

## The Conflict Between Fisheries and Cetaceans in Bulgaria's Black Sea Territorial Waters

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### Abstract

Conflicts between fisheries and cetaceans exist in many areas around the world, and the Bulgarian territorial waters of the Black Sea are no exception. In Bulgaria, there have been few studies of the conflict's nature and extent, and the government and local authorities do not have appropriate policies for conflict management. To address this information gap, we conducted interviews from 2012 to 2014 of approximately 50% of the fishermen population using the existing dalyans (the traditional Bulgarian fishing gear). The research objectives were to identify the current fishermen's attitudes and knowledge about cetaceans, understand the damage caused by local marine mammals to their gear, and hear their proposals to resolve the problems. A specially designed, structured survey was conducted to capture a snapshot of the prevailing situation. The results indicate that dalyan fishermen have some negative attitudes towards cetaceans and that there is poor knowledge among the fishermen of marine mammal natural history. Successful resolution and management of this conflict are essential due to its impact on the Bulgarian fishing industry and for the protection of Black Sea cetaceans. The study recommends measures for better communications and knowledge-sharing with the fishermen, investments in the modernization of fishing methods and tools, and the conducting of systematic research and monitoring activities. Further development of Bulgarian fisheries policies may create financial opportunities for fishermen to acquire repellent devices and apply modern, ecologically safe fishing practices.

**Key Words:** cetaceans, fisheries, questionnaire, Black Sea, Bulgaria

### Introduction

Cetacean interactions with fisheries are a global problem, and all types of fishing gear are believed to be involved to some extent (Reeves et al., 2001). Among all the interactions, the depredation of fisheries by cetaceans is of greatest concern to fishermen because it may cause negative economic consequences for the fisheries concerned (Northridge & Hofman, 1999; Reeves et al., 2001). Cetacean predation of target species caught in fishing gear causes significant loss of time, money, and equipment to fisheries, and it reduces the size or quality of the catch (Northridge & Hofman, 1999; Reeves et al., 2001; Bearzi, 2002; Lauriano et al., 2004). These factors often lead to fishermen having a negative attitude towards cetaceans or sometimes even taking action against them, which may include the use of dangerous methods, such as dynamite, to scare cetaceans away from nets (Reeves et al., 2001; de Stephanis, 2004). Additionally, fishermen may lobby for cetacean culls (Lauriano et al., 2004).

Studies of cetacean–fisheries interactions (including damage to fishing gear, spoilt prey in the net, fish taken from the net, and reduced catch rate) have been conducted in several European countries—for example, Greece (Casale et al., 1999), Spain (Alonso et al., 2000; Lopez et al., 2000; Gazo et al., 2001; Diaz López, 2012), and Tunisia (Naceur Lofti, 2000). Studies specifically focusing on cetacean–fisheries interactions in the Black Sea are few (Birkun, 2002). One way to study the relationship between fisheries and cetaceans is to conduct interviews with members of the affected community (Lauriano et al., 2009). Such surveys can include face-to-face contact with fishermen and are a convenient and reliable method to collect preliminary information (Lien et al., 1994; Wise et al., 2007). Analysis of public attitudes has been used successfully in the past to inform measures that reduce human and wildlife conflict and

encourage joint resource management (Lamb & Cline, 2003; White et al., 2005).

As a member of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS), Bulgaria has committed itself to protecting cetaceans and, thus, has a duty to assist fishermen in finding appropriate means of minimizing conflict (ACCOBAMS, 2004). However, studies of cetacean–fisheries interactions are generally lacking in Bulgaria and, thus, regulators cannot provide appropriate guidance or measures to address the problem. To evaluate the need for mitigation measures and/or economic compensation related to damage caused by these interactions, it is essential to fill these knowledge gaps as the first step to addressing the conflict is to evaluate its nature (Bearzi, 2002).

The Black Sea is a semi-closed, intercontinental sea. It connects to the Mediterranean and the rest of the world's oceans only through the Istanbul Strait (Bosphorus) (Prodanov et al., 1997). Three species of odontocetes (dolphins and porpoises) occur in the Black Sea: Black Sea common dolphin (*Delphinus delphis* ssp. *ponticus*), Black Sea bottlenose dolphin (*Tursiops truncatus* ssp. *ponticus*), and Black Sea harbour porpoise (*Phocoena phocoena* ssp. *relicta*). Because the Black Sea is isolated from other bodies of water, these species are defined as subspecies that occur only here (Tzalkin, 1938; Barabash-Nikiforov, 1960; Amaha, 1994; Rosel et al., 1994). The hunting of odontocetes in the Black Sea that occurred in the middle of the 20th century caused a sharp decline in the populations of these three species. Further, these marine mammals are vulnerable to various factors such as water pollution, food shortages, microbial contamination, habitat loss, and incidental catches (Birkun, 2002; Birkun et al., 2006). Odontocete conservation, including assessment of their interaction with fisheries, is seen as a significant challenge worldwide, especially in isolated water basins such as the Black Sea (Birkun et al., 2006).

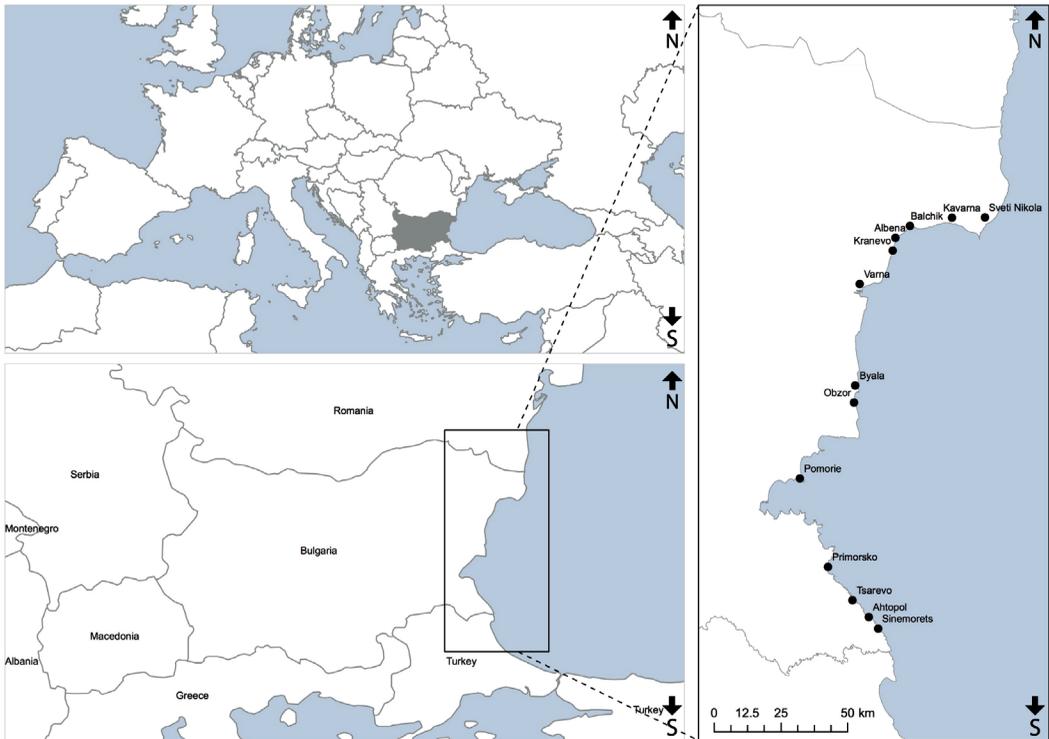
Over the last 15 years, the conflict between marine mammals and fishermen in Bulgaria has been widely known and broadly debated in society and the media. The news media has reflected the strong discontent among fishermen who work on one traditional form of Bulgarian fishing gear, the dalyan, due to claims that dolphins and porpoises cause significant damage to their fishing gear and catch rate. To achieve a solution to this problem, make legal arrangements, and create mitigation policies, a precise understanding of the conflict's scope, factors, conditions, and consequences is needed. The primary goal of this study is to capture the personal experience of dalyan

fishermen with cetaceans—whether there have been interactions between fisheries and marine mammals, what types of interaction occurred, and what measures fishermen recommend to mitigate these conflicts. Examining and better understanding the attitudes, beliefs, expectations, level of support or opposition, as well as other factors that might influence the fishermen may help to resolve their conflict with cetaceans (Bath & Enck, 2003). Our initial expectation was that the fishermen would tell us about damage to their gear, recommend solutions to deal with the conflict, and have an overall negative opinion towards cetaceans. We also hypothesized that fishermen with a different attitude towards cetaceans would propose different measures to mitigate the conflict and that the age of the fishermen would affect their attitude and knowledge because of the difference in experience and access to information. These factors were chosen to get a clearer picture of the motives that determine fishermen's actions in the unwanted conflict with marine mammals and to propose some realizable and potentially useful response measures.

## Methods

### Study Area

Bulgaria is a European country located along the southeastern edge of the continent, occupying the central and eastern boundaries of the Balkan Peninsula to the south of the Danube River, with access to the Black Sea to the east. The Black Sea coastline of 378 km defines Bulgaria as a maritime country (Krastev & Stankova, 2008). The coastline is divided into northern and southern regions by physico-geographical and climatic features, as well as economic factors (Penin, 2007). The coastline and the continental shelves of the two regions exhibit some differences in the relief (much steeper in the north), which leads to differences in the exploitation of the dalyans. Tourism is more developed in the southern region, which dictates a higher demand for fish. The seasonal distribution of fish species and the territorial deployment of dalyan fishing gear also differs (Executive Agency of Fisheries and Aquaculture [EAFA], n.d.). Consequently, the study area follows this north-south regional divide. The fieldwork and fact-finding visits included several fish landing sites in the northern and southern regions (Figure 1). The study sites in the northern region included Biala, Varna, Albena, Kranevo, Balchik, Kavarna, Kaliakra, and St. Nikola, while the southern region study sites included Pomorie, Primorsko, Tsarevo, Ahtopol, and Sinemorec (Figure 1).



**Figure 1.** Study area: the Bulgarian Black Sea coast. The study sites in the northern region include Biala, Varna, Albena, Kranevo, Balchik, Kavarna, Kaliakra, and St. Nikola, and the study sites in the southern region include Pomorie, Primorsko, Tsarevo, Ahtopol, and Sinemorec. Map courtesy of Magdalena Kircheva.

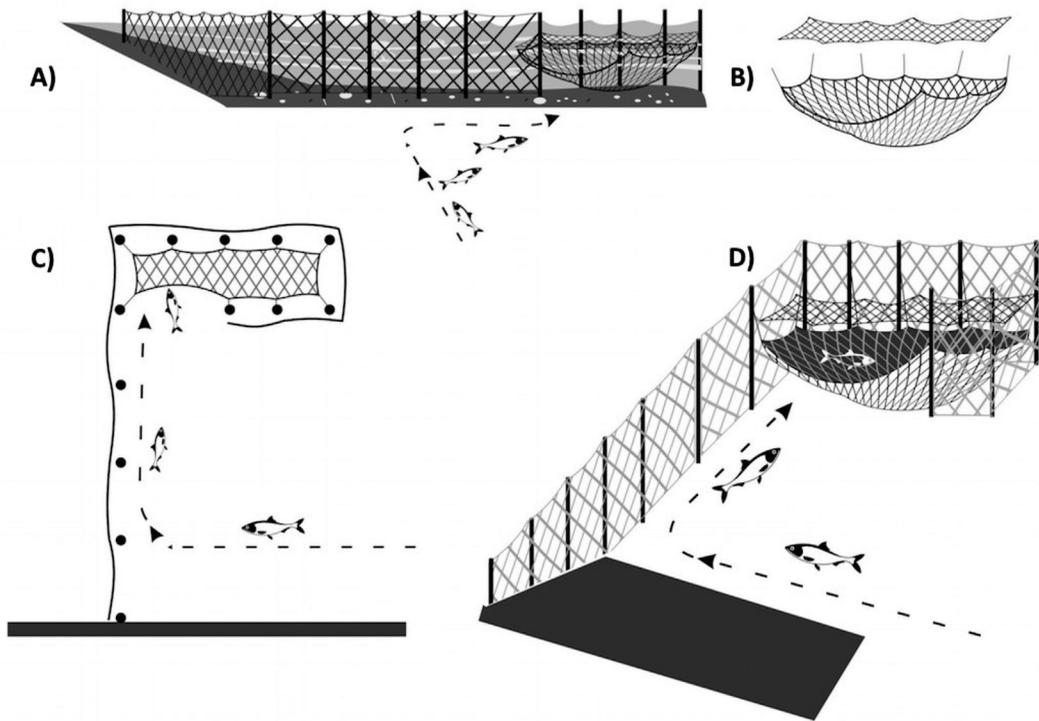
#### *Description of the Dalyan Fishing Gear*

A specific Bulgarian law defines the *dalyan* as “special trap gear” for which deployment and use are under government control (Law on Fisheries and Aquaculture Act, 2005, Article 21). The *dalyan* is a stationary fish trap net used for passive commercial fishing (Figure 2). It is attached to both the seabed and the beach. The *dalyan* is located about 150 m from the shore, and the size of the construction varies from 25/30 to 35/50 m. It is deployed at about 12 m of depth, and the netting usually reaches above the waterline with the trap open at the surface. The opening of mesh is 6 mm (EFAA, n.d.). To service the *dalyans*, fishermen use a small motorized boat, usually around 12 m in length. The main fish caught with this gear are pelagic species such as sprat (*Sprattus sprattus*), horse mackerel (*Trachurus mediterraneus*), garfish (*Belone belone*), and Pontic shad (*Alosa immaculata*). This type of fishing gear is deployed mainly in Bulgaria, Greece, and Turkey.

#### *Data Collection*

The data collection method was in-person interviews with the fishermen using a specific questionnaire created for this study (see the Supplemental Appendix; this appendix can be found in the “Supplemental Material” section of the *Aquatic Mammals* website: [https://www.aquaticmammalsjournal.org/index.php?option=com\\_content&view=article&id=10&Itemid=147](https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147)). 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 & Parker, 1997). This method of data collection previously has been used in other studies to obtain information on different species of odontocetes such as spinner dolphins (*Stenella longirostris*), humpback dolphins (*Sousa* sp.; Omar et al., 2002), and bottlenose dolphins (*Tursiops truncatus*; Kuznetsov, 2004).

To get a representative sample of Bulgarian fisheries, all available fishermen working during the studied period were included. The fish landing sites were randomly selected along the Bulgarian part of the seacoast. The interviewed *dalyan* owners



**Figure 2.** Design of the dalyan fishing gear: (A) Side view of poles, leader, and trap—Fish swim perpendicular to the shore, reaching the leader, which leads them to the trap; (B) Side view of the trap—The fish fall into the lower net of the trap, and fishermen in their boats gradually take them out; (C) Top view of leader and trap; and (D) View from the shore of the fish swimming towards the leader, which then leads them to the trap. Schematic dalyan created by Bozhidar Manolov.

represented more than 50% of their total number present in Bulgarian waters. It should be noted that there were no dalyan owners who declined to be interviewed. We targeted all of them who were present and available for interviewing during the study period within the selected sites. Aiming to maximize the number of interviews, timing of interviews was adjusted to the seasonal and daily routine of the fishermen sampled.

#### *The Questionnaire*

Fishermen answered questions concerning their vessels, the fish species they catch, their attitudes towards and knowledge about cetaceans, the significance and cost of damage to their gear, and also general personal information, including age, education, and occupational experience. The research team paid particular attention to fishermen's proposals related to resolving the interaction problems and also to their practical measures for preventing cetaceans from entering the dalyans. The survey consisted of 23 questions divided into four sections, corresponding to both the various aspects of the conflict and the research aims (see the Supplemental Appendix):

- Five questions asked about the respondents' knowledge of cetacean biology and conservation status
- 11 questions asked about the fishermen's personal experience with cetaceans
- Two questions asked about the observed cetacean behavior during attacks on gear
- Five questions queried about the respondents' personal information

Eighteen of the questions contained multiple-choice options; and for five questions, the answer "Do not know" was an option to minimize guessing. On ten questions, the answer "Other" was an option to allow for respondents to share personal opinions and ideas.

#### *Data Analysis*

A Chi-square test with contingency tables was performed to compare answers from the questionnaire between interviewed fishermen from the northern

and southern Black Sea coast regions. A Student's *t* test was carried out to assess differences in fishermen's age between the studied regions. A multiple comparison procedure, Fisher's Least Significant Difference (LSD), was used to determine divergence among (1) fishermen with a particular attitude towards cetaceans correlated to proposed measures to mitigate the conflict and (2) the answers given by fishermen to particular questions correlated to their age. Statistical data analysis was performed using *SPSS*, Version 21. A *p* value of less than 0.05 was considered statistically significant.

### Results

Sixty-one fishermen, working on 54 separate dalyans, roughly 50% of the existing dalyans in Bulgaria (EAFA, n.d.), were interviewed (Table 1). The interviewed fishermen provided valuable information and shared their opinions on all questions openly. As the local fishing industry is still predominantly a male occupation, only men ( $N = 61$ ) participated in the surveys. Participating fishermen varied widely in age from 15 to 80 years, with an average age of 46 years. Their formal education level was generally low (primary and secondary), and they usually did not have other sources of income. We assumed that the data summarized in Table 1 were representative of all Bulgarian Black Sea fishermen using dalyans.

Interviews with local fishermen in the two subregions of the Bulgarian Black Sea territorial waters identified some key features of the escalating conflict with local odontocetes. These included (1) damage caused to fisheries, reducing the catch rate by depredation, breaking the net sets, and reducing the size or quality of the catch; (2) very poor knowledge about local marine mammals and insufficient information about their protection and the legal regulations of fisheries; (3) the fishermen's general attitude towards cetaceans; (4) the impact of dalyans on odontocetes; and (5) the current improvised fishing practices for tackling interaction problems with odontocetes. The following is a summary of the core findings.

#### Damage

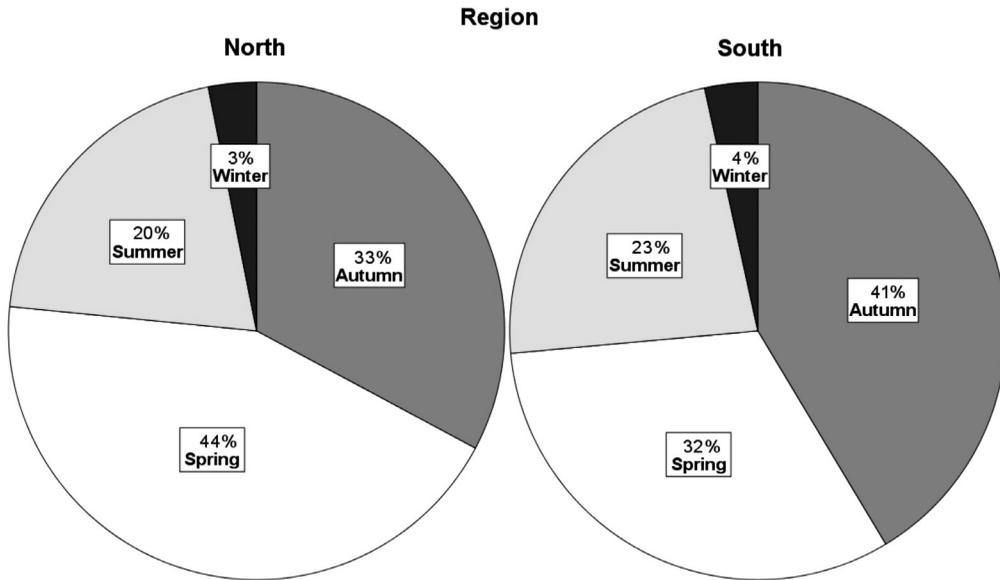
The interviewed fishermen unanimously confirmed that they all had experienced odontocetes entering their dalyans. Asked about the type of damages caused by cetaceans, 13% responded "destruction and damage to fishing gear," 11.4% responded "destruction and damage to fishing gear" and "consumption of fish," 1.6% responded "destruction and damage of fishing gear" and "scaring the fish," while 74% indicated "all of the above." Damage to the gear manifested in the form of holes torn in the nets as the odontocetes

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

Study area	Region	Number interviewed	Percent of total (%)
Albena	North	2	3.28
Balchik	North	8	13.11
Varna	North	3	4.92
Kavarna	North	8	13.11
Kaliakra	North	3	4.92
Kranevo	North	3	4.92
Byala	North	3	4.92
Sveti Nikola	North	2	3.28
Northern region		32	52.46
Ahtopol	South	5	8.20
Pomorie	South	8	13.11
Primorsko	South	7	11.47
Sinemorec	South	4	6.56
Tsarevo	South	5	8.20
Southern region		29	47.54
Total		61	100.00

attempted to remove fish. Concerning seasonality of damage caused by odontocetes, there was no significant difference between the regions ( $\chi^2 = 2.179$ ,  $p = 0.536$ ). In both the north and south, the incidents occurred mostly in spring and autumn (Figure 3). In both areas, the dalyans are not in the water in the winter and, thus, did not suffer damage from marine mammal attacks and interactions. However, in the north, the fishermen use other types of fishing gear during winter months. They informed us that even with other types of gear, they ran into problems with cetaceans damaging the gear, albeit with less frequency.

As an additional comment, 100% of the interviewed fishermen noted that fish stocks had fallen sharply over the last 10 years and, in their opinion, perhaps this was one of the reasons why marine mammals attack the gear. Moreover, their opinion was that odontocete numbers in the Black Sea are in the "millions" and are rapidly increasing (the most significant number mentioned was "about 10 million"). In three cases, the fishermen declared that they had to give up fishing with the dalyan because of the enormous daily damage and catch loss caused by cetaceans (Erhan Mehmedov, pers. comm., 15 May 2014).



**Figure 3.** Seasonal variation of damages in the northern and southern Bulgarian Black Sea regions

#### *Education and Knowledge*

The data collected about the fishermen's education level and knowledge of cetaceans, namely how many species inhabit the Black Sea, what their main characteristics are, and what their conservation status is, helped us understand the arguments and motives that drive fishermen's attitudes regarding the conflict. Most of the surveyed fishermen, 83.6%, have secondary education with no significant difference between the two regions ( $\chi^2 = 4.825$ ,  $p = 0.090$ ). However, regarding their detailed knowledge about how many species are in the Black Sea, 78.1% from the northern region responded correctly, while only 55.2% from the southern region did so ( $\chi^2 = 3.637$ ,  $p = 0.05$ ; Figure 4).

Regarding the association between the fishermen's age and knowledge of the three species of cetaceans found in the Black Sea, the respondents who answered "1 species" tended to be younger than respondents who answered "2" or "3" species (Figure 5). However, 100% of interviewed fishermen answered correctly that any breach on cetaceans is forbidden. Indeed, in Bulgaria, cetaceans are included in the Biodiversity Act (Appendices II & III), which states that "all forms of deliberate capture or killing of specimens are completely forbidden by any means and methods, persecution and disturbance."

#### *Attitude*

The majority of respondents (44%) demonstrated a positive attitude regarding cetaceans, 36% indicated a neutral attitude, while 20% took a negative stance (Figure 6).

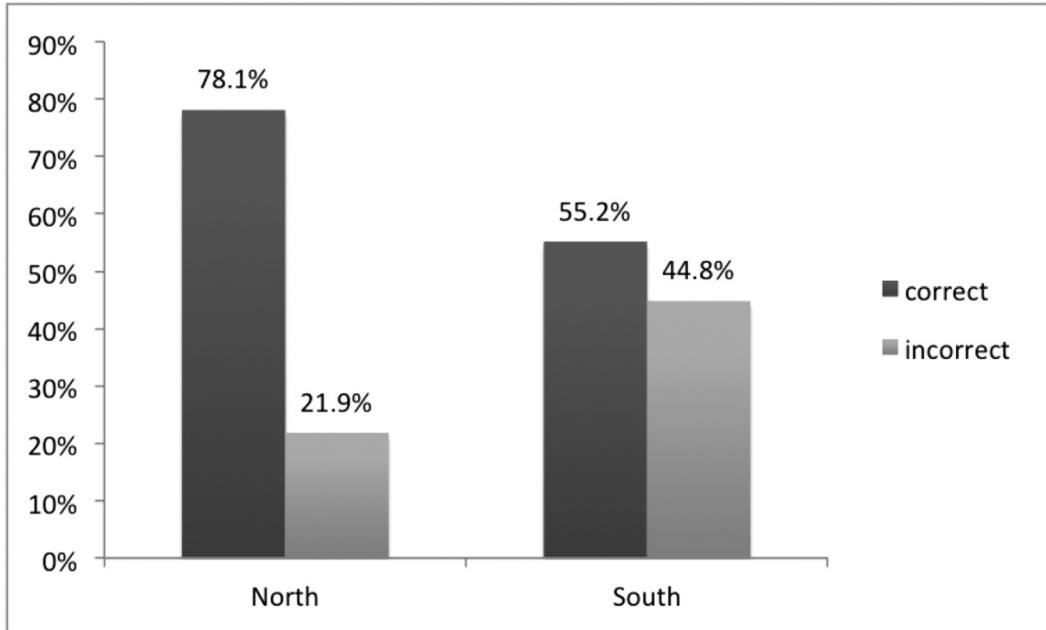
There were significant differences in the attitudes of fishermen from the north vs the south regarding cetaceans ( $\chi^2 = 12.252$ ,  $p = 0.016$ ). Overall, 21.9% of fishermen from the north had a positive attitude towards cetaceans compared to 10.3% of fishermen from the south. In the southern region, 17.2% of respondents had a negative attitude towards cetaceans compared to none from the northern region (Figure 7).

#### *Bycatch*

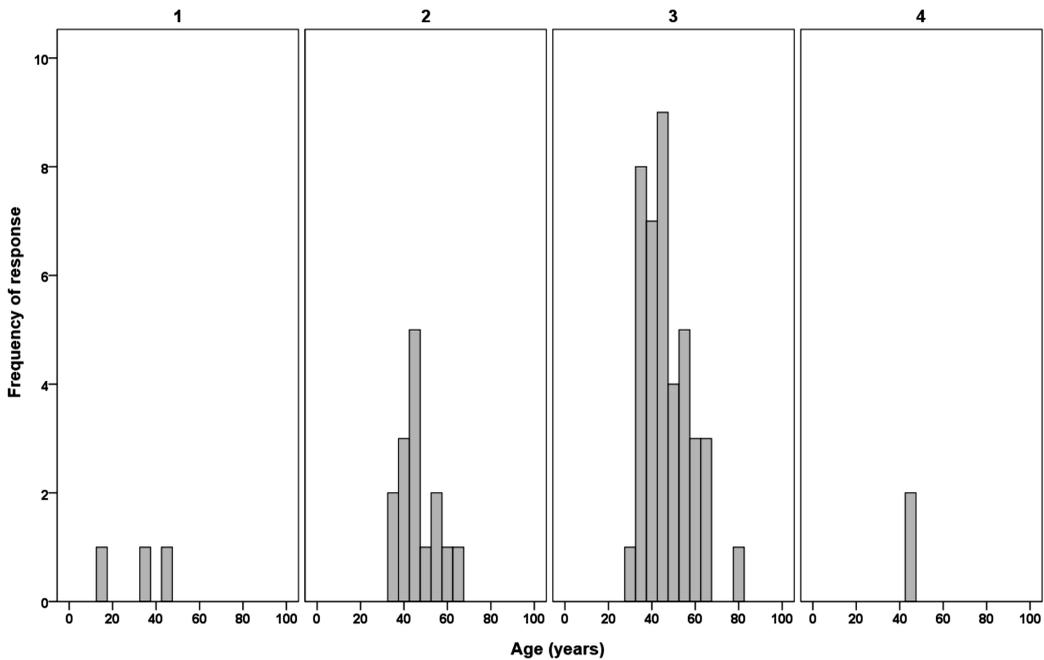
Regarding the impact of dalyans on cetaceans, the fishermen stated that they rarely find entangled cetaceans in dalyans. Only five instances of cetacean mortality in dalyans have been reported to our team over the last three years: two dead bottlenose dolphins (one in Kavarna and one in Sinemorets) and three dead harbour porpoises found in Ahtopol.

#### *Tackling the Problems*

Interviewed fishermen provided a more detailed picture of situations when they found cetaceans in their gear. For better awareness, the researchers extended the structured interviews with informal discussions on measures undertaken by the fishermen to deal with cetaceans. Most of the fishermen



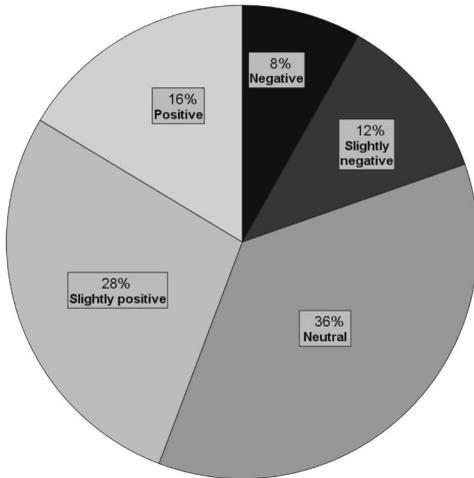
**Figure 4.** The percentage of correct and incorrect answers to the question, “How many species of cetaceans do you know in the Black Sea?” divided by region



**Figure 5.** Correlation between the age of respondents and their answers to the question, “How many species of cetaceans do you know in the Black Sea?” The range in responses is between 1 and 4, and each block in the figure presents an answer. The correct answer is 3.

(61%) explained that the dolphins or porpoises leave the dalyan on their own without any human engagement, 32.8% said that they catch and move the animals away from the net, and 4.9% reported killing the animals. Analysis of these data did not identify significant differences between the northern and southern regions about how fishermen deal with cetaceans that had entered their gear ( $\chi^2 = 3.020, p = 0.389$ ). Regarding fishermen's preferences of which method is most useful to reduce damage caused by cetaceans, 51.7% of those from

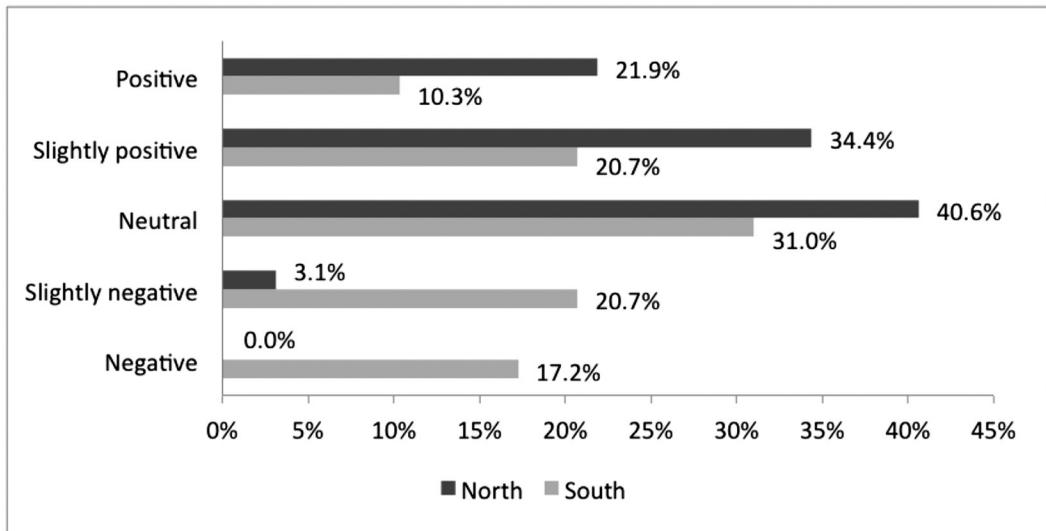
the south vs only 31.3% from the north considered culling as the only effective method ( $\chi^2 = 26.028, p < 0.001$ ). There is a statistically significant relationship between fishermen's attitudes and the measures proposed by them ( $\chi^2 = 32.6, p = 0.37$ ). The result shows that fishermen with a negative attitude mostly recommend culling, and those with a positive attitude cite mainly using disturbance measures. The research team also acquired information on the fishermen's practical measures to prevent cetaceans from entering the dalyans. Many fishermen placed additional nets around their gear to protect it. Another method was to place a scarecrow on a boat positioned next to the gear. Some fishermen admitted to using dynamite to scare the animals.



**Figure 6.** Percentage ratio of fishermen's attitudes towards cetaceans

### Discussion

In this study, results are presented from an investigation of the interactions between Bulgarian fishermen using traditional fishing gear (dalyan) and local odontocetes (bottlenose dolphin, common dolphin, and harbour porpoise). This study is the first to attempt to assess the conflict between fisheries and cetaceans in the Bulgarian Black Sea territorial waters. Despite widespread complaints in the region and an increase in attention to the problem, no detailed information was available on this topic. As an initial effort, this study did not aim to fill all knowledge and management gaps. Instead, the objective was to start building a quantitative assessment of the basic dimensions of the fishermen-cetacean conflict.



**Figure 7.** Fishermen's attitudes towards cetaceans in the two Bulgarian Black Sea regions

From the research perspective, the methods of collecting and analyzing information provided opportunities for closer contact with fishermen (Lien et al., 1994; Wise et al., 2007). Considering that in most cases small cooperatives operate the dalyans, this study focused on the fishermen's personal experiences, attitudes, and solutions. The survey respondents accepted the study approach and methodology well and shared their opinions on all questions openly. The reason for their cooperation may be due to the understanding that they are unlikely to solve the problem of cetacean–fisheries interactions alone and their desire to gain broader public, political, and technical support. Firstly, the study focused not only on building a complex picture of the situation across the Bulgarian Black Sea territorial waters, but also to identify the differences between the two subregions (north and south). Secondly, the study aimed to understand the role of the fishermen's age on attitudes towards cetaceans. Both observations were intended to provide a baseline for establishing a consolidated approach to conflict mitigation through systematic monitoring, research, and awareness.

The results revealed a considerable conflict due to damages caused by cetaceans to fishermen's traditional fishing gear and the subsequent loss of catch, time, and money. Damages to dalyans are in the form of holes torn in the nets as the cetaceans attempt to remove fish. Moreover, there is a reduction in the amount or value of the catch as the cetaceans mutilate or remove caught fish from nets. Such results have been observed in other studies in Europe, although on different fishing gear (Reeves et al., 2001; Lauriano et al., 2004, 2009). Most fishermen demonstrated strong concerns about their livelihood because of the inability to be compensated for damages caused by cetaceans. In their view, with increased demand for fish due to a continuing tourism boom, any severe catch loss could lead to a cessation of their business. The generally negative attitude towards marine mammals is also fed by the fishermen's impression that the number of cetaceans in Bulgarian territorial waters is rising rapidly. The fishermen consider the perceived increase in cetacean population as the primary reason for attacks on their dalyans. However, according to the latest survey from 2014–2015, the number of marine mammals is estimated as 8,207 individuals (Min–Max: 2,752 to 13,662) for common dolphin, 1,057 individuals (Min–Max: 613 to 1,500) for bottlenose dolphin, and 4,886 individuals (Min–Max: 128 to 9,643) for harbour porpoise (Black Sea Research Program NOAH [BSRPN], 2015). Such high population estimates from the fishermen probably result from the frequent interactions they have with these marine mammals. The

frequency of interactions is likely to represent a strong psychological factor in the fishermen's perceptions (Lauriano et al., 2004).

This study also investigated the seasonal rate of cetacean interaction and damage to dalyan sets. In both regions, severe incidents have been reported in the spring and autumn when the dalyans are in the water most of the time and the fishing season is at its peak. The climate differences on the northern and southern Bulgarian coast (Penin, 2007) obviously do not affect the seasonal use of dalyans.

Concerning the fishermen's knowledge about cetaceans, the results of this study indicated a general lack of awareness, especially among the younger generation. Knowledge about the different species of cetaceans is essential because they behave differently and have varying seasonal dynamics by species; their effective differentiation may help fishermen find better ways to address the issues. Some respondents voiced dissatisfaction with the strictly protected status of the odontocetes, saying that the catch quotas for these marine mammals that were in place at the beginning of the last century should be brought back (Nikolov, 1963). Regarding the impact of dalyans on cetaceans, the indication is that the number of dead bottlenose dolphins in the examined dalyans for the last three years (two individuals in total) may be too small to have a negative impact on the species population. The same goes for the dead harbour porpoises—only three individuals for three years have been reported. Such low numbers suggest that dalyan nets are not an obstacle or threat to cetacean populations, although they may cause mortality in some cases. The construction of the dalyan itself, as well as the type of net used, is not a significant impediment for cetaceans as they are free to enter the gear and often leave it unharmed.

During the survey, the research team acquired additional information on the fishermen's practical measures to prevent cetaceans from entering the dalyans. Many fishermen place additional nets around their gear, which proved not to be particularly useful because the cetaceans go through them easily. Another method was to place a scarecrow on a boat next to the gear. The fishermen said that this method is only effective short-term because after a day or two, the cetaceans acclimate to the scarecrow and attack the dalyans again. Some fishermen admitted to using dynamite to keep the animals away, which is a criminal act. The use of such dangerous methods to deal with cetaceans was reported in other studies as well (Reeves et al., 2001; de Stephanis, 2004). Often, fishermen guard the dalyans in person at night and shine spotlights from their boats; this method

works well until the boat gets too far away or they turn off the spotlights. The research team sees the fishermen's reality as complicated and controversial. Due to insufficient knowledge of the species and poor awareness about modern methods (such as pingers) for avoiding cetacean–fisheries interactions, the fishermen's preventive measures were mostly improvised and ineffective. According to interviewed Bulgarian fishermen, the most effective action to limit the damage caused by marine mammals is to reduce their numbers through culling. Such measures were used in the past in Italy and former Yugoslavia; rewards were paid for killed dolphins, which were considered vermin to be eradicated (Holcer, 1994). Another example is a study on the Balearic Islands that estimated that the interaction between dolphins and fisheries led to a 6.5% reduction of the total landed catch value due to fish loss and net damage. Although the loss is not catastrophic, the perception of it was significant enough for some fishermen to call for dolphins to be culled (Brotons et al., 2008). According to interviewed fishermen, compensation for lost catch is an option, but they do not believe that the government will ever implement such measures (personal communication with fishermen). At this stage, there are no statistics available for the Bulgarian Black Sea on these conflicts and the respective financial losses, and, thus, no appropriate compensation is stipulated for fishermen by the government. In the entire Black Sea region, there is no management procedure or even an approach to address and mitigate cetacean depredation (Birkun et al., 2006).

In conclusion, the study recognized and elucidated a substantial ongoing conflict between fishermen using dalyans and local cetaceans in the Bulgarian Black Sea territorial waters. Frequent damage from cetaceans to the dalyan fishing gear has led to economic losses. Combined with the ineffective measures that fishermen apply against cetaceans, these attacks on the gear are the root cause of the conflict. From the perspective of the fishermen, it has profound consequences for their livelihoods, both directly and indirectly, as they suffer from damage to their gear and a decrease in fishery catches. There is generally a more negative attitude towards cetaceans by fishermen from the southern region who are also more extreme in their opinions on what measures should be taken to minimize the damage. At this stage, we cannot tell why there is a difference in fishermen's attitudes in the two regions. Further study on this question is needed because it may be that management approaches in the two regions should be different. In terms of the impact on the local marine mammals, the study identified infrequent cases of entanglement and death.

### *Recommendations*

At present, there does not appear to be any one simple panacea that will solve the cetacean–fisheries conflict (ACCOBAMS, 2004). Recognizing the existence of competitive interactions is considerably easier than devising a strategy to minimize such interactions (Lauriano et al., 2004). The present study found sufficient commonalities between the cetacean–fisheries conflict in Bulgaria and in other European countries (Cannas et al., 1994; Gazo et al., 2001; Reeves et al., 2001; Lauriano et al., 2004, 2009; Díaz López, 2012). The interviews with the fishermen also highlighted similar needs for conflict management. Possible strategies for improving the situation in Bulgaria include better communication and knowledge-sharing with the fishermen, modernization of fishing methods and tools, and the establishment of a partnership network for systematic research and monitoring to provide evidence-based assessments and recommendations (Birkun et al., 2006).

It is of utmost importance to improve the fishermen's knowledge about local cetaceans. The expected outcome could be the construction and use of fishing gear with the goal of both better protecting the catch and saving cetacean lives. Well-designed educational campaigns could increase awareness of modern methods for conflict mitigation consistent with the biology and ecology of the marine mammals. A practical and sustainable resolution of the conflict could require research on the potential impact of one of the most widely used methods: acoustic repellent devices (e.g., pingers; Jefferson & Curry, 1996). Overall, acoustic tools to minimize cetacean predation should be used cautiously. Additional research should be performed to determine how and if acoustic repellent devices work, and under what circumstances, as well as the nature and extent of any ill effects that they might cause (ACCOBAMS, 2004). Creating financial opportunities for fishermen to acquire pingers can lead to a change in their attitudes towards cetaceans by reducing damages. Finally, establishing contacts and working relationships between Bulgarian scientific organizations, local and national institutions, and fishing associations would be useful for effective management of local fishery resources and protection of Black Sea biodiversity.

### **Acknowledgments**

We thank the fishermen who took part in the present study, allowing us to see their fishing gear and sharing their experiences. Special thanks to Vladimir Kamenov from the Agency for Fisheries and Aquaculture Burgas for consultation and invaluable assistance in collecting the data. We

would like to thank Katerina Zareva from the Ecological Science and Educational Center of the Sofia Zoo for participation and help during the fieldwork.

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