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Fishers' Perception on the Interaction between Dolphins and Fishing Activities in Italian and Croatian Waters

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Abstract: Interactions between fishing and dolphins can be detrimental, since on one hand dolphins can be lethally entangled by nets and trawls, and on the other dolphins can predate fish caught by nets. For dolphins, this interaction can be dangerous as they can be wounded or accidentally killed; for fishers, the predation of their catch results in economic losses due to reduced quantity and/or quality of catches and damage to fishing gear. During July and November 2020, we surveyed the "dolphin–fisheries conflict" through compiling 209 fisher interviews from nine locations in Italy and Croatia. Fishers mentioned the common bottlenose dolphin (*Tursiops truncatus*) as the species primarily interacting with fishing, with the major issue being catch damage by predation. The interaction probability varied among gears and seasons, with some fishing activities (e.g., passive nets) more affected than others (e.g., bottom trawls), especially in terms of economic loss (1000–10,000 €/year on average). More than 70% of the fishers claimed that dolphin populations have increased over the last 10 years, in different degrees and based on different areas. Dolphin bycatch rates are generally low; however, 34.6% of respondents reported having captured at least one dolphin during their career. The fishers' attitude towards acoustic deterrents ("pingers") as a mitigation measure revealed that few of them were aware of these devices or were using them.

Keywords: dolphin–fisheries interaction; bottlenose dolphin; fishers' ecological knowledge (FEK); bycatch; Mediterranean Sea

1. Introduction

The interactions between fishers and dolphins (family *Delphinidae*) in the Mediterranean Sea have a long and often controversial history. The earliest reports depict idyllic relationships between dolphins and humans, such as the care shown by fishers for dolphins accidentally entangled in nets described in Plutarch's Moralia [1], or the alliance between dolphins and fishers for cooperative fishing, as reported by Pliny the Elder [2]. In contrast, interactions with fisheries are currently considered one of the most pressing anthropogenic threats for many cetacean species inhabiting the basin [3]. Among these, the common bottlenose dolphin (*Tursiops truncatus*) is considered to be the most involved species due to its wide distribution, including coastal synanthropic areas which largely overlap with the majority of the Mediterranean fishing areas (in particular, those exploited by the artisanal fleets [4]). Moreover, the bottlenose dolphin has both a high adaptability to human activities and opportunistic feeding habits, which together allow this species to take advantage of foraging opportunities provided by fisheries [5–7].

The so-called "depredation", i.e., the behavior in which a predator damages or kills prey species, usually in the form of a raid on the fishing gear [8], is arguably the most common and reported type of interaction between bottlenose dolphins and fishing activities [9]. In passive set net fisheries, evidence of depredation by bottlenose dolphins on passive gears (namely, gillnets and trammel nets) have been reported in several Mediterranean areas [4]. In trawl fisheries, the "trawler foraging", as defined by [10], is a well-documented strategy adopted by *T. truncatus* throughout the Mediterranean basin [11]. It consists of following the trawlers to feed on organisms inside the net, entangled in the meshes or discarded by fishers [11]. To a lesser extent, conflictual interactions have been reported in purse seine, long-line and hand line fisheries [12].

The main consequences for the fishery sector are the economic losses due to net depredation and the consequent reduction in the quantity and/or quality of the catch [5,13], along with damages to the fishing gears caused by the dolphins' incursions [5,14,15]. On the other hand, although dolphins may benefit from depredating fish from nets, the proximity to the fishing gears exposes them primarily to accidental entanglement or capture, defined as "bycatch". In addition, the active contact with nets/fishing gear may result in sub-lethal and long-term effects, including decreased reproductive capacity, debilitating lesions, behavioral alterations, gastric impaction and/or larynx strangulation due to the ingestion of fishing gear or fragments [16]. Another threat posed by the dolphin-fisheries interactions is the voluntary wounding or killing as a retaliatory action by the fishers towards the animals, in an attempt to protect their catch or gear [3,17].

Currently, quantitative estimates of dolphin bycatch are lacking for many Mediterranean areas [4]. However, the Commission Delegated Decision (EU) 910/2019 [18] regarding Regulation (EU) 1004/2017 [19] on EU framework for the data collection requires data on bycatch of all mammals in all types of fisheries during scientific observer trips, either on fishing vessels or by the fishers themselves through logbooks.

One of the main technical solutions to address the interactions between dolphins and fisheries resides in the use of acoustic deterrent devices on fishing gear such as "pingers". The basic principle behind these devices is to create an alarm sound, a warning that is distracting enough to displace animals from the vicinity of fishing gear. Generally, they work by broadcasting a variety of acoustic signals, depending on the manufacturer's brand specification, from middle to high frequencies (10–180 kHz) at relatively low intensity (Sound Pressure Level < 150 dB re 1 μPa at 1 m; [20]). The effectiveness of these devices depends on the pinger type, dolphin species and area investigated [21,22]. Concerning *T. truncatus* in the Mediterranean, no conclusive results have been determined so far; however, even though pingers do not exclude the bottlenose dolphin interaction, they may help to reduce its effects [23].

A better understanding of the "dolphin–fisheries conflict" in the Mediterranean can be achieved through on-board observations; however, this approach is time-consuming and cost-intensive, and reliable information can only be obtained through a massive sampling effort. In addition, data from artisanal fisheries are particularly difficult to obtain due to different constraints (lack of space on board, difficulty in reaching the landing points, etc.).

An alternative approach to assess the interactions between fishing activities and megafauna, where information is scarce or lacking, is through gathering data by interviewing fishers [24]. The fishers' ecological knowledge (FEK) can support the scientific research by providing a useful human dimension information on the ecology, behavior, abundance and distribution of cetaceans [25,26], as well as on the identification of potential high-risk gear/location/season combinations [24,27,28].

In the present study, interview surveys were used to collect FEK data on the interactions between dolphins and fishing activities within several Italian and Croatian areas. The aim of this work was to identify the perception of fishers from Italy and Croatia on (i) the type and extent of interactions between fishing and dolphins, (ii) the economic impact due to these interactions on dolphin populations, and (iii) on using acoustic deterrent devices (pingers) to displace dolphins from the fishing gear.

2. Materials and Methods

2.1. Data Collection through Interviews

The interview surveys were conducted in different Italian and Croatian areas as part of the Life DELFI project (LIFE18 NAT/IT/000942), aiming at reducing the interactions between dolphins and fishing activities. Trained interviewers met the fishers at the harbors, onboard fishing vessels, and during ad hoc meetings with fishers' associations. The interviewers were left free to choose the most appropriate technique for collecting information from the fishers based on three different approaches:

Option 1: Question–answer interview. This option is the most convenient, since it allows respondents to precisely fill in the questionnaire entries, however it requires the fisher to be very keen in terms of time to reply. The data entries were collected through printed forms or a smartphone/tablet using Google Forms.

Option 2: Colloquial interview. This option is preferable when the fisher is not completely available for the interview because it may take too much time. In this way, instead of following the question–answer structure, the interviewer can chat in person or talk on the phone with the fisher to obtain useful information.

Option 3: Direct data entry by the fisher. This approach has been adopted only when the questionnaire was distributed during dedicated events or meetings to maximize time and resources. In this case, at least one person was required to support the data entry.

A "snowball" sampling technique was used for the interviews. Briefly, randomly chosen fishers indicated future study subjects from among their acquaintances [29,30]. Each questionnaire, given to the interviewee, consisted of 19 questions with multiple answers grouped into 3 sections (about 15 min; Supplementary File S1). Before administering the questionnaire to the fishers, they were shown fact sheets on the three dolphin species regularly present in the Mediterranean i.e., common bottlenose dolphin, short-beaked common dolphin (*Delphinus delphis*) and striped dolphin (*Stenella coeruleoalba*), for obtaining information about the species to which they interact the most. For the purpose of this study, only the data from Sections 1 and 2 were considered (Supplementary File S1), because Section S3 is aimed at gathering information concerning the possible involvement into the future activities of the project. Sections S1 and S2 mainly consisted of closed-ended questions to collect quantitative and factual information; respondents were also required to give an opinion on a certain topic. Section S1 focused on obtaining all the necessary information on the dolphin presence and interaction with all of the fisheries and fishing methods; Section S2 focused on the respondent's opinion towards pingers as mitigation devices, since they represent the most common devices produced on a commercial scale and are already employed by fishers [31].

Any extra information was reported in a specific section "Interviewer's notes" (Supplementary File S1), where personal opinions about the following points were reported (if any):

- Feelings about the honesty of the fisher in answering the questions;
- Feelings about the interest and involvement of the fisher;
- Feelings about the precision of the fisher in answering the questions;
- Useful details for the questionnaire's goals.

This additional information was considered in the following data treatment to validate each questionnaire.

2.2. Data Treatment

The information obtained from the survey has been primarily divided by GSAs (Geographical Sub-Areas) and fishing gear. Data was considered useful when at least 5 interviews per gear and area were collected. We used descriptive statistics (i.e., means, standard deviations and percentages) to quantitatively describe and summarize the data. An interaction probability (P_i) for each season (Spring: 21 March–20 June; Summer: 21 June–22 September; Autumn: 23 September–21 December; Winter: 22 December–20 March) and gear was then calculated based on the fishers' score. This score ranged from 1 to 4, with 1 being the lowest interaction probability and 4 the season with the highest one. Scores were then normalized to the 0–1 interval and displayed as a local polynomial regression fitted to the sample data with 95% confidence intervals. The R packages *ggplot2*, *likert* and *ggalluvial* were used to plot the figures.

3. Results

A total of 209 interviews were collected between July and November 2020 in 9 different Italian and Croatian macro-areas (Figure 1), grouped by GSAs to facilitate consultations.

All of the respondents were currently active fishers and the average age, independently of the area, was 52 (SD: 11, range: 25–76). On average, they had 31 years (SD: 13, range: 1–65) of experience in the fisheries sector. Eight fishing gears were reported by fishers of different areas as the primary gears in their activity: set nets (GEN according to FAO classification of fishing gears; [32]), bottom otter trawls (OTB), mid-water pair trawls (PTM), longlines (LL), hand lines (LHP), pots (FPO), purse seines (PS) and spearfishing (MHI). However, LHP, FPO, PS, and MHI were not included in the analysis due to their low occurrence, i.e., less than in 5 interviews by area. Therefore, 196 interviews were considered for further analysis.

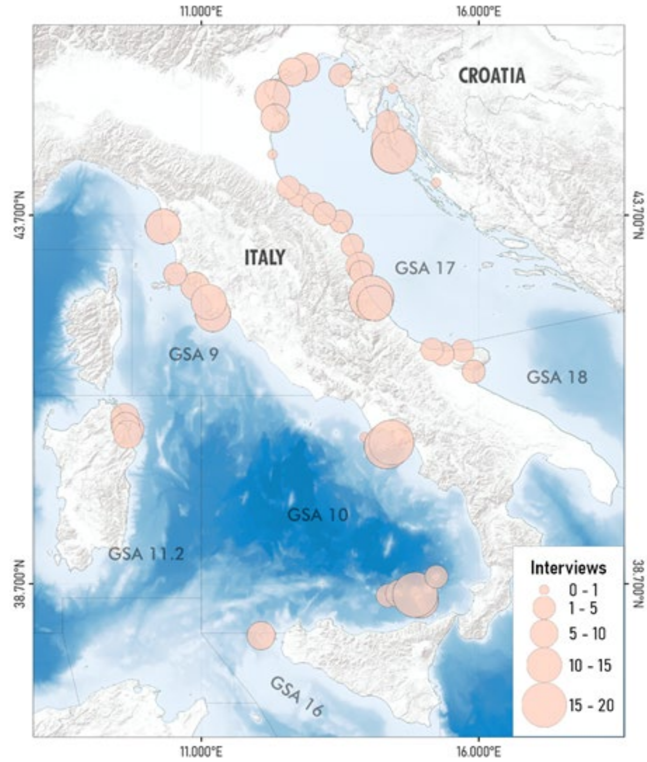

Figure 1. Study area. The orange circles indicate the number of respondents by area.

3.1. Interactions

Among the 3 species of free-ranging dolphins (*D. delphis, S. coeruleoalba, T. truncatus*) regularly occurring in Italian and Croatian waters, all of the fishers indicated the bottlenose dolphin as the species primarily interacting with fisheries. Only those fishers operating with lines (LL and LHP) in GSA10 also reported *S. coeruleoalba* as a frequently sighted species during their activities.

Regardless of the fishing gear used, 88.0% of the respondents (n = 176) stated that they experienced interaction with dolphins in their careers. Table 1 shows the type of interaction with dolphins grouped by GSAs and fishing gear. Overall, the fishers reported damages to their catch (58.7%, n = 115) as the primary outcome, followed by net depredation (i.e., fisher's perception of the catch removal from the net; 56.1%, n = 110) and damage to fishing gears (22.5%, n = 84) (Table 1). Some fishers (20.0%, n = 44) additionally reported that dolphins are responsible for reducing catch efficiency by scaring and scattering the school of fish in the proximity of the net ("catch scattering"; Table 1).

Fishers using set nets (GEN) declared that catch damage is the most predominant interaction (31.6% regardless of the GSA), followed by net depredation (29.1%) and net damage (25.6%); usually, these three interactions are associated (Table 1). Few fishers thought the dolphins were responsible for catch scattering (9.8%), while the remaining 3.9% declared not to interact with dolphins. By contrast, bottom trawlers (OTB) did reveal a higher percentage (12.9%, regardless of GSA) of "no-interaction" with dolphins; only in GSA 17-C (the Croatian sector) did all the fishers agreed to have always experienced interaction with dolphins (Table 1). The highest percentages for OTB were observed for both net depredation and damage to the catch (32.9% for both). The net depredation seemed to be the main issue in the Adriatic Sea (for both the Croatian and Italian sectors).

The catch scattering, with a consequent reduction of catch efficiency, was the prevailing form of interaction (70%) occurring in the midwater pair trawl fishery (PTM) of the northern Adriatic Sea, Italian sector (GSA 17-I). In the longline fishery of GSA 10, the most critical issues were the bait or catch depredation and catch scattering (37.5% for both; Table 1).

Table 1. Type of interaction reported by fishers grouped by GSA and fishing gear. OTB: bottom trawls; GEN: set nets; LL: longlines; PTM: mid-water pair trawls; f: frequency for each answer, in both number of answers and percentages.

GSA	Fishing Gear	Type of Interaction									
		No Interactions		Net Depredation		Damage to the Catch		Damage to the Gear		Catch Scattering	
		f	%	f	%	f	%	f	%	f	%
9	OTB	2	14.3	3	21.4	6	42.9	3	21.4	3	21.4
	GEN	2	11.1	11	61.1	4	22.2	4	22.2	1	5.6
10	LL	0	0.0	3	60.0	1	20.0	1	20.0	3	60.0
	GEN	5	11.9	21	50.0	34	81.0	33	78.6	12	28.6
11.2	GEN	0	0.0	4	40.0	6	60.0	4	40.0	2	20.0
16	GEN	0	0.0	3	27.3	11	100	7	63.6	0	0.0
17-C	OTB	0	0.0	6	66.7	9	100	3	33.3	0	0.0
	GEN	0	0.0	12	100	9	75.0	0	0.0	0	0.0
17-I	OTB	5	22.7	12	54.5	8	36.4	3	13.6	3	13.6
	GEN	4	11.1	27	75.0	24	66.7	23	63.9	13	36.1
	OTM	0	0.0	1	14.3	1	14.3	1	14.3	7	100
18	OTB	2	40.0	2	40.0	0	0.0	0	0.0	0	0.0
	GEN	0	0.0	5	100	2	40.0	2	40.0	0	0.0
Pooled GSAs	GEN	11	3.9	83	29.1	90	31.6	73	25.6	28	9.8
	LL	0	0.0	3	37.5	1	12.5	1	12.5	3	37.5
	OTB	9	12.9	23	32.9	23	32.9	9	12.9	6	8.6
	PTM	0	0.0	1	10.0	1	10.0	1	10.0	7	70.0
Total		20	10.2	110	56.1	115	58.7	84	22.5	44	20.0

Figures 2 and 3 display the estimated interaction probability P_i between dolphins and fishing activities throughout the seasons in the different GSAs and for the different fishing gears. In general, P_i is always significantly above 0% for each fishing gear (GEN, OTB, LL, PTM) regardless of the GSA, highlighting a constant dolphin–fisheries interaction (Figures 2 and 3). Regarding GEN, both Spring and Summer evidence the highest interaction (70% on average), which slightly decreases towards Autumn and Winter, down to around 60% on average. The general P_i trend for OTB shows a constant decrease from Spring (90% on average) to Winter (50% on average). The wide P_i fluctuations for LL and the wide confidence intervals reflect the low number of respondents for this gear; however, the highest interaction probability occurs in Autumn. Finally, PTM displays the highest interactions with dolphins among all the gears, since P_i remains above 90% (on average) in all seasons (Figure 3).

In set nets fisheries, P_i revealed a noticeable seasonal trend in the GSAs 9,17-I and 18, with maximum values in Summer, decreasing gradually towards Winter, when P_i reached the minimum level (Figure 2). Less pronounced or opposite trends (maximum peak during cold months) were reported for the GSAs 10,16,17-C (Croatian sector) and GSA 11.2, respectively.

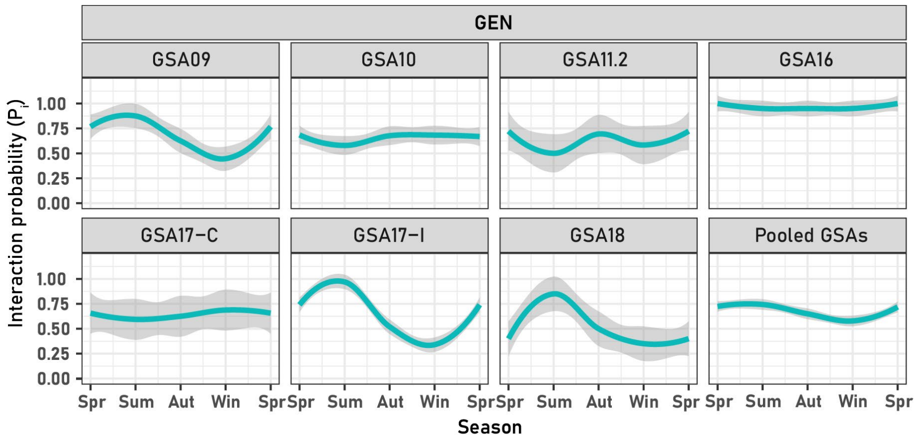

Figure 2. Interaction probability (P_i%) between dolphins and fishing activities throughout the seasons in the different Geographical Sub Areas (GSAs) for the set nets (GEN). The cyan line represents the average trend, while the grey shadowed areas represent the 95% confidence intervals.

Concerning bottom trawl fisheries, minimum interaction values during the Winter were also prevalent in the central and northern Adriatic Sea, both on the Italian and Croatian sides (Figure 3). Finally, fishers from both the North Tyrrhenian Sea and the Adriatic Sea reported that the extent of interactions with bottom and mid-water trawlers remains high, and stays mostly the same throughout the year (Figure 3).

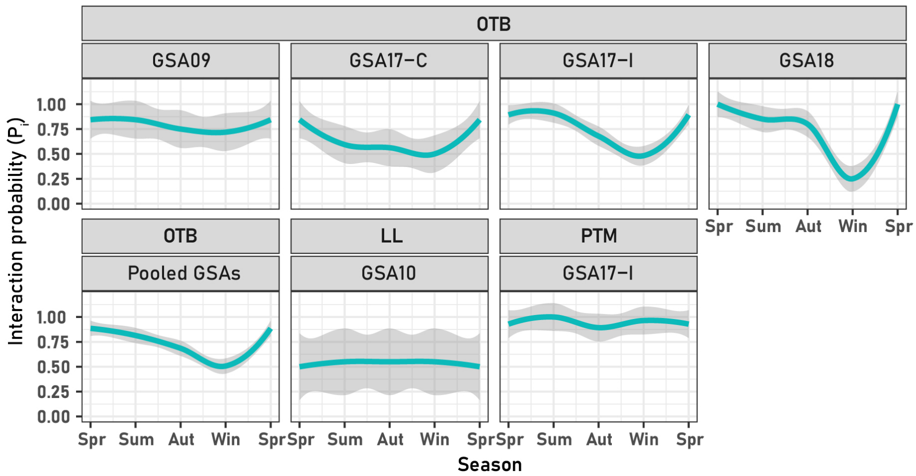

Figure 3. Interaction probability (P_i%) between dolphins and fishing activities throughout the seasons in the different Geographical Sub Areas (GSAs) and for bottom trawl (OTB), longline (LL), and midwater pair trawl (PTM). The cyan line represents the average trend, while the grey shadowed areas represent the 95% confidence intervals.

3.2. Economic Loss

Figure 4 shows the economic loss caused by the dolphin interaction in different GSAs. The economic loss included both the catch and the gear damages. Quantitative estimates have been obtained only for set nets, bottom trawls and longlines. Regardless of the area and fishing gear, the economic losses were estimated, on average, to be from EUR 1,000 to 10,000/year. Overall, the fishers operating with bottom trawls reported a lower economic loss than those operating with set nets. This difference was significant in GSA 18 but not in the GSA17-I, C and GSA 9 (Figure 4). More than one-third of the respondents (39.8%, n = 78, mainly using bottom or midwater trawl nets) stated that interactions with dolphins had no associated financial costs, or such costs were negligible i.e., between EUR 0 and 1,000/year. On the contrary, 60.2% (n = 118) of respondents (mainly using set nets and longlines) reported significant damage to their gear and catch: approximately 30.6%

(n = 60) of respondents suffered economic loss between EUR 1,000 and 5,000/year, and another 14.3% (n = 28) indicated costs of between EUR 5,000 and 10,000/year. The remaining 15.3% of the respondents (n = 30), mostly using set nets, estimated a financial loss exceeding EUR 10,000 annually. On average, the artisanal fishers estimated an annual economic loss of EUR 4,519.7 ± 4,807 (S.D.). In particular, those operating in both the GSAs 16 and 17 quantified the highest economic losses, which were reported to be up to EUR 20,000/year in the northern Adriatic Sea, Italian side (Figure 4).

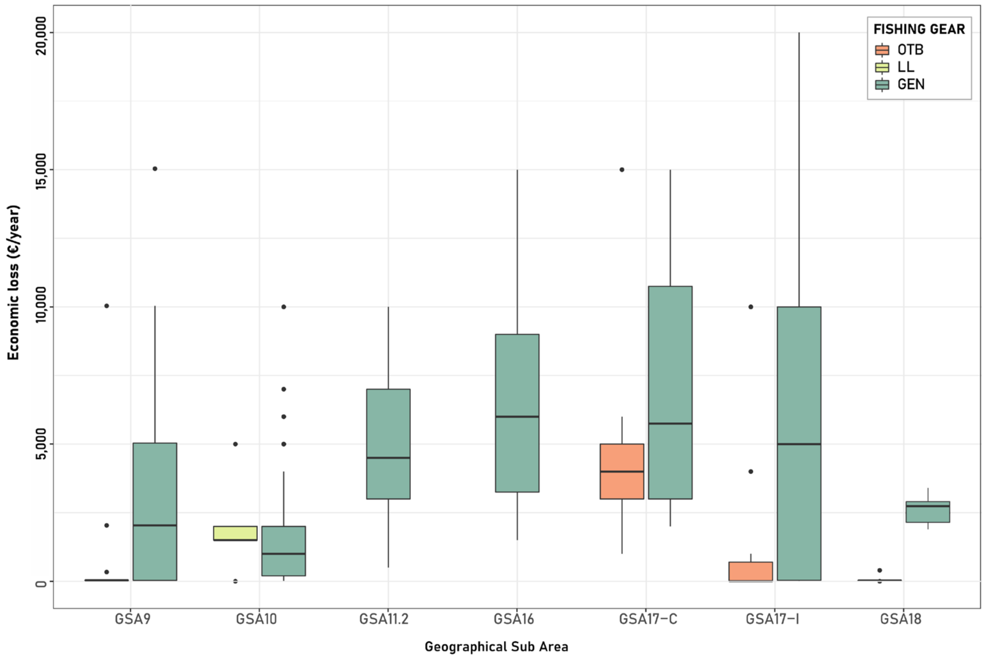

Figure 4. Estimated annual cost of damages caused by dolphins organized by area and type of fishing gear (set nets: GEN, bottom trawl: OTB, longlines: LL).

3.3. Trends in Dolphin Population

Overall, the majority of the fishers (74.0%, n = 145) claimed that dolphin populations have increased dramatically over the last 10 years, followed by 12.8% (n = 25), perceiving that the population is consistent. Only 7.9% (n = 14) perceived that the population has decreased, while 5.1% (n = 10) did not provide an estimate. However, these results vary in the different GSAs (Figure 5). For example, the fishers operating in GSA 9 and GSA 17-C unanimously perceived an increase in the dolphin populations, and the majority of them estimated that the population has tripled. In the other GSAs, the perception of the dolphin population increase was claimed by 40–78% of the respondents, while 9–40% declared that the population is consistent and 1–21% has decreased (Figure 5). In GSAs 9, 10, 11.2, 17-I, it is interesting to note that a range of 11–20% of the fishers who reported a population increase assessed that it has quadrupled. However, the majority of fishers (31–50%) reporting a population increase in all the different GSAs assessed that the dolphin population has doubled (Figure 5).

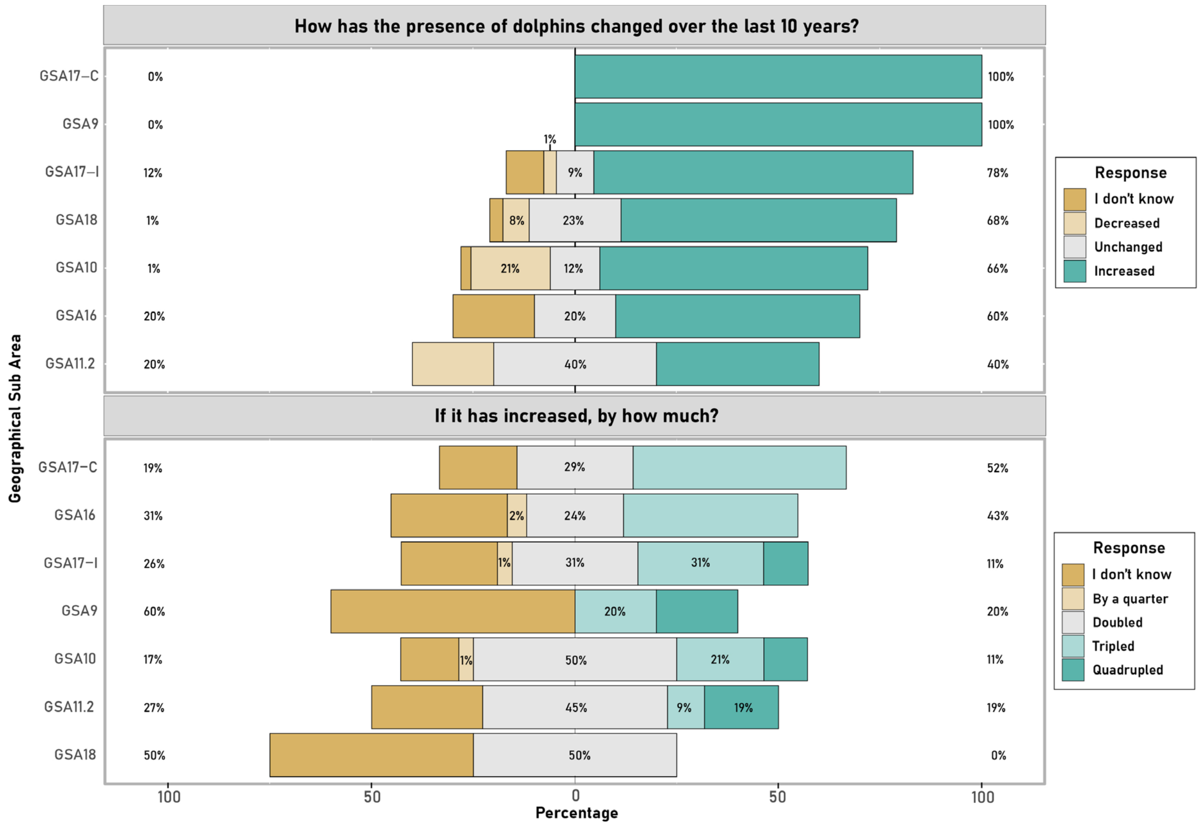

Figure 5. Dolphin population trends in the last 10 years, as perceived by the fishers interviewed. The original questions are shown in bold as the title of each barplot, while the possible responses are included in the corresponding legends.

3.4. Bycatch

More than a third (34.6%, n = 68) of the fishers stated that the incidental bycatch of dolphins has occurred at least once in their fishing activity, identifying the bottlenose dolphin as the sole species bycaught. Incidental catch cases were found in each area and fishery surveyed, except in GSA16, where the respondents declared exclusively the opposite (i.e., bycatch never happened).

The midwater pair trawling of the GSA17-I had the highest proportion of respondents (75%) reporting at least one bycatch event, with 62.5% declaring that the bycatch occurred several times (Figure 6). The survey revealed a high incidence of dolphin bycatch also in set nets fisheries, where, in all the GSAs except for GSA16, a range of 17–60% of the respondents declared to have caught a dolphin at least once, with the highest percentages in Croatia (62%) and Sardinia (60%); 3–40% of them declared to have caught dolphins several times (Figure 6).

A lower incidence of the unintentional dolphin catch was observed from data on the bottom trawl, since most respondents (70%, n = 35), regardless of the area, claimed that such an event had never occurred. By contrast, 15 respondents (30%) stated that dolphin bycatch occurred once or several times during their careers.

The fishers operating with set nets, regardless of the area, reported catching 0.14 animals per vessel on average yearly, while trawlers (both OTB and PTM) reported slightly lower rates (0.10 animals × vessel^{-1} × year^{-1}). Interestingly, all set net fishers, who in the past employed the driftnets targeting large pelagic species, also known as “spadara nets” (illegal since 1998; [33]), said that they regularly caught dolphins with those nets, up to many times during the year. Regarding the bycaught dolphin mortality, only a small fraction of the fishers (20%, n = 13) reported having released the animals still alive, while most of them (80%, n = 55) stated that the dolphins probably died during the fishing operations (primarily in the bottom and midwater trawl fisheries). However, regardless of the release condition, the fishers said they managed the situation by disentangling the animal. Only 4 fishers added that the incident was reported to a reference authority (e.g., coast guard). On the contrary, another fisher opted for the release at sea without reporting it "for fear of legal consequences".

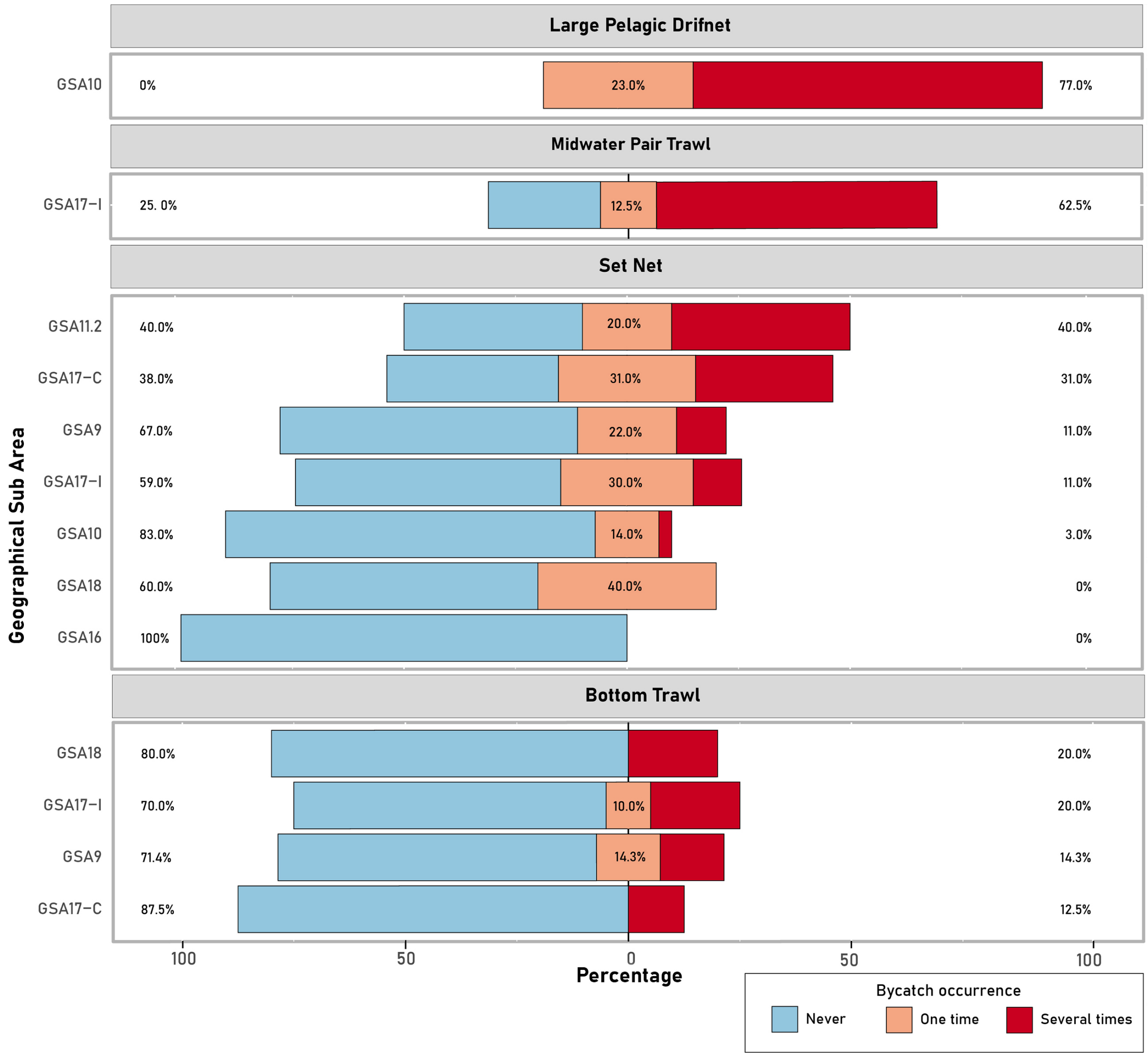

Figure 6. Bycatch occurrence by percentage and organized by Geographical Sub Area (GSA) and type of fishing gear. The barplot represents responses to the questions "Did you ever accidentally catch a dolphin?", "If yes, which gear was by?", and "How many times has it happened? (number of bycatch events/years of activity)".

3.5. Fishers' Attitude towards Pingers

The pingers, presented as a possible mitigation measure to reduce the dolphin–fisheries conflict, were the subject of Section S2. Out of the 196 valid interviews, we obtained data from 188 interviews, since 8 respondents decided not to answer, stating that they were not interested in the subject of the section. Figure 7 represents the alluvial plot displaying the combinations of the answers received.

At the time of the interviews, most of the respondents (87.2%, n = 164) had never used an acoustic deterrent device in their careers (Figure 7). Of these, 106 stated that they were unaware of pingers at all, while 17 were aware of this mitigation measure but considered it ineffective, thus were not willing to use it in their nets. Eleven respondents were not inclined to use pingers (Figure 7), because they had received negative feedback from other fishers. Finally, 9 fishers claimed that the reason for not using pingers is the excessive cost of the devices. Interestingly, 18 fishers who have never used pingers, regardless of their prior knowledge of the devices, expressed their willingness to try pingers to test their efficacy.

A total of 12.8% (n = 24) of the respondents declared to have used pingers at least once in their careers. The most commonly used pingers were the "DiD-01" (manufacturer: STM Ltd., Italy), followed by "DDD line" (manufacturer: STM Ltd., Italy) and "Banana Pinger" (manufacturer: Fishtek Marine, UK), although the majority of respondents did not remember the manufacturer. Of these, the majority reported using pingers in the past, but they consider them ineffective; thus, they are not currently using them. The fishers who stated that they occasionally use these deterrents were partially satisfied: some of them considered the pingers effective, while the remaining respondents did not specify why, although deemed effective, they did not continue to use them. However, all of them believed that these devices were the only mitigation measure to reduce interactions. Few respondents affirmed using the devices regularly, considering these devices effective (Figure 7).

Interestingly, 11.7% of the fishers (n = 22) reported already using other strategies besides pingers to keep dolphins away from their gears. In OTB, they reported using an additional netting panel covering the codend to reduce the access to the codend meshes or ropes attached at this level to scare the dolphins. In GEN, the majority of respondents claimed to produce noise by hitting the boat to scare dolphins away, while others affirmed moving to other areas, shifting the timing of the net deployment and hauling or simply stopping their fishing activities when sighting dolphins. In PTM, the fishers claimed to change the towing direction towards other fishing vessels to bring the dolphins' attention towards other nets in the same area.

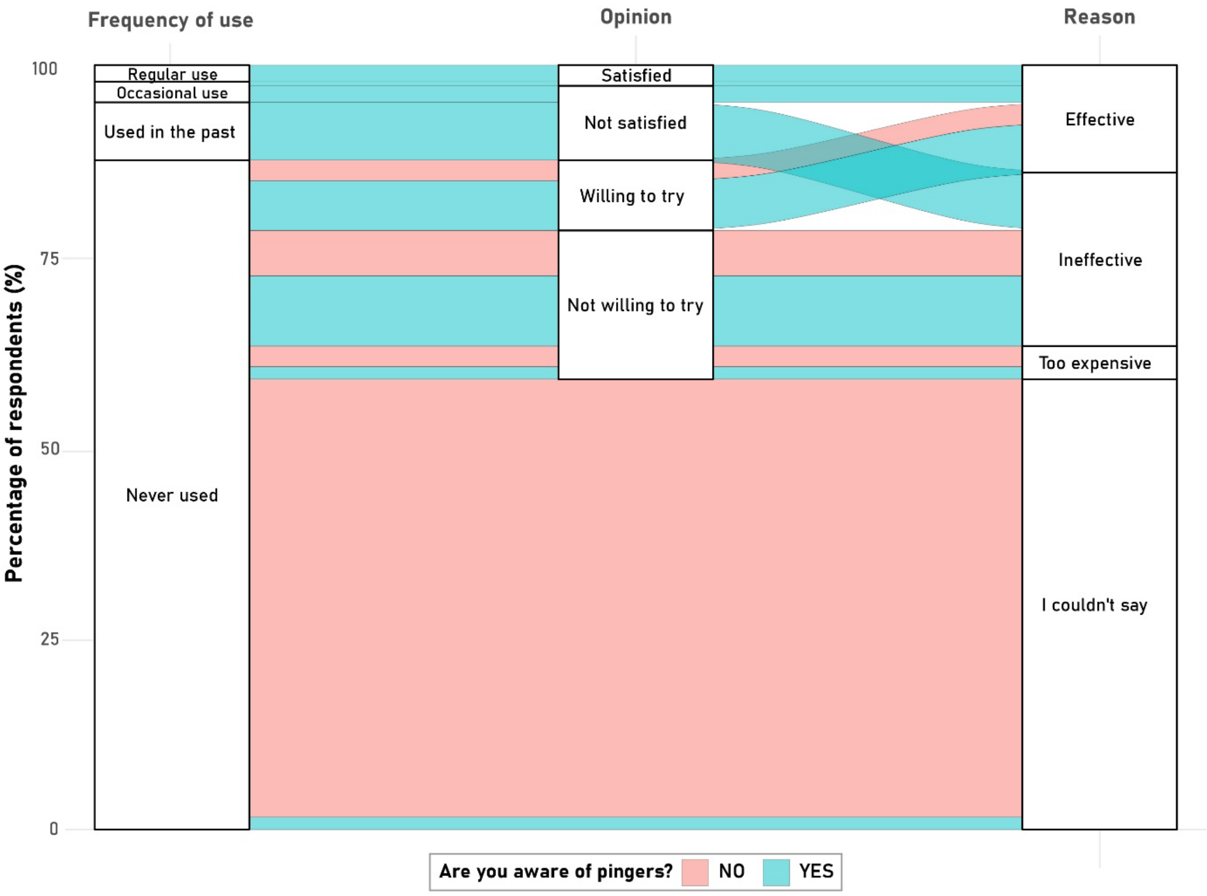

Figure 7. Alluvial plot representing the combinations of answers to the following questions: "Are you aware of pingers?"; "What is your experience with their use?"; "What is your opinion?"; "What

is the reason for your opinion?". The height of each flux represents the percentage of respondents to a certain question.

4. Discussion

The present study aimed to provide information on the dolphin–fisheries conflict in Italy and Croatia through the local ecological knowledge of the fishers operating in those areas.

Altogether, our findings are consistent with those available from other Mediterranean areas, in which conflicts with dolphins were reported primarily in set net fisheries [34–38]. In fact, both gill and trammel nets are the most widespread gears along all Mediterranean coasts, being used by around 80% of the whole fishing fleet (namely, small-scale fisheries, SSFs) of the basin [39]. Therefore, given the wide distribution and adaptation of *T. truncatus* along the Mediterranean coastal areas, its interactions with set nets may likely occur along any coastal areas where these nets are employed by artisanal fishers [5]. As evidence of this, almost all of the interviewed artisanal fishers reported interacting with dolphins somehow, identifying the depredation and its related consequences as the major dolphin-related concern.

Overall, Summer was the season with the highest occurrence of depredation events, especially in coastal areas. Several artisanal fishers in the Italian Adriatic Sea made a general consideration (recurrent in many respondents' notes) that during the time-closure for bottom trawls (August–September), dolphins approach the coastal areas to feed on set nets. They also added that the gillnet fishery for the common sole (*Solea solea*), one of the most important in terms of fishing effort and profitability, mainly in the Summer [40], was the most frequently affected gear. This may be consistent with [9], who showed that bottom trawlers significantly affect the spatial distribution of *T. truncatus* in the Northern Adriatic Sea, with dolphins being more dispersed during the Summer days of no-trawling. In addition, the common sole represents an important part of the diet of the bottlenose dolphin [17]. Hence, the extent of damage from dolphin depredation might be heavier in this mono-specific fishery during Summer. Accordingly, the interactions on a seasonal basis may be influenced by the higher number of fishing days of artisanal fishers in Summer compared to the rest of the year, which could give a misleading perception of the real annual trend of dolphins in coastal areas.

Notably, the small-scale fisheries in many Mediterranean areas have become economically marginal, thus even a small reduction in their profits can be perceived as having a significant economic impact [8]. The wide range of economic losses per year suffered by the interviewed artisanal fishers, i.e., from EUR 0 to 20,000, is in accordance with the estimates of other studies in other Mediterranean areas (e.g., EUR 500–20,000 per vessel in Italy and Greece, and EUR 1,000–2,000 in Spain, Italy and France [15]). This variability strictly depends on the métier and target species, the cost of the gears employed, the number of days at sea, and the fishers' perception on depredation. However, relevant studies providing absolute estimates of the economic loss attributable to dolphin interactions have found a modest impact, even within areas of acute conflict [6,37,41].

The same attention in evaluating fishers' perception should be paid to their estimates of the dolphin population trends. In fact, the perceived increased dolphin presence around fishing gears does not directly imply an increase in the dolphins' population. Some authors have pointed out that the scarcity of marine resources has pushed opportunistic species, such as bottlenose dolphins, to increasingly feed on the easier preys caught in the nets, despite the associated risk [17,42].

The current bycatch rate of bottlenose dolphins is reported to be low in all the Mediterranean, as it is for the two other delphinid species [4]. However, an alarming outcome emerging from our results is that more than one-third of the respondents reported having caught at least one dolphin in their entire career. Among the different gears included in the study, the mid-water pair trawling technique employed in the Italian Adriatic Sea (called "Volante") was found to produce the highest bycatch rate. Each net has high vertical (11–15 m) and horizontal (25–40 m) net openings, and is towed in mid-water at high speed (4–4.5 knots) to target schools of anchovies (*Engraulis encrasicolus*) and sardines (*Sardina pilchardus*), which are an important food source for dolphins [43]. The relatively high speed with the associate unpredictable route changes can results in bycatch events [44]. In fact, besides foraging behind the codend, dolphins have been also seen entering the net to feed during towing [43].

Fishers with past experience using driftnets for tuna (*Thunnus thynnus*) and swordfish (*Xiphias gladius*) reported a higher dolphin bycatch rate, and confirmed the danger of this fishing gear towards megafauna, which led to the total ban for driftnets targeting large pelagic species with an individual or total length of more than 2.5 km [33].

Concerning the set nets, dolphins' bycatch may be underestimated since it is difficult to monitor all the SSFs, which are highly fragmented along the coast and are generally less covered by on-board monitoring programs compared to other fisheries such as trawls. Therefore, much of the information on SSFs bycatch comes from localized case studies or anecdotally reported events. In addition, it is not usual practice for fishers to report an accidental catch of sensitive species such as dolphins [3]. Moreover, the impact of set nets fishery on dolphins is not limited to bycatch, since around 20% of the stranded animals analyzed in 2020 in Italy showed evidence of interactions with passive nets (larynx entanglement and ingestion in the first instance [8]). Thus, the negative effects of set nets could be more profound when considering the long-term health deterioration and consequent mortality.

Over the past two decades, there has been heightened awareness and attention to developing solutions to reduce cetacean interactions [45–47]. Accordingly, the fishers interviewed in the present study were in favor of any solution able to reduce the interaction with dolphins. The current options for preventing or minimizing this interaction can be categorized as follows: (i) time/area closures; (ii) deterrent devices (e.g., acoustic deterrents); (iii) modifications to fishing gear or procedure; (iv) gear switching.

The solution considered here is the use of pingers in fishing gear as acoustic deterrents, representing one of the most studied and promoted solutions in this basin [48]. Interestingly, although pingers have been available on the market (especially in Italy) for more than 20 years, most of the fishers were unaware of their existence. This underlines that, potentially, these devices can still be tested, either by fishers themselves or through research and dissemination projects in several coastal areas to verify their efficacy. However, the different perceptions and attitudes of those fishers having used (or using) the pingers during their normal fishing activities well reflect the divergent results obtained in scientific studies (promising outcomes; e.g., [49]; ineffective; e.g., [50]). Some evidences have suggested that they can be effective only in the short term to deter depredation by bottlenose dolphins [51], while in the long term they can have a null if not opposite effect (e.g., acting as a "dinner bell", as hypothesized by [52] in the "Volante" Adriatic fishery). Many fishers might be discouraged by their experiences with the older generation of pingers, which were not interactive; these factors made pingers ineffective in the long run. The development of "new generation pingers" (e.g., more interactive, and more effective in producing alarming sounds that avoid dolphins' habituation [51] is therefore highly encouraged, together with the other mitigation approaches. Concerning the solutions already put in place that emerged from this study, such as the use of ropes and additional netting panels at the codend level in bottom trawls, their use could be spread to other areas.

Further research is also needed to understand the social behavior of dolphins in the vicinity of fishing; in this regard, modern technologies such as drones, underwater cameras and passive acoustics monitoring are now also available for a reasonable cost, and this could certainly help to understand these relationships more thoroughly [51,53]. In particular, the use of low-cost hydrophones attached to the nets during fishing [54] could also be spread to create a capillary marine detection network, in order to improve the knowledge of their behavior and thus provide more specific management and mitigation measures.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d15020133/s1; Supplementary File S1: Questionnaire used in the present study.

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Data Availability Statement: Data is available upon reasonable request to the authors.

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