1 Charter fishing in the Aegean Sea (Turkey), Eastern

2 Mediterranean: the missing point of fisheries management

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10 **Abstract**

11 This study attempts to improve the scientific knowledge of charter fishing on the Aegean coast

12 of Turkey, where fishing activity and ecological indicators were investigated. Fishing and

13 socio-economic data from both charter boat owners and charter fishers were collected using on-

14 site questionnaires, and seasonal on-board surveys during 2017. No differences were observed

15 between CPUE estimates from the questionnaire and the on-board surveys. The highest and

16 lowest fishing activity were found in autumn and summer respectively. Charter owners reported

17 conflicts with both private boat owners as well as commercial fishers. The annual activity was

18 estimated to be 9,246 charter trips hosting 138,690 charter fishers, who caught 277-305 tonnes.

19 The total annual fisher and boat owner expenditure was estimated at €3.5 million and €0.6

20 million respectively. A total of 38 species were identified; most of the catch was represented

21 by sparids, of which there were several species, such as *Diplodus vulgaris*, *Sparus aurata*, and

22 *Pagellus erythrinus,* all of which were highly undersized. The results highlighted that the fishers

23 and boat owners had limited knowledge of fishing policies. We conclude that managers should

24   pay more attention to this activity and revise the existing regulations of charter fishing to

25   improve fisheries management.

28   **1. Introduction**

29   Managing fisheries requires the collection and analysis of fisheries' data in order to

30   produce a thorough knowledge base for planning. This allows for decisions, such as the

31   allocation of resources, or the enforcement of fishery regulations, to part from knowledgeable

32   foundations, and can help mould stakeholder behaviour towards ensuring the sustainable

33   productivity of living resources. Fisheries management requires a balance between fish stock

34   sustainability and fishing effort, while taking into account the environmental, social and

35   economic dimensions of fisheries (Hilborn and Walters, 1992; Link, 2010). Thus, management

36   authorities have a responsibility to take into account not only commercial fishing but also any

37   other mode of fishing, such as recreational, sport, and charter fishing. Similarly, FAO (1995)

38   stated that the existing draft is geared toward industrial fisheries in developed countries but in

39   fact, care should be taken to assure balanced consideration of the diverse array of fishery types,

40   including small scale, subsistence, and recreational fisheries. However, in many coastal

41   countries, fisheries management often focuses on large scale commercial fisheries, slightly pays

42   attention recreational or sport fisheries but almost entirely ignores specifically charter fishing

43   when designing fisheries policies (FAO, 2012).

44   Numerous studies have reported that recreational fisheries are a major contributing

45   component to total fishery harvests and ecosystem impacts (Coleman et al., 2004; Cook and

46   Cowx, 2004). Not only do commercial fisheries have the potential to negatively affect fish and

47   shellfish stocks, and their habitats; recreational fisheries may also have a similar influence

48 (Coleman et al., 2004; Cooke and Cowx, 2004, 2006; Rangel and Erzini, 2007; Lloret et al.,

49 2008a; Font and Lloret, 2014). Other anthropogenic impacts of recreational boat fisheries, such

50 as pollution caused by vessels (e.g. sewage, toxic antifouling, and grey waters), damage caused

51 by boat anchors, or other damage caused to caught species, have also been reported (Alós et al.,

52 2009; Lloret et al., 2008b). In spite of this, and of the call for a greater emphasis on the

53 monitoring of recreational fisheries (Gray and Kennelly, 2018), managers have paid little

54 attention to the impacts of recreational fisheries in the Mediterranean, which are not monitored

55 with the same thoroughness and frequency as commercial fisheries (Lloret et al., 2008a;

56 Cardona and Moralis-Nin, 2013) in comparison the one in the USA (Lew and Larson, 2015;

57 Lew et al., 2016). In the Mediterranean, the attention to recreational fisheries began

58 approximately two decades ago at the General Fisheries Commission of the Mediterranean

59 (Caddy, 2012). In 2010, the first workshop on the Monitoring of Recreational Fisheries in

60 GFCM was organised for developing a monitoring framework for recreational fisheries to

61 establish the basis for the term monitoring programme. Finally, GFCM established a Working

62 Group on Recreational Fisheries (WGRF) in 2017 (FAO, 2017). Although the WGRF

63 developed a handbook for the data collection on recreational fisheries in the Mediterranean and

64 the Black Sea, a monitoring program has not been fully implemented in the Mediterranean

65 region so far (FAO, 2018; ICES, 2018).

66 Charter fishing is the commercial segment of recreational fisheries. It is developed by

67 charter boat owners/operators, and contains within it the recreational fishing activity. In fact,

68 for many people, charter fishing often represents the first introduction to recreational fisheries,

69 since fishing equipment can be rented and a range of baits are sold by charter companies

70 (Pawson et al., 2007). Therefore, Abbott et al. (2009) refers to the charter fishing as a

71 ''commercial recreational fisheries activity'' while other authors call it "commercial passenger

72 fishing'' (Bellquist et al., 2017). The activity is commonly known as ''fishing from a vessel

73 carrying a passenger for hire that are engaged in recreational fishing'' (Norris-Raynbird, 2004).

74 GFCM also provides a definition of charter fishing to be used in the management of fisheries

75 in the Mediterranean and the Black Sea. According to the GFCM (2010), charter fishing is

76 ''recreational fishing practiced from a rented boat, with a captain or fishing guide on board, for

77 leisure or sport purposes''. Although there is a gap of knowledge on this subject, fishery

78 management authorities make decisions without information about the magnitude of the impact

79 of this activity. Exceptionally, Pitt and Trott (2013) reported that Bermuda manages charter

80 vessels as part of the commercial fishery fleet, and their catches are reported through the

81 commercial statistics circuit.

82   The conflicts arising between small-scale fisheries, aquaculture and other relevant

83 sectors, such as recreational fisheries and charter fishing in coastal zones, are other important

84 issues that have been ignored by management authorities. Moreover, Gordoa (2009) stressed

85 that recreational fisheries data should not be underestimated by managers or by fishing

86 administrators, as this information can also be used to describe and assess littoral fish

87 communities, thus providing additional and complementary data for the monitoring of coastal

88 resources. Recreational and charter fishing are getting increasing attention because of their

89 impact on fish stocks and habitats, as well as for their economic, cultural and social benefits.

90 Their management plays an important role in the protection of marine resources from

91 overfishing and other associated negative anthropogenic impacts (Mueller et al., 2008; Pranovi

92 et al., 2015). It has been reported that anglers can positively influence the conservation of

93 natural resources, and contribute to increased management success by complying with

94 developing regulations (Arlinghaus, 2006; Cardona and Moralis-Nin, 2013; Nguyen et al.,

95 2013). Hence, there is no doubt that the awareness and perception of fishers regarding fisheries

96 legislation is important for the sustainable management of fisheries.

97   Considering the bulk amount of research relating to the recreational fisheries area

98   around the world, little has been studied on charter fishing in the Mediterranean, even though

99   this activity has a long history and is well developed in many countries. For instance, in

100   Australia, the New South Wales (NSW) coastal charter-vessel line fishery has been in operation

101   since the 1950s, and currently has 276 registered vessels operating from 36 ports. Furthermore,

102   it is one of the most valuable fisheries in the state providing $AUD 50.2 million annually to

103   local economies (McIlgorm and Pepperell, 2014; Gray and Kennelly, 2018). There have also

104   been studies on charter fishing in other regions, such as South Africa (Pradervand and Van der

105   Elst, 2008) and the USA (Liese and Carter, 2011; Steinback and Brinson, 2013; Lichtkoppler

106   et al., 2015; Lew and Seung, 2014; Lew et al., 2015; Leonard, 2016; Lew et al., 2016; Hilger

107   and Lovell, 2017; Rollins and Lovell, 2019).

108   Although Hyder et al. (2018) reported that the total number of European recreational

109   sea fishers was estimated to be approximately 8.7 million, with 5.9 million and 2.8 million in

110   the Atlantic and Mediterranean regions respectively. The number of anglers for the whole

111   Mediterranean basin has not yet been documented. Recent estimates of the marine recreational

112   fisher population in Spain was around 900,000 fishers, including shore fishers, boat fishers and

113   spear fishers (Gordoa et al., 2019). Of these, 63% fish in Mediterranean waters (575,082

114   fishers), of which a total of 40,015 fishers undertake the activity from a boat. These estimates

115   were based on the number of licenses, which are mandatory in this country. Although the

116   Spanish boat-based recreational fishing has been documented, there is no information available

117   to date on charter fishing there or elsewhere in the Mediterranean.

118   In Turkey, as in many Mediterranean countries, recreational fishing licences are not

119   mandatory. However, a certificate is given to those who are willing to obtain one, although it

120   does not give anglers access to any privileges. Fishery managers rely on bag (5 kg) and size

121   limit restrictions as the principal tools to manage harvest levels. Only for several species,

122　including Atlantic Bluefin tuna, Atlantic bonito, common octopus, leerfish, swordfish, turbot

123　and white grouper, do seasonal closures exist. However, spatial restrictions are in practice in

124　some protected areas, as well as in military areas. Other restrictions are related to fishing gear,

125　for example, each fisher can use a maximum of 4 fishing rods, and can include a maximum of

126　6 hooks per rod, with the exception of handlines. Minimum landing sizes (MLS) and minimum

127　landing weight (MLW) restrictions were established for 25 and 1 species, respectively

128　(Anonymous, 2016). Although there are some regulations and management tools (e.g. bag limit,

129　closed areas, MLS, restrictions and prohibitions on fishing gear), recreational fishers do not

130　have to report catches in Turkey (Öndes et al., 2018).

131　　In Turkey, some studies revealed the magnitude of recreational fisheries (Ünal et al.,

132　2010; Tunca et al., 2016) but the magnitude of the impact of charter fishing and its contribution

133　to the economy remains unknown. The present study aims to fill these gaps by providing

134　information on catch, effort, operational characteristics of charter fishing, demographics of

135　charter boat owners and charter fishers in the Aegean Sea. Moreover, the existing management

136　measures and regulations are discussed with charter fishing users as a means to produce

137　informed management measures for the fisheries management authorities.

138　**2.　Material and Methods**

139　*2.1. Study area*

140　　The Aegean Sea is located between the Greek and Anatolian peninsulas in the

141　Mediterranean Sea (Fig. 1). Traditionally, it has had an extremely important role as a trading

142　and fishing area, having more than 3,000 islands and many small bays which facilitate marine

143　activities. Due to its geographic and coastal structure, the Aegean Sea provides suitable

144　conditions for fishing, particularly small scale and recreational fisheries. In 2017, a total of

145　13,868 small scale fishing boats and 1,538 industrial fishing boats produced 322,173 tonnes of

146　fish and shellfish in Turkey (GTHB, 2018). Moreover, 29% of the Turkish commercial fishing

147   fleet operating in the Aegean Sea produced a total of 47,677 tonnes in 2017 (GTHB, 2018). In

148   addition to commercial fishing boats, the number of boats with a charter fishing licence in the

149   Aegean Sea (Turkey) in 2017 was 201.

150   *2.2. Data collection*

151   The charter fleet consisted of 201 boats in the Turkish Aegean Sea. The list of licenced

152   charter boats was provided by the Ministry of Agriculture and Forestry, and the Ministry of

153   Culture and Tourism of the Republic of Turkey. The face to face sampling could covered up to

154   45% of the fleet (90 boats) due to the rejection to answer of some boat owners and the

155   inaccessibility of others during 2017. In the same time period, a different questionnaire was

156   addressed to charter fishers (n = 479). The fishers fishing at the main charter fishing sites of the

157   Aegean Sea (Fig. 1) were chosen randomly because there was no mandatory licence for the

158   charter fishers in Turkey. Both questionnaires gathered four types of information: (1) socio-

159   demographic features (e.g. age, gender, education, occupation, salary, income), (2) activity

160   expenditures (fuel, insurance, repair and maintenance, mooring, salary of crews, transportation

161   for boat owners and bait, boat tickets, gear, and travel costs for fishers), (3) magnitude and

162   characteristics of the fishing activity (trip frequency, fishing times, temporal and spatial changes

163   in the fishing activity, bait and gear characteristics, catch composition, daily catch (kg), annual

164   catch per species, fishing effort (in number of trips per year), and (4) boat owner and fisher

165   perspectives on the management measures. Additionally, the questionnaires directed to boat

166   owners included questions regarding boat descriptors (age, material, size, HP, equipment, and

167   client capacity) in order to characterize the charter fleet. The entire survey was carried out by

168   the same scientist to guarantee survey consistency (Supplementary material).

169   The catch data, in addition to the face-to-face questionnaire surveys, were also collected

170   directly on-board throughout 2017. Samples were collected on charter fishing boats to obtain

171   information on size distribution, daily catch rates (CPUE) and undersize ratios of fish and

shellfish species. A total of 15 days, distributed throughout the seasons (winter, autumn, summer, spring) were carried out at three different sampling sites (Çeşme, Foça, Kuşadası). The samples were obtained from volunteer fishers: a total of 150 volunteer fishers (10 fishers per day) were randomly selected, and the total length (TL) of each fish was measured using callipers. In order to estimate the fishers' daily catch, the total weight of caught fish was recorded.

2.3. Data Analysis

In order to estimate fishing effort and the catch of the whole charter fleet operating in the Aegean Sea in 2017, the sequence for the estimations was:

- Total number of tours (TNT)= annual average tours per vessel x nº of vessels
- Total number of fishing days (TNFD)= average daily number of fishers per tour x TNT

Here, the total number of fishing days can also be read as the total number of fishers (=clients), but it cannot be interpreted or inferred to as the total population of individual fishers. The rationale for this argument is justified by the fact that several clients may correspond to the same individual fisher, because fishers often go charter fishing several times a year.

- Total number of hooks (TNH) = average daily hooks per fisher x TNFD
- Annual total catch (ATC) = average daily catch rate per fisher x TNFD
- Total number of fishers (TNF) = TNFD / annual average fishing days per fisher
- Annual total expenditure of boat owners (ATEOBO) = average annual expenditure per boat owner x Total number of boats.
- Annual total expenditure of fishers (ATEOF) = average annual expenditure per fisher x TNF

195   A Kruskal-Wallis test was performed to assess potential seasonal patterns in the number

196   of organised tours as well as for the fishers' activity. Spearman's rank correlation coefficient

197   was used to test for potential relationships between fishers' experience (years) and catching

198   efficiency (daily catch). Linear regression was used to test the potential relationship between

199   the fishers' fishing effort and their salaries, to understand whether their activity was related to

200   their salary or not. Regarding the daily CPUE estimations, a Mann-Whitney U test was used to

201   test for potential differences between the data obtained by the questionnaire and the data

202   collected on-board. All these analyses were undertaken using the statistical software SPSS 20.0.

3. Results

204   The mean daily fishing duration (fishing action spent at the fishing ground excluding

205   the trip) was 10.0 hours ($CI_{95\%}$ = 9.8-10.2) and 98% of boat owners declared that no seasonal

206   differences were observed in the length of the fishing days. Similarly, the daily fishing duration

207   did not differ between weekdays and weekends. The maximum charter capacity ranged from 6

208   to 85 clients according to the charter boat licences. Boat owners declared that the mean client

209   number per trip was 15.4 fishers ($CI_{95\%}$ = 13.8-16.9).

210   The charter fishing boat descriptors estimated a fleet mean length of around 14.9 m

211   ($CI_{95\%}$ = 13.8-15.9), and an age of around 14.6 years ($CI_{95\%}$ = 12.9-16.3). The charter fleet was

212   primarily wooden boats (95%), 3% were built with fibre and only 2% were iron. The average

213   engine HP was 211.7 HP ($CI_{95\%}$ = 183.8-239.5). All boats were equipped with a fish finder,

214   GPS and echo sounder.

3.1. Boat owners

216   The mean age of the interviewed charter boat owners was 44.9 years ($CI_{95\%}$ = 42.8-

217   47.1). Only 1 boat owner was a woman. They lived in households with a mean of 3.4 family

218   members ($CI_{95\%}$ = 3.1-3.6). The boat owners' educational attainment level was varied: 21%

held a university degree, 47% had accomplished high school, 23% completed middle school and 9% finished primary school. The main reasons for starting charter businesses were explained by high income (31%), lifestyle (20%), a lack of alternate employment (19%), family tradition (17%), and other undefined reasons (10%). The results showed that charter fishing is a relatively new activity in the Turkish Aegean waters; the mean boat owner experience was 7.0 years ($CI_{95\%}$ = 5.7-8.3). All owners were insured, and 64% were members of charter cooperatives. None of them had any type of training or had attended any program on recreational fisheries. Moreover, 35% of boat owners reported that they were commercial fishers: trawlers (8%), purse-seiners (7%), set netters (16%) and long liners (4%) before their current job (charter fishing).

The total annual gross profit of boat owners was €1,129,821. Charter boats were also used for other leisure activities: 77% of boat owners revealed that during summer months they organised daily tours for sunbathing-swimming instead of charter fishing tours. Based on the boat owners' responses, their mean annual gross profit from the charter fishing activity was calculated as €5622 ($CI_{95\%}$ = 3949-7294), whereas the mean annual gross profit for daily sunbathing-swimming tours was €2359 ($CI_{95\%}$ = 2003-2714). The results showed that 41% of boat owners had a second job in addition to boat fishing, which provided them with an additional annual gross profit estimated to be €5501 ($CI_{95\%}$ = 4193-6808). Fig. 2 shows the estimates of the total annual expenditures of boat owners, excluding the loss of boat depreciation and loan interest. In addition, the boat prices ranged from €11,200 to €420,000 with the mean individual annual expense being €3187 ($CI_{95\%}$ = 2734-3640). Another cost was associated with the crew hired for the trips: 61% of boat owners declared that they hired between 1 and 5 crew members. Concerning client services on board, 11% of boats provided breakfast and lunch, 46% provided only lunch, and 43% of boats did not provide breakfast or lunch. Only 4% of boat owners offered rod renting services, and 11% of boats provided fishing

244   bait. A relevant proportion of boat owners (45%) declared that they also fish during tours, and

245   39% cook their clients' catches on board.

246   Fishing sites were generally decided by boat owners (67%); only 3% of boat owners

247   reported that their clients chose the fishing sites, whereas 30% of boat owners declared that the

248   fishing site choice was by consensus between them and their clients. Fishing site selection

249   depended on: weather conditions, familiar fishing habitats and sonar fish detection. Fishing

250   locations ranged from 1 to 15 miles offshore, on average being 4.4 miles ($CI_{95\%} = 3.7$-5.1) from

251   the coast.

252   *3.2.Charter fishers*

253   Results showed that the mean age of charter fishers was 38.0 years ($CI_{95\%} = 36.8$-39.2),

254   90% of which were men. Fisher´s education level showed that 45% of fishers had a university

255   degree, 3% had an MSc degree, 36% completed high school, 7% finished middle school and

256   9% attained primary school. The fishers' mean annual salary was €6078 ($CI_{95\%} = 5724$-6432).

257   Their mean charter fishing experience was 7.4 years ($CI_{95\%} = 6.6$-8.2). Many fishers were

258   introduced to charter fishing by friends (73%) or family (20%), whereas 7% of fishers started

259   this activity for other reasons (e.g. curiosity). The reasons for continuing the charter activity

260   were: 28% consider it a hobby, 25% did it to overcome stress, 20% to relax, 16% participated

261   just for fun, and 11% did it for sport. None had any specific training or had taken any courses

262   on charter fishing, and only 1% of fishers had a membership of a social society related to charter

263   fishing.

264   The mean ticket cost per trip was €10.3 ($CI_{95\%} = 10.1$-10.5), and the mean daily cost per

265   fishing day, after adding transportation, bait and other expenses, was €21.3 ($CI_{95\%} = 20.6$-21.9).

266   The most common means of transportation were: by a personally owned car (36%), by a friend's

267   car (36%), by tour services (17%), on foot (10%), and by bicycle (1%). The mean annual

expenses on charter fishing activity was €336.3 (CI$_{95\%}$ = 306.4-366.1), including the annual expenses on fishing equipment. Fishers declared that the highest expenditure was on the boat tickets (Fig. 3). Our findings showed that 25% of fishers had a volunteer recreational fishing licence. A relevant proportion of fishers (33%) believed that a fishing licence should be mandatory for recreational fisheries, and stated that the mean licence price they would be willing to pay annually would be around €8.5 (CI$_{95\%}$ = 6.4-10.5); this value was widely ranged, ranging between a minimum of €2 and a maximum of €140. Charter fishers reported that the highest and lowest boat ticket prices varied between €4 and €46, and considered that the optimal boat ticket price was €8

Charter fishers generally go on board with friends or family members and only 13% of fishers declared fishing alone; the mean size of these groups was 3.1 people (CI$_{95\%}$ = 2.9-3.2). Most fishers (62%) contacted the boat owners via internet advertisements, 25% because of a friend's suggestions, 10% responded to advertisements in ports, while the rest declared they already knew about the tours beforehand. Most fishers (96%) used troll fishing, followed by hand lines (3%) and by harpoons (1%). The mean number of hooks per line was 3.22 (CI$_{95\%}$ = 3.16-3.27). Furthermore, fishers reported that they used up to 11 different types of bait, of which shrimp was the most commonly used (33 %), followed by razor shell (20%), Mediterranean mud shrimp (12%) and pilchard (9%). Other lees common bait included crab, chicken, anchovy, artificial (fishing lures), squid, tube worm and gastropods.

3.3. Fishing activity

Most of the charter fishing activity took place only during weekends (71% of boats), whereas 29% of boats fished both during weekends and weekdays. Consistently, charter fishers generally fished during weekends (Fig. 4a). The best catch time was reported to be early morning. These results were consistent among sampling sites (Fig. 4b).

The mean annual number of fishing tours per fisher was 13.6 d (CI$_{95\%}$ = 12.5-14.6), and the number of fishing days increased significantly with the fisher´s salary (R^2 = 0.04, P < 0.001). The mean number of organised tours was estimated at 45.8 days (CI$_{95\%}$ = 41.1-50.4) per boat yearly. The frequency of charter fishing attendance compared to fishing tours significantly changed throughout the seasons (χ^2 = 98.56, P < 0.001) peaking during the autumn months (Fig. 5a). Similarly, the number of organised tours significantly varied throughout the seasons (χ^2 = 430.80, P < 0.001); the highest activity was found in autumn (Fig. 5b).

A total of 38 species were identified from the questionnaires (Table 1), while the results of the on-board observations identified a total of 28 species. Bogue (*Boops boops*) was the most commonly reported species, accounting for 21% of the catch in weight, and was followed by red sea bream (*Pagellus erythrinus*), and the common two-banded sea bream (*Diplodus vulgaris*). These three species also had the highest values of annual CPUE in weight per fisher (Table 1). Based on the questionnaire surveys, the daily catch rate averaged at 2.2 kg per fisher (CI$_{95\%}$ = 2.1-2.3). Daily catch rates did not show a significant relationship with fisher experience (r = 0.09, P = 0.082). On the other hand, based on on-board observations, the daily catch rate averaged at 2.0 kg per fisher (CI$_{95\%}$ = 1.9-2.1). There was no significant difference between the CPUE estimates from the questionnaire surveys and on-board observations (P = 0.160). Estimated undersized catch ratios and mean species body size were shown in Table 1. Results indicated that 81 % of *D. vulgaris*, 65 % of *S. aurata*, and 28 % of *P. erythrinus* were below the legal minimum size (Table 1).

The extrapolated estimates of charter activity in the region are presented in table 2. The total annual catch was around 300 tonnes. The estimates of the total annual catch from the questionnaire study and on-board surveys showed small and non-significant differences in their respective daily catch rates. The total annual expenditure of fishers came close to €3.5 million (€3,328,560), whereas boat owners' total annual expenditures were estimated at €631,944.

Regarding the perception of historical changes, all boat owners with at least 10 years of experience considered that fish stocks have decreased during the last decade. Furthermore, most of them (63%) also perceived that the size of catches has been decreasing. The fishers´ perception was similar to that of boat owners; most of them perceive a decline in both fish stocks (84%) and fish body size (68%). On the other hand, the majority of boat owners (83%) considered that the number of charter boat trips has markedly increased during the past decade. In both sectors, the clients (64%) and owners (43%) considered the trips overcrowded, and suggested that daily client restrictions should be considered.

But few of them considered that conservation measures may be effective: only 17% agreed that the increase of the minimum landing size may help protect stocks, and only 9% of them considered that the establishment of artificial reefs could be beneficial. Similarly, both owners and clients considered that regional and seasonal closures are unnecessary for recreational fisheries. But, both sectors considered satisfactory the daily bag limit in the same proportion (50%) and a relevant proportion of fishers (42%) would accept a mandatory logbook for reporting species' catch and length.

A significant number of charter boat owners (71%) reported that they had conflicts with recreational private boat owners who organise illegal fishing tours. Additionally, 60% of respondents also had experienced conflicts with commercial fishers because of competition for fishing sites. This is an issue to such an extent that 17% of them have considered leaving the charter fishing activity, due to unfair competition with private boats, and the increase in costs, particularly fuel and mooring prices.

The results on the experience and perception of management measures of boat owners and clients were similar, except for the subject of control surveillance (Fig. 6). All charter boat owners were regularly controlled by the Coast Guard, whereas only 2% of charter fishers were

341 controlled and only half of the charter boat owners (52 %) declared that they had information

342 on the fishing regulations issued by the government.

343 **4. Discussion**

344 This study represents the first research providing information about social, economic,

345 and catch characteristics of charter fishing in Turkey. The intensity of charter fishing, which

346 involves thousands of annual trips, significantly indicates that this activity should be considered

347 by the management authority.

348 The profile of charter fishers showed that they were mostly male, as has been previously

349 documented for boat recreational fisheries in the Mediterranean (Gordoa et al., 2019; Ünal et

350 al., 2010; Tunca et al., 2016). The mean age of charter fishers was younger than that of boat

351 owners, but both estimates were also within the ranges of the previous studies (Morales-Nin et

352 al., 2005; Lloret et al., 2008a; Tunca et al., 2016). The educational attainment was lower for

353 boat owners, and a high proportion of them came from the commercial fishing sector.

354 Accordingly, previous studies reported that many commercial fishers have a primary or middle

355 school diploma in Turkey (Ünal and Franquesa, 2010), whereas recreational fishers generally

356 have a high school diploma or a Bachelor's degree (Ünal et al., 2010; Tunca et al., 2016).

357 Boat recreational fishing activity is related to favourable weather conditions, with

358 summer and autumn being the most preferred in the Mediterranean (Pranovi et al., 2015). While

359 Pranovi et al. (2015) did not mention any reason other than weather conditions for the

360 seasonality, Font and Lloret (2014) reported that fish diversity and accessibility to fish stocks

361 influence the activity period. In the present study, charter fishing in the Aegean region also

362 showed seasonality, but with the particularity that this decreased during the summer. This

363 decrease is not related to the aforementioned reasons, but due to the shift of charter boats to

364 other tourist activities during the touristic season.

365   Catch rate estimates from questionnaires may incur recall bias (Gray and Kennelly,

366   2018). Although our results showed that daily catch rates did not show a significant difference

367   between the questionnaires and the direct observations. This indicates that in the absence of

368   observations, the estimates based on questionnaires can be used as a proxy for the charter

369   fishing daily CPUE. The results of the mean daily catch rate were below the 5 kg daily bag

370   limit. Although the annual harvest impact of this activity, in 2017, represented only 0.6 % of

371   the total commercial catch in the Aegean Sea (43 833 t), the impact on certain species and areas

372   might be relevant. In particular, for some species of commercial value, such as *D. vulgaris, P.*

373   *erythrinus, S. aurata* where the charter fishing catch represents 36%, 13%, and 9% of the total

374   commercial catch of the Turkish coasts of Aegean Sea respectively (GTHB, 2018). A previous

375   study in Turkey (Tunca et al., 2016), on private boat-based recreational fisheries, reported a

376   smaller number of species, but similarly, *D. annularis, D. vulgaris,* and *S. aurata* were common

377   species. Comparing these results with other studies carried out in the Mediterranean is complex

378   due to their scarcity. However, comparing the available information from local studies on boat

379   fishing (Font and Lloret 2014) to a nationwide study on recreational fishing in Spain proved

380   that for the main fishing modalities, sparids accounted for 30% to 54% of the total catch (Dedeu

381   et al., 2019).

382   In Turkey, 25 species are regulated with a minimum size limit (MSL); of the 38 species

383   reported in this study only 15 of them have a MSL. The undersized estimates could only be

384   done for those with sampling size measurements from the on board surveys. The present study

385   showed that the undersized rate varied among species, and were particularly high for some

386   commercial species such as *D. vulgaris*, *S. aurata* and *P. erythrinus*. Similar findings were

387   reported for recreational boat angling in the North West Mediterranean (Lloret et al., 2008a).

388   In this study, other commercial species were also undersized such as *Octopus vulgaris*, *Scomber*

389   *japonicus* and *Mullus barbatus*. However, here we differentiate between undersized

390   individuals, those sized below the MSL, and individuals, which corresponds to those whose

391   sizes are below the 50% sexual maturity (L50) threshold. The most abundant species caught by

392   charter fishers was *B. boops,* which has no minimum landing size but 35% of the specimens

393   were smaller than size at maturity (Soykan et al., 2015). Our study also showed that the mean

394   length of some species such as *S. japonicus, P. acarne* and *Sarda sarda* were also below their

395   size at maturity values (FISHBASE, 2018). Consequently, we advise that highly fished species,

396   such as *B. boops*, should have MLS. This advice extends to *Pagellus bogaraveo* and any other

397   species considered by the IUCN as near threatened, vulnerable, or critically endangered, to

398   minimise their extinction risk (IUCN, 2018).

399   The state of present ecosystem changes in a historical context is challenging when

400   historical data is limited (Beaudreau and Levin, 2018). The lack or deficiency of historical data

401   causes a need to use local ecological knowledge (LEK). The LEK, which was derived from a

402   series of interviews with resource users, has been used to identify historical changes in

403   population structure and fishing effort (Ames 2007; Whiteley, 2009; Bender et al., 2014;

404   Piroddi et al., 2017). According to results on the historical perception of our most experienced

405   fishers, the resources of the Aegean Sea might be declining: both experienced clients and boat

406   owners perceived a reduction in fish stocks and fish size. The Aegean Sea is not an exception;

407   the reduction in commercially fished species throughout the Mediterranean Sea is well-known

408   (Piroddi et al., 2017). However, despite the fact that charter fishers declared being aware of the

409   state of fish resources, they lack understanding of their role in the sustainability of fish

410   resources. More than half of the charter fishers and boat owners showed disagreement towards

411   any potential regulations related to the increase of MLS; they considered it would decrease their

412   daily catches, reducing satisfaction levels, and that this would have a direct negative impact on

413   income from the activity. Our results also showed that charter boat owners object to any spatial

414   or temporal limitations for charter fishing, and practically all of them consider that these

shouldn´t be applied to them. In the Western Mediterranean, recreational fishers expressed similar attitudes to these types of conservation measures (Cardona and Morales-Nin, 2013). Additionally, our results showed that two out of every three fishers were opposed to a mandatory license system, while in Mallorca, where the license system is mandatory, only 12% of the fishers had unfavourable opinions towards licencing (Cardona and Morales-Nin, 2013).

In general, the popularity of charter fishing and the number of charter boats have increased over the past twenty years (Lew and Seung, 2010; Chan et al., 2017). Likewise, our study demonstrated that there has been a relevant increase in charter boats in the Aegean Sea during the last decade. But, fishing specific regulations and consciousness among fishers and boat owners is low. This is a cause for concern; particularly, in the case of charter boat owners, given that one third of them were commercial fishers in the past. Although Ünal and Kıraç (2013) provides a code of conduct for recreational fishers in Turkish waters, the results of the present study showed that none of the actors, boat owners or charter fishers, had attended any training program on this activity. DG-Fisheries issue licenses without any associated educational program to ascertain that fishers receive essential information. Additionally, the implementation of control and surveillance programs on charter fishing should be considered.

The results on charter fishing costs showed, similarly to previous studies on recreational boat fishing (Gordoa et al., 2004, Lichtkoppler et al., 2008; Pita et al., 2018), that the highest costs were related to maintenance and fuel. The development of charter fishing will depend on social and environmental conditions. The suitable state of fish resources is essential to maintain or increase the population of both local and foreign charter fishers, which would allow further development of the sector. The results of this study indicate that the charter fishing sector in the Aegean region might be under threat, due to the boat owners' low net incomes, the dependence of the fisher's activity on their salary, and the decrease of fish resources limiting the potential to attract of foreign fishers. Furthermore, the conflicts of interest with other fishing sectors, as

440 well as charter fishers' generalized unawareness of regulatory measures and a lack of interest

441 of the management authorities, compromise the future of all fishing activities including charter

442 fishing in the region. Although the present study was conducted in a Mediterranean region, it

443 hopes to encourage decision-makers across the globe to pay more attention to recreational

444 fisheries and charter fishing, and wishes to contribute to stimulate the development of

445 monitoring strategies. In the meantime, besides the socioeconomic and operational

446 characteristics of charter fishing given in the present study, further studies should also provide

447 information on the environmental impacts (e.g. boat anchoring) of charter fishing.

5. Conclusion

449 Overall, this study points out the urgent need for regulations related to management

450 tools, and stresses the necessity for an increase in the control of charter boat owners and their

451 customers' activities. This is vital to maximize the net economic benefits of both charter fishers

452 and charter boat owners. However, in order to contribute to the sustainable use of marine

453 resources, both the commercial and recreational fisheries (including charter fishing) should be

454 managed by effective measures, of which stakeholders should be provided with comprehensive

455 information (Lew and Larson, 2015). Thus, setting up training (workshops, courses, etc.) for

456 charter fishers and monitoring programs for the activity, may prove to be effective instruments

457 for the sustainable management of marine resources.

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Supplementary data

Supplementary material related to this article can be found in the online version, at doi:

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Figure captions

Fig. 1. Map of the sampling sites (Aegean Sea, Eastern Mediterranean).

Fig. 2. Annual reported expenditures of charter boat owners. Expenditures include fuel, insurance, repair and maintenance, mooring, payment for staffs (crews), transportation (between house and port) and other (including food, drink water, waste water and electricity).

Fig. 3. Annual reported expenditures of charter fishers. Expenditures include baits, boat tours' tickets, fishing gear and annual expenses on fishing gears (e.g. additional fishing line, hook, bullet), transportation (between house and port) and others (food, snacks).

Fig. 4. a) Fishing times of charter fishers, b) reported best fishing times during the day.

Fig. 5. a) Number of fishing tours of charter fishers in each season, b) number of organised boat tours in each season.

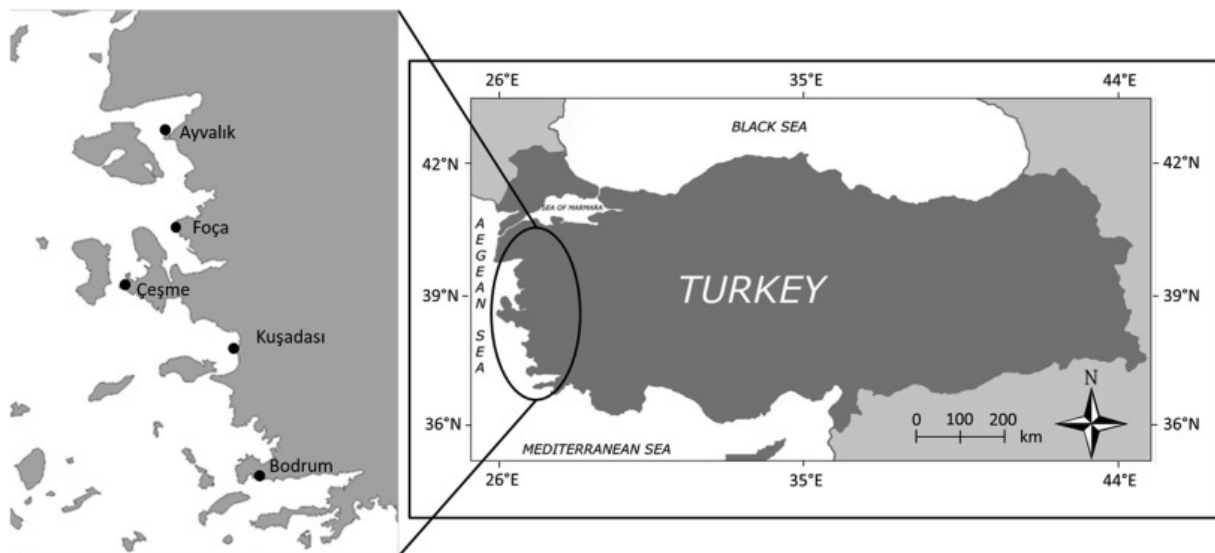**Fig. 6.** Experience and perceptions of charter boat owners and fishers on fisheries management measures.

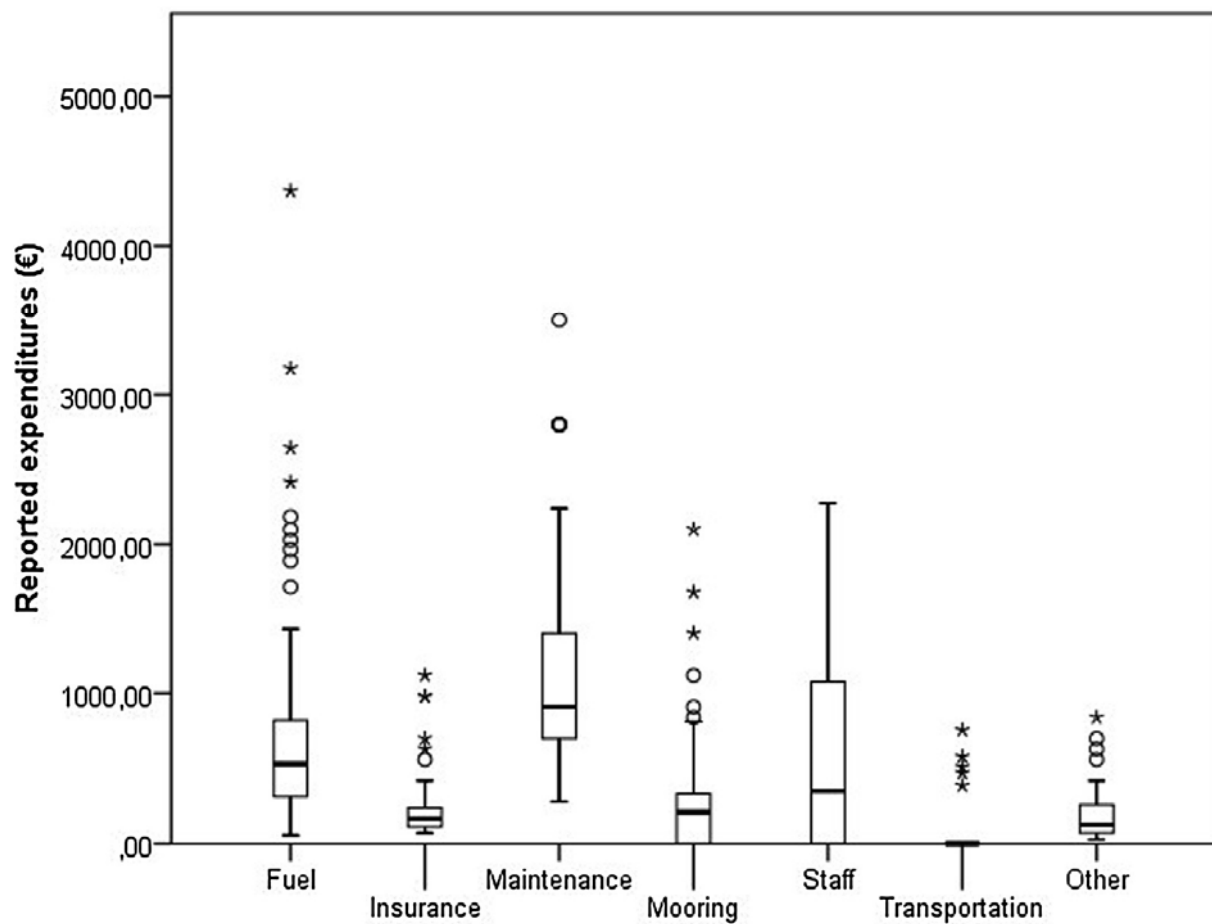**Fig. 1.** Map of the sampling sites (Aegean Sea, Eastern Mediterranean).

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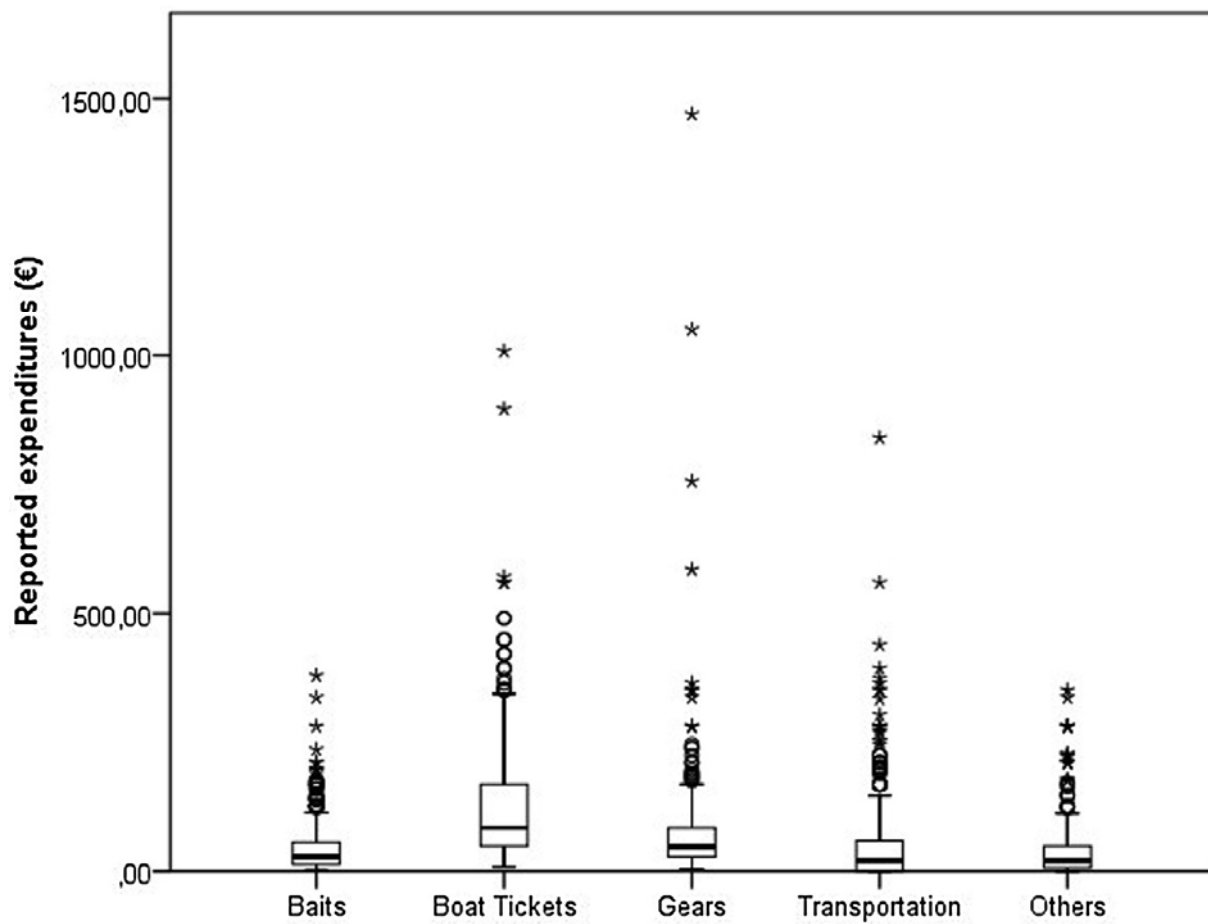
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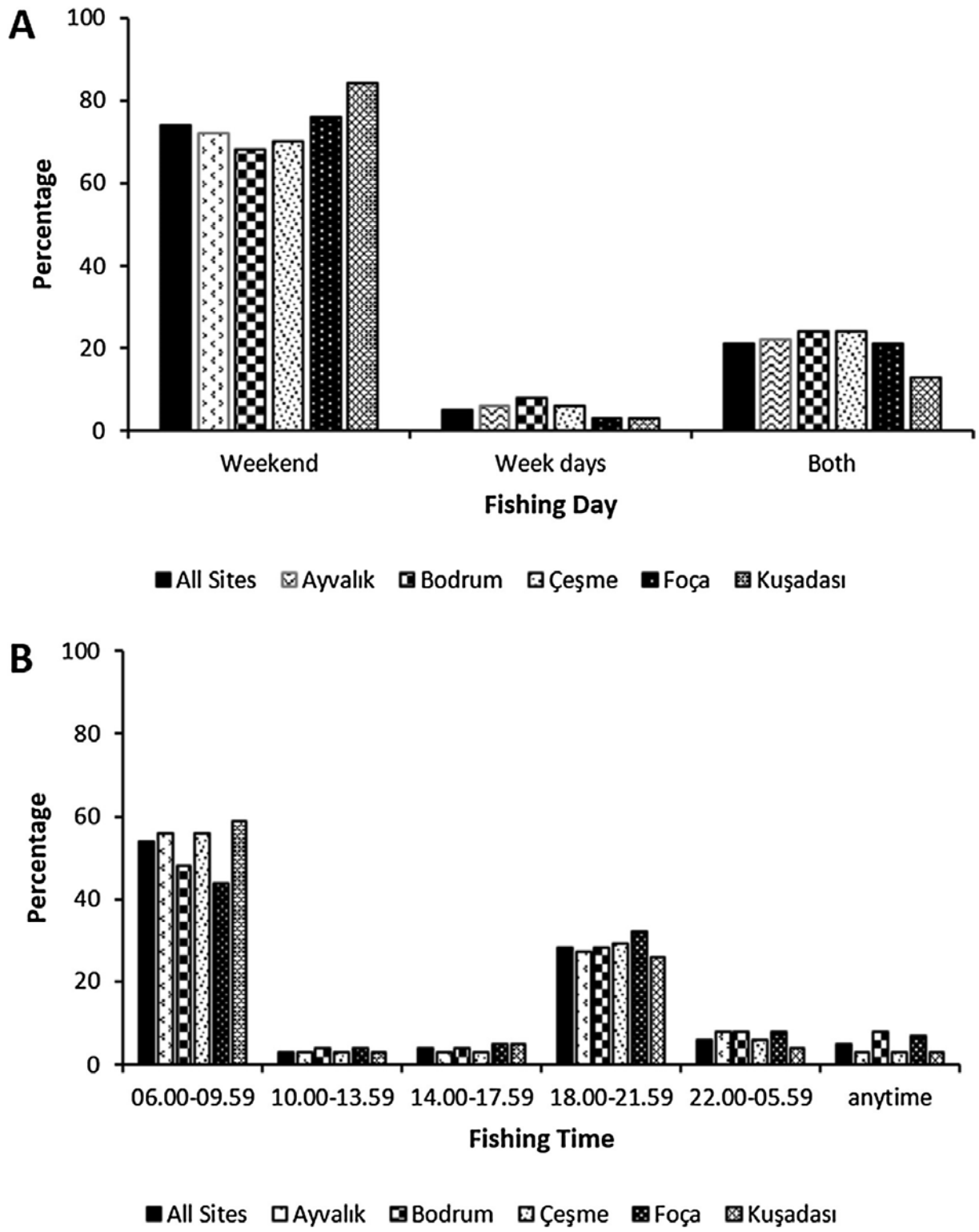
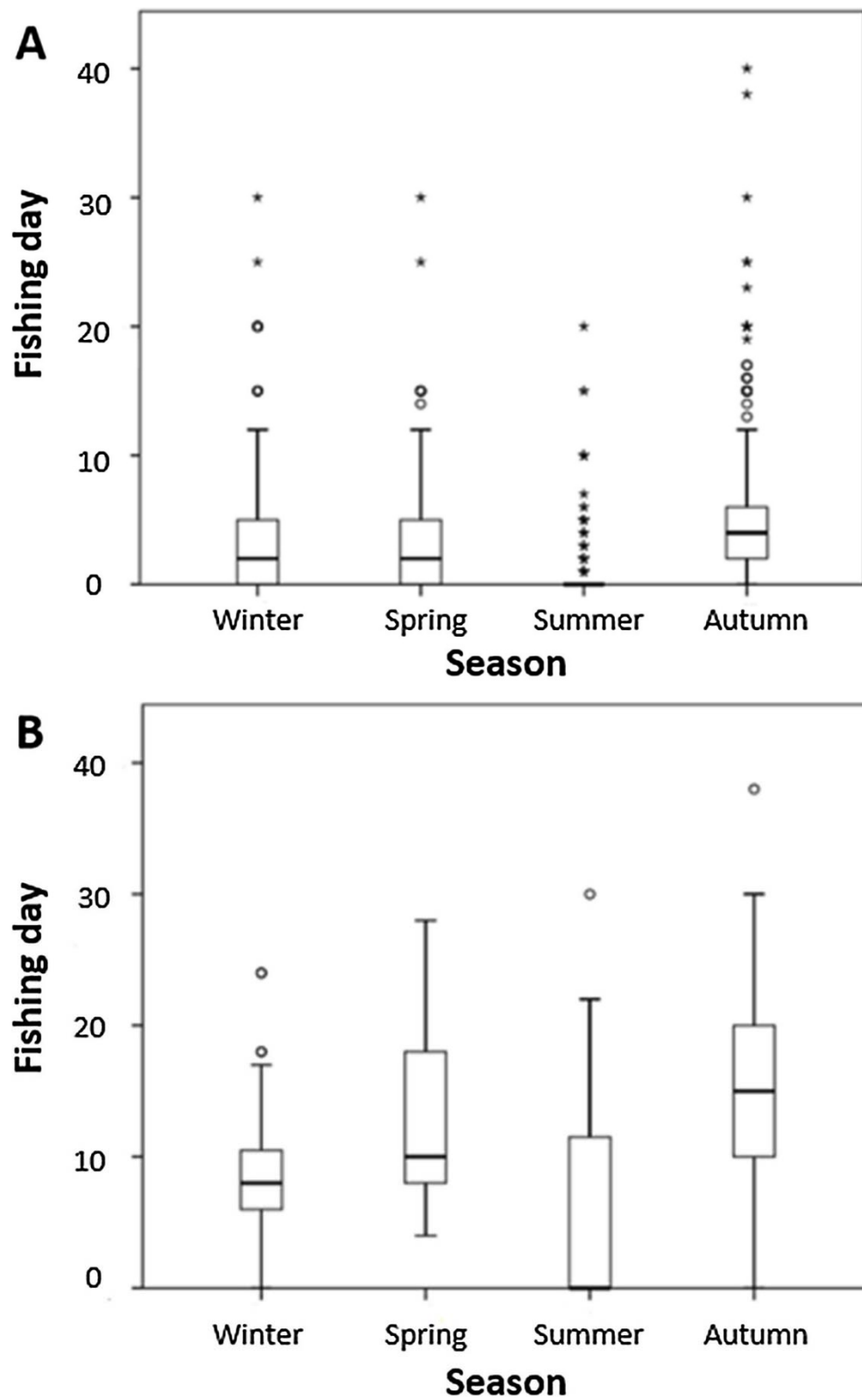Fig. 4. a) Fishing times of charter fishers, b) reported best fishing times during the day.

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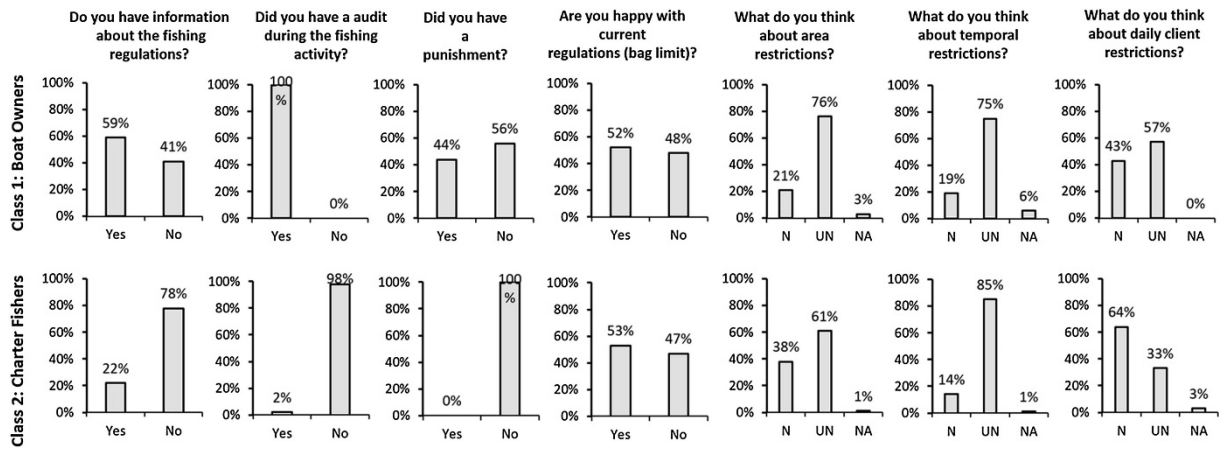
Fig. 6. Experience and perceptions of charter boat owners and fishers on fisheries management measures.

Tables

Table 1. Catch composition with mean CPUE values, mean body length values, L50, MLS, undersized catch ratio and IUCN Red List categories of species.

Species	Latin name	Percentage (%)	CPUE (kg person y^{-1})	Mean body length (mm)	L50 (mm) based on fishbase website	MLS (mm)	Undersized catch ratio (%)	IUCN Red list Category
Bogue	*Boops boops*	20.88	6.34	138	143	-	-	Least Concern
Common pandora	*Pagellus erythrinus*	15.90	4.83	181	147	150	28	Least Concern
Common two banded seabream	*Diplodus vulgaris*	12.09	3.67	152	170	180	81	Least Concern
Gilthead seabream	*Sparus aurata*	9.52	2.89	197	NA	200	65	Least Concern
Pickerel	*Spicara smaris*	5.65	1.72	96	91	-	-	Least Concern
Axillary Seabream	*Pagellus acarne*	5.36	1.63	155	160	-	-	Least Concern
Annular Seabream	*Diplodus annularis*	5.02	1.52	118	112	-	-	Least Concern
Chub Mackerel	*Scomber colias*	4.84	1.47	234	215	180	13	Least Concern
Red porgy	*Pagrus pagrus*	2.56	0.78	NA	266	-	-	Least Concern
Comber	*Serranus cabrilla*	1.99	0.60	93	175	-	-	Least Concern
Atlantic mackarel	*Scomber scombrus*	1.39	0.42	NA	287	200	NA	Least Concern
Pink dentex	*Dentex gibbosus*	1.39	0.42	289	347	-	-	Least Concern
Striped Seabream	*Lithognathus mormyrus*	1.39	0.42	NA	188	-	-	Least Concern
Octopus	*Octopus vulgaris*	1.17	0.35	0.88 kg*	NA	1kg**	75	Least Concern
White seabream	*Diplodus sargus*	1.03	0.31	250	NA	210	0	Least Concern

Tub Gurnard	*Chelidonichthys lucerna*	0.96	0.29	NA	216	-	-	Least Concern
Common squid	*Loligo vulgaris*	0.93	0.28	NA	NA	-	-	NA
Meagre	*Argyrosomus regius*	0.88	0.27	NA	NA	-	-	Least Concern
Bonito	*Sarda sarda*	0.86	0.26	315	370	250	0	Least Concern
Atlantic horse mackarel	*Trachurus trachurus*	0.80	0.24	171	239	130	0	Vulnerable
Common dentex	*Dentex dentex*	0.79	0.24	NA	346	350	NA	Vulnerable
Bluespotted seabream	*Pagrus caeruleostictus*	0.69	0.21	NA	187	-	-	Least Concern
Goldline	*Sarpa salpa*	0.60	0.18	NA	165	-	-	Least Concern
Largescaled scorpionfish	*Scorpaena scrofa*	0.49	0.15	NA	NA	-	-	Least Concern
Black scorpionfish	*Scorpaena porcus*	0.47	0.14	397	144	-	-	Least Concern
Blackspot Seabream	*Pagellus bogaraveo*	0.47	0.14	NA	314	-	-	Near Threatened
Red mullet	*Mullus barbatus*	0.34	0.10	147	111	130	10	Least Concern
European seabass	*Dicentrarchus labrax*	0.31	0.09	285	323	250	8	Least Concern
Greater weever	*Trachinus draco*	0.25	0.08	NA	NA	-	-	Least Concern
Black Seabream	*Spondyliosoma cantharus*	0.23	0.07	NA	197	-	-	Least Concern
Bluefish	*Pomatomus saltatrix*	0.18	0.05	NA	300	180	NA	Vulnerable
Flathead Mullet	*Mugil cephalus*	0.12	0.04	NA	354	200	NA	Least Concern
European Lobster	*Homarus gammarus*	0.09	0.03	NA	NA	250	NA	Least Concern
Common Smoothhound	*Mustelus mustelus*	0.08	0.02	NA	NA	-	-	Vulnerable
John Dory	*Zeus faber*	0.08	0.03	285	362	-	-	Data Deficient
Saddled seabream	*Oblada melanura*	0.08	0.02	NA	NA	-	-	Least Concern
Thornback Skate	*Raja clavata*	0.08	0.03	NA	766	-	-	Near Threatened
Blotched picarel	*Spicara maena*	0.05	0.01	NA	103	-	-	Least Concern

*Percentage and species' CPUE were obtained using a questionnaire-based study, whilst mean body size and undersized catch ratio of species were determined by on-board observations. Furthermore, information about the L50 was obtained from the Fishbase website (FISHBASE, 2018). Information on the IUCN red list categories was obtained from the IUCN website (IUCN, 2018). Ten species from this table were not found during field observations, and were recorded only based on the information provided by the questionnaires. These species were: *Chelidonichthys lucerna, Argyrosomus regius, Pagrus caeruleostictus, Pagellus bogaraveo, Spondyliosoma cantharus Pomatomus saltatrix, Mugil cephalus, Homarus gammarus, Oblada melanura, and Spicara maena*.

**Concerning the octopus, instead of a minimum landing size, minimum landing weight (kg) was used (Anonymous, 2016).

***In addition to the listed caught species, fishers reported that they caught the following untargeted (unconsumed) species: Mediterranean rainbow wrasse *Coris julis*, Swallowtail Seaperch *Anthias anthias* and puffer fish *Lagocephalus sceleratus*. However, the volume of their catch could not be determined due to the unreliability of respondents' declarations.

Table 2. Estimations on the fishing effort of charter fishing.

Estimated parameter	Value
Total annual organised tours	9,246 times
Total annual fishing days (TNFD)	138,690 people
Total annual number of hooks	416,070 hooks
Total annual catch	277-305 t
TNF	9907 people