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Questionnaire and experimental surveys show that dolphins cause substantial losses to a gillnet fishery in the eastern Mediterranean Sea

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Common bottlenose dolphins (*Tursiops truncatus*) are known to depredate fishing gear, resulting in damage to the catch and/or the gear itself. The extent of this damage and estimated financial loss varies between areas, métiers, and survey methods. We quantified losses due to bottlenose dolphin depredation in a coastal gillnet fishery in the Thermaikos Gulf, Greece, in terms of CPUE reduction, catch damage, and gear damage. Experimental fishing effort was carried out over two seasons (2020 and 2021), along with concurrent questionnaire surveys over the second season (2021). Depredation frequency (∼35%) and CPUE changes due to depredation (a significant decrease of 45–50%) were similar for both sampling schemes. The number of damaged fish in experimental hauls increased significantly with dolphin depredation, but did not fully account for the sizeable loss in marketable catch, indicating that large numbers of fish were removed from the nets entirely. Damage to experimental nets increased with dolphin presence and group size, with an average of 0.59% of net surface area damaged per depredation event. Both datasets point to annual economic losses of over €5000 per vessel in this fishery, while the similarity between direct observations and self-reported losses highlights the usefulness of frequent questionnaire surveys.

Keywords: bottlenose dolphin, catch loss, depredation, gear damage, small scale fishery.

1 Introduction

Depredation of fishing gear is a widely reported foraging tactic for common bottlenose dolphins (*Tursiops truncatus* Montagu 1821) globally (Tixier *et al.*, 2021). Interactions with small-scale fisheries in particular are a long-standing issue in the Mediterranean Sea (Bearzi, 2002; Blasi *et al.*, 2015; Alexandre *et al.*, 2022) and elsewhere (e.g. Rechimont *et al.*, 2018). Taking fish that have already been caught in fishing gear can have negative consequences for both the humans and the animals involved in the interaction. For the dolphins, it can result in wounds, entanglement, or retaliation from the fishers (Read, 2008; Pardalou and Tsikliras, 2018), while for the fishers, it can result in damage to catch and/or gear (Jog *et al.*, 2022).

Direct financial losses incurred by the fishers in these interactions can stem from three causes: removal of biomass from the fishing gear or immediate vicinity of the gear leading to reduced catch and loss of profit; damage to the catch left on the gear rendering it unmarketable, again with a loss of profit; and damage to the gear itself, resulting in additional cost in order to repair/replace it. While the extent of losses depends on the combination of métier and depredating species in question, gillnet and trammel net fisheries depredated by bottlenose dolphins appear to suffer more damage and at higher rates than other métiers (Goetz *et al.*, 2014; Tixier *et al.*, 2021; Alexandre *et al.*, 2022).

Quantifying the direct impacts that depredation has on small-scale fishers is not an easy task, but recommendations for the best approach have been outlined by Reeves *et al.* (2001). Indeed, there are numerous studies in which some or all the recommended observations were carried out in relation to small-scale fisheries in the Mediterranean and elsewhere (e.g. Lauriano *et al.*, 2004; Brotons *et al.*, 2008; Gazo *et al.*, 2008; Gonener and Ozdemir, 2012; Pennino *et al.*, 2015). Because direct observations such as these are not always feasible, identifying the magnitude of depredation damage has often relied on questionnaire surveys (e.g. Lauriano *et al.*, 2009; Goetz *et al.*, 2014; Gonzalvo *et al.*, 2015; Geraci *et al.*, 2019; Pardalis *et al.*, 2021; Romero-Tenorio *et al.*, 2022). In some cases, field measurements and questionnaire surveys have been combined (e.g. Snape *et al.*, 2018), but often there is a mismatch between the self-reported and *in situ* observations of interaction rates and associated losses (e.g. Bearzi *et al.*, 2011; Pennino *et al.*, 2015).

As befits its lengthy coastline, Greece features the largest small-scale fishing fleet in Europe, with over 13000 vessels under 12 m operating static gear (Annual Fleet Report, 2020). Despite a steady decline in numbers over the last decade, this sector still comprises at least 94% of the national fleet and carries considerable social and historical significance for the communities involved (Tzanatos, 2020Vessels operating gillnets and trammel nets target primarily fish species such as sole, red mullets, bogue, and pandora, as well as cuttlefish, octopus, and prawns, depending on seasonality and each fisher's personal strategy of maximizing efficiency (Pardalou and Tsikliras, 2018; Pardalis *et al.*, 2021; Pardalou *et al.*, 2022). In the

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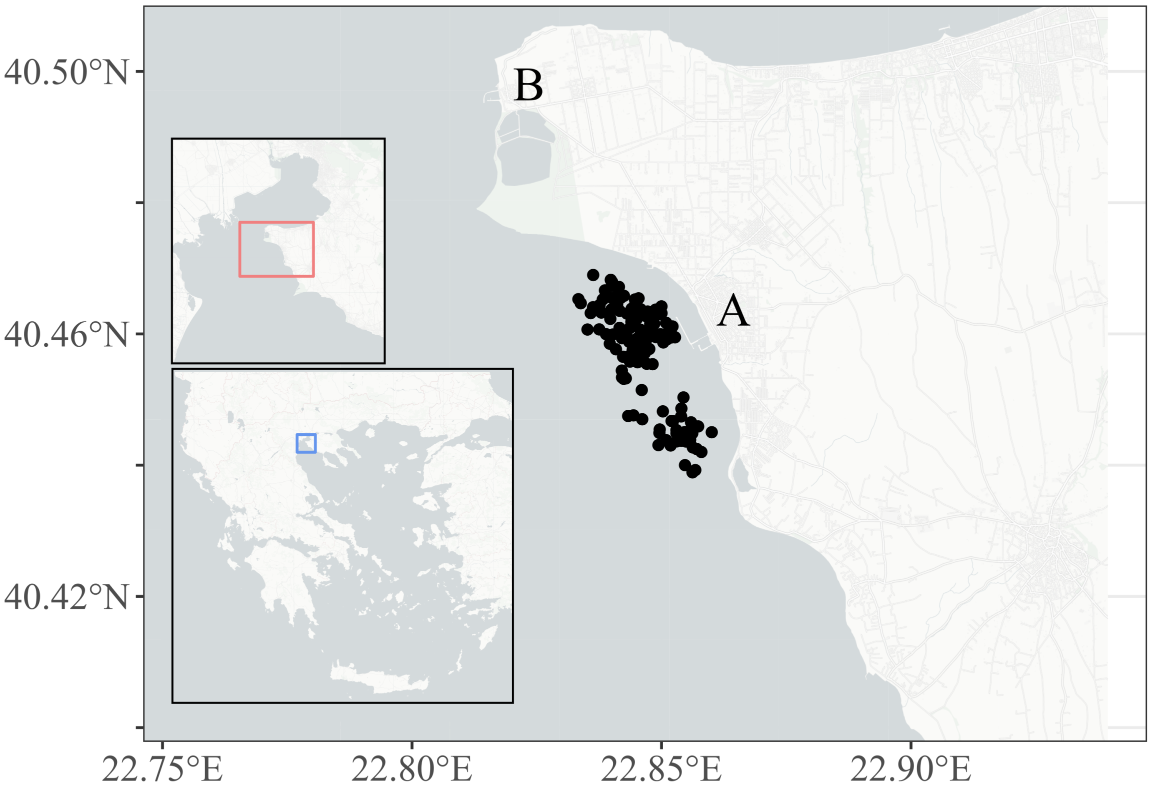

Figure 1. Map of the study area with insets showing Greece and the inner Thermaikos Gulf (outlined in blue). Red outline in the second inset highlights the study area. (A) Port of Nea Michaniona, with points showing the locations of the experimental fishing effort (EE). (B) Port of Angelochori.

northern Aegean, as elsewhere in the Mediterranean, depredation by dolphins and other marine megafauna is frequently reported as a source of damage to these métiers, with bottlenose dolphins being the most commonly cited predator (e.g. Maccarrone *et al*., 2014; Pardalis *et al*., 2021; Pardalou *et al*., 2022); indeed, the overlap between target catch species and bottlenose dolphin dietary preferences supports such observations (Bearzi *et al*., 2009).

The Thermaikos Gulf supports a large proportion of the Aegean Sea's coastal fishing fleet, as well as being frequented by bottlenose dolphins year-round (Giannoulaki *et al*., 2017; Foskolos *et al*., 2020). As a result, conflict between small-scale fisheries (SSFs) and dolphins in the area is intense, although the precise extent of the damage caused by dolphins has not yet been properly measured. The aims of this study were to (a) quantify catch loss due to dolphin depredation through experimental gillnet fishing trials, (b) compare the measured reduction in catch size with concurrent questionnaire data, and (c) quantify the damage to catch and fishing gear attributable to dolphin depredation.

2. Methods

2.1 Study area

Data collection was carried out in the inner Thermaikos Gulf (Figure 1) in the northern Aegean Sea, a semi-enclosed shallow (<100 m) basin characterized by high productivity due to four large river systems that flow into it, making it one of the most important fishing grounds for both large- and small-scale fisheries in Greece according to the Hellenic Statistical Authority (ELSTAT). We conducted experimental fishing trips outside the port of Nea Michaniona, while questionnaire surveys took place there and in the neighbouring port of Angelochori.

2.2 EE

Experimental surveys took place over two seasons, from May to October in 2020 and 2021, on a chartered 8 m coastal fishing vessel (2.3 GT, 43 hp). We spread out the fishing effort evenly across the study area in every month, as much as weather conditions and the presence of other fishing gear allowed. All trials took place within the 20 m isobath, in keeping with the predominant red mullet-fishing tactics in the area, and in Beaufort sea state <4. We used multifilament nylon gillnets with a stretched mesh size of 36 mm. Each net panel was 100 x 1.8 m and was attached to a head rope equipped with floaters and a ground rope with a lead core. Three net panels were connected in line to form a 300-m-long fleet, at either end of which we attached a 50 m rope leading to a surface marker. During each fishing trip, we deployed three fleets, which is a total of 900 m of fishing gear, just before sunrise, and then anchored the vessel nearby with the engines off. Fishing gear was allowed to soak for ~1.5 h.

Throughout each fishing trip, two observers and the fisher on board visually scanned the area for cetaceans and other predators. When cetaceans were sighted, the species was identified, group size estimated, and behaviour and time spent around fishing gear were recorded. All fish and invertebrates caught in the nets were removed from the gear and transported in a cooler to a wet lab for processing. Individuals were identified to the lowest taxonomic level possible and a series of morphometric and weight (0.1 g precision) measurements were taken. Fish and cephalopods were visually inspected for damage due to depredation, such as bite marks or missing parts, and each was labelled as damaged or intact. Nets were inspected for damage upon hauling and mended prior to redeployment, in order to maintain the gear's efficiency. During the second season, the number of holes was recorded

Table 1. EE over two seasons, self-reported (QE) fishing effort over two depth classes, and dolphin depredation frequencies for each group.

	EE 2020	EE 2021	QE 2021; <20 m	QE 2021; >20 m
Fishing trips	31	43	38	22
Depredated trips	11	15	10	11
Depredation frequency	35.5%	34.9%	26.3%	50%
	For both years 35.1%		For all depths 35%	

systematically, and the size of each was measured (length x width) and subsequently classed into four size categories: tiny (<10 cm^2), small (10–99 cm^2), medium (100–999 cm^2), and large (≥1000 cm^2) (see also Garagouni *et al*., 2022), as not all hole sizes affect catchability to the same extent. Prior to redeployment, the holes were repaired with twine of a different colour to that of the net panel, to ensure that they would not be counted again if they re-opened due to tension in other parts of the net.

2.3 Questionnaire surveys

Interviews were conducted from May to October 2021, concurrently with the experimental fishing trials, with fishers who had just returned from their own fishing trips. To maximize consistency and obtain a more complete picture of their fishing effort, the same fishers were interviewed as frequently as possible. Care was taken to ensure the questions were not leading in any way. During the first interview with each fisher, we established the details of the fishing vessel itself (type, engine hp), and in all interviews we enquired about fishing effort (location, depth, distance from shore, type of fishing gear, number of nets, and hours of vessel activity), catch size and composition, and whether dolphins interacted with their gear. We also included brief questions about whether they had fished during the two to three days immediately preceding the interview and if dolphins had approached their gear.

2.4 Data analysis

All analyses and graphing were conducted in R version 4.1.0 (R Core Team, 2021); model predictions were plotted with *sjPlot* (Lüdecke, 2021) and *ggplot2* (Wickham, 2016). Overall depredation frequency (number of depredation events per number of fishing trips) was calculated for both the EE and the questionnaire effort (QE) and the two were compared with binomial exact tests.

The effect of dolphin depredation on CPUE was assessed with generalized linear models (GLMs) using a Gamma error distribution with a log link function. In order for the datasets to be directly comparable when comparing EE and QE data, we only used EE data from 2021 and QE data pertaining to gillnets set shallower than 20 m. We defined CPUE as catch size (in kg) of intact fish and cephalopods per haul for both the EE and the QE data, as neither soak time nor gear length had any noticeable effect on catch size. We excluded damaged individuals from CPUE as they are considered lost (unmarketable) catch and thus are not weighed by the fishers. CPUE was modelled as the response variable, separately for EE and QE. Dolphin depredation was included as a two-level factor (Present/Absent). Because we observed temporal fluctuations in catch size in both datasets (regardless of dolphin depredation), we also included Month as a fixed effect in each model. We tested the best way to include this factor by specifying one model featuring the interaction of Dolphin depradation: Month, one featuring Dolphins and Month with no interaction, and one featuring only Dolphins; the model with the lowest Akaike's information criterion was considered the best. The difference in CPUE between the two Dolphin depredation levels (Present/Absent) was tested with the emmeans package (Lenth, 2022).

The effect of dolphin depredation on catch damage was tested with a binomial GLM with a logit link function, using the numbers of damaged and intact fish per EE haul as the dependent variable and the two-level dolphin depredation factor as the independent variable. Total catch size was included as an offset term and year as another fixed effect. The overall difference in the proportion of damaged catch between days when dolphins did or did not depredate our gear was compared with a chi-squared test.

Finally, gear damage (the number of new holes counted after each haul) was modelled against the presence of dolphin depredation, using a zero-inflated Poisson GLM (pscl package by Zeileis *et al*., 2008). Two independent variables were used, namely the presence/absence of dolphins and the number (best field estimate) of dolphins in the group (continuous variable). Additionally, the cumulative daily damage to our nets—both by number of holes and by damaged surface area—was calculated, separately for days in which dolphin depredation did or did not take place, to compare the relative damage rates.

3. Results

We conducted a total of 31 EE fishing trips in 2020 and 43 in 2021, during 11 and 15 of which, respectively, we sighted bottlenose dolphins (*T. truncatus*) depredating our gear (Table 1). Dolphin group sizes ranged from one to ten individuals per depredation event, the average number being four. We also occasionally observed cormorants taking fish from the nets, and found evidence of seabird- and cephalopod-induced damage on some fish specimens, but these incidents proved difficult to quantify explicitly.

Of ten fishers confirmed to occasionally use gillnets in both ports, we interviewed six on multiple occasions. These questionnaire surveys resulted in 60 interviews where depth was recorded, and 38 of those referred to fishing effort within the 20 m isobath (i.e. did not exceed the deepest EE fishing effort).

3.1 Depredation frequency

Overall depredation rates (Table 1) were similar in experimental (35.1% of all EE fishing trips) and self-reported (35% of all QE fishing trips, 26.3% of shallow QE trips) data, according to the binomial tests ($p = 1$). Depredation events appeared to decrease towards the end of the study season in both experimental and shallow-set QE fishing efforts (Figure 2).

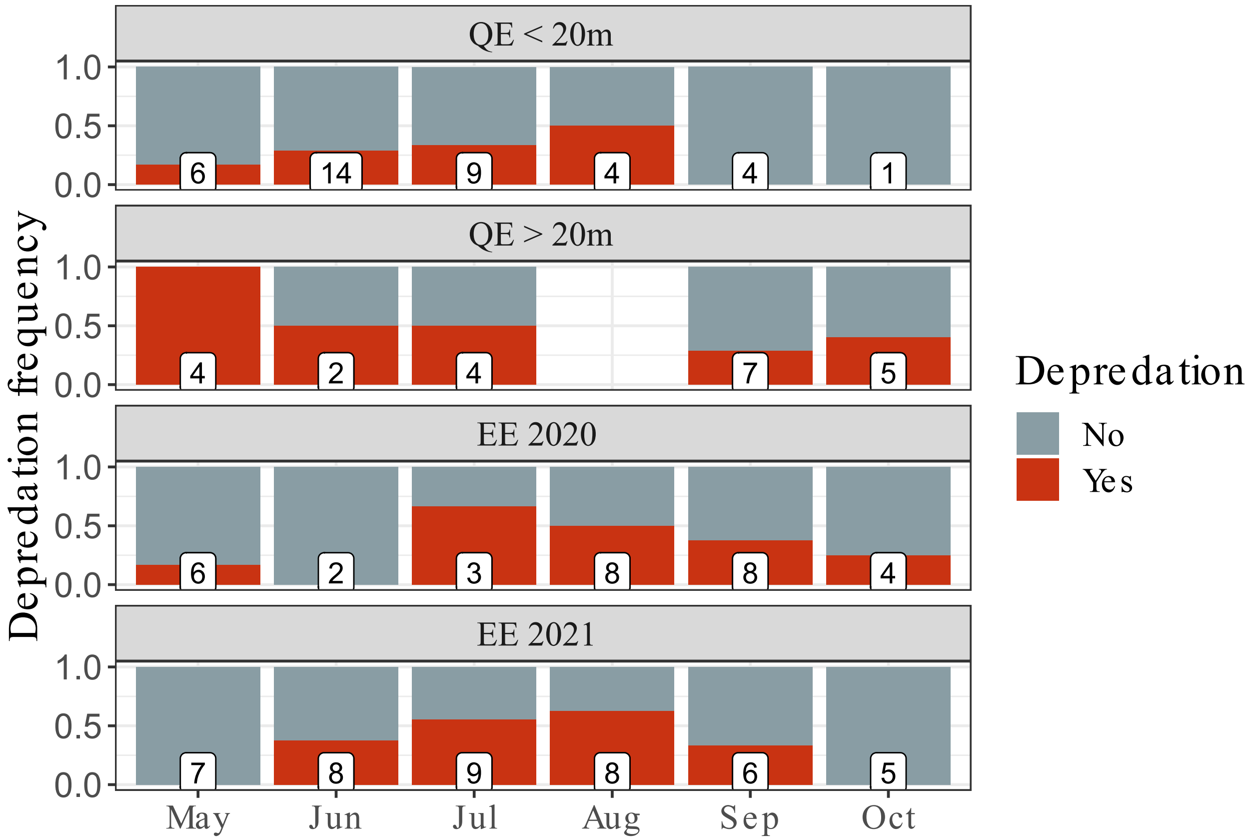

Figure 2. Monthly frequency of fishing trips depredated by dolphins; experimental effort was grouped by year (EE 2020 and EE 2021) and QE was grouped by fishing depth (QE < 20 m and QE > 20 m). Label shows the total number of fishing trips for that month.

3.2 Catch loss due to depredation

Catches for each year of the experimental hauls and each depth stratum of questionnaire surveys are shown in Table 2. Mean cpue was lower in the presence of dolphins than in their absence across all data groupings.

The GLMs showed that both experimental and self-reported catch sizes were significantly reduced when dolphin depredation occurred (Figure 3). In fact, both models resulted in similar estimated coefficients for the effect of dolphin depredation (EE: -0.551, SE = 1.33, and $p = 0.0002$, Nagelkerke's $R^2 = 0.706$; QE: -0.503, SE = 1.30, $p = 0.0061$, Nagelkerke's $R^2 = 0.651$), while the contrast ratio of CPUE in the absence/presence of dolphins was calculated by emmeans as 1.81 (i.e. a 44.7% reduction, SE = 0.334, df = 35, and $p = 0.002$) and 1.99 (i.e. a 49.7% reduction, SE = 0.48, df = 28, and $p = 0.008$), respectively.

3.3 Catch damage due to depredation

In experimental hauls over both years, the total percentage of damaged fish increased from 6.2% when dolphins were absent to 17.7% when they were present (chi-squared = 138.91, df = 1, and p-value < 0.0001). The GLM showed that the same pattern holds for each year (0.91, SE = 0.52, and $p < 0.001$), confirming that bottlenose dolphins damage more of the catch than non-cetacean predators (Figure 4).

3.4 Gear damage due to depredation

Over the course of 43 experimental fishing trips in the second season, our nets acquired a total of 1661 holes, equating to a damaged surface area of 140.56 m^2. The damage rate during fishing trips when dolphins were present was strikingly higher than when they were absent (Table 3 and Figure 5), as, indeed, only 70 holes (totalling 6.68 m^2, or 0.41% of the entire net area) were recorded in total on days when dolphins did not approach the nets. Most holes were classed as either small or medium in both cases, while large holes accounted for most of the damaged surface area despite being considerably fewer in number.

Predictably, the GLM showed that dolphin depredation caused significantly higher numbers of holes in the gear than non-dolphin predators (6.82, SE = 1.14, $p < 0.001$). Moreover, there was a significant positive correlation between the number of holes and the number of dolphins (1.23, SE = 1.01, $p < 0.001$) (Figure 6).

4. Discussion

Our study confirms that bottlenose dolphins cause significant damage to gillnets in terms both of lost catch and of torn gear. Moreover, the questionnaire surveys resulted in similar estimates of depredation frequency and catch loss as that quantified by the experimental effort. We found that gillnets set within the 20-m-depth contour are depredated approximately a third of the time, which is lower than the average depredation rate for gillnets in the northern Aegean as a whole (~80% of the time according to Pardalou and Tsikliras, 2020), but higher than rates reported elsewhere in the Mediterranean for either gillnets or trammel nets (Lauriano *et al.*, 2004; Rocklin *et al.*, 2009; Pennino *et al.*, 2015)—a comparable

Table 2. Number (N) and weight (kg) of intact and damaged fish caught in two seasons of EE and one of questionnaire surveys QE, in the presence and absence of bottlenose dolphins.

		Total N	Total kg	Mean + SE kg/haul	Total N	Total kg	Mean + SE kg/haul
			EE 2020			EE 2021	
Dolphins absent	Intact	2724	134.67	6.73 + 1.91	3341	155.48	5.55 + 1.98
	Damaged	155 (5.3%)	–	–	243 (6.7%)	–	–
Dolphins present	Intact	575	25.8	2.57 + 1.50	405	16.99	1.13 + 0.17
	Damaged	80 (12.2%)	–	–	132 (24.5%)	–	–
			QE < 20 m			QE > 20 m	
Dolphins absent	Intact	–	252.6	8.71 + 1.48	–	208.7	18.97 + 9.16
Dolphins present	Intact	–	30.0	4.28 + 0.84	–	100.0	10.00 + 2.96

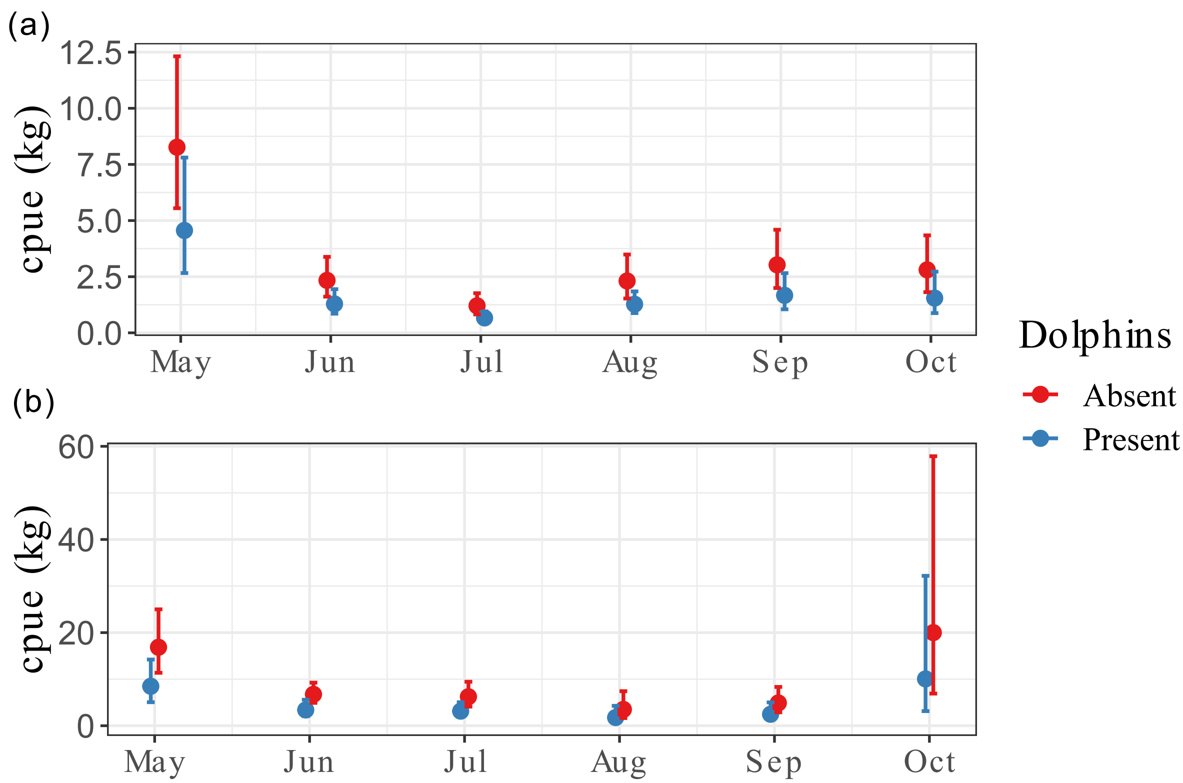

Figure 3. Predicted CPUE values (points) and associated 95% confidence intervals (bars) depending on whether dolphin depredation does or does not occur, based on a season of EE (a) and questionnaire surveys (b).

depredation rate of 28% was observed in a trammel net fishery in Cyprus (Snape *et al.*, 2018), but those records primarily spanned deeper waters than our current study. Our questionnaire data pertaining to deeper-set (20–40 m) gillnets and other métiers support the likelihood that dolphins target other depth strata and gear types with varying and often higher frequency, depending on the target catch species (unpublished data). The main target catch for gillnets in this area are *Mullus* spp., which have been noted as a preferred prey item for bottlenose dolphins in several other depredation studies (e.g. Rocklin *et al.*, 2009; Pardalou *et al.*, 2022), so it is likely that depth or some associated prey distribution/environmental parameter plays a role in dolphin activity.

Because cetacean depredation of fishing gear is a global and controversial phenomenon, there have been many attempts to quantify its direct impact on catch size, with varying results. For instance, Rechimont *et al.* (2018) found that bottlenose dolphin depredation of gillnets in the Gulf of Mexico does not significantly reduce CPUE. Similarly, near Corsica, Rocklin *et al.* (2009) found higher CPUE values in trammel nets that had been depredated by dolphins than ones that had not, in contrast with Brotons *et al.* (2008), who found lower catch sizes in depredated gillnets and trammel nets around the Balearic Islands, as did Pennino *et al.* (2015) with trammel nets around Sardinia. The latter study, however, concluded that depredation did not result in substantial economic loss. In our own study, dolphin depredation reduced catch size in both experimental and self-reported hauls by 45–50%, a loss that cannot be considered insignificant to a small-scale fisher, especially given the high frequency of depredation events in the area. Based on our survey data, a crude estimate of loss is as follows: if each un-depredated haul results in an average of 4–5 kg of marketable red mullet/surmullet, sellable at ∼10 euro/kg, then a fisher's daily

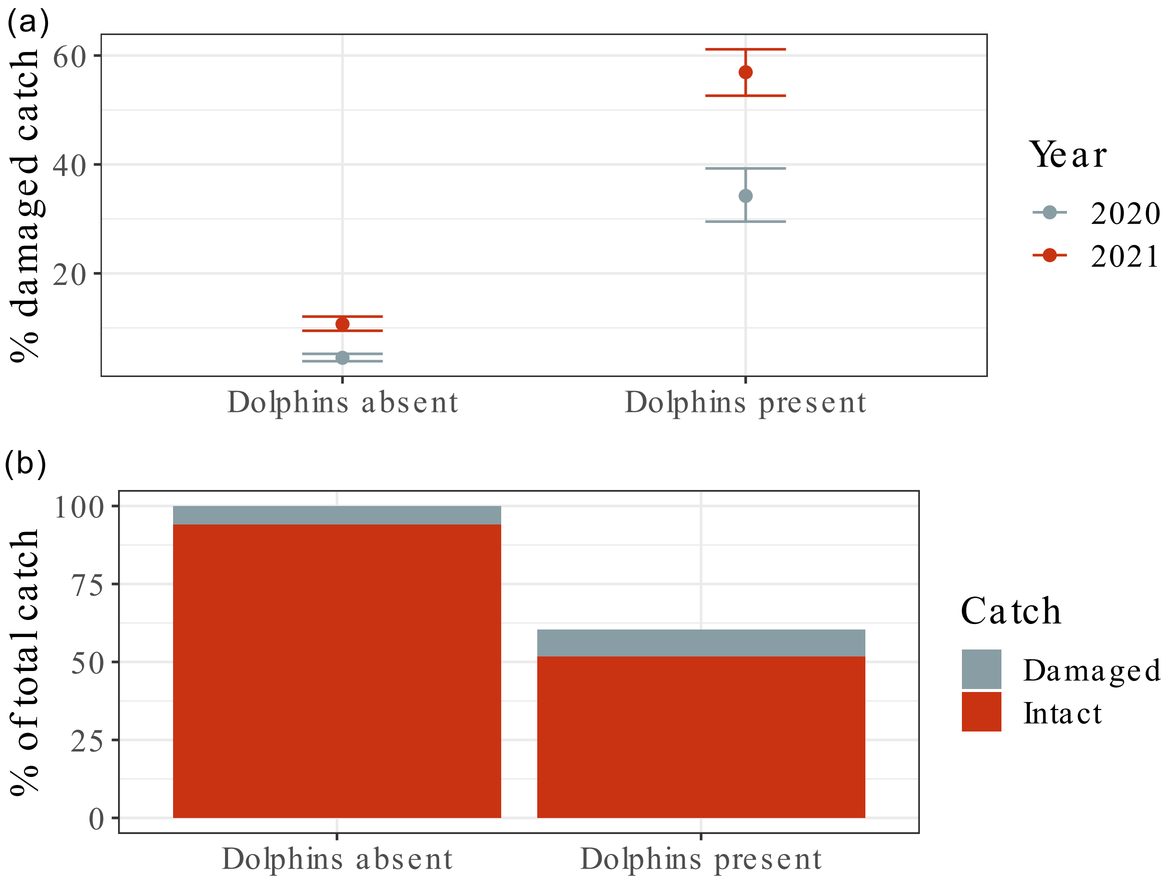

Figure 4. (a) Predicted proportion of damaged fish per experimental haul in each year, depending on whether or not dolphin depredation occurred, with associated 95% confidence intervals. (b) Summary of predicted changes in catch size due to dolphin depredation, showing a 45% reduction in intact catch, and an increase of damaged fish to 17% of the total catch.

Table 3. Gear damage recorded in each of four size classes during experimental fishing trials, depending on whether dolphin depredation occurred or not.

	Total *N*		Mean ± SE N per trial per 50 m		Total damaged area (m^2)		Total damaged area (%)		Mean damaged area (%)	
Dolphins	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Tiny	9	33	.083 ± 0.018	.458 ± 0.384	.0028	.0232	<0.001	.0014	$<10^{-4}$	3×10^{-4}
Small	36	618	.50 ± 0.188	2.45 ± 1.23	.1284	2.726	.0079	.1683	.002	.012
Medium	16	720	.098 ± 0.024	2.85 ± 0.959	.4826	24.388	.0297	1.505	.003	.107
Large	9	220	.071 ± 0.0102	.873 ± 0.366	6.075	106.74	.3750	6.588	.053	.470
All	70	1591	.324 ± 0.11	6.313 ± 2.49	6.688	134.08	.4128	8.264	0.034	0.590

(*N*: number of holes).

income would be €40–50, dropping to €20–28 if there is a depredation event. Over the course of 90 days of fishing effort, total income would range from 3600 to €4500 with no depredation events, whereas if a third of those hauls are targeted by dolphins, this would drop to 3000–3750 euros, suggesting a maximum decrease in revenue due to catch loss of €1500.

We found that dolphins cause far more damage to gillnets than other predators (such as cormorants or large fish) do locally, leading to a loss of 0.59% of total surface area per depredation event. This is roughly six times less than Snape *et al.* (2018) found in a similar assessment of trammel nets in Cyprus. Following a similar calculation as for catch loss, over the course of 90 fishing days, on 30 of which depredation occurs, the total lost surface area would approach 20%, which is equivalent to 18 m^2 removed from every 50 m panel of net. And while that in itself is already a substantial loss, it does not take into account the occurrence of intense depredation events, which can create upwards of 150 holes per net (as seen in Figure 5a), rendering it immediately useless due to the effort it would take to repair. Based on anecdotal estimates from the fishers we interviewed, they swap out all their nets three or four times per year. Indeed, having to replace gear four times per year would indicate that a 20% loss of efficiency (as calculated for three months of fishing effort) is the approximate threshold at which a net is considered useless. The average total gear length for local gillnetters is 1400 m, sourced at €10–15/50 m, with an added cost of €17/50 m or 2.5 h of labour for the rigging process. Therefore, supposing that each gear replacement takes place over a 90 fishing days period,

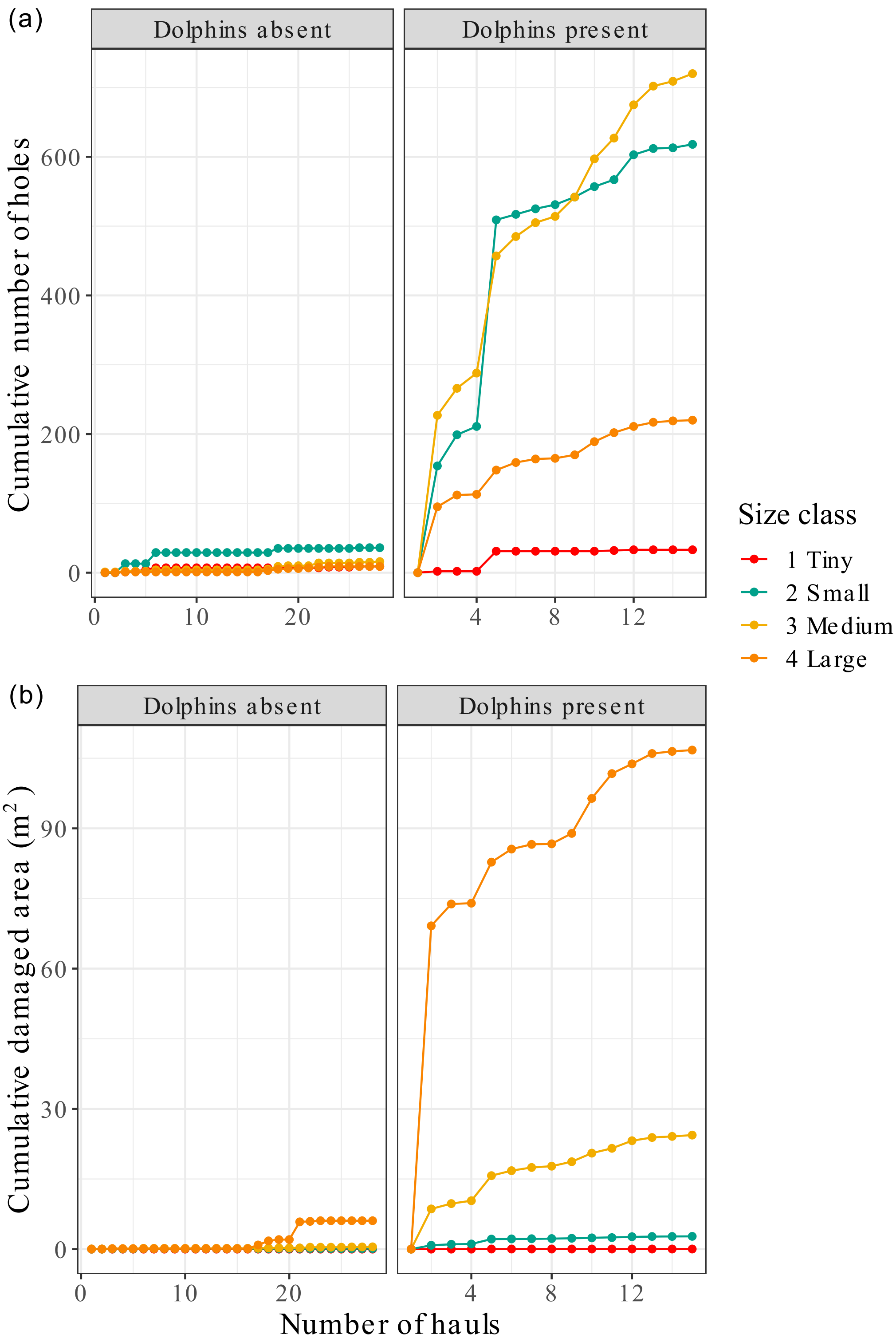

Figure 5. Cumulative number of holes (a) and cumulative damaged surface area (b) torn in 900 m of fishing gear during experimental fishing trips when dolphins were either present or absent.

this would average either €280–420 plus 70 h of labour, or €760–900 if the rigging process is outsourced.

These calculations of cost do not take into account the reduced efficiency of torn nets before they are replaced. Tiny holes show a comparable profile regardless of dolphin presence, perhaps indicating that the perpetrator (such as cormorants, which were often observed taking fish from our nets) is the same in both cases. However, even ignoring tiny and small holes as having less impact on catchability than larger sizes, when dolphins depredated our nets, they caused on average three to four medium or large holes per 50 m of net. Anecdotally, if these holes are evenly distributed across the entire gear length, local fishers are more likely to continue using the nets as they are, despite the large tears allowing more fish to

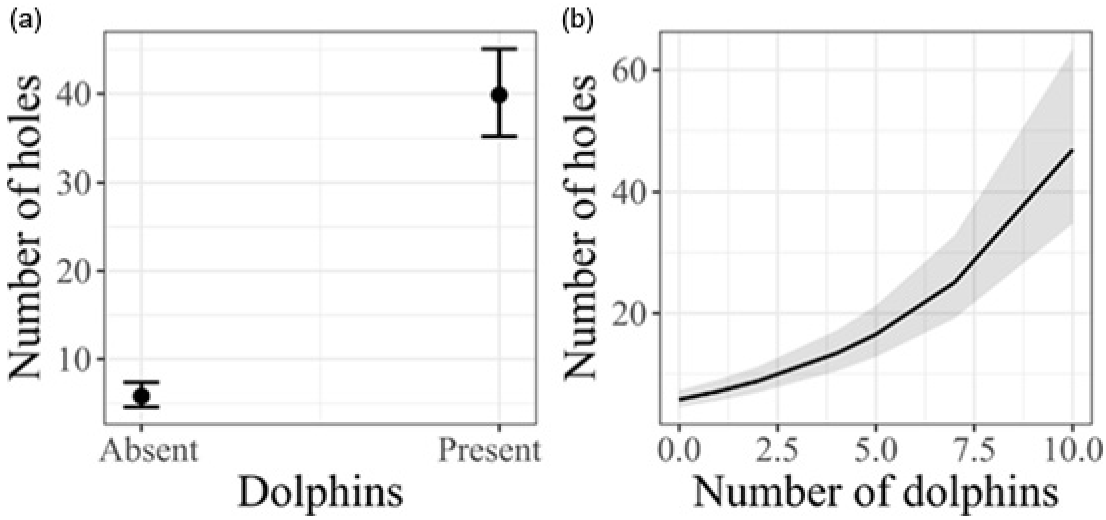

Figure 6. Predicted effects of dolphin depredation (a) and group size (b) on the number of holes torn in 900 m of net during experimental fishing trials. Error bars and shading indicate 95% confidence intervals around predictions.

escape. Conversely, if most of the damage is created in a few nets, those panels will be replaced sooner rather than later, as they will have reached the damage threshold faster.

Marketable catch loss due to depredation can be perceived as much more serious in those months when overall catch size is already reduced compared to late spring/early autumn. There is an element of uncertainty as to why catch size is lower in those months when dolphin depredation frequency is highest. It could be attributable to higher dolphin presence resulting in larger biomass removal from the overall area, that is, lower numbers of fish available to be caught by the gear (a form of biological competition *sensu* Jusufovski *et al*., 2019), or to a migration of certain target species (such as red mullets) to slightly deeper waters, or a combination of such factors. That the same pattern was observed in both years of our experimental trials suggests that it is not a random event. Giannoulaki *et al*. (2017) modelled habitat suitability for bottlenose dolphins in summer months and found that their (already generally coastally distributed) suitable range shrinks in August and September. If the northern Aegean bottlenose dolphins move farther into the Thermaikos during those months, this would lead to a larger removal of fish biomass from the area than in the months when they move further from the coast.

Our analysis of damaged catch left in the nets showed that the proportion of damaged fish does increase significantly when dolphins are the depredating species, but not to a high enough percentage to account for the total loss of marketable catch. As shown in Figure 4b, if the number of intact fish is reduced by 45%, but the proportion of damaged fish is only 17% of the remaining catch, the latter amount does not equal the number of intact fish lost. As a result, it would be insufficient to use damaged catch on its own as an indicator of total catch loss, for example, if attempting to quantify damage in order to establish compensation schemes.

Our field observations showed that depredation is carried out by fairly small groups of bottlenose dolphins. While the model showed that larger group sizes correlate with the number of holes torn in the gear—indeed, the two trials with the largest number of holes observed were depredated by seven dolphins in each event—it does not take many dolphins to cause substantial damage. This is in contrast to several fishers' estimates of group size—some reports ranged from 30 to 70 dolphins—and conviction that there are thousands of dolphins in this small region that are directly to blame for the damages they suffer. We presume that such over-estimates are the combined result of (a) not being able/willing to monitor the dolphins during fishing operations (Goetz *et al*., 2015), especially when trying to quickly haul the gear in order to avoid them, and (b) feeling the need to portray the dolphins as a formidable opponent, particularly to prevent conservationists from thinking the animals are at risk and thus require the closure of this fishing area.

Our experimental trials produced similar results to the self-reported fishing effort. The total financial losses in the area could reach €2500 per vessel per 90 fishing days, when examining both catch loss and gear damage. This estimate corresponds to a typical fishing period for the surveyed métier, that is, gillnets fishing for red mullet and surmullet, which in the Thermaikos gulf takes place between late spring and early fall. If these calculations are extrapolated to the whole year, allowing for bad weather days and potentially cheaper target species, the financial loss gillnet fishers face could easily exceed €5000 per vessel per year. Previous attempts to quantify depredation impacts on fishers have resulted in very broad ranges of values when relying exclusively on questionnaires (e.g. Gonzalvo *et al*., 2015; Geraci *et al*., 2019; Alexandre *et al*., 2022), while efforts to compare questionnaire data with direct observations have found discrepancies between the reported and observed depredation rates (e.g. Bearzi *et al*., 2011). To our knowledge, this is the first published study directly comparing frequent EE with concurrent repeated questionnaire surveys to evaluate depredation impacts. The benefit of this approach is obvious, as the short span (less than a week) covered by each interview reduced subjectivity and increased accuracy in the fishers' responses, which we were able to validate thanks to the frequency of our own experimental efforts. By combining data from concurrent and repeated field observations and questionnaire surveys, we provide an accurate estimate of cetacean-induced damage in a small-scale fishery—as well as an example of robust methodology that could be implemented in other areas—which can be used to inform compensation and conflict mitigation schemes.

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Supplementary Data

Supplementary material is available at the *ICESJMS* online version of the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

Author contributions

K.G. conceptualized and coordinated the study and supervised methodology, the statistical analysis, and the writing of the manuscript. M.G. performed the statistical analysis and the visualization of results, wrote the original draft and contributed to field work, sampling, and laboratory work. G.A. contributed to field work, sampling, and laboratory work. F.A.M. contributed to laboratory work. G.M. administrated the study and reviewed the original draft.

Data availability statement

Data available on request.

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