, the CPUE of the Turkish fleet in the Aegean Sea showed a decrease of 67% from the early 1990s (about  $6 \text{ kg} \cdot \text{ kW} \cdot \text{day}^{-1}$ ) to the 2010s (about  $2 \text{ kg} \cdot \text{ kW} \cdot \text{day}^{-1}$ ) (Ulman & Pauly, 2016). In addition, the ratio of initial to current CPUE (initial: the year fishers commenced fishing; current: the year 2013) of artisanal and bottom trawl fishers marked a significant decline from the 1960s to 2013 (Ulman & Pauly, 2016). The decline in employment, landings, and CPUE (HELSTAT, 2022; TURKSTAT, 2022), combined with more and more overexploited stocks (FAO, 2020) indicate that technical measures in fisheries are currently insufficient at protecting the resources and need revamping. The co-operation amongst stakeholders and research organisations between the two neighboring states towards the establishment of an efficient licence-control system will beneficially improve fisheries data quality (Moutopoulos & Koutsikopoulos, 2014). An important future step towards the sustainable management of the Aegean fisheries resources is the estimation of total CPUE from both Greek-Turkish catch data for the Aegean Sea, taking

into account the reconstructed fisheries catches produced by Sea Around Us, whereby previously unreported catches are accounted for (Moutopoulos *et al.*, 2015; Ulman & Pauly, 2016, respectively). In line with the above, a major shortfall of the analysed national data sets is the absence of discarded amounts, which comprise a considerable amount of unreported catches (e.g., bottom trawls, longlines for example) as well as the decrease of bias for inshore fisheries (Moutopoulos & Koutsikopoulos, 2014), which both highly contribute to the total fisheries catches for both countries (Moutopoulos *et al.*, 2015; Ulman & Pauly, 2016). Furthermore, one major limitation of this study is the deficiency of stock assessment data to enable a comparative analysis of the Aegean Sea fisheries. Such data would beneficially improve our capabilities to perform a comprehensive Aegean fish stock assessment and address missing gaps in cross-border fisheries management.

A comparison of MCRS regulations for Türkiye and Greece for a total of 74 species, showed that 48 species are protected under both states, but 38 of these different MCRS sizes have been issued. Twenty-five species are only protected under Greek legislation, and one species only under Turkish legislation. It should be stressed that the seemingly arbitrary 8 cm length limits applied by Greece (10 cm for *Boops boops* and 8 cm for the remaining species) in the 1950s urgently needs reassessment as these values show the largest discrepancies compared with Turkish regulations. A total of 20 fish taxa exhibited MCRS differences of 10 cm or greater between Greece and Türkiye mostly owing to this 8 cm assignment. Another key issue is that MCRS values have only been determined only for a small percentage of the landed species, and are not applied to the most valuable species in Türkiye. MCRS regulations can be ineffective if they are set lower than the  $L_{m50}$  of the species; as our results show, only 11 out of 74 species have proper MCRS values set, demonstrating the ineffectiveness of this measure. In contrast, 22 out of 74 species have MCRS values set too low, while 18 species did not have data on length of maturity.

The application of closed seasons for commercial species is used by both states in principle to protect the reproductive periods of the stocks, yet we found many of these periods do not fully or even partially cover the spawning periods of the respective species. Closed seasons cover the spawning periods of only three species (i.e., *D. trunculus*, *Rapana venosa*, *Holothuria* spp.) applied by both states. Interestingly, for five species (i.e., *R. decussatus*, *V. verrucosa*, *O. vulgaris*, *O. edulis*, *X. gladius*) the closed seasons of both states do not coincide at all with their spawning periods. A total of seven species whose spawning periods have not yet been regionally studied, still have closed seasons applied by both states. Thus, the effectiveness of closed seasons measures on commercial fish stocks strongly needs to be reassessed using reproductive/spawning periods (hence science) as the basis. Harmonization of closed seasons using the best available data, with targeted research for the many species missing this information would improve this measure's success. A very small proportion of commercial species of both states are subject to the closed season practices and spe-



cies with closed seasons applied only account for a very small fraction of the total annual landings in the Aegean Sea (4.3% for Türkiye; almost 5% for Greece) (HELSTAT, 2022; TURKSTAT, 2022).

Alternatively, ten species which are not prescribed closed seasons and targeted by large-scale fishing methods (trawl and purse seine) accounted for 80.7% of Türkiye's total catch in the Aegean Sea in 2021. Four pelagic species (*E. encrasicolus*, *S. pilchardus*, *S. aurita* and *S. japonicus*) are mostly targeted by purse seiners, while three demersal species (*P. longirostris*, *M. merluccius* and *M. surmuletus*) are mostly targeted by trawlers. In both states, aside from closed seasons applied to individual species, the spawning periods of demersal and pelagic commercial species not included in these specific lists are thought to be somewhat protected by a seasonal prohibition period for the large-scale sector (trawl and purse seine), which provide most of the catches. Yildiz *et al.* (2020) provides a nice synopsis of what commercial species spawning periods are not covered by the industrial fishing ban from the adjacent Marmara Sea region. The overall cumulative timespan for seasonal closures for trawl gear is roughly the same in both states, amounting to approximately 4.5 months covering late spring and summer (Dereli *et al.*, 2022). Most of the fish species are known to spawn in the spring-summer period in the Aegean Sea, a temperate sea (Tsikliras *et al.*, 2010; İlkayaz *et al.*, 2018; Froese & Pauly, 2020). However, with Mediterranean Sea warming much faster than other seas (WWF, 2021), the effects of sea warming on stocks will likely continue to alter their spawning seasons, so the collection of ongoing reproductive information is needed to update the science in rapidly changing seas.

Only fourteen species are protected by both states, a total of 32 species are protected only under Turkish legislation, and 20 species only under Greek, the latter which mainly follows EU regulation. It is inevitable that wherever protected species and fishing activities co-exist, interactions will continue. Thirty-two species (11 of them VU, one of EN and six CR categories of IUCN Red List) are protected only under Turkish legislation, while twenty species (four of them VU, nine of EN, three of CR categories of IUCN Red List) are protected only under Greek legislation. Sixteen shark species are protected only in Türkiye, and five sawfish species are protected only in Greece, which highlights some key differences, although sawfish are now regionally extinct in the Eastern Mediterranean anyways. There are also some erroneous species within some regulations, which were explained in Table 3, in that there are 11 manta ray species listed as protected species under the EU regulations, however, there is only one confirmed species in the Mediterranean *M. mobular*, and only three others which exist in the Eastern Atlantic which are *Mobula birostris*, *Mobula tarapacana*, *Mobula thurstoni* (FAO, 2009; Ebert & Dando, 2021), which would benefit from a correction.

The Mediterranean hosts elevated extinction risks for over half (53.6%) of its elasmobranchs, about 20 of which critically endangered (Dulvy *et al.*, 2016). Three elasmobranch families have all their species listed as critically

endangered: Alopiidae, Rhinobatidae and Squatinidae. It is imperative that critically endangered species might be listed as protected across the entire Mediterranean to ensure their recovery and localized survival. Their declines are nearly totally attributable to overfishing and time is running out to reverse the damage (Walls & Dulvy, 2021). Both Greece and Türkiye have presented regional action plans in place for angel shark recovery in the Aegean Sea and Crete (GSA 22 and 23), the Northern Levant (GSA 24), which have been put into action (Gordon *et al.*, 2020; Fakioğlu *et al.*, 2021). In addition, many ecosystem-important taxa (*Hippocampus hippocampus*, *Myliobatidae*, *Trionyx triunguis*, *Savalia savaglia* and *Zostera nolti*) are protected only in Türkiye. Again, the two states need to better align common policies towards the development of sustainable fisheries.

Apart for the harmonization of the MCRS,  $L_{m_{50}}$  and protected species lists between the two neighbouring states, two other important points should be considered for the sustainability of the commercial stocks in the Aegean Sea. The first point is that the fishing gear used by the fishing fleet must be selective to support the MCRS's. In trawl fishing targeting demersal resources in the Aegean Sea, the minimum mesh size for the codend is 40 mm for the square mesh (S40) in both states, 50 mm for the diamond mesh (D50) in Greece and 44 mm in Türkiye (Dereli *et al.*, 2022). From selectivity studies in the Aegean Sea, it was shown that the use of 44 mm diamond mesh in the codend was not selective enough for the high value target species *M. barbatus* (Tosunoğlu *et al.*, 2003a; Özbilgin *et al.* 2011; Dereli & Aydın, 2016) and *M. merluccius* (Aydın & Tosunoğlu, 2010; Dereli & Aydın, 2016), and the 50% retention total length values ( $L_{50}$ ) were under the MCRS of the species. The use of D50 in the codend increased  $L_{50}$  for these species, but was still insufficient to increase catch lengths above the MCRS values (Tosunoğlu *et al.*, 2008; Dereli & Aydın, 2016).  $L_{50}$  values have been increased in many species with an increase in mesh sizes and the use of square mesh in the codend (Dereli & Aydın 2016). However, due to the differences in body shapes and sizes of the caught species, the mesh size and body shape that is suitable for one species is not suitable for many other species (Stergiou *et al.*, 1997; Tosunoğlu *et al.*, 2003b; Sala *et al.*, 2008), making these measures ineffective in the context of mixed-species fisheries. Secondly, the use of S40 or D50 in Mediterranean trawlers codend have not been adequate in significantly increasing its selectivity and eliminating discards, undersized and/or unwanted catches (Brčić *et al.*, 2015; Mytilineou *et al.*, 2018). Furthermore, incorporating the use of S40 or D50 results in 17% and 21%, respectively, economic losses in landings (Özbilgin *et al.*, 2015). Further increasing codend mesh sizes would result in increased catch losses and hence economic losses, but would increase the species caught above MCRS. Thanks to MCRS and the strong enforcement needed to accompany it from the authorities, fish are prevented from being caught at a young age/small size before they grow up, in other words, growth overfishing is prevented. Rebuilding fisheries will come at a cost at present, but will yield

much higher rewards in the future, so the future potential of the resources need to be properly valued to account for this. In the context of mixed-species fisheries, advanced species separation tools (use of grids, etc.) are recommended in addition to mesh size regulation for improved fisheries management (Stewart, 2002; Memarzadeh *et al.*, 2019). To ensure the sustainability of multispecies Mediterranean demersal fisheries without causing major social problems, Fiorentino & Vitale (2021) suggested choosing the optimal fishing effort of the small and medium-sized species (crustaceans, cephalopods, fish) that comprise most of the trawling catch using the “pretty good yield” concept.

The two most commercially important species in the Aegean Sea (*Engraulis encrasicolus* and *Sardina pilchardus*) are not protected under species-specific seasonal bans, but are assumed to be protected under the seasonal industrial fishing (purse seine) bans (15 April–31 August in Türkiye and 1 July–31 August, for daytime and 15 December to 28 February, for night purse seines in Greece). Thus, these stocks are unprotected during winter spawning season for *S. pilchardus* (Cihangir, 1991; Akyol *et al.*, 1996) for Türkiye (Dereli *et al.*, 2022), and during the summer spawning season for *E. encrasicolus* for Greece (as this species is also targeted by the night purse seines). In addition, the closed season for the Greek night purse seine during winter has no effect on anchovy, and a displacement towards September–November will be beneficial both to sardine and anchovy stocks, by protecting at the same time the young anchovy of the year and the onset of the sardine spawning season (Somarakis *et al.*, 2007). One additional remedy for key commercial species proposed by Fiorentino & Vitale (2021) is to adopt individual catch quotas, leaving a calculated amount of the stock left to replenish their populations.

Another additional application in the Aegean Sea to protect spawning habitats and juveniles from the effects of fishing is the assignment of Special Protected Areas (SPAs) and Marine and Coastal Protected Areas (MCPAs) where fishing is partially or permanently restricted for some sectors. Approximately more than 100 Special Protected Areas (SPAs) in Greece have been defined (Aegean and Ionian Sea: Petza *et al.*, 2017 and Moutopoulos *et al.*, 2020, respectively) and 15 MPA's exist in Türkiye (Aegean Sea: Güçlüsoy, 2015). In addition to these, many protected areas, mainly gulfs and bays, have been specifically restricted from OTB and PS fishing in Türkiye (Dereli *et al.*, 2022) and Greece (Moutopoulos *et al.*, 2016, 2020). However, for these areas to be effective, they must be complemented with adequate monitoring, control and surveillance capabilities instead of just being ‘paper parks’.

These results clearly demonstrate the key differences and few similarities between Greece and Türkiye regarding the implementation of species-specific fisheries management measures, which highlights the inequities of the measures for shared stocks and biodiversity. As both states are active members of GFCM, a regional fisheries management organization that has been working since 1949 to develop coherent fisheries policies and harmo-

nized management measures for sustainable fishing in the Mediterranean and Black Seas, we suggest the GFCM could play an integral role to help harmonize the regulations in this sea between the two neighbouring states in the future, to help improve the efficacy of such policies. In this context, the implementation of a logbook system to record catches and trip-related information, which is mandatory for vessels greater than 12 meters in Türkiye since 2012 and 10 meters in Greece since 2014, could beneficially improve the quality of fisheries data on both sides of the Aegean Sea. The same requirement applies also to VMS data, which has been mandatory since 2016 in Türkiye and for much longer in Greece. Additionally, Greece operates a national monitoring program that collects biological data from fisheries under the EU Data Collection Framework. However, taken into account the lack of robust fisheries data in Aegean stocks and the lack of many missing points in the DCF dataset (STECF, 2023) there is a need for reliable fisheries data through a decent stratified statistical survey for monitoring the official fisheries statistics (Moutopoulos & Koutsikopoulos, 2014). In this context, a harmonisation of the DCF and HELSTAT fisheries data should be taken place to reduce the uncertainty of the reported data. Also, the newly established alien species in the region should be incorporated into the statistics platforms as soon as possible, to better understand their trends. Lack of collaboration may threaten sustainability, reduce economic performance and increase conflicts between the two neighbouring states.

Management measures should focus on stock rebuilding, which is the necessary step towards achieving sustainable fisheries, as many stocks have been depleted to alarmingly low levels (Demirel *et al.*, 2020; Tsikliras *et al.*, 2021). When rebuilding fisheries from critical levels, every attempt should be made to ensure that important early life stages are provided the best chance of survival, specifically that species are able to spawn at least once before caught, that their spawning season is protected and that their recruits have a fair chance of survival.

Naturally rare species and species with poor conservation statuses may require special protection or management through measures such as a prohibition on catch, injury and interference, or critical areas applied to them. A relatively recent development on this front is the identification and protection of their essential and critical habitats, a new initiative taking shape for cetaceans and elasmobranchs under the IUCN's Important Marine Mammal Areas (IMMA's) and Important Shark and Ray Areas (ISRAs), which are (to be) placed to protect known feeding, mating, spawning or transit routes. Statutes and regulations governing commercial fishery/protected species interactions provide for the conservation and recovery of protected marine species. Some species of marine mammals, sea turtles, and fish are listed under the Endangered Species Act of 1973, and all marine mammals are managed under the Marine Mammal Protection Act of 1972 (Allen, 2000).

Considering the connections drawn between the findings and the broader realm of fishery management, it is pertinent to underscore that the management measures

outlined herein necessitate the concurrent implementation of joint effective monitoring, rigorous enforcement, and improved governance, constituting fundamental prerequisites for ensuring efficacious fisheries management.

Furthermore, pivotal to the attainment of comprehensive fisheries management is the imperative of fostering a spirit of compromise and concerted endeavors to accord due valuation to the natural resources of the region. Through the cultivation of collaborative frameworks and the adoption of holistic management paradigms, Greece and Türkiye seem to be more obliged than ever to stand poised to advance endeavors aimed at fostering the enduring sustainability of shared fisheries resources in the Aegean Sea, thereby fortifying both environmental robustness and socioeconomic resilience.

## Conclusions

Although data gaps and coherence issues are frequently mentioned as serious discrepancies in Aegean stock assessment methods (STECF, 2022), certain approaches implemented in the area have shown that 70% of the 20 stocks targeted by the Greek fleet in the Aegean Sea and 43% of the 54 non-targeted stocks are unsustainable (Tsikliras *et al.*, 2021). Similarly, 85% of 54 stocks along Turkish coasts are overfished (Demirel *et al.*, 2020). As a solution, fishing mortality rates should first be reduced and this should be complemented by other effective management measures such as improving MCRS effectiveness and incorporating the Ecosystem Approach to Fisheries (EAF) (Demirel *et al.*, 2020). Recently, encouraging and successful cases in the Aegean and Mediterranean regarding the transition to EAF stand out (Vasconcellos & Ünal, 2022). On the other hand, many experiences and studies have shown that sustainable fisheries cannot be achieved through monitoring and control measures unless there is an agreed Multiannual management plan (MAP) that aligns management objectives and resulting management (technical measures) (Cochrane & Garcia, 2009). The lack of MAP in the Aegean Sea fisheries should be resolved by agreement between Greece and Türkiye. The management system needs to be revamped so that it prioritizes the rebuilding of wild marine fisheries, so there is a chance of sustaining the resources for future food security and livelihoods. In the transboundary waters of the Aegean Sea, sharing knowledge and streamlined measures between Greece and Türkiye contributes towards harmonized fisheries management in the context of the ecosystem approach to fisheries. However, ensuring sustainability for the shared stocks as well as comprehensive fisheries management requires more than the above-mentioned, it will require some compromise now in lieu of reversing the decline of most commercial stocks, and perhaps properly valuating the potential of the future resources can help assign more importance to these natural resources (Sumaila, 2021).

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## Supplementary Data

The following supplementary information is available online for the article:

**Table S1.** Species reported from Aegean Sea by the official statistical authorities of Greece and Türkiye. (+: Indicates that the species is reported).

**Table S2.** Closed seasons for species in Greece and Turkish Legislations.