

## SOCIO-ECONOMIC CHARACTERISTICS OF SMALL-SCALE FISHERIES IN THE AEGEAN SEA, TURKEY (EASTERN MEDITERRANEAN)

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**Background.** The socio-economic characteristics of small-scale fisheries have rarely been documented in the eastern Mediterranean. This study aimed to determine the current socio-demographic status, historical changes in demography and fishing activity, fishing expenditures, and the main problems of small-scale fisheries in the Aegean Sea.

**Material and methods.** Data were collected in 2018, using face-to-face questionnaires from small-scale fishers ( $n = 190$ ) representing three sub-regions (northern, central, and southern Aegean Sea). The questionnaire included information regarding the main characteristics of fishing vessels, demographic characteristics of fishers, expenditures involved, and other important issues. Furthermore, some demographic characteristics (e.g., age and marriage status) and fishery-specific characteristics (e.g., active fisher ratio) observed in our study, were compared to the published data, to reveal if any changes have prevailed historically.

**Results.** The mean age of fishers was  $50 \pm 10$  years, and many of them were married males with primary school education. The highest two fisheries expenditures were fuel and oil expenses and personnel (crew) expenses. The fisheries expenditures did not show a statistically significant difference in terms of geographical location. However, there was a significant difference in the total fisheries expenditures depending on fishery type; fishers who use an encircling net reported higher expenditures, in comparison to other fishing types. The results showed that the active fisher ratio and the ratio of fishers who do not have other income has decreased significantly over the last 10 years. In addition, engine power (kW) showed a significant increase over the last 15–16 years. The main problems identified were insufficient inspection, illegal fisheries, and a decrease in stocks.

**Conclusions.** Increased fishing expenditures and decreasing fish stocks in the Aegean Sea resulted in a decrease in the number of active fishers. Therefore, many fishers tended to have additional jobs, and some of them considered leaving fishing. To maintain the sustainable management of the small-scale fisheries in Turkey, we suggested that the catch and fishing effort should be monitored using the mandatory logbooks, and the hook number should be standardized.

**Keywords:** Aegean Sea, fisheries management, fisheries economy, sustainable fisheries, fishing expenditures

### INTRODUCTION

To date, no uniform and straightforward definition has been developed for small-scale fisheries (SSF). The European Maritime and Fisheries Fund (EMFF) has defined SSF as “fishing carried out by fishing vessels of an overall length of less than 12 m and not using towed fishing gear” (Regulation 1198/2006) (Anonymous 2006). However, some studies reported that not only the vessel size and type of fishing gear, but also the characteristics of fishing activity (e.g., fishing time, fisher number, and fishing ground), social organization, and economic behavior should be considered as indicators when identifying SSF (Johnson 2006, Guyader et al. 2013, Fréon et al. 2014, Natale et al. 2015). SSF was mostly operated by just the vessel owner or fewer fishers, often characterized by several hours of operation in coastal fishing sites, with small capital investment (Colloca

et al. 2004, Maynou et al. 2013). In addition, SSF usually includes selective and environmentally friendly fishing gears compared with towed mobile fishing gears which are mainly used in industrial fisheries (Jacquet and Pauly 2008, Farrugio et al. 2015). Undoubtedly, SSF contributes to nutrition, food security, and sustainable livelihoods, particularly in developing countries. Despite this, issues related to SSF in many developing countries are poorly documented and not well understood (Farrugio et al. 2015, Gianelli et al. 2018). Specifically, SSF is in jeopardy in countries within the Mediterranean region because the coastal fisheries are subject to overfishing, as well as illegal, unreported, and unregulated (IUU) fishing (Tzanatos et al. 2013, Ünal et al. 2015b).

More than 90% of the world’s fishing vessels (approximately 4.36 million) were reported to be small-

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scale fishing vessels, and the total number of small-scale fishers was estimated to be over 22 million worldwide (Teh and Sumaila 2013, Verones et al. 2017). It was emphasized that over 100 million people were employed in other fishing-associated occupations, especially in processing and trading (Béné et al. 2007). In the European Union, of the 25 countries with sea access, 81% of the whole fleet was composed of vessels shorter than 12 m, and 87% of the fleet was less than 15 m (Anonymous 2007). The main characteristics of the Mediterranean coastal fisheries are represented by low investment activities (Malorgio et al. 2017). Therefore, the entire fleet is comprised of 59 800 small vessels (Morales-Nin et al. 2010, Anonymous 2018). In other words, over 80% of the Mediterranean fleet is comprised of vessels under 12 m in length (Anonymous 2002).

Similarly, in Turkey, the total number of vessels in marine fisheries was 15 352 and 90% of them were smaller than 12 m in 2018. The total seafood production by capture fisheries, in Turkey, was 322 173 t in 2017 (Anonymous 2019). However, there is no information related to the contribution of SSF and industrial fisheries for total seafood production. It was reported that about 29% of the Turkish SSF fleet operated in the Aegean Sea in 2017 (Anonymous 2020). In addition, 96% of fishing vessels which fish around the Aegean coasts of Turkey were smaller than 12 m, and so their activity was classified as SSF (Anonymous 2020).

Even though the vessel number was higher in SSF than industrial fisheries in both Turkey and other Mediterranean countries, SSF was poorly documented and there were limited statistics (Natale et al. 2015). In Turkey, fishing vessels that are larger than 12 m have to keep mandatory logbooks to record their daily catch, whereas SSF vessels do not provide any regular information about the daily catch. Thus, this situation results in a significant loss of data. Regarding the regulations of SSF in Turkey, some legislative limits were listed. In total, the capture of 23 marine fish species, 9 invertebrate species, 2 algae species, and groups of sea turtles and sea mammals were prohibited. A total of 40 fish species and 8 invertebrate species (crustaceans and mollusks) have a minimum landing size and 1 fish species (*Thunnus thynnus*) and 1 invertebrate species (*Octopus vulgaris*) have minimum landing weight, respectively. On the contrary, in industrial fisheries, there are no seasonal closures in SSF, except for some species including the sole, flounder, and common dolphinfish. There are several no-take zones and no-industrial fishing zones in the Aegean Sea, while there is no quota application for marine fish species except for tuna (Anonymous 2016).

Studies related to the socio-economic characteristics of fisheries have gained worldwide interest over the last three decades, and are essential for the development of management strategies of marine resources (Tzanatos et al. 2006, 2013, Lloret et al. 2018). In particular, many studies were carried out on the socio-economical characteristics of SSF in the western and central Mediterranean (Battaglia et al. 2010, Maynou et al. 2013, Quetglas et al. 2016, Pita et al. 2018), while this issue has rarely been investigated in the eastern Mediterranean (Tzanatos et al. 2006, Ünal and Franquesa

2010, Roditi et al. 2018). The first regional symposium on sustainable SSF in the Mediterranean and the Black Sea was organized by the General Fisheries Commission for the Mediterranean (GFCM) on Malta in 2013. And it was emphasized that not only biological parameters of target species but also socio-economic factors and the current status of the fleet of SSF should be investigated using collected regional-level data (Farrugio et al. 2015). Therefore, the longer historical series of data should be assessed.

The aims of the presently reported study were; 1) to assess socio-economical characteristics of SSF around the Aegean coasts of Turkey, 2) to provide information on fishery-based expenditures of small-scale fishers, 3) to compare the current status and previous status of aspects relating to this activity, including the active number of fishers, socio-demographics and vessel characteristics.

## MATERIALS AND METHODS

**Study area.** The Aegean Sea is a part of the Mediterranean Sea, located between the Greek and Anatolian peninsulas. The northern border of the Aegean Sea begins at the Dardanelles Strait, whereas Rhodes and Crete islands mark its southern border (Fig. 1). The Aegean Sea is divided into three regions namely, the northern, central, and southern in terms of morphological characteristics. While the coastal part of the northern Aegean Sea features a mean depth of 120–200 m, the mean depth of the central Aegean Sea is around 200 m. The depth of the southern Aegean Sea is generally between 1300 and 2200 m (Tokaç et al. 2010). Regarding biodiversity, it was reported that more than 440 fish species live in the Aegean Sea coasts of Turkey and the existence of fertile gulfs contributes to aspects of the reproduction, feeding, and nursery areas of certain fish species (Tokaç et al. 2010, Bilecenoğlu 2015).

A total of 43 833 t of fish and 3844 t of other seafood were caught in 2017 around the Aegean coast of Turkey. This accounts for approximately 16% of fish and 7% of other seafood production in Turkey (Anonymous 2020).

**Data sampling.** A total of 190 small-scale fishers (skippers), including set netters (gillnets and trammel nets), longliners, and encircling netters in the northern, central, and southern parts of the Aegean Sea, were interviewed during the period from October to December 2018. Face-to-face questionnaires gathered information on:

- socio-demographic characteristics of fishers (e.g., age, gender, education, marital status, and number of family members);
- income by fisheries and fisheries expenditures (e.g., fuel, repair and maintenance, mooring, crew salary, transportation, and bait);
- vessel characteristics (e.g., value, age, length, material, engine power, and equipment);
- characteristics of fishing activity (e.g., trip frequency); and
- other related issues.

An additional questionnaire was also distributed to fishery cooperative presidents to assess information on active fisher ratio, and the ratio of fishers who do not have any other income.

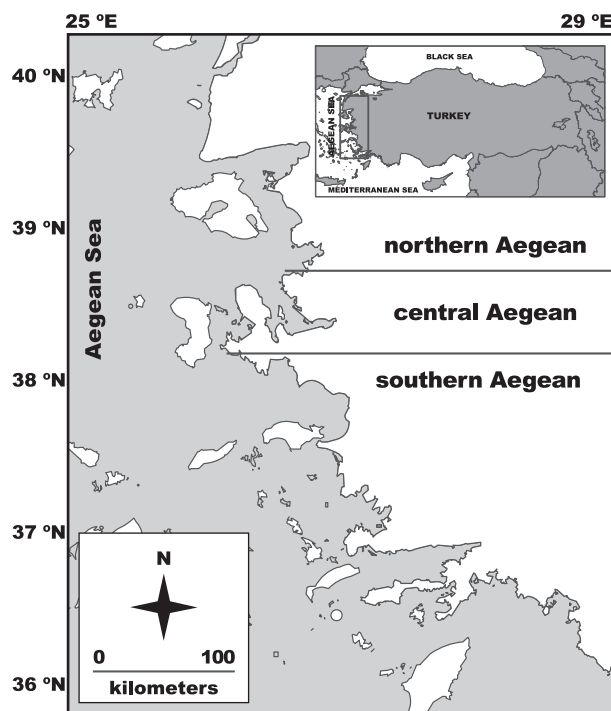


Fig. 1. Map of the study area (Aegean Sea)

**Data analyses.** Statistical analyses were performed with the SPSS (Ver. 20.0). A regression was used to test the relation between the vessel size and engine power. A Kruskal–Wallis test was used to understand whether fisher’s income and fisheries expenditures have changed depending on sub-regions. Furthermore, the results of the presently reported study and previous studies (Ünal et al. 2009, Ünal and Franquesa 2010), which were performed in the same area, were compared to clarify historical changes in several indicators: vessel characteristics (size, age, engine power), fisher characteristics (age, fishing experience, marriage status ratio, family member number) and activity characteristics (active fisher ratio, the ratio of fishers who do not have other income). To test the aforementioned changes of the selected indicators using present and past data from previous studies, *t*-test and Mann–Whitney *U* test were performed. The mean values were shown with standard deviation ( $\pm$  SD).

## RESULTS

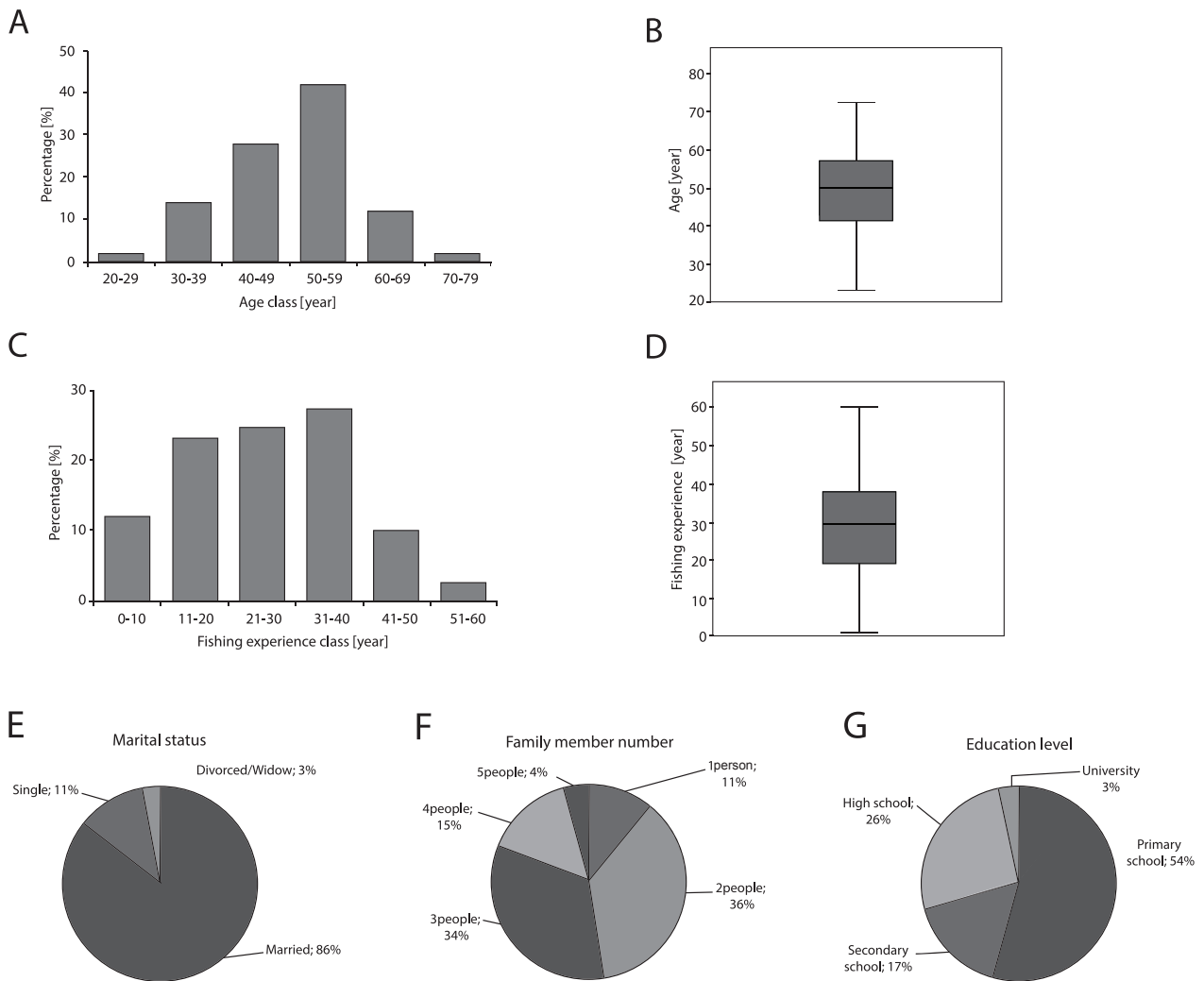
The small-scale fishers interviewed in this study spent from 70 to 305 working days at sea a year, and the mean value of the annual working days was  $191 \pm 62$  days. The number of hooks used per day on longlines ranged from 100 to 1100 depending on the longline type (thin and thick longlines). The net length of set netters (gillnet and trammel net) and encircling netters used per day ranged from 550 to 7000 m depending on targeted species and crew size. The main bait used by longline fisheries were shrimp, common cuttlefish, sardine, and Spanish mackerel (shrimp was preferable). The mean daily used bait amount was calculated as  $5 \pm 2$  kg per fisher (depending on daily used hook number).

**Vessel characteristics.** The mean age of the vessels was  $16 \pm 8$  years; they ranged in length from 6.0 to 11.8 m,

with the mean length being  $8.1 \pm 1.5$  m. The mean engine power was  $55.2 \pm 37.3$  kW and 43% of the SSF fleet’s engine power was below 37.3 kW. There was a statistically significant relation between the length of the vessels and engine power ( $r = 0.77$ ,  $R^2 = 0.59$ ,  $P < 0.001$ ). All vessels were built of wood and 83% of them were equipped with a GPS. Concerning the value of the vessel, 20% of the vessels’ price was lower than €10 000 and the mean vessel price was estimated as  $\text{€}17\,441 \pm \text{€}13\,131$ .

**Socio-demographic characteristics of fishers.** The mean age of fishers was  $50 \pm 10$  years and 42% of fishers were aged between 50 and 59 years (Fig. 2A, 2B). The age distribution of fishers shows a significant difference depending on sub-regions (northern, central, and southern parts of the Aegean Sea) ( $P < 0.05$ ), and the mean age of fishers who fish in the northern Aegean Sea was lower than in other areas. The mean fishing experience was  $28 \pm 13$  years and many fishers had experience ranging from 31 to 40 years (Fig. 2C, 2D). The fishing experience did not change significantly depending on sub-regions ( $P > 0.05$ ). All fishers who attended the face-to-face questionnaire were men and during the survey female fishers were not observed. The results demonstrated that 86% of fishers were married, 11% were single and 3% were divorced (Fig. 2E). They lived in households with a mean of  $3 \pm 1$  family members (Fig. 2F). There was no significant difference in the family member numbers in different sub-regions ( $P > 0.05$ ). Regarding education level, 54% of fishers completed primary school, whilst a few fishers had a university degree (Fig. 2G).

**Fishing expenditures and fishers’ income.** The results showed that the total fishing expenditures significantly changed depending on the fishing type (set netting, longlining, and encircling netting) ( $P < 0.05$ ). The encircling netters reported higher expenditures in



**Fig. 2.** Socio-demographic characteristics of fishers representing small-scale fisheries of the Turkish Aegean coasts; (A) age distribution by a bar graph, (B) age distribution by a box-plot graph, (C) fishing experience distribution by a bar graph, (D) fishing experience distribution by a box-plot graph, (E) marital status, (F) family member number, (G) education level

comparison to other fishing types. For all fishing types, the highest expenditures were fuel and oil expenses (Fig. 3). On the other hand, fishing expenditures did not show a difference in different sub-regions ( $P > 0.05$ ).

The mean annual gross profit from the small-scale fishery was calculated as €8757 ± €4034. Results showed that there was no significant difference in the annual gross profit of fishers based on sub-regions ( $P > 0.05$ ). On the other hand, 63% of fishers had a second job in addition to the small-scale fishery. It was reported that 85% of fishers had social insurance and 80% of fishers were members of fishery cooperatives.

**Historical changes.** Regarding the comparison of the vessel characteristics between the years 2002–2003 and 2018, the mean engine power changed significantly (Table 1 and Fig. 4A), whilst the mean vessel age and the mean vessel length did not show any significant difference. The mean vessel age was higher in this study in compared with the previous study (Ünal and Franquesa 2010) (Fig. 4B). Demographic characteristics including age, fishing

experience, marital status, and family member number did not show a significant difference for the compared periods (Table 1). The active fisher ratio and the ratio of fishers who do not have other income has decreased significantly over the last 10 years (Table 1 and Fig. 5).

**Main problems of SSF.** The results showed that 89% of fishers declared that they had conflicts with other stakeholders. In particular, many small-scale fishers (71%) had a conflict with other commercial fishers. Furthermore, 58% of fishers had problems with recreational fishers, whereas 5% and 2% of fishers declared a conflict with scuba-divers and aquaculture units, respectively.

Fishers noticed the main problems included:

- illegal fisheries (illegal trawl and purse seine operations in the prohibited areas and fishery closed seasons, fisheries with prohibited gears and tools (e.g., beam trawl, beach seine, dynamite), illegal collection of fish and shellfish specimens which are smaller than minimum landing sizes, illegally organized recreational boat tours, trade of recreational catch);

- technical problems (insufficient port capacity, boatyards, cold storages, modern fishing markets);
- insufficient control by government officers;
- decreased fish and shellfish stocks;
- negative impacts of non-target species (seals, dolphins, turtles, and some invasive species such as pufferfish,

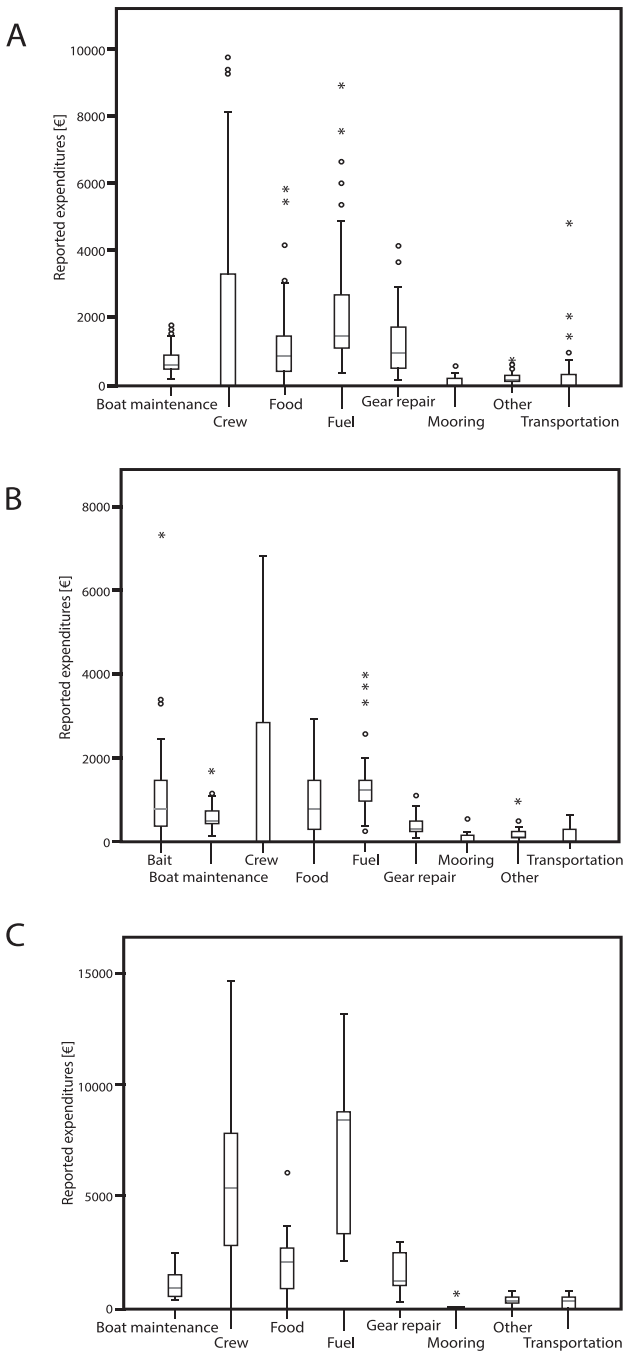
causing damage to both target species and fishing gear and nets); and

- increased fishing expenditures.

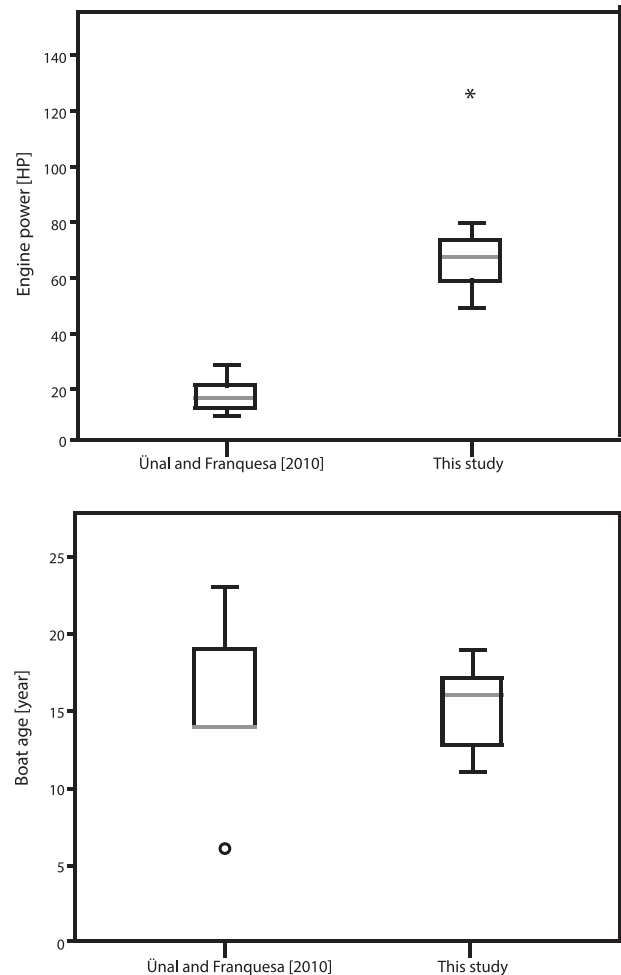
In particular, due to increased fishing expenditures, decreased income, and health problems associated with old age, 29% of small-scale fishers considered leaving their fishing job.

## DISCUSSION

It is clear from this study that the active fisher ratio of the small-scale fleet in the Aegean Sea (Turkey) showed a dramatic decrease over the last decade due to the increased fishing expenditures and decreased income. Consequently, a quarter of the fishers declared that they will leave their jobs if their income does not increase in the future. It should be noted that these fishers may seek alternative jobs. In support of this, Öndes et al. (2020) reported that 20% of charter boat owners in the Aegean Sea were small-



**Fig. 3.** Annual reported expenditures of fishers representing small-scale fisheries of the Turkish Aegean coasts; (A) set netters (gillnets and trammel nets), (B) longliners, (C) encircling netters; expenditures include bait, fishing gear, transportation (between home and port), repair and maintenance, mooring, payment for the crew, fuel and oil, food and snacks, and other expenses (e.g., wastewater and electricity)



**Fig. 4.** Comparison of the engine power (A) and boat age (B) in small-scale fisheries of the Turkish Aegean coasts in 2002–2003 (Ünal and Franquesa 2010) and 2018 (this study)

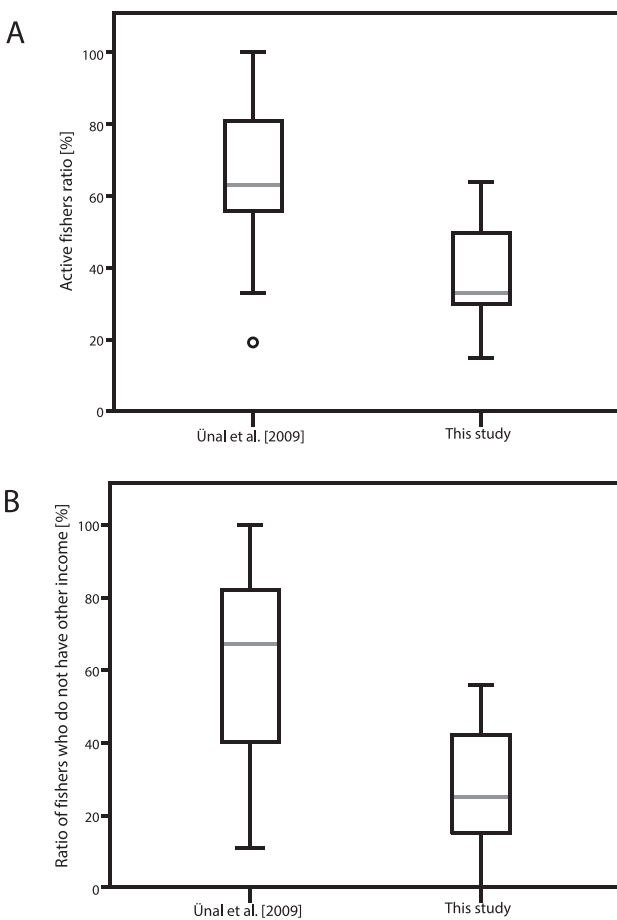


**Table 1**

Historical changes of the vessel, demographic characteristics of fishers and fishing activity in small-scale fisheries of the Turkish Aegean coasts

Vessel characteristics	Variable		Test
	<i>t</i> or <i>U</i> -value	<i>P</i> -value	
Mean engine power [kW]	<i>t</i> = -7.56	<b>&lt;0.05</b>	<i>t</i> -test
Mean vessel age [year]	<i>t</i> = -0.11	>0.05	<i>t</i> -test
Mean vessel length [m]	<i>U</i> = 25.00	>0.05	Mann–Whitney <i>U</i> test
Demographic characteristics			
Mean fisher age [year]	<i>t</i> = -0.65	>0.05	<i>t</i> -test
Mean fishing experience [year]	<i>t</i> = 0.17	>0.05	<i>t</i> -test
Married fishers [%]	<i>t</i> = 1.02	>0.05	<i>t</i> -test
Family member number	<i>U</i> = 39.00	>0.05	Mann–Whitney <i>U</i> test
Fishing activity			
Mean annual fishing day	<i>t</i> = -0.11	>0.05	<i>t</i> -test
Active fisher ratio [%]	<i>t</i> = 3.50	<b>&lt;0.05</b>	<i>t</i> -test
Fishers with no other income [%]	<i>t</i> = 3.89	<b>&lt;0.05</b>	<i>t</i> -test

*P*-values < 0.05 (bold font) indicate a statistically significant difference; vessel and demographic characteristics were compared between 2002–2003 (Ünal and Franquesa 2010) and 2018, whereas fishing activity was compared between 2008 (Ünal et al. 2009) and 2018.



**Fig. 5.** Comparison of the active fishers' ratio (A), the ratio of fishers who do not have other income (B) representing small-scale fisheries of the Turkish Aegean coasts in 2008 (Ünal et al. 2009) and 2018 (this study)

scale fishers before their current occupation. Similarly, a decrease in the fleet size of SSF was determined in other Mediterranean countries, owing to EU effort reduction measures and retirement of small-scale fishers (Gómez et al. 2006, Morales-Nin et al. 2010, Maynou et al. 2013). In the Balearic Islands, the number of SSF vessels was 698 in 1970, whilst the vessel number was counted as 345 in 2010, showing a notable decrease (Maynou et al. 2013). Specifically, in Mallorca, Quetglas et al. (2016) reported that the SSF vessel number has decreased by about 45 percentage points over the last 25 years. Another study from the Mediterranean, carried out by Pita et al. (2018), noticed a reduction in the number of shellfishing vessels used in SSF by 13 percentage points between 2004 and 2016. In addition to Mediterranean countries, in northern European countries the vessel number in SSF showed a marked decrease. For example, the vessel number in Sweden has decreased by 18 percentage points from 2007 to 2013 (Natale et al. 2015). Lloret et al. (2018) reported that the EU small-scale fleet declined by about 20 percentage points between 2000 and 2010. The aforementioned study also noted a marked decrease of new SSF vessels entering the fisheries in the EU since 2000. The presently reported study highlighted that the ratio of small-scale fishers who do not have other income has decreased over the last ten years in comparison with previous studies (Ünal et al. 2009, Ünal and Franquesa 2010). Similarly, in the Dağca-Bozburun Special Environmental Protection Area (SEPA) (southern Aegean Sea), Ünal et al. (2015b) reported that 41% of small-scale fishers did not have another job and 69% of small-scale fishers identified their activity as a part-time job.

Mediterranean fish stocks have shown a distinct decline over the past two decades (Vasilakopoulos et al. 2014). Demirel et al. (2020) evaluated the 54 commercial fish and invertebrate stocks in Turkey (the eastern

Mediterranean and the Black Sea) by using catch data and resilience indices, and they reported that of the 54 stocks, 85% of them can be considered as overfished. Similarly, the landing of many target fish species of SSF (e.g., *Sciaena umbra*, *Mugil* sp., *Pomatomus saltatrix*, *Scomber scombrus*) have decreased markedly over the last decade in the Aegean Sea, Turkey (Table 2). However, it should be noted that the total landing information of the species included both SSF and the industrial fisheries. Hence, there is no doubt that not only increased fishing expenditures but also decreased stocks, directly influence the income of fishers. Due to the decline in catch per unit effort (CPUE), many fishers may need to increase daily used hook number or use longer nets in the future, and this situation may constitute another risk. The results of the presently reported study also underlined insufficient control of management measures (e.g., minimum landing size, caught of prohibited species) by government officers and this situation may potentially have a negative influence on the fish and invertebrate stocks. Demirel et al. (2020) suggested that in order to rebuild commercial stocks within 15 years, fishing mortality should be reduced to  $F_{MSY}$  level\* and the 40% effort decrease should be considered. If managers do not successfully obstruct the overfishing and illegal fisheries and do not standardize the fishing effort with the daily hook and net limits, the status of the current stocks may be worse in the future.

The presently reported study showed that male fishers were dominant in the eastern Mediterranean SSF. Similarly, this situation was reported from the other parts of the Mediterranean (Tzanatos et al. 2006, Battaglia et al. 2010, Villasante et al. 2019). Our study demonstrated that the mean age of small-scale fishers in the Aegean Sea increased non-significantly from 2002–2003 to 2018 (Ünal and Franquesa 2010). The mean age of small-scale fishers ranged from 45 to 49 in the Mediterranean region including the Balearic Islands, Spain, Italy, and Greece (Tzanatos et al. 2006, Battaglia et al. 2010, Maynou et al. 2013, Villasante et al. 2019). Both our study and previous studies (Ünal and Franquesa 2010, Maynou et al. 2013) noticed that the proportion of young fishers (<30 years) was very small in the Mediterranean SSF and this situation verified that SSF was not an attractive job for young people over the last years. Regarding marital status, both this study and previous studies showed that many small-scale fishers in the Aegean Sea, were married and their family members generally consist of 3–4 people (Ünal and Franquesa 2010, Ünal et al. 2015b).

Concerning educational status, our results indicated that more than half of SSF fleet consists of fishers who had completed primary school and few fishers had a university degree. Similarly, Ünal (2003) noted that in Foça, Turkey (Central Aegean Sea) the most common level of education for SSF fishers was the primary school level. Moreover, it was reported that 4.7% of small-scale fishers, from the eastern Mediterranean coast of Turkey, had no education and many of them only completed primary school (Sangün et al. 2018). Similarly, many small-scale fishers in Spain

and Greece also completed just primary school (Tzanatos et al. 2006, Villasante et al. 2019). However, Battaglia et al. (2010) reported that many small-scale fishers in Italy had a junior high school diploma.

In general, in SSF in the Mediterranean, the mean vessel size and engine power ranged within 8–9 m and 57–80 kW, respectively (Battaglia et al. 2010, Maynou et al. 2013). The presently reported study exhibited similar results and it was determined that although fishers generally did not buy new vessels, the mean engine power of the small-scale fleet increased significantly over approximately the last 20 years. Whilst vessel size did not show a significant difference in the Aegean coasts of Turkey, Tzanatos et al. (2006) also noticed that the vessel age was related to the fisher's age in Greece. It was reported that in contrast to industrial fishers, small-scale fishers do not have easy access to low-interest institutional credit (Panayotou 1982, Pauly et al. 2005). Therefore, it should be noted that the creation of appropriate credit conditions for the small-scale fishers will help fishers to renew their existing vessels (Sangün et al. 2018).

Throughout this research, the highest fishing expenditure was fuel and oil expenses. In addition, many fishers worried about the increase in the prices of imported materials (e.g., fishing nets) over the last year. Furthermore, it should be noted that crew size does not only depend on vessel size but is also influenced by existing fishing expenses and fishers' income. Villasante et al. (2019) revealed that the crew size of SSF in Galicia (Spain) decreased by 20.2 percentage points from 2004 to 2014.

In the presently reported study, many fishers declared a conflict with other commercial fishers. Charles (1992) underlined the competition for resources generally results in increased illegal activities and increased fishing pressure. Similarly, our results indicated that the illegal operations of trawls and purse seines in prohibited areas and the catching of undersized specimens were denoted by small-scale fishers. In Turkey, there is no depth limit for trawl fishery, and the depth limit of purse seine fishery is 24 m in the Aegean coasts of Turkey (Anonymous 2016). Thus, this causes conflicts in the shallow waters of the Aegean Sea which are shared by trawlers, purse seiners, and small-scale fishers. Hence, the regulation on the depth limit for trawl fishery should be urgently reconsidered to protect the habitats and species, and minimize the conflicts. On the other hand, our results showed that more than half of the fishers had a competition with recreational fishers because they shared the same fishing grounds and targeted the same species. Although there is a bag limit (5 kg per day per person) for the recreational fisheries, many recreational fishers do not have enough information about the bag limit and other regulations, and they were rarely audited by government officers (Öndes et al. 2020). Additionally, Öndes et al. (2020) reported that some sparids including *Diplodus vulgaris*, *Sparus aurata*, and *Pagellus erythrinus* were highly undersized in the recreational fisheries. Thus, it is critically important to control not only

\*  $F_{MSY}$  is the maximum rate of fishing mortality (the proportion of a fish stock caught and removed by fishing).

Table 2

The main target species of small-scale fisheries of the Turkish Aegean coasts (source: Anonymous 2020)

Scientific name	Common name	Total landings [t]		PR [%]
		2001–2009	2010–2018	
<i>Alosa fallax</i>	Twaite shad	8251	10 485	27%
<i>Belone belone</i>	Garfish	366	489	34%
<i>Boops boops</i>	Bogue	17 290	19 023	10%
<i>Chelidonichthys lucerna</i>	Tub gurnard	379	115	–70%
<i>Dentex dentex</i>	Common dentex	800	565	–29%
<i>Dentex gibbosus</i>	Pink dentex	397	215	–46%
<i>Dicentrarchus labrax</i>	European seabass	4141	1378	–67%
<i>Diplodus annularis</i>	Annular seabream	2458	878	–64%
<i>Diplodus vulgaris</i>	Common two banded seabream	1214	791	–35%
<i>Homarus gammarus</i>	European lobster	66	31	–47%
<i>Lithognathus mormyrus</i>	Striped seabream	717	421	–41%
<i>Loligo vulgaris</i>	Common squid	3025	2667	–12%
<i>Merluccius merluccius</i>	European hake	10 930	5263	–52%
<i>Mugil</i> sp.	Mullet	34 561	7328	–79%
<i>Mullus barbatus</i>	Red mullet	5390	3815	–29%
<i>Mullus surmuletus</i>	Surmullet	3581	4072	14%
<i>Mustelus mustelus</i>	Smooth-hound	1576	383	–76%
<i>Oblada melanura</i>	Saddled seabream	1076	885	–18%
<i>Octopus vulgaris</i>	Octopus	6070	2183	–64%
<i>Pagellus erythrinus</i>	Common pandora	2329	2483	7%
<i>Pagrus pagrus</i>	Red porgy	579	316	–45%
<i>Palinurus vulgaris</i>	European spiny lobster	135	63	–53%
<i>Penaeus kerathurus</i>	Caramote prawn	N/A	N/A	N/A
<i>Pomatomus saltatrix</i>	Bluefish	9998	2342	–77%
<i>Sarda sarda</i>	Bonito	6710	7507	12%
<i>Sardina pilchardus</i>	Sardine	85 800	96 607	13%
<i>Sarpa salpa</i>	Salema	2336	1346	–42%
<i>Saurida lessepsianus</i>	Lizardfish	525	367	–30%
<i>Sciaena umbra</i>	Brown meagre	115	11	–90%
<i>Scorpaena porcus</i>	Black scorpionfish	197	182	–8%
<i>Scorpaena scrofa</i>	Red scorpionfish	1286	626	–51%
<i>Scomber colias</i>	Mackerel	11 735	8790	–25%
<i>Scomber scombrus</i>	Atlantic mackerel	3270	1291	–61%
<i>Sepia officinalis</i>	Common cuttlefish	3300	2786	–16%
<i>Serranus</i> sp.	Comber	950	207	–78%
<i>Sparus aurata</i>	Gilthead seabream	4158	3309	–20%
<i>Spicara maena</i>	Picarel	1962	1119	–43%
<i>Solea solea</i>	Common sole	N/A	N/A	N/A
<i>Trachrus</i> spp.	Horse mackerel	11 124	7872	–29%
<i>Umbrina cirrosa</i>	Shi drum	62	33	–47%
<i>Xiphias gladius</i>	Swordfish	1844	867	–53%

PR = probability.

commercial fishers but also recreational fishers to provide sustainable use of marine resources. Similarly, a conflict between the small-scale fishers and recreational fishers were noticed in western Greece (Conides et al. 2015).

The presently reported study showed that many problems declared by fishers were related to the illegal, unreported, and unregulated (IUU) fishing. The main devastating consequences of IUU were reported as a loss of biodiversity, decreased stocks, habitat degradation, loss of income and employment in fisheries and related sub-sectors, and even loss of human lives (Öztürk 2015). It was

estimated that IUU fishing accounts for 31% of the world catch and even up to half of the catch in some regions (Pramod et al. 2014). Little is known about the quantitative impacts of IUU in the Mediterranean (Falautano et al. 2018). In Sicily, illegal non-professional fishing vessels, which did not hold a fishing license, were very active in some periods and their CPUE values were higher than professional fishing vessels for some species, such as *Mullus surmuletus* and *Scorpaena porcus* (see Falautano et al. 2018). Similarly, the results of the presently reported study indicated that fishing without a license, the use of



prohibited fishing gears, and the catching of specimens which are smaller than the minimum landing size are the main illegal activities. The majority of coastal states do not record bycatch, ghost fishing, or data related to illegal fishing activities (Öztürk 2015). It was reported that lost fishing gear caused ghost fishing in the Aegean coasts of Turkey (Ayaz et al. 2010). Not only in Turkey, but also other Mediterranean countries, lost traps, and nets continue to catch both target and non-target species and this results in cannibalism, disease, or poor water quality (Lively and Good 2019). Yıldız and Karakulak (2016) evaluated the lost fishing gears of the Istanbul artisanal fleet and reported that approximately 29% of trammel nets, 17% of gillnets, 15% of longlines, and 9% of traps were lost annually. On the other hand, Ayaz et al. (2010) declared that 0.84% of gillnets, 3.41% of trammel nets, and 79.2% of longlines were lost annually in Gökova Special Environmental Protection Area (eastern Mediterranean). The main reasons for ghost fishing were: bottom structure, bad weather conditions, conflicts with other gears, and sea mammals (Ayaz et al. 2010). To monitor ghost fishing, fishing gear should be tagged for each vessel by responsible governmental units, and each item should be checked at the end of the fishing season. In addition, special fishing grounds for different fishing gears should be considered to prevent conflicts with other gears, to minimize the possibility of ghost fishing.

One of the significant problems in SSF in Turkey is to monitor fishing effort data. Due to the lack of mandatory logbook or return forms in Turkey's SSF, it was not possible to determine the fishers' effort. The presently reported study proved that there was a marked difference between the fishers' daily used number of hooks and net length. In Turkey, there was no standardization for daily used hook number per fisher (Anonymous 2016). In order to monitor the fishing effort and catch data, there should be a standardization on the daily used hook number and net length, and the daily catch records should be regularly provided using logbooks, by not only industrial fishers (trawlers and purse seiners) but also small-scale fishers. The catch records should include not only information on target species but also discard ratio. Although many fishing gears used in the SSF are considered as selective, the discard ratio for some species in some regions can be high (Veiga et al. 2016). Thus, based on the EU landing obligation, it is important to record discards in addition to target catch. Öndes et al. (2018) reported that the mean number of hooks used per day on longlines was  $725 \pm 400$  and the mean net length per each operation of set nets was  $2893 \pm 1661$  m in the Aegean and Mediterranean coasts of Turkey. Similarly, Ünal et al. (2015a) collected data from the same regions and reported that the mean length of the gillnet was  $2501 \pm 5684$  m and the mean used hook number was  $865 \pm 781$ . These aforementioned studies may be useful to determine the standardizations.

The presently reported study highlighted some non-target species damage to small-scale fishers' fishing gear and target catch, which caused a monetary loss. It was reported, non-native pufferfish species (*Lagocephalus*

*sceleratus*, *Lagocephalus suezensis*, *Lagocephalus guentheri*, *Sphoeroides pachygaster*, and *Torquigener flavimaculosus*) around the southern Aegean coasts were common in summer and autumn months and in particular *L. sceleratus* caused economical loss for the last several years (Ünal et al. 2015a, Öndes et al. 2018). There is no doubt that climate change has triggered the distribution of non-native species and influenced the SSF. As a further study, the target catch and pufferfish catch should be investigated for set nets and longlines using the regression to compare the CPUE and bycatch per unit effort (BPUE) to understand whether non-native species negatively influence the target catch.

In conclusion, this study revealed that, for the SSF in the Aegean Sea, the active fisher number decreased and many fishers had a second job. Due to decreased catch and income, many fishers faced challenges and some of them considered leaving their job. To provide sustainable management of SSF in Turkey, we suggested the monitoring of the catch and fishing effort should be provided using the mandatory logbooks and the standardization on the hook number should be considered. However, it is critically important before the application of the suggested adjustments, that the resilience and the fishers' capacity to adapt is investigated, as these changes may cause social and economic consequences. Information on the resilience of fishers within resource-use policies will contribute to the sustainable use of marine sources and will assist in the implementation of policies that aim to minimize the negative impact on fishers (Marshal and Marshal 2007). In addition, fishers should have education on the importance of fisheries management tools. Thus, further study needs to be done in order to gain more insight as to how this would work in practice. This should focus on the fishers' perception of the associated risks regarding the proposed arrangements, limitations, adaptability on potential policy amendments, and the prospective impact on income.

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