Iranian Journal of Fisheries Sciences 18(4) 745-762 2019
DOI: 10.22092/ijfs.2019.118840

The economic losses of small-scale fishers caused by Mediterranean monk seals, *Monachus monachus* (Hermann, 1779) in the Southern Aegean Sea: Muğla coasts

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Received: February 2017 Accepted: April 2017

Abstract

This study analyzed the interaction between the small-scale fishers and the Mediterranean Monk Seal (MMS) in an important Peninsula and two important marine protected areas on the southwest coast of Turkey. The survey was carried out from January 2014 to December in 2015 in the Muğla Province. Small-scale fishers in the study sites were interviewed to assess the interactions between small-scale fishers and the MMSs including total economic loss of fishers from MMSs, the number of MMS sightings, the reactions of the seals and the fishers during the sightings, fishers' perceptions on the MMS, and demographic and socio-economic profiles of the fishers. Small-scale fishers from Bodrum appeared to be the group that suffered the most among the locations with an annual loss of $1465.4 in contrast with Datça fishers with the lowest annual loss ($397.6). The annual loss in Fethiye-Göcek ($860.4) was almost double the loss of Bozburun fishers ($492.4). Harvesting costs varied from $6.7 kg^{-1} in Bodrum to $14.5 kg-1 in Fethiye-Göcek, whereas it was $11.8 kg-1 in Datça and $8.8 kg-1 in Bozburun. In conclusion, small-scale fishers should be subsidized to cover their economic losses caused by MMSs. Furthermore, re-regulating and minimizing the relation between fishing areas and MMS habitats, and raising the awareness of the fishers about the MMS can be essential in minimizing the negative interactions. We also recommend the use of economic indicators such as DPUE rather than absolute values to better understand and illustrate the negative economic impacts of MMSs.

Keywords: Mediterranean monk seal, Small-scale fisheries, Marine protected areas, DPUE, Economic loss

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Introduction

The Mediterranean monk seal (MMS), *Monachus monachus,* is a phocid or "true" seal. It is one of the rarest and most endangered species of the pinnipeds, belonging to the same genus of the Hawaiian and the Caribbean monk seals (Aguilar and Lowry, 2013). This species has been internationally protected by the Bern, Bonn, CITES, Barcelona (Fourth protocol species), and Biodiversity Conventions (Eligible species). In Turkey, it was protected by the Turkish Ministry of Environment and Forestry in 1977 as well as the Ministry of Agriculture and Rural Affairs in 1978 (Güçlüsoy, 2008a). However, previous conservation acts for the MMS were incapable of stopping the declining population trends (Israël, 1992; Aguilar and Lowry, 2013). The population of the MMS has been decreasing for a variety of reasons including; habitat loss, tourism disturbances in high seasons, intentional killing, and entangling in fishing nets (Berkes, 1982; Kiraç and Savaş, 1996; Güçlüsoy *et al.*, 2004). Added to those reasons, there is a decrease in the carrying capacity of the seals environment due to overfishing (Aguilar, 1999) which had previously placed this species at imminent risk of extinction (Van Blaricom *et al.*, 2001), especially, the eastern Mediterranean population (Johnson and Lavigne, 1998).

World population estimates of the MMS have previously been fewer than 600 individuals, mostly distributed in the north-eastern part of the Mediterranean Sea, the Cabo Blanco region in the Atlantic Sahara, and the Archipelago of Madeira in Portugal (Johnson *et al.*, 2006; Hale, 2011). Some studies have demonstrated high population numbers distributed along the Turkish coasts of the eastern Mediterranean (Fig. 1), ranging from less than 50 individuals to less than 300 individuals (Berkes *et al.*, 1979; Marchesseaux, 1987; Öztürk *et al.*, 1991). A recent estimate by Güçlüsoy *et al*. (2004) proposes the number of individuals at 104 for all Turkish coasts and more than 28 individuals on the southwestern Turkish coasts (Fig. 1).



Figure 1: Mediterranean Monk Seal observed areas on shores of the Turkey (Güçlüsoy *et al*., 2004) (In the Marmara Sea, along the coasts of Gürecealtı and Karabiga, Marmara Islands, Mola Islands and north coasts of Kapıdağ Peninsula, along the coasts between Mudanya and Bandırma, North-West coasts of Armutlu Peninsula, along the coasts of the Aegean Sea (Saros Bay, along the coasts of the Gelibolu Peninsula and Behramkale; Yeni Foça and Datça-Bozburun Peninsula) and on the southern coasts (Between coasts of Datça-Bozburun peninsula and Kemer, between Alanya and Taşucu and between İskenderun-Arsuz and Syrian border).

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Although a low population of the MMSs exists, up until now, two types of interactions between marine mammals and fisheries have previously been identified: marine mammals' impacts on fisheries; and fisheries' impacts on marine mammals (GFCM, 2012). These interactions have usually caused conflicts in the areas that have relatively higher stocks of target commercial fish (Reeves *et al.*, 2001; Bearzi, 2002). The MMSs' impacts on fisheries include destroying fishing gear (especially net fisheries). Consequently, this will lead to decrease in the quantity or the value of the harvest, the cost of repairing and replacing lost fishing gear, the time taken for by-catch removal, and the general depredation that reduces fish availability to fisheries (according to the perception of the fisher) (Reeves *et al.*, 2001).

The intense commercial fishing (Erdem, 2006) along with recreational fishing pressure (Tunca *et al.*, 2016) in the South-West Coasts of Turkey might have triggered functional and structural alterations in the trophic levels of the marine ecosystem (Pauly, 1995; Myers and Worm, 2003). Fishing, among other human activities, is possibly resulting in an increase in the damaging behavior of MMSs, which could be targeting netted fish. For example, the reduction of fish stocks in Greek seas seems to have intensified the harmful behavior of MMSs, as fishing efforts throughout the country increase and MMSs keep on looking out for fishing gear to "steal" a meal (Johnson and Karamanlidis, 2000; Karamanlidis *et al.*, 2008). It was documented that seals can cause income loss to commercial fishers by stealing fish from fyke nets and gillnets, damaging fishing gear besides the cost of the time lost due to gear repairing (Königson *et al.*, 2003; Königson *et al.*, 2006; Königson *et al.*, 2007; Königson *et al.*, 2013; Güçlüsoy, 2008a; Güçlüsoy, 2008b; Lundstrom *et al.*, 2010; Königson, 2011). The impact of marine predators on fisheries elsewhere in the world has previously been documented. For example, Ünal *et al.* (2015a) found that the 78% of all surveyed fishers suffered economic loss caused by lessepsian pufferfish species and, the annual economic loss reached approximately €442 per year per fisher. Kobayashi and Kawamoto (1995) demonstrated that the current economic impact of sharks, dolphins and monk seals on the northwestern Hawaiian Island bottom fisheries are estimated to be approximately $700,000 annually i.e. averaging $7,000 of lost revenue per trip (considering all types of revenue loss). Furthermore, Güçlüsoy (2008a) found substantial total economic loss of $462.5 in different geared coastal fisheries including gillnets, trammel nets, longlines and lures. Despite the monetary losses incurred by the fishers, there is currently no compensation for net damages attributed to the MMSs in Turkey, Greece or the rest of the Mediterranean countries (Trivourea *et al.*, 2011). The issue of compensating may complicate the matter even more and increases the threat to the MMSs.

The main aim of this study is to evaluate the economic losses of small-

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scale fishers caused by the MMSs. The study investigated for the first time the economic losses caused by the MMSs on small scale fishers and collected data from Bodrum Peninsula, Datça-Bozburun MPA and Fethiye-Göcek MPA that are located on the southwest Turkish coasts. The data included the number of MMSs sightings, interactions between fishers and MMSs during those sightings, fishers' perceptions of the MMS, socio-demographic dimensions and fishing profiles. The outcomes from these data would be useful in managing the small-scale fisheries in the studied areas and maintaining the MMS population in these regions.

Materials and methods

Study area and its features

Muğla Province has several natural marine and coastal habitats (e.g., coves, bays and underwater caves) that provide shelter and food for the MMSs population (Güçlüsoy *et al.*, 2004). Additionally, the considerably long coastline of Muğla that stretches for about 1,479 km is suitable for small scale fisheries (Erdem, 2006). Consequently, there is a historical relation between the MMSs and the small-scale fishers. The study sites, namely; Bodrum Peninsula, Datça-Bozburun and Fethiye-Göcek, are in Muğla. Total marine area surrounding Muğla coasts includes four Special Environmental Protection Areas (SEPAs) named as Gökova, Datça-Bozburun, Köyceğiz-Dalyan, Fethiye-Göcek. These areas are commonly referred to as Marine and Coastal Protected Area (MCPA). However, instead of SEPA or MCPA, the term Marine Protected Area (MPA) will be used since it is the most recognized term in the literature (McPhee *et al.*, 2008). Small-scale fishers in Gökova and Köyceğiz-Dalyan MPAs were not included in our survey, because the interviews and the personal communications done prior to the survey showed there was no significant interaction determined between the small-scale fishers in these areas and the MMSs.

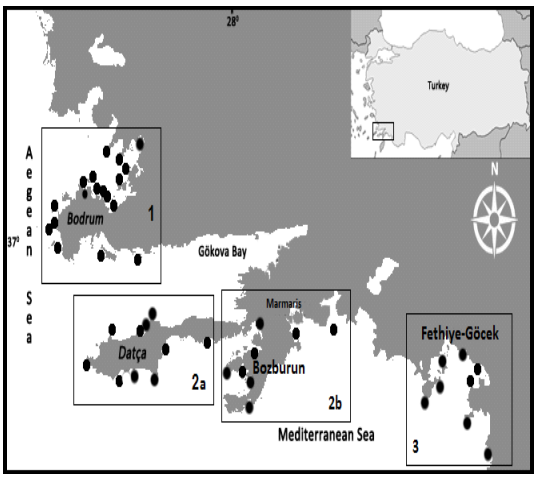


Figure 2: Study Sites. Black points shows the MMS observed places 1: Bodrum Peninsula: Torba, Salih Adası, Demirkuyu, Bayraklı, Gök Burun, Dikilitaş, Gündoğan, Fener Adası, Gemitaşı, Gümüşlük, Dilek Burnu, Kızıl Burun, Adaboğazı, Teke Burnu, Yılan Adası, Karaburun Feneri, Karaada, Kiremit Adası, Orak Adası, Göl-Türkbükü, Güllük, Turgut Reis (Çatalada), Çavuş Adası. 2: Datça-Bozburun MPA-Datça Peninsula: Palamutbükü, Knidos, Körmen, Mersincik, Karaköy, Mine cape, İnceburun, Kurubük, Uzuncaada, Domuzizi. 2a: Datça-Bozburun MPA-Bozburun Peninsula Bozburun harbor, Apostol feneri (Atabolu cape), Uzunada, Hisarönü, Selimiye, Dişinmez coasts, Yılancık island, Turunç, Söğüt, Kızılkaya and Marmaris.
3: Fethiye-Göcek: Kızılada, Şahin cape, Katrancı cove, Yedi burun, Zeytinli island, Kurtoğlu cape, Göcek coves, Gemiler island.

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Study methods

The survey was conducted in the period from January 2014 to December in 2015 along the coasts of Muğla (Bodrum Peninsula, Datça-Bozburun MPA as Datça and Bozburun Peninsulas including Marmaris and Fethiye-Göcek), (Fig. 2). The data was collected from small-scale gillnet and trammel net fishers before, after and/or during the fishing operations via on-site face-to-face interviews and using questionnaire forms at known fishing sites or at access points.

In this study, the following sample size formula was used to estimate the sample size:

$$n = \frac{z^2 p(1-p)}{d^2}$$

where; z is normal distribution value for a certain confidence interval and p is the percentage of respondents who are fishing (taken as 0.50 to reach maximum sample size) and d is the deviation from the population mean. We used the Snowball method for the selection of respondents (Newbold, 1995). There are 1,387 net and longline small-scale fishing vessels in Muğla Province (Dereli and Belli, 2014). A considerable number of licensed fishers are not actively fishing. On the other hand, there is also a substantial number of unlicensed fishers who illegally fish in this area. Therefore, a total of 97 small scale fishers were surveyed in the study sites to obtain a representative sample of small-scale fishers and their interactions with MMSs. The collected data were classified into three categories: (1) Fishers' socio-demographic and economic dimensions (gender, age, marital status, education, occupation, monthly income, fishing profiles); (2) Interaction between small-scale fishers and the MMSs (the number of a MMSs' sightings, total economic loss of fishers given to the MMSs, fishers and MMSs reactions during the sightings, MMSs' characteristics); (3) Fishers' perception on the MMSs. Dollar/TL average exchange rate in 2014, 1 US Dollar = 2.189 Turkish Liras, (OECD 2015) was used to change all monetary numbers in Turkish Liras. In this study, fishers used longlines, handlines and gillnets during their fishing operations. There was a mixed nature of the fishing activity and limited reliable access to gear sizes (e.g., net, line) as well as the catch amount for each fishing gear in study areas. The number of days were as a unit to calculate catch per unit effort (CPUE) and damage per unit effort (DPUE). CPUEs and DPUEs per site were calculated by using the following formulas: CPUE (kg)=Annual catch amount per fisher/Number of annual fishing days per fisher;

During the questionnaire survey, damages of fishers during the last 10 years were queried. So, the results were divided by 10 to reach the average. DPUE (US $) = (10 years) Total cost of damage per fisher/(10*Annual fishing days per fisher). Ten years of total damage that was suffered by fishers were accounted during the survey. The damage pattern of the MMS to the fishing gear is very distinguished compared to other marine animals. Karavellas (1994) characterized a

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unique three-hole damage pattern; where, the one in the middle is caused by the mouth of the MMS and the flippers cause the two side cuts (left and right sides). In this study, this pattern was used to identify and differentiate the damage caused by the MMS to the fishing gear. The costs associated with damage were mainly the maintenance expenditures such as new fishing gears as well as losses due to the time spent to repair the damaged gears. Therefore, we used the following formula: the total annual monetary loss of Muğla fishers resulted from MMSs damages = annual cost of MMS damage per fisher * total number of net fishers in Muğla * mean percentage of MMS damage case in the study sites (56%). Fishers' perceptions about the MMSs were assessed using 7 statements. These statements were mainly targeted to analyze the natural and economic importance of MMSs with relation to the MPA concept. The degree of agreement to the statements was assessed via Likert Scale that included 5 choices: 1: Strongly disagree, 2: Somewhat agree, 3: Moderately agree, 4: Highly agree, 5: Strongly agree.

Results

Fishers' socio-demographic and economic dimensions

Descriptive indicators of small-scale fishers, including owning a health insurance, marriage rate, female rate, education, income, occupation, were analyzed for each study sites. Small-scale fishing for all fishing types are predominantly practiced by men. The maximum percentage of female fishers determined in Bodrum was 5.4% and it was 5.9% in Bozburun, whereas, there were no female fishers observed in Datça and in Fethiye-Göcek MPAs. The highest mean fishing experience, of about 33 years, was observed in Fethiye-Göcek MPA on the other hand the fishers' mean experience in Bodrum Peninsula was 29 years. The education level among fishers in all studied sites was very low (usually up to elementary school only) in Bozburun and Fethiye-Göcek, no fisher had an education above high school, while in the case of Bodrum and Datça, the shares of highest level of education, bachelor's degree were 5% and 14%, respectively. Regarding the economic profile of fishers, Bodrum fishers are notable for being represented between the $458 and $1142 income interval; whereas, Datça and Bozburun fishers were mostly accumulated within $229 and $914 income interval. This makes Datça and Bozburun fishers the poorest among the fishers in the surveyed sites. Fethiye-Göcek fishers' income was distributed in all income groups mainly accumulating between the $229 and $1142 income interval. Considering owning health insurance, the survey showed variation among study sites; the highest was in Fethiye-Göcek (100%) followed by Datça (85.7%) and Bozburun (76.5%) and the lowest was in Bodrum (70.1%) (Table 1). The type of the occupation that is perceived as a second or first occupation in the same time with the fishing activity was farming, which was observed with high percentages in all sites. The numbers of retired fishers were also significant

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except in Fethiye-Göcek; where self-employed fisher was the last other occupation after fishing and farming. In Bodrum and Datça, fishers who only defined themselves as commercial fishers represented 5.4% and 4.8% respectively. Furthermore, the results onthe proportion of fishers who have a second occupation was the highest in Bozburun (70.6%); whereas, less than half of the respondents had a second job in Bodrum, Datça and Fethiye-Göcek. Regarding the membership rates of a fishery cooperative, Bodrum (62.2%) and Bozburun (64.7%) fishers had relatively higher shares compared to fishers in Datça (47.6%) and Fethiye-Göcek (36.4%) (Table 1).

Table 1: Socio-demographic and economic characteristics of artisanal fishermen in the Bodrum Peninsula, Datça-Bozburun and Fethiye-Göcek MPAs.

		Bodrum	**Datça**	**Bozburun**	**Fethiye-Göcek**
Number of surveyed fisher		37	21	17	14
Surveyed fisher (%)		40.7	23.1	18.7	15.4
Owning health insurance (%)		70.3	85.7	76.5	100
Mariage rate (%)		83.8	95.2	70.6	90.9
Females (%)		5.4	0	5.9	0
Education (%)	Elementary School	59	33	55	53
	Secondary School	24	14	27	24
	High School	11	38	18	24
	Bachelor's degree	5	14	0	0
	Master's degree and above	0	0	0	0
Monthly Income %	<$228	5.4	0	0	5.9
	$229-457	5.4	33.3	54.5	17.6
	$458-685	40.5	33.3	9.1	23.5
	$686-914	18.9	14.3	27.3	17.6
	$915-1142	16.2	0	0	11.8
	$1143-1370	5.4	14.3	0	5.9
	$1371-1599	5.4	0	0	5.9
	$1600<	2.7	4.8	9.1	11.8
Occupation (%)	Public servant	0	4.8	9.1	0
	National company employee	0	4.8	0	0
	Foreign company employee	2.7	0	0	0
	Farmer	78.4	52.4	45.5	82.4
	Retired	10.8	9.5	36.4	0
	Unemployed	0	0	0	0
	Student	0	14.3	0	0
	Commercial fisherman	5.4	4.8	0	0
	Self-employed	0	9.5	9.1	17.6
	Other	2.7	0	0	0
Having a second occupation (%)		37.8	42.9	70.6	36.4
Experience of fishers (in years)		29	24	29	33
Membership of a fishery cooperative (%)		62.2	47.6	64.7	36.4

The annual fishing effort varies between studied locations (Table 2). The annual fishing days in Fethiye-Göcek, which had the highest number

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of annual fishing days, was 212 days followed by Bodrum (187 days), Datça (186 days) and Bozburun fishers (142 days). The mean daily catches per fisher were higher in Bodrum (15.2 kg) and Fethiye-Göcek (16.3 kg) compared to Datça (9.8 kg) and Bozburun (6.1 kg). The results were the same for annual catches per fisher and were in decreasingly order as Fethiye-Göcek (4,209 kg), Bodrum (3,026 kg), Datça (2,027 kg) and Bozburun (788 kg). Regarding the expenses of the fishers, the survey showed that the highest total annual expense per fisher was observed in Fethiye-Göcek ($4,089.3) whereas, Bodrum and Bozburun fishers' annual total expenses were slightly lower at $2,141.5 and $2,319.7, respectively and, the lowest was in Datça fishers reaching $1,627.4. Regarding the annual loss resulting from the MMSs damages, Bodrum fishers seem to be the most affected group in the studied sites, suffering about $1465.4 annual losses; On the contrary, Datça fishers suffered the the lowest annual losses of about $397.6. The annual losses due to MMSs damages in Fethiye-Göcek were $860.4 which is almost double the loss of fishers in Bozburun at $492.4. Furthermore, the harvesting cost varied from $6.7 kg^{-1} in Bodrum to $14.5 kg^{-1} in Fethiye-Göcek; whereas it was $11.8 kg^{-1} in Datça and $8.8 kg^{-1} in Bozburun.

Table 2: Catch and economic indicators in the Bodrum Peninsula, Datça-Bozburun and Fethiye-Göcek MPAs

	Bodrum	Datça	Bozburun	Fethiye-Göcek
Catch Indicators				
Annual fishing days	187	186	142	212
CPUE (kg d^{-1})	15.2	9.8	6.1	16.3
Annual catch per fisher (kg)	3,026	2,027	788	4,209
Economic Indicators				
Annual fishing gear expense per fisher (excluding the MMS damage cost) ($)	137	456.8	685.2	388.3
Annual bait expense per fisher ($)	127.9	159.9	456.8	563.3
Annual fuel expense per fisher ($)	246.7	374.1	685.2	1,827.3
Other annual expenses per fisher ($)	164.5	238.9	0	450
Total annual expense per fisher (including damage expenses) ($)	2,141.5	1,627.4	2,319.7	4,089.3
Annual cost of MMS damage per fisher ($)	1,465.4	397.6	492.4	860.4
Share of MMS damage in annual costs (%)	68.4	24.4	21.2	21
Damage per unit effort (DPUE) ($)	7.8	2.1	3.5	4.1
Harvesting cost ($/$kg^{-1}$)	6.7	11.8	8.8	14.5
Annual estimated cost of MMS damages in Muğla Province ($)	624,669			

Interaction between small-scale fishers and the MMSs

The rates of MMS sightings in each site varied from 88.2% in Bozburun to 100% in Fethiye-Göcek. The mean number of sightings per fisher did not show significant differences among certain locations other than being 1 or 2 times. In Fethiye-Göcek, fishers showed a slight difference with sightings of 2 times per fisher and a maximum of 5 sightings. The surveyed

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fishers in Bozburun had the highest total number of sightings (220) being about three times higher than the fishers in Bodrum (49), Datça (22) and Fethiye-Göcek (15) all together. Grey-colored MMSs had the highest share among recorded MMSs sightings in each site; however, the length of spotted MMSs showed some variation among sites. Observed MMSs had the mean length of about 2 m as well as the longest observed individual (3m). The mean length of MMSs in Bodrum was close to the ones observed in Datça; while, it was the shortest in Bozburun. Furthermore, dolphins and turtles' sightings were reported by fishers at high rates in all locations except Bozburun (58.8%). Dead MMSs were only recorded at a low percentage in Bodrum (8.1%) and Fethiye-Göcek (7.1%) (Table 3). Regarding the reactions of the surveyed fishers, most of them were not against the MMSs except being excited, happy, surprised, swearing, or scared (Fig. 3). On the other side, regarding the reaction to observed MMSs, the main type of response in all locations was "no reaction at all" except in Fethiye-Göcek where the percentage of escaped MMSs slightly surpassed the percentage of no-reaction to MMSs (Fig. 4).

Table 3: Fishermen's interaction with the MMSs in the Bodrum Peninsula, Datça-Bozburun and Fethiye-Göcek MPAs.

		Bodrum Peninsula	Datça	Bozburun	Fethiye-Göcek
Sights of a MMS (%)		91.9	95.2	88.2	100
Mean number MMS in each sight (min-max)		1 (1-3)	1 (1-2)	1 (1-3)	2 (1-5)
Total number of sights		49	22	220	15
Colour (%)	Brown	7.7	0	0	33.3
	Grey	57.6	75	53.8	55.6
	Black	34.6	25	46.2	11.1
Mean length of the MMSs (m) (min-max)		1.96 (1-3)	2 (1.5-3)	1.48 (0.75-2)	1.66 (0.75-2)
MMS entanglements in nets (%)		8	5	0	9
MMS harm to nets (%)		65	57	47	55
Sight of a death MMS (%)		8.1	0	0	7.1
Sight of other sea mammals and turtles (%)		83.8	90.5	58.8	90.9
Sights by other species (%)	Dolphins	81.1	58.8	90.5	90.9
	Whales	5.4	0	0	9.1
	Turtles	16.2	0	19.1	0

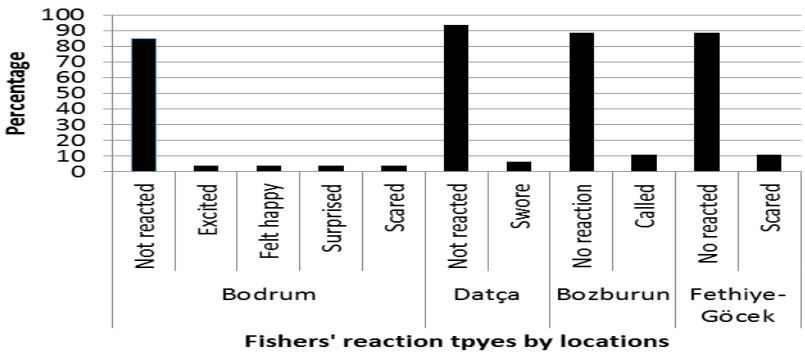


Figure 3: The fishers' % reaction types by the study sites.

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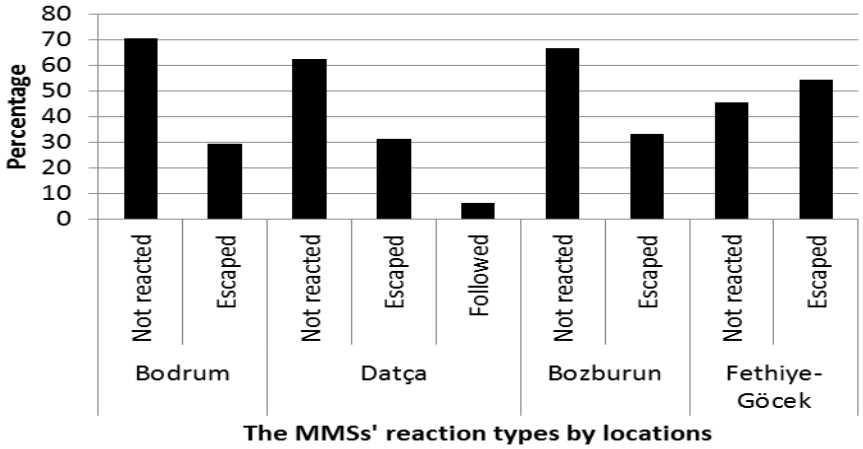


Figure 4: The MMSs' % reaction types by the study sites.

Fishers' perceptions on the MMSs

Considering the perceptual statements, the first statement, "*the MMS is a natural heritage*" was mostly strongly agreed by all fishers especially in Datça and in Fethiye-Göcek with a general average of 70.5%. "The MMS is important for tourism" was the second strongly agreed upon statement by the majority in all studied sites. Similarly, all respondents strongly agreed to the statement "Conservation measures should be taken to provide future existence of the MMS". However, "The MMSs causes economic losses to fishers was another statement that was strongly agreed upon with high percentages among the fishers. The respondents also agreed with the statement regarding the MPAs, "MPAs are important for the existence of MMSs' generations" but, it received considerably weak agreement or even disagreement. All fishers also strongly agreed with the statement "the management authorities do not take adequate measures for conservation of the MMSs". Almost half of the respondents agreed and the other half disagreed with the statement "The MMSs are harmful marine species".

Table 4: Fishermen's perception via 7 statements about the MMS.

Statements	Bodrum	Datça	Bozburun	Fethiye-Göcek	General
1-The MMS is a natural heritage					
Strongly disagree	21.6	14.3	29.4	18.2	20.5
Somewhat agree	2.7	4.8	0	0	2.3
Moderately agree	5.4	0	5.9	0	3.4
Highly agree	5.4	0	5.9	0	3.4
Strongly agree	64.9	81	58.8	81.8	70.5
2-The MMS is important for tourism					
Strongly disagree	0	14.3	17.6	27.3	22.7
Somewhat agree	0	4.8	5.9	0.0	3.4
Moderately agree	0	0	5.9	9.1	12.5
Highly agree	0	0	11.8	0	10.2
Strongly agree	100	81	58.8	63.6	51.1
3-Conservation measures should be taken in order to provide future existence of the MMS					

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Table 4 continued:

Strongly disagree	21.6	14.3	17.6	27.3	19.3
Somewhat agree	5.4	0	0	0	2.3
Moderately agree	10.8	19	5.9	0	10.2
Highly agree	5.4	0	5.9	9.1	4.5
Strongly agree	56.8	66.7	70.6	63.6	63.6
4-The MMSs causes economic losses to fishermen					
Strongly disagree	18.9	9.5	11.8	0	12.5
Somewhat agree	5.4	14.3	0	0	5.7
Moderately agree	2.7	9.5	5.9	18.2	8.0
Highly agree	5.4	0	23.5	9.1	8.0
Strongly agree	67.6	66.7	58.8	72.7	65.9
5-MPAs are important for the existence of MMSs' generations					
Strongly disagree	27	28.6	5.9	27.3	22.7
Somewhat agree	2.7	4.8	5.9	9.1	4.5
Moderately agree	5.4	9.5	0	9.1	5.7
Highly agree	8.1	0	11.8	9.1	6.8
Strongly agree	56.8	57.1	76.5	45.5	60.2
6-The management authorities do not take adequate measures for conservation of the MMSs					
Strongly disagree	13.5	9.5	11.8	18.2	12.5
Somewhat agree	2.7	4.8	5.9	9.1	4.5
Moderately agree	5.4	9.5	0	0	4.5
Highly agree	10.8	9.5	11.8	9.1	10.2
Strongly agree	67.6	66.7	70.6	63.6	68.2
7-The MMSs are harmful marine species					
Strongly disagree	40.5	52.4	41.2	45.5	45.5
Somewhat agree	10.8	4.8	0	0	5.7
Moderately agree	0	0	11.8	18.2	4.5
Highly agree	5.4	0	5.9	0	3.4
Strongly agree	43.2	42.9	41.2	36.4	40.9

Discussion

This study presents detailed information on interactions between MMSs and small-scale net fisheries in Muğla Province of Turkey and the results were compared between the four studied sites as well as with the previous studies. Socio-demographic features, fish catch, economic and MMS interaction with small-scale fishers showed several differences among the study sites. Additionally, this study provided a rough estimate of overall MMS damage cost to fishers for the study sites.

The calculated fishing efforts for Bodrum and Datça were like previous findings for Datça yet it was higher than the previous finding for Bozburun (Akyol and Ceyhan, 2007b). The fishing effort calculated for Fethiye-Göcek in this study was found to be higher compared to the other study sites. The unit catch amounts varied between locations by differences in local fish densities and/or via fishing efficiency. These amounts are impossible to determine because of the insufficient information and the lack of reliable data. The highest first and second CPUEs in the study sites were observed for fishers in Bodrum and Fethiye-Göcek that are close to the

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calculated CPUEs for the studied net fishers in Gökova MPA (Akyol *et al.*, 2007a; Dereli *et al*., 2015). This contrasts with the CPUEs in Datça and Bozburun that had relatively lower CPUEs. Even if CPUEs in this study are like the previous ones found in Muğla Province, any comparison between CPUEs of fishers in the four study sites seems inappropriate because of the differences in CPUE calculation methods.

DPUE and annual cost of MMS damage per fisher varied between the studied sites. The highest DPUE and annual cost of MMS damage per fisher were found in Bodrum; whereas, the same indicators were the lowest in Datça. However, the total annual expenses of fishers including MMS damage costs were highest in Fethiye-Göcek; while, they were the lowest in Datça. The values calculated for Bodrum and Bozburun were almost the same. The share of MMS damage cost in the total annual cost per fisher was almost three times higher in Bodrum than the remaining three sites that had similar values. CPUE values are considered as intensity indicators (FAO, 2000). DPUEs and annual damage costs per fisher in Bodrum and Fethiye-Göcek were higher compared to Datça and Bozburun. Additionally, our MMS damage cost results were supported by a previous study that calculated the MMS damage as maximum at $462.5 per occasion with irregularities of the values throughout the studied period 1994–2002 (Güçlüsoy, 2008a). The selected study sites, Bodrum, Datça, Bozburun and Fethiye-Göcek, and all coasts of Muğla were previously reported to have a diverse fauna that comprised of bony fishes and cephalopods (Akyol and Ceyhan 2007b; Çoker and Akyol, 2014). Bony fishes and cephalopods that represent the major part of small-scale fisher's target catch were also found in the diet of MMSs (Sergeant *et al.*, 1978; Cebrian *et al.*, 1990; Neves, 1998; Salman *et al.*, 2003; Güçlüsoy, 2008b). During the study, we did not determine or record any deliberate killing or entanglement of MMS although persecution and deliberate killing possibly occurred because of two reasons: (a) the MMSs' attacks on the fishing nets or (b) at least, getting entangled in different kinds of nets (Northridge and Hofman, 1999; Güçlüsoy *et al.*, 2004).

There is a variability and, to some extent, contradictory relations between socio-demographic and economic indicators and the fishers' perception on the MMS. The weak agreement from respondents for the first statement, "the MMS is a natural heritage", in Bodrum generally is attributed to the relatively high MMS damage cost; whereas, in Bozburun, the fishers' low annual catch amounts would explain the low agreement for the first statement. Interestingly, Bodrum fishers' perception changed when we queried the second statement "The MMS is important for tourism" that got a 100% strong agreement close to the result of Datça fishers, whereas; Bozburun and Fethiye-Göcek fishers got somehow low values compared to Bodrum and Datça fishers due to the relatively

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strong relation with tourism and the apparent economic dependence of fishers on the income produced directly or indirectly from tourism in Bodrum and Datça. Slight response biases were observed in fishers' income levels in Datça and Bozburun but, fishers in these regions still had the lowest income levels (Ünal *et al*., 2015b).

Similarly, Bodrum and Fethiye-Göcek fishers gave the lowest agreement for the third statement "Conservation measures should be taken to provide future existence of the MMS", possibly because of the high MMS damage costs. Other notable results were the ones gathered from the forth perceptual statement "The MMSs causes economic losses to fishers" that was strongly agreed by about two-third fishers in the study sites. This conveys that MMSs are causing economic losses to fishers which were also supported by the statistical results obtained on MMS harm to fishing nets.

On the one hand, there was no significant difference in different study sites in terms of the results taken for the fifth statement "MPAs are important for the existence of MMSs' generations"; which received low percentage of agreement by the fishers especially in Bodrum, Datça and Fethiye-Göcek. This can be the result of low awareness of fishers regarding the activities of MPAs or questionably low effectiveness of MPAs in protecting the MMS. Also, Bodrum Peninsula does not, currently, have any legal MPA status beside its neighboring location to the other study sites and MPAs. Similar results with high percentages were recorded for fishers in each study site considering the sixth statement "the management authorities do not take adequate measures for conservation of the MMSs". The weak governmental protective measures for the MMS and lack of compensation for the damages caused by them may explain the feelings about the inadequacy of the conservation measures. The respondents in each site were divided into two parts for the seventh statement "The MMSs are harmful marine species": (a) the ones who strongly agree, and (b) those who strongly disagree. This result can generally be explained by the reasonable costs arising from MMS damages in each individual site.

In conclusion, in the studied sites, both small-scale fishing and the population of MMS are important and interconnected; but from the economic point of view, we put forward the negative mutual impact between these two users because the market value of the catch as fishers' income was below the fishing activity and the MMS damage costs. In addition, fishers were left to find their own solutions to tackle this ignored problem by the authorities even if the monthly income with additional income resources may not be enough to meet their living and fishing costs. But this is absolute that this problem can be solved by management acts including direct subsidies to fishers for MMS damage, re-regulating and minimizing the relation between fishing areas and MMS habitats, and raising the awareness of the fishers about the MMS can be essential in minimizing the

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observed negative relations. For some regions, touristic sight-seeing around the famous MMS areas can even be a new source of income through generating alternative activities for fishers. Good management of the relations between MMS and fishers, which is nowadays considered very deficient, may minimize or even stop the MMS damages to fishing gear and this will have positive consequences on the local population.

It is recommended to investigate more deeply, at a local level, the interrelation between the local fishers and the MMSs. We also recommend the use of economic indicators such as DPUE rather than absolute values to better understand and illustrate the negative economic impact of MMSs. Furthermore, regular data collection programs focusing on small-scale fishers-MMSs interaction should be included in the management plans of MPAs as well as national and regional fisheries management plans to create sustainable socio-ecological system.

Future focus regarding this work would consider the economic losses or interactions of different fisheries such as longline, net and, trawlers and purse-seiners as well as socio-ecological impact of non-native or invasive species in these MPAs.

Acknowledgements

This paper is the one of the outputs of the Scientific Research Project "NO: 13/105" funded by Muğla Sıtkı Koçman University. The authors are very thankful to all small-scale fishers who answered the questions sincerely and patiently.

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