

# Fishermen's perception of interactions between fisheries and cetaceans in the Bulgarian Black Sea area

Zornitsa Zaharieva<sup>1\*</sup> and Venislava Spasova<sup>2</sup>

<sup>1</sup> Department of Zoology and Anthropology, Faculty of Biology, Sofia University "St. Kliment Ohridski", Sofia, Bulgaria

<sup>2</sup> Department of Ecology and Environmental Protection, Faculty of Biology, Sofia University "St. Kliment Ohridski", Sofia, Bulgaria

**Abstract:** The eastern part of Bulgaria entirely borders the Black Sea, which defines it as a maritime country. The Bulgarian coast is an important fishing region for local people and has a high potential for interactions between fisheries and cetaceans. Depredation caused by cetaceans and damage to fishing gears can potentially lead to substantial economic loss for fishermen, while cetacean bycatch raises conservation concerns. Over the period 2016 - 2019, we conducted face-to-face interviews with fishermen in local fishing areas to better understand the fisheries - cetacean interactions in the Bulgarian part of the Black Sea. The research objectives were to identify the current fishermen's attitudes toward cetaceans, understand the damage caused by local marine mammals to the different types of fishing gear, and gather fishermen's proposals to resolve the problems. To record all of this, a specially designed structured survey was conducted. The results showed that fishermen's attitude towards cetaceans was mostly positive and was not influenced by the type of fishing gear used. We found that fisheries - cetacean interactions are frequent, especially with *dalyans* gear and set gillnets. Cetacean bycatch mortality was reported to be highest for set gillnets, and the most vulnerable species was the *Phocoena phocoena*. Although interview data may be biased due to differences in perceptions and experience of the interviewees, and therefore should be interpreted with caution, this method allowed us to cover multiple types of interactions between cetaceans and Bulgarian fisheries.

**Keywords:** dolphins; interview survey; bycatch; depredation

**Sažetak:** PERCEPCIJA RIBARA O INTERAKCIJI MORSKIH SISAVACA I RIBARSTVA U BUGARSKOM DIJELU CRNOG MORA. Istočni dio Bugarske u potpunosti izlazi na Crno more, što je definira kao pomorsku državu. Bugarska obala važno je ribarstveno područje za lokalno stanovništvo i ima veliki potencijal za interakciju između ribarstva i morskih sisavaca. Štete koje uzrokuju dupini i pliskavice, kao i oštećenja ribolovnih alata, potencijalno mogu dovesti do znatnih ekonomskih gubitaka za ribare, dok slučajni ulov morskih sisavaca izaziva zabrinutost u smislu očuvanja njihovih populacija. U razdoblju od 2016. do 2019. godine intervjuirali smo ribare na pojedinim ribolovnim područjima u cilju boljeg razumijevanja interakcije između ribarstva i morskih sisavaca u bugarskom dijelu Crnog mora. Ciljevi istraživanja bili su utvrditi trenutne stavove ribara prema dupinima i pliskavicama, razumjeti štetu koju morski sisavci uzrokuju na različitim vrstama ribolovnih alata te prikupiti prijedloge ribara za rješavanje ovog problema. U tu svrhu, provedeno je posebno osmišljeno istraživanje putem strukturiranih upitnika. Rezultati su pokazali da je stav ribara prema morskim sisavcima većinom pozitivan i da na njega nije utjecala vrsta ribolovnog alata koji koriste. Utvrdili smo da su interakcije između ribarstva i morskih sisavaca česte, osobito kod upotrebe posebno konstruiranih mrežnih klopki (*dalyan* tipa) kao i mreža stajačica. Prema navodima ribara, najveća smrtnost slučajno ulovljenih morskih sisavaca bila je kod mreža stajačica, a najranjivija vrsta bila je obalna pliskavica *Phocoena phocoena*. Iako prikupljeni podaci mogu imati otklon zbog različite percepcije i iskustva ispitanika, te ih stoga treba tumačiti s oprezom, ova metoda nam je omogućila da rasvijetlimo različite vrste interakcija između morskih sisavaca i ribarstva u Bugarskoj.

**Ključne riječi:** dupini; istraživanje putem intervjua; prilov; depredacija

## INTRODUCTION

Interactions between cetaceans and fisheries involve almost all existing fishing gear and typically result in negative economic, ecological, and social consequences (Perrin *et al.*, 1994; Northridge and Hofman, 1999; Reeves *et al.*, 2001; Read, 2002; Ayers and Leong, 2020). Conflicts between cetaceans and humans, in pursuit of common sources of food, have increased in recent decades (Plagaynyi and Butterworth, 2002). From one side, bycatch in marine fisheries is an increasingly prominent international ecological issue (Alverson

*et al.*, 1994; FAO, 1999) and it is considered to be the greatest threat to the conservation of cetaceans (Read *et al.*, 2006; Reeves *et al.*, 2013). In Europe, bycatch is of concern for a number of cetacean species (ICES, 2010), and in the Black Sea, the harbour porpoise *Phocoena phocoena* is particularly vulnerable to bycatch in gillnets (Pavlov *et al.*, 1996; Blasdol, 1999; Mihaylov, 2011; Tonay, 2016; Zaharieva *et al.*, 2022). Another side of the interaction is the depredation of fisheries by cetaceans which is of greatest concern to fishermen

\*Corresponding author: zornitsa\_zaharieva@yahoo.com

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because it may cause negative economic consequences for the fisheries concerned (Northridge and Hoffman, 1999; Reeves *et al.*, 2001; Fader *et al.*, 2021). Cetacean depredation on target species caught in fishing gear causes significant loss of time, money, and equipment to fisheries, and reduces the size or quality of the catch (Reeves *et al.*, 2001; Lauriano *et al.*, 2004; Gilman *et al.*, 2006; Brotons *et al.*, 2008; Gazo *et al.*, 2008; Bearzi *et al.*, 2010; Rechimont *et al.*, 2018). These interactions can even stimulate some policies of culling cetacean's populations in order to increase the resource base available to fishermen, by reducing marine mammal predation on fish stocks (Crespo and Hall, 2001; Yodzis, 2001; Fertl, 2002).

Three species of cetaceans (dolphins and porpoises) live in the Black Sea – Black Sea harbour porpoise (*Phocoena phocoena* ssp. *relictus*), Black Sea common dolphin (*Delphinus delphis* ssp. *ponticus*), and Black Sea bottlenose dolphin (*Tursiops truncatus* ssp. *ponticus*). Because these cetaceans differ morphologically and genetically from those in other bodies of water, they are defined as subspecies (Barabasch – Nikiforov, 1960; Amaha, 1994; Rosel *et al.*, 1995).

In December 2019, the Bulgarian fishing fleet consisted of 1,841 vessels, with around 95% of it composed of small vessels (<12 m in length) mainly operating with gillnets. Ships over 12 meters in length represented only 5.5% of Bulgaria's fishing fleet and vessels over 24 m accounted for only 0.6% of the total number of fishing vessels. Most Bulgarian fishing vessels (about 97%) use fixed fishing gear while trawlers represent only about 3% of the fishing fleet. Most of these vessels use gillnets - 83.6% while the proportion of other types of fishing gears including purse seine, static pound nets (*dalyan*), trap net, and hooks is relatively small (EAFA, 2020). As the Bulgarian fishery is very diverse gathering complete information on the cetacean - fisheries interactions would require considerable effort and costs. A convenient and reliable way to study the interactions is to conduct interviews with members of the affected community (Reeves *et al.*, 2001; Wise *et al.*, 2007; Gazo *et al.*, 2008; Lauriano *et al.*, 2009). The face-to-face interviews with fishermen are a handy and reliable method to infer preliminary information (Wise *et al.*, 2007). This method of data collection has been previously used in other studies to obtain information about interactions between cetaceans and fisheries in different areas (Omar *et al.*, 2002; Moore *et al.*, 2010; Goetz *et al.*, 2013; Snape *et al.*, 2013; D'Lima *et al.*, 2014). In the Black Sea, the survey method was successfully applied to investigate interactions between cetaceans and static pounds nets (*dalyans*) (Zaharieva *et al.*, 2020). The study revealed a considerable conflict due to damages caused by cetaceans to fishermen's fishing gear - *dalyan* and the subsequent loss of catch, time, and money.

The aim of this research was to study the interactions of the cetaceans with the most common fishing gear as well as fishermen's attitudes towards them. Research

objectives were to: (1) explore the fishermen's attitude toward cetaceans and test whether fishermen's perceptions were influenced by their community background, age, or by their personal experience with cetaceans; (2) identify which fishing gears contribute to interactions; (3) describe types of damage to the various gears; (4) obtain information on bycatch rate in different fishing gears; (5) provide financial assessment of damages; and (6) present potential conflict management measures.

## MATERIALS AND METHODS

### Study area

The present study was conducted between April 2016 and May 2019 (mainly during spring and summer months), along the coastline of the Bulgarian Black Sea. It is a separate district of Bulgaria and is divided into northern and southern regions that differ in physico-geographical, climatic and economic factors (Penin, 2007). Consequently, we have divided our study area into two sub areas - North and South. The study sites included in the Northern area were Varna, Kranevo, Balchik, Bojurec, Kavarna, Bulgarevo, Krapec and Shabla, while the Southern area sites included Nesebar, Pomorie, Burgas, Sozopol, Lozen, Primorsko, Tsarevo, Ahtopol, Varvara and Sinemorets (Fig. 1).

### Questionnaire design and data collection

Fish landing sites were randomly selected and visited within the study sites. Face-to-face interviews

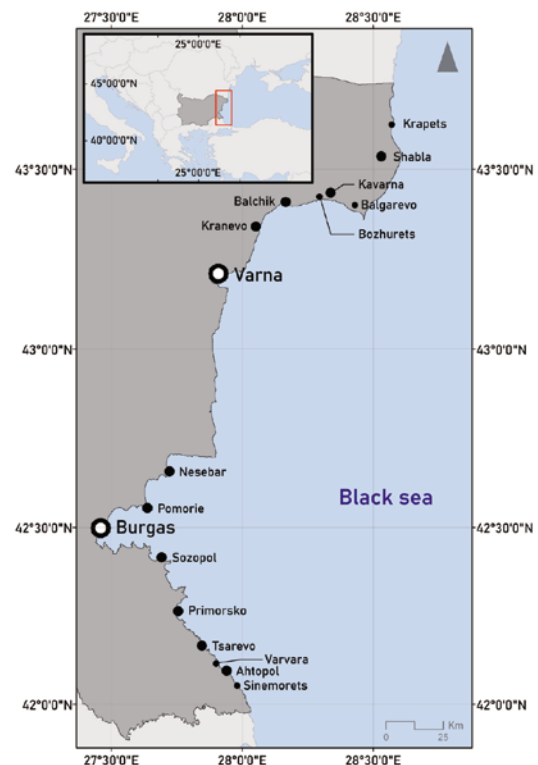


Fig. 1. Study area: the Bulgarian Black Sea coast.

with the fishermen working on different fishing gears were conducted, using a questionnaire specifically designed for this study. Answering the questionnaire was preceded by open, judgment-free discussions on the problem and clarification of the aims of the research to predispose the participants for a constructive contribution (Rea and Parker, 1997). Only professionally active fishermen were interviewed. Mainly fishing gears owners or captains of the vessels participated. All interviews were kept anonymous. It should be noted that there were no fishermen who refused to be interviewed.

The survey included mainly close-ended questions designed, but also free text options (open-ended) in some of the questions. The following data was collected from the fishermen during the survey: personal information, their knowledge about cetaceans in the Black Sea, their attitudes towards cetaceans, personal experience - characterization of the fishing activity (gears used), the occurrence of interactions, seasonal variations of interactions, occurrence and the level of bycatch, type of depredation and associated economic loss, mitigation measures employed and suggestions for solutions to avoid interactions. In order to identify which fishing gears represent the greatest threat to cetaceans, fishermen were asked about the approximate number of cetaceans that they have found as bycatch between the years 2012 - 2018.

The questionnaire consisted of 18 main questions and 13 sub-questions and was divided into three parts. Part 1 was about general knowledge of cetaceans, part 2 - about personal experience with cetaceans and the last part of the questionnaire was about the personal information of the interviewee. The scale of possible answers to the questions varied but in almost all questions, there was an "I don't know" answer to minimize attempts of guessing. In three of the questions, the answer "other" was possible, to show the personal view or experience of the respondent to the respective question.

## Data analysis

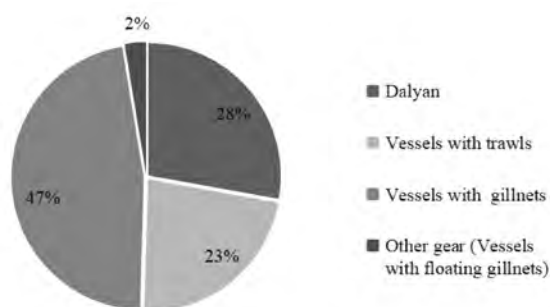
Beside basic descriptive statistics, Chi-square Test of Independence for 3x2 and 2x2 tables was used to determine association between separate variables such as knowledge, attitude, type of gear and region. For the statistical significance of the differences between the compared data, a confidence level of 95%,  $P < 0.05$ , was considered. Statistical data analysis was performed using SPSS v.25. Bycatch rates in gillnets were calculated by a number of specimens per km of net.

## RESULTS

A total of 83 fishermen were interviewed, 37 in the Northern study area and 46 in the Southern (Table 1). The interviewed fishermen worked with different fishing gears - *dalyans*, trawls, and gillnets (Fig. 2). Some of the fishermen used more than one type of fishing gear.

**Table 1.** The number of interviewed fishermen by location.

Region	Study area	Number of interviewed	Percent of total (%)	
North	Varna	9	10.8	
	Kranevo	1	1.2	
	Balchik	11	13.25	
	Bojurec	1	1.2	
	Kavarna	10	12.3	
	Bulgarevo	1	1.2	
	Krapec	2	2.5	
	Shabla	2	2.5	
	<b>Northern region</b>	<b>37</b>	<b>44.6</b>	
	South	Nesebar	2	2.5
		Pomorie	2	2.5
Burgas		5	6	
Sozopol		5	6.2	
Lozen		1	1.2	
Primorsko		15	18.5	
Tsarevo		8	9.9	
Ahtopol		5	6.2	
Varvara		1	1.2	
Sinemorets		2	2.5	
<b>Southern region</b>		<b>46</b>	<b>55.4</b>	
<b>Total</b>	<b>83</b>	<b>100</b>		



**Fig. 2.** Number of fishing gears included in the survey.

A total of 128 *dalyans* were registered in the EAFA, but only 40 of them were operating during the study period, which means that about 80% of the *dalyans* operating during this period were included in the study. Between 95 and 110 trawlers were registered with the EAFA during the study period and this fishing gear, with a total nets length of about 900 km according to the official data of EAFA. Despite the available information on gillnets, it is not clear what part of the registered nets are used in practice, so based on official information we assume that this study includes about 1/3 of all registered gillnets in Bulgarian waters.

Fishermen interviewed were only males, between 20 and 78 years of age, with an average age of 46 years. Most of the fishermen (57.7%) had a working experience of more of than 20 years. Fisheries as the sole source of income were reported by 53% of the respondents.

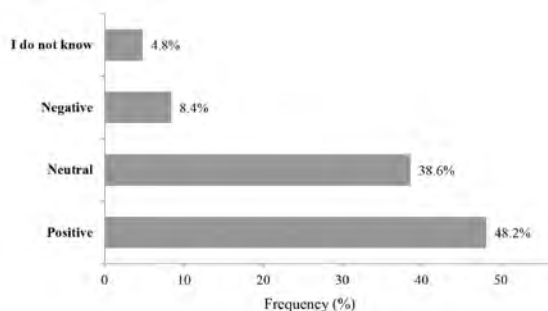
## Knowledge

Information was gathered on fishermen's knowledge of cetaceans, namely how many species inhabit the Black Sea and their conservation status. Majority of fishermen (67.5%) correctly answered how many species of cetaceans live in the Black Sea (3 species). There was no significant difference between the North and the South in this regard ( $\chi^2 = 0.16$ ,  $p = 0.68$ ). In 27.7% of the cases, the fishermen answered there were only two species of cetaceans in the Black Sea and have indicated that these were *P. phocoena* and *T. truncatus*. Four respondents (4.8%) believed that there were more than three species of cetaceans in the Black Sea, but did not specify which ones. Concerning cetacean conservation status, 89.2% of the interviewees correctly answered that cetaceans are protected by law.

There was no significant relationship between the years of professional experience of fishermen and knowledge about cetaceans ( $\chi^2 = 3.95$ ,  $p = 0.68$ ). Regarding perception of trends over the last 10 years, 55.3% of fishermen believed that the population of cetaceans was increasing.

## Attitude towards cetaceans

Overall, 48.2% of fishermen showed a positive attitude towards cetaceans (summed up answers "very positive" and "rather positive") (Fig. 3).



**Fig. 3.** Fishermen's attitude toward cetaceans in the Bulgarian Black Sea region.

There was no statistically significant difference in the attitude of fishermen from the Northern and Southern study areas ( $\chi^2 = 4.68$ ,  $p = 0.19$ ).

## Personal experience

Most of fishermen indicated interactions of cetaceans with fishing gear (73.5%). The gear with the most frequent interactions were gillnets (n=43), then *dalyans* (n=30), while the least contact had trawls (n=4). The fishermen working with *dalyans* stated that cetaceans have repeatedly entered their nets during the study period and in most cases, they released them. Based on these answers, it was estimated that the average number of cetaceans entering the *dalyans* in the period 2012 - 2018 was 63 individuals. We did not find relation

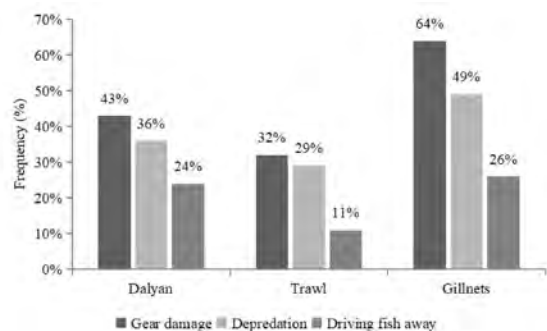
between the attitude toward cetaceans and the type of fishing gear used by fishermen. The trend was the same for all three types of gear and the fishermen attitude was not formed by it (*dalyans*:  $\chi^2 = 3.22$ ,  $p = 0.52$ ; trawl:  $\chi^2 = 2.42$ ,  $p = 0.66$ ; gillnets  $\chi^2 = 0.55$ ,  $p = 0.94$ ).

## Bycatch

To the question "Have you ever found a dead (entangled) cetaceans in your fishing gear?", 50.6% of the respondents answered positively and 46.9% said they never found marine mammals in their gear. Some fishermen did not want to answer this question (2.4%). In an attempt to estimate the bycatch in the various fishing gears, additional questions were asked about the number of bycatch found during the period 2012-2018. The total number of cetaceans found dead in turbot gillnets, declared by fishermen, was 384 individuals. Based on these data, the bycatch in the gillnets was calculated to 0.84 individuals per km of net. Only five individuals were found in *dalyans*, and three in trawls. The most frequently entangled species was the harbor porpoise (82.8%), followed by the bottlenose dolphin (15.6%), while the least caught were common dolphins (1.6%).

## Depredation

When asked about the type of damage and depredation caused by cetaceans, 93.1% of fisherman declared at least some kind of "destruction and damage to fishing gear". In 76.4% of the cases, fishermen responded that cetaceans also affect the catch by eating the fish, and in 45.8% that they also scare and drive away the fish. Most frequent damage to the gears was holes in the nets torn by the cetaceans trying to catch the fish inside. Concerning the seasonality of damage caused by odontocetes, there was no significant difference between the regions ( $\chi^2 = 2.179$ ,  $p = 0.54$ ). In both the North and South, the incidents occurred mostly in spring and autumn. The results showed that all types of gear suffered damages, the most common being in the form of torn nets (Fig. 4).



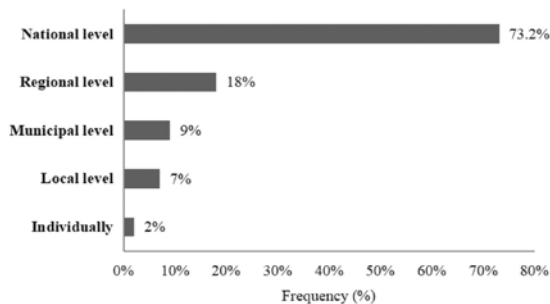
**Fig. 4.** Damages to different type of fishing gear.

An attempt was made to calculate the approximate costs of damages to fishermen as a result of interactions with cetaceans. The results showed that 21.7% of fishermen could indicate the calculated value of their

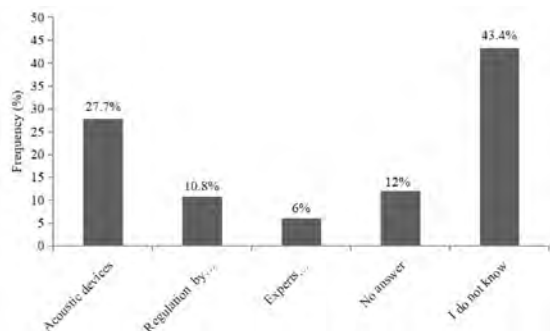
financial losses from depredation during the last year, in 8.4% of cases fishermen stated that they had no financial losses, and 69.9% of fishermen could not assess exactly how much they were. Based on the provided information, monetary losses per fishermen were between 600 and 5000 BGN (approximately between 300 and 2500 EUR), and it was estimated that the average amount of financial losses of fishermen was 1727.78 BGN (around 883 EUR) for the period 2012 – 2018. The fishing gear for which fishermen could calculate the losses more accurately, were the *dalyans* and the gillnets. For the Southern Black Sea, the average financial loss was 2291 BGN (1171 EUR), while for the North it was only 842 BGN (430 EUR) mainly to purchase new nets.

### Tackling the problems

The level at which measures should be taken and the personal suggestions of fishermen to manage the conflict with cetaceans were addressed in two consecutive questions. Most of respondents (68.3%) agreed that measures need to be taken, but the share of those how were not sure was also high - 30.5%. Only one fisherman was on the opinion that measures were not needed all. Regarding the level at which these measures should be taken, the national level was prevailing in the answers - 73.2% (Fig. 5).



**Fig. 5.** Answer of question “In your opinion, at what level should measures be taken against damage caused by cetaceans?”.



**Fig. 6.** Measures recommended to reduce cetacean damage to fishing gear.

The answers to the question “What measures do you recommend to reduce cetacean damage to fishing gear?” varied, and the highest percentage of fishermen did not

know what was the right way to tackle the problem (Fig. 6). However, 27.7% of the fishermen believed that the use of modern repellents devices (pingers) could be an effective measure. There was a statistically significant difference between the attitude of fishermen and the measures proposed by them ( $\chi^2 = 77.8, p = 0.04$ ). The results showed that fishermen negative attitude towards cetaceans tend to recommend culling dolphins, and those with a positive attitude suggested the use of pingers as a measure.

### DISCUSSION

The present results provide a valuable insight on the gears, bycatch rate, overall revenue, and economic losses due to negative interactions between fishing gear and cetaceans in the Black Sea. The fishermen that took part in this survey accepted the approach well and provided valuable information and their opinions on all questions asked. The reason for their cooperation may be due to their understanding that they are unlikely to solve the problems of fisheries - cetacean interactions alone and their desire to gain broader public support.

The results showed the fishermen’s knowledge of cetaceans was not at a sufficiently high level. Knowledge of the different species of cetaceans is essential because they behave differently and have different seasonal dynamics depending on the species. Therefore, their effective differentiation can help fishermen find better ways to deal with problems.

In general, fishermen’s attitudes toward cetaceans were mostly positive or neutral. From the results obtained, it could be concluded that the attitude of fishermen toward marine mammals was determined neither by their years of professional experience nor by what type of fishing gear they work with. The result of fishermen’s attitude was similar to the attitude in an interview survey conducted in India where the average attitude score of fishers towards dolphins ranged from neutral to positive (D’Lima *et al.*, 2014). The negative fishermen’s attitude was probably fueled mainly by the frequent damage to their gear in their individual experience and practice, as well as by socio-economic and cultural factors.

The current survey outlined a significant ongoing conflict between fisheries and local cetaceans in the territorial waters of the Bulgarian Black Sea coast. Fishermen often suffer financial losses and lost profits as a result of interactions. The frequent depredation that cetaceans inflict on fishing gear leads to economic losses, as all types of gear are damaged, most often in the form of torn nets. Torn nets are a serious problem because, in addition to the cost of replacing the nets, many hours of extra work are required to repair them. Additionally, the torn net is out of the water for some time which leads to lost catch for the fishermen. It was not possible to calculate at this stage what is the amount of fish that cetaceans actually depredate and whether

this would bring additional losses to fishermen. In this case, the eaten fish, as well as the “chased away fish” were rather a strong psychological factor in the perceptions of fishermen.

The current results were similar to those obtained in a survey in Northern Cyprus, where fishermen point that the main damage was “damage to gear” as a result of their interaction with dolphins, which is the main economic factor of concern among them (Snape *et al.* 2013). In Spain, Italy and France, studies of the interaction between commercial fisheries and cetaceans have estimated that the annual cost of damage to gear and catches was between € 1,000 and € 2,000 per ship (Brotons *et al.* 2008; Gazo *et al.* 2008), losses close to those identified in the present study. Italian (Bearzi *et al.*, 2010) and Greek (Gonzalvo *et al.*, 2015) fishermen claim that due to their interaction with dolphins, their losses range between 500 and 20,000 euros per vessel per year. Obviously, the financial losses of fishermen are significant and it is necessary to pay serious attention as they may lead to a more negative attitude towards marine mammals and hence to the provision of more severe measures against them.

The results clearly showed that all major types of fishing in Bulgaria have interactions with cetaceans. Fishermen working on vessels with trawls had the least interactions, compared to *dalyans* and gillnets. The results confirmed conclusions from the *dalyan* studies conducted in the Bulgarian Black Sea area 2012-2014, that the conflict between fishermen and cetaceans was caused mainly by lack of knowledge about marine mammals, accumulated negative attitudes regarding their impact on the fisheries, and insufficient access to modern fishing equipment and practices (Zaharieva *et al.*, 2020). Bycatch of cetaceans is an integral part of the interactions and in this case, there were no exceptions. Although the main fishing gear leading to the death of cetaceans was gillnets, and *dalyans* and trawls had far less impact, the prevention of the bycatch of cetaceans in all types of gear must be given equal attention and concern. According to fishermen’s responses about the main bycaught species, the results almost completely overlap with the results of many by-catch surveys in the Black Sea, where the harbour porpoise was the highest bycaught species (Pavlov *et al.*, 1996; BLASDOL, 1999; Tonay, 2016; Zaharieva *et al.*, 2022.). The interview survey method showed good results in gathering information about bycatch in different areas, such as in the gillnets of Zanzibar’s fleet (Omar *et al.*, 2002) and at local fisheries in Galicia, Spain (Goetz *et al.*, 2013).

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- Moore *et al.* (2010), also through interviews, collected information and evaluated a considerable part of fisheries and bycatch in a few countries in Africa.
- Fishermen could not identify specific measures and approaches to address the problems, probably due to the lack of good communication with interested and responsible institutions and the lack of good practices in the area. The first step to solving a problem is acknowledging it, so getting them involved in this research and sharing information may be just that first step. A cause for concern was that some fishermen were proposing to reduce problems by culling cetaceans rather than through more innovative and humane measures. Not quite rational measures to deal with the problem were also proposed in a study in Galicia, where the fishermen proposed scaring the cetaceans away from the vessels and gear, for instance by making noise, using firecrackers, throwing stones at the animals, or hosing them with seawater (Goetz *et al.*, 2013). As D’Lima *et al.* (2014) claimed, our results also showed how important was the attitude of the affected group because a more positive attitude also generated better suggestions and ideas for dealing with the problems rather than extreme ones that endanger the species. It would be useful to increase contacts and dialogue between fishermen and other stakeholders and to study and promote more methods of management of the problem. It must be kept in mind that perception is subjected to bias, so this study was intended to provide a rough indication of the interactions and to show where future studies should focus.

## CONCLUSION

The fisheries - cetacean interactions affect all main commercial fishing gear, as well as all the three species of cetaceans in the Bulgarian area of the Black Sea. The fact that fishermen who participated in the current study shared their experiences and opinions openly shows their willingness for these interactions to improve for both sides. During this study valuable information was collected that brought more clarity to the interactions between cetaceans and fisheries in the Black Sea and could be useful in planning future conservation and management strategies.

## ACKNOWLEDGEMENTS

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