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Research Article

An evaluation on interaction of Cetaceans with fisheries in the seas around Turkey

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Abstract

Interaction between fisheries and cetacean species has been one of the challenging issues in marine biology for the last three decades. Even though there have been some attempts to regulate legislations or mitigation action for their by-catch in certain regions, the bilateral effects of this interaction are not fully understood for the seas around Turkey. Therefore, interviews were carried out between March 2019 and February 2020, with 186 fishers from the coasts of the Turkish Black Sea and the Mediterranean. As a result of the interviews, fleet, and fishing characteristics of sampling groups were described for each sea region. Then, the interaction and attitude of fishers against to the cetacean species were presented and evaluated to provide a baseline for developing effective conservation and management strategies in Turkey. As a conclusion, it was pointed out that a higher dependency of cetaceans to fishery year by year for all regions. Regional differences were determined for the characteristics of the interaction. The fishery in the Black Sea, results in higher by-catch events for cetaceans, while cetaceans lead to higher damages on fishing gear and catch in the Mediterranean. Additionally, a notable phenological shift was observed between industrial and small-scale fisheries in the Mediterranean. Even though most of the fishers like cetaceans and accept sharing fish with them, results highlighted the requirement of a severe consideration to increasing their awareness in fishers from the Black Sea region as well as actions must be prioritized to reduce damage on fishing gears and mitigation of cetacean by-catch to deliver more effective conservation of cetacean.

Keywords: Conservation, ecological interaction, The Aegean Sea, The Black Sea, The Levantine Sea

Introduction

Cetaceans, which are known as dolphins, whales, and porpoises in popular classification, includes entirely water dependent marine mammal species. Recently, a total of 89 species are reported under the taxa (Committee on Taxonomy 2019). In the case of the Mediterranean and the Black Sea, 24 cetacean species are observed, with nine resident species (Notarbartolo di Sciara 2002, Notarbartolo di Sciara and Birkun 2010, Bengil 2019a). Among these species, there are 15 found in seas around Turkey, including eight resident species. Though there were studies on these species from Turkey, most of them are limited to reporting observations (e.g., Kinzelbach 1991, Sonmez *et al.* 2011). However, some studies focused on population (e.g., Dede 2000, Alan *et al.* 2017), stranding (e.g., Tonay 2016), by-catch and fisheries interactions (e.g., Ozturk *et al.* 2001, Guclusoy 2006, Enul 2009), nevertheless, with very restricted spatio-

temporal coverage. Recently, a cetacean information system was suggested and developed by Bengil (2019b) to determine information gaps throughout the Turkish Sea.

Most of the cetacean species are apex predators in the trophic web, even though feeding habits of some giant species are planktivorous (Jefferson *et al.* 1993). Because of being in higher levels in the marine ecosystem, they have to compete with humankind, who has excessive consumption behavior towards marine resources. Interaction with marine megafauna has become crueler with the improvements in fisheries technology (Bengil 2019a). Ozturk (1996) reviewed threats against cetaceans and indicated serious considerations required for the conservation of these species in these regions. The IUCN (2012) pointed out the pressure of fisheries on cetacean species as by-catch as well as suggested applicable conservation measures, such as enforcing current legislation and increasing conservation areas for the species in the Mediterranean and the Black Sea.

In a consequence of the interaction, the sustainability of the populations is under risk for cetacean species throughout the world. Therefore, most of the species are protected by international conventions, and their targeted fisheries are completely banned except for some specific countries (Bengil 2019a). However, being critical by-catch species in fisheries operations pose a threat to them (Ozturk 1996) as well as illegal capturing of cetacean species for dolphinariums (Bengil *et al.* 2012). On the other hand, feeding behavior of cetaceans can result in financial loss as well as damage or loss in fishing gear and/or catch (Bengil 2019a and references therein). The intensity of these impacts is also a critical factor sculpturing fishers' attitudes against cetacean species. It should also be noted that the interaction between cetacean and humankind is not only via fisheries but also due to other reasons, such as marine traffic, anthropogenic chemical pollutants, etc. (Parsons *et al.* 2010).

The requirement of filling data gaps on the marine organism and their threats is a necessity for developing practical and effective conservational and management strategies. This study aims to provide a scientific baseline on interactions between cetacean species and fishers based on local knowledge in the regional seas of Turkey. Information on characteristics of the fishery, interaction with cetacean species, and attitude of fishers against cetacean species were collected to describe essential components for this interaction depending on sea regions; the Aegean Sea, the Levantine Sea, and the Black Sea.

Material and methods

Interviews were carried out between March 2019 and February 2020, via visiting fishery ports at certain towns located on the coasts of the Black Sea (BS), the Aegean Sea (AS) and the Levantine Sea (LS) (Figure 1). Most of the interviews were conducted in summer months, which is relatively low effort season in each sea region. Questionnaires were administered with fishers from both industrial and small-scale fisheries operating in seas around Turkey. At the beginning of the inquiries, a short introductory explanation was given to the fishers on the data gaps on cetacean species and how they could contribute to an effective conservation and management strategy. Regarding both fisheries, the objective of each question was explained to the fishers before asking it to obtain more reliable answer. Questionnaires consisted of personal information, type of fishing activity (industrial or artisanal fishery), fishing information (target species for fishing, total cost, etc.) information on interaction with cetacean (encounter rate, species if possible, cost, damage on fish and gears, etc.), and attitude to cetacean. To assist with the correct identification of species, illustrations of cetacean species were shown to the fishers. In case of doubt of identification, generalized group names were used.

Each interview was imported into a database for summarizations for the description of each component that are strongly related to

understanding the relationship between fishes and cetaceans. In order to provide practical summary, collected components were grouped based on the type of the fisheries, sea region, as well as overall evaluation for the fishing in Turkey.

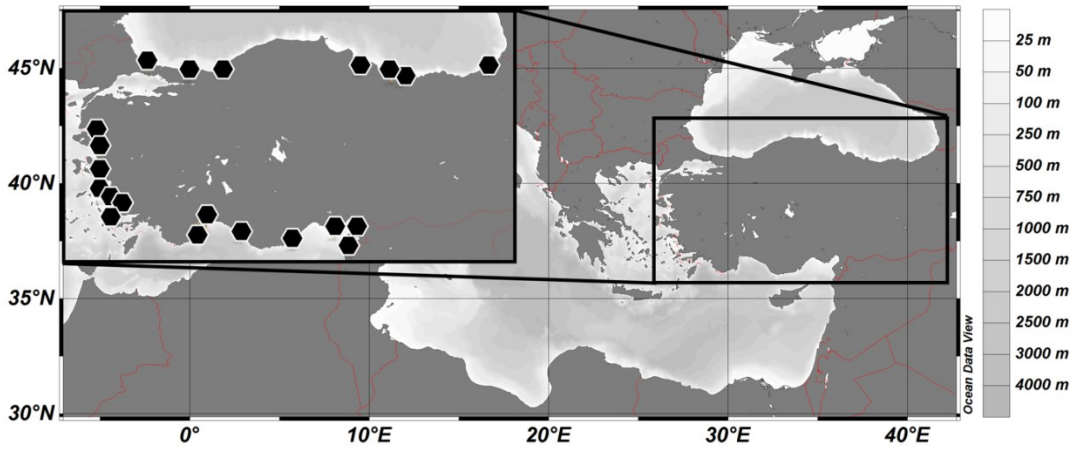

Figure1. Location of visited fishery ports along Turkish coasts

Results

A total of 186 interviews were carried out throughout the coasts of Turkey (Table 1). However, 28 of them were excluded from analyses because of insufficient and contradictive answers were received from fishers. Most of the responses (61%) were obtained from small-scale fisheries, while fishers from industrial fisheries were 61 (39%). Regarding regions, the percentage of fisheries type showed similar values for the BS and the LS, while a small-scale fishery has a relatively higher rate in AS (Table 1). Most of the fishers (81%) were older than 30 years old, with 88%, 80%, and 78% in AS, BS, and LS, respectively. While 90% of the overall were fishers who had more than ten-year experience, this percentage was 97% in AS, 88% in BS, and LS. The most common vessel length was between 5-10m for small-scale fisheries, as the most common length interval was between 26-40m for industrial fisheries in all seas (Table 2).

Results of fishing effort per day in a year showed that most of the sample groups in both fisheries have fishing efforts between 101 and 200 days in a year. The percentage of the fishing effort more than 200 days was 25%, which is in the small-scale fisheries of BS, while the highest rate for industrial fisheries with 27% was observed in AS. Distribution percentages of fishing effort in days per year for each sampling group are presented in Table 3. The annual cost for fishing gears reported by fishers indicated that most of the small-scale fishers spend a budget between 1000 and 5000 Turkish Lira (TL), as most of the industrial fisheries spend a budget more than 10000 TL per year. Exceptionally, small-scale fishers of BS reported mostly spending more than 5000 TL. Annual costs of fishing gear per sampling groups are presented in Table 4.

Table 1. Distribution percentages of number of the fishers using small-scale and industrial fishing methods in each regional sea of Turkey

Region	Fishery type	Percentage (%)
The Aegean Sea	Small-scale Fisheries	70
	Industrial Fisheries	30
The Black Sea	Small-scale Fisheries	58
	Industrial Fisheries	42
The Levantine Sea	Small-scale Fisheries	59
	Industrial Fisheries	41

Results from interviews pointed out red mullet (*Mullus barbatus* Linnaeus, 1758), Brünnich,

1768)) was common target especially for AS and LS. The bonito (*Sarda sarda* (Bloch, 1793)), sea bream (*Sparus aurata* Linnaeus, 1758) and horse mackerel (*Trachurus trachurus* (Linnaeus, 1758)) were the most frequent reported target fish species in all sea regions of this study (Table 5).

Results from the interviews showed no clear description in terms of the identification of the cetacean species. The most frequently identified species was *Tursiops truncatus* (Montagu, 1821), the bottlenose dolphin. Fishers from the BS also identified *Phocoena phocoena* (Linnaeus, 1758), harbor porpoise. On the other hand, all reported encounters were grouped under unidentified small dolphins. Some fishers from the southern AS reported also observation of *Monachus monachus* (Hermann 1779), Mediterranean monk seal, as marine mammal alongside cetacean species. Fishers frequently reported their encounter rate as few times per month in AS and LS for both types of fisheries, while fishers from BS repeatedly indicated encounter rate as 26-50 and 11-25 times per month for small-scale and industrial fisheries, respectively.

Table 2. Distribution percentage of length class of vessels used by fishers in Turkey and each regional sea (AS is the Aegean Sea; BS is the Black Sea; LS is the Levantine Sea)

Fishery type	Length of vessel	AS	BS	LS	Overal l
Small-scale Fisheries	05-10 m	48%	45 %	47 %	46%
	11-15 m	20%	13 %	7%	12%
	16-20 m	3%	2%	3%	3%
	21-25 m	0%	0%	1%	1%
	26-40m	0%	0%	0%	0%
Industrial Fisheries	05-10 m	0%	0%	0%	0%
	11-15 m	0%	4%	3%	3%
	16-20 m	8%	17 %	4%	9%
	21-25 m	10%	4%	16 %	11%
	26-40m	13%	15 %	19 %	16%

Table 3. Distribution percentage of fishing efforts per year in Turkey and each regional sea (AS is the Aegean Sea; BS is the Black Sea; LS is the Levantine Sea)

	Days	Overal l (%)	AS (%)	BS (%)	LS (%)
Small-scale Fisheries	01-10	2	3	4	0
	11-50	1	3	0	0
	51-100	13	24	4	13
	101-200	36	29	24	51
	201-250	7	5	9	7
	>250	7	8	16	0
Industrial Fisheries	01-10	0	0	0	0
	11-50	0	0	0	0
	51-100	4	0	11	0
	101-200	19	3	27	24
	201-250	7	11	4	5
	>250	4	16	0	0

Table 4. Distribution percentage of annual cost spend for fishery equipment in Turkey and each regional sea (AS is the Aegean Sea; BS is the Black Sea; LS is the Levantine Sea)

	Turkish Lira (appr. 0.16 $)	Overall (%)	AS (%)	BS (%)	L (%
Small-scale Fisheries	500-999	4	5	4	4
	1000-4999	32	39	9	4
	5000-9999	14	13	13	1
	10000-29999	12	13	24	2
	30000-74999	4	0	7	5
	>75000	0	0	0	0
Industrial Fisheries	500-999	0	0	0	0
	1000-4999	0	0	0	0
	5000-9999	3	0	4	4
	10000-29999	12	3	16	1
	30000-74999	8	21	4	2
	>75000	11	5	18	9

Regarding the number of individuals per encounter, from AS and LS disclosed between one to 25 individual groups per fishing effort (frequently 1-3 individuals per encountering). At the same time, it was flocked with more than 50 individuals in some encounters in BS with high fluctuations in the number of individuals. Most of the fishers from BS (75%) also reported an increase in the number of individuals over

the last decade, while high percentages of fishers from AS and LS reported no change in the number of dolphins for the same period, with 43% and 41%, respectively.

The percentage of the interactions resulting in damages to the fishing gear was 52% in small-scale fisheries, while 51% in industrial fisheries. Overall results of the temporal distribution of the clashes indicated an unimodal increase between April and August for small-scale fisheries, while bimodal increases with peaks in April and September for industrial fisheries. However, monthly encounter percentages of BS did not follow this temporal pattern in industrial fisheries. Instead, there was only a unimodal increase for both fisheries. Temporal distributions of fisheries in each regional sea are presented in Figure 2.

Table 5. Reported target species of each fisheries in each regional seas of Turkey

The Aegean Sea		**The Black Sea**		**The Levantine Sea**	
Artisanal Fishery	**Industrial Fishery**	**Artisanal Fishery**	**Industrial Fishery**	**Artisanal Fishery**	**Industrial Fishery**
Mullus barbatus	*Sparus aurata*	*Mullus barbatus*	*Mullus barbatus*	*Mullus barbatus*	*Mullus barbatus*
Sparus aurata	*Solea solea*	*Pomatomus saltatrix*	*Sprattus sprattus*	*Sparus aurata*	*Sparus aurata*
Solea solea	*Mugil cephalus*	*Sciaena umbra*	*Pomatomus saltatrix*	*Solea solea*	*Trachurus trachurus*
Loligo vulgaris	*Dicentrarchus labrax*	*Solea solea*	*Solea solea*	*Sciaena umbra*	*Parapanaeus sp.*
Diplodus puntazzo	*Pomatomus saltatrix*	*Trachurus trachurus*	*Trachurus trachurus*	*Gümüş*	*Mugil cephalus*
Pomatomus saltatrix	*Merlangius merlangus*	*Scophthalmus maximus*	*Scophthalmus maximus*	*Trachurus trachurus*	*Dicentrarchus labrax*
Boops boops	*Sarda sarda*	*Mugil cephalus*	*Merlangius merlangus*	*Loligo vulgaris*	*Pomatomus saltatrix*
Coryphaena hippurus	*Sardina pilchardus*	*Dicentrarchus labrax*	*Gadus sp.*	*Parapanaeus sp.*	*Merlangius merlangus*
Pagellus bogaraveo		*Pomatomus saltatrix*	*Sarda sarda*	*Gobius sp.*	*Thunnus thynnus*
Sarda sarda		*Merlangius merlangus*	*Tekir*	*Mugil cephalus*	*Sarda sarda*
Sardina pilchardus		*Sarda sarda*		*Scomber japonicus*	*Mullus surmuletus*
Diplodus sargus		*Rapana venosa*		*Epinephelus sp.*	
Dentex dentex		*Belone belone*		*Dicentrarchus labrax*	
Sepia officinalis				*Pomatomus saltatrix*	
				Pagellus bogaraveo	
				Sarda sarda	
				Diplodus sargus	
				Sphyraena sphyraena	
				Auxis rochei	
				Anguila anguila	

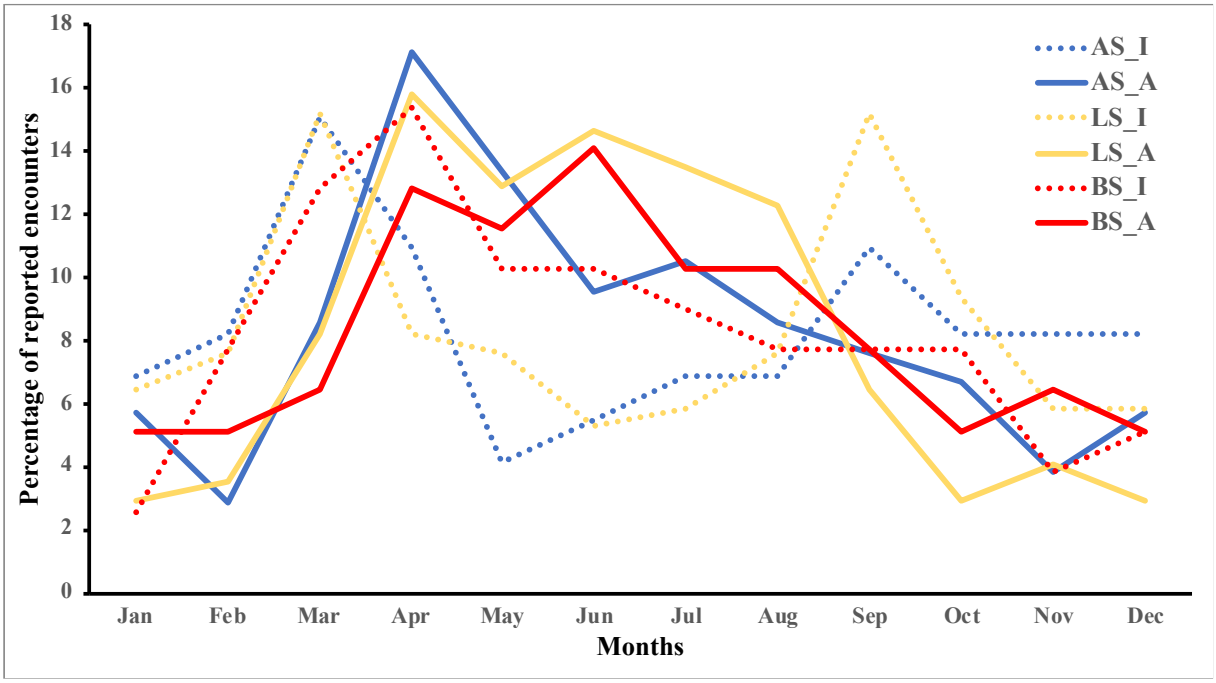

Figure 2. Monthly percentages of reported by fishers in sea regions of Turkey for encounters with cetacean: AS_I indicates industrial fishery from the Aegean Sea; AS_A indicates small-scale fishery from the Aegean Sea; LS_I means industrial fishery from the Levantine Sea: LS_A indicates small-scale fishery from the Levantine Sea; BS_I indicates industrial fishery from the Black Sea; BS_A indicates small-scale fishery from the Black Sea

Results on damaged catch indicated that damages by cetaceans were more frequent in AS for both fisheries (93% and 83% for small-scale and industrial fisheries, respectively). Similar high percentages were also reported from BS for both small and industrial fisheries (79% and 65%, respectively). Results of LS showed different patterns and relatively lower frequency than other regions. While 34% of small-scale reported damages in their catches, relative rate was 66% for industrial fisheries. Most of the fishers reported losses to their target species in all regions. Red mullet (for all sea regions), red sea bream (*Pagellus bogaraveo* (Brünnich, 1768)) (AS and LS), bonito (BS and LS), sole (*Solea* solea *Linnaeus, 1758*) (LS), anchovy (*Engraulis encrasicolus* (Linnaeus, 1758)) (BS), sardines (*Sardina pilchardus* (Walbaum, 1792)) (AS) and whiting (*Merlangius merlangus* (Linnaeus, 1758)) (BS) were the main damaged species by cetaceans.

Results for accidental by-catch of cetaceans showed that accidental by-catch percentages with 43% and 35% for small-scale and industrial fishers in BS were relatively higher, respectively. Accidental by-catches in both AS and LS were reported only for industrial fisheries with a 25% percentage. Post-catch release survival rate was high with 100% in AS and 70% in LS and very low with 16% in BS.

Results for knowledge of implemented legislation on cetacean in Turkey indicated that almost all the fishers in AS and LS (98% and 91%, respectively) are not aware of the regulations on the conservation of cetacean in Turkey, while 38% of fishers from BS reported that they are aware. The interviews showed that in each region, a small portion of fishers despises the cetacean species. More than 90% of fishers in the AS and industrial fishers of LS reported liking the cetacean. In each region, a majority reported to like cetaceans and accepted sharing their catch with them. Exceptionally, small-scale fisheries in BS mostly reported (54%) not agreeing to share their catch with them. Attitude responses are presented in Table

6 for each sea region and fishery type.

Table 6. Percentage distribution of attitude in responses from fishers in each region and fishery type of Turkey

		Hating	Ignoring	Liking without wanting to share catch	Liking with wanting to share catch
The Aegean Sea	Small-scale F.	4	0	21	75
	Industrial F.	0	0	33	67
The Black Sea	Small-scale F.	4	11	54	32
	Industrial F.	0	15	35	50
The Levantine Sea	Small-scale F.	2	17	22	59
	Industrial F.	3	0	48	48

Discussion

Characteristics of the fishery fleet and catches were described in detail within the scope of the study, in regards to filling a required data gap for developing a management strategy. Fisheries statistics of Turkey are systematically available based on data sets collected by the Turkish Statistical Department (TUIK) for the last two decades and varied spatial coverage from sea region base to country base. These data sets make it possible to evaluate characteristics of the fishery fleet of Turkey as well as catch composition and abundance according to landing statistics. Additionally, there are some studies to confirm that TUIK provides reliable data sets for further evaluations in certain fish species (Mavruk 2020). Therefore, it might be possible to develop management plans in the regions of seas around Turkey by a compilation of characteristics of the fleets and fisheries described in this study. TUIK (2018) clearly showed that there is a majority of small-scale fisheries in Turkish coasts to the number of vessels for the most common fishery types, which were evaluated in this study. It should be considered that a special evaluation is required for any other specific fisheries used in Turkish coasts, which have previously reported remarkable interaction with cetaceans (Ozturk 2001, Guclusoy 2006).

Fisheries statistics by TUIK (2018) showed that most abundantly landed species in terms of biomass are; anchovy, bonito, european sprat (*Sprattus sprattus* (Linnaeus, 1758)) and sardine for 2018. Similarities in dominant species in the landing statistics indicate that fishery in BS majorly determines the landing characteristics in Turkey, when considered there are relatively different landing compositions in the other regions. On the other hand, target species obtained from interviews in this study were similar for the landed demersal fish species of TUIK (2018). Limited pelagic fishers from BS, which contribute remarkably in landing biomass, were reached in this study. This was the result of a difference in the weight of pelagic species between data sets. Overall, the results encourage speculation that local environmental knowledge of fishers provides reliable data for filling data gaps required for conservation and management purposes throughout sea regions in Turkey. It should also be noted that there are some successful examples of this approach in Turkish coasts (Mavruk *et al.* 2018, Ondes *et al.* 2019, 2020).

As reported by previous studies (e.g. Birkun *et al.* 2014, Enul 2009, Guclusoy 2006), clear identification of *T. truncatus* by fishers of all regions point out high interaction pressure on this species in the eastern Mediterranean and BS. Additionally, there is severe pressure on *P. phocoena* as well in BS. These two species are reported as accidental by-catches of fisheries operations. Fishers also reported an increasing trend in terms of encountering, especially in BS.

This outcome implies higher dependency of cetaceans to fishery year by year. Thus, conservation actions to mitigate by-catch of these species should be prioritized in the eastern Mediterranean Sea and BS as well as attempts reducing interaction in the central Mediterranean Sea (Quero *et al.* 2000).

Spatial differences were observed in the characteristics of interaction between cetaceans and fishers. The fishery in the BS resulted in higher by-catch numbers for cetaceans, while cetaceans lead to greater damages on fishing gear and catch in AS and LS. Post-catch release survival rates highlighted the requirement of urgent conservation actions in BS. Attempts to reduce losses should be focused in the eastern Mediterranean Sea.

Results showed temporal differences among regional seas in terms of characteristics of interaction between cetaceans and each fishery. A distinctive phenological shift was observed between industrial and small-scale fisheries in AS and LS. This shift was determined by a seasonal fishing ban for the spawning period. Therefore, it can be concluded that industrial fishery is the main type for interaction in the eastern Mediterranean Sea due to yielding higher fish biomass in their catch per unit efforts. This phenological shift was also mentioned by Bengil (2013) to explain the seasonal spatial distribution of cetaceans in Izmir Bay, AS. However, there were similar temporal patterns for both fisheries in the BS. Intense fishing effort per year (Table 3) and higher annual cost in fishing gear (Table 4) in BS can be the reason having higher landing biomass in small-scale fisheries compared to other regions, thus could be more attractive for a cetacean. Another possibility is that occurrence of *P. phocoena* in BS can speculate a unique interaction structure for all types of fisheries in BS.

Another significant output from this study was providing some understanding of fisher's attitude against cetaceans. It can be concluded that most fishers like cetaceans and accept sharing fish with them. However, results highlighted that attitude of small-scale fishers is relatively less friendly in BS since their clash result in higher expenses. Additionally, a high by-catch ratio is another problem for this region. On the other hand, fishers of this region are the most knowledgeable community among Turkish fishers in terms of legislation on conservation of cetaceans, since cetaceans were historically target species for them. Similar findings were also reported by Birkun *et al.* (2014) for the fisher community of Turkish BS. In the shade of consideration of this sociological behavior, particular interest should be paid to increase awareness of fisher communities in the BS to deliver more effective conservation of cetaceans in the region as well as actions must be prioritized to reduce damage on fishing gears and mitigation of cetacean by-catch.

Conclusion

Knowledge obtained from local fishers has pointed out that higher dependency of cetaceans to fishery year by year for all regions. Regional differences were determined for the characteristics of the interaction. The fishery in the Black Sea, results in higher by-catch events for cetaceans, while cetaceans lead to greater damages on fishing gear and catch in the Mediterranean. Additionally, a notable phenological shift was observed between industrial and small-scale fisheries in the Mediterranean. Even though most of the fishers like cetaceans and accept sharing fish with them, results highlighted the requirement of a severe consideration to increasing their awareness in fishers from the Black Sea region as well as actions must be prioritized to reduce damage on fishing gears and mitigation of cetacean by-catch to deliver more effective conservation of cetacean.

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