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Research Article

Overview of Bottlenose dolphin depredation in Teboulba region (East of Tunisia)

Rimel BENMESSAOUD *[1, 2], Maissa GHARBI [1], Mourad CHERIF [2], Wael KOCHED [2] & Lobna BEN NAKHLA [3]

[1] Institut National Agronomique de Tunisie. 43 Av. Charles Nicolle, Tunis ;
[2] Institut National des Sciences et Technologies de la Mer- Annexe La Goulette, Tunis ;
[3] Centre d'Activités Régionales pour les Aires Spécialement Protégées (RAC/SPA). Boulevard du Leader Yesser Arafet, Tunis.

*__Correspondence__: benmessaoud_rimel@yahoo.fr

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Abstract: This work was carried out in response to the numerous fishermen claims following to the interaction between dolphins and fishing gears along the coast of Teboulba. The aims of this work were: to establish an inventory of dolphins present in the study area and interacting with fisheries, to define the most affected fisheries by the depredation and to attempt to assess it economic consequences.

For this purpose, field surveys as well as weekly monitoring of a sample of the fleet and sea trips were carried out in order to respond to the previously mentioned objectives.

The findings of this study led to the conclusion that there are two dolphin's species: the Bottlenose dolphin and the Striped dolphin. These two species have a different demographic and ecological distribution. They also interact in two different ways with the fishing boats and their nets. According to the surveys, the most depredated fisheries is the small scale fisheries. Set gillnet and trammel nets were the types of the fishing gear most vulnerable to dolphin depredation. The depredation rate and economical loss due to depredation vary slightly between gillnets and trammel nets. The depredation induces many holes with different size requiring mending operations that can be onerous. Likewise for landing, the resulting bites on the catch leave it unsaleable. It is necessary to continue this study in order to identify the factors that can cause the depredation and propose mitigation measures to avoid any ecological and economic blunder.

Keywords: Bottlenose dolphins; Striped dolphin; depredation; Small Scale fishery; Teboulba region.

1. Introduction

Depredation is defined by Zollett et al., (2006) as the removal or damage of catch or bait attached to fishing gear by marine predators. Depredation is a worldwide issue affecting diverse fisheries and involving various marine predators, such as cetaceans, sharks, squids, and birds.

Cetaceans' depredation is one of the biggest challenges faced by various fishing gears (Reeves et al., 2001; Donoghue et al., 2003;

NRC, 2003; Benmessaoud et al., 2018). It seems that dolphins are most species involved in this type of competitive conflict (Bearzi, 2002). Basically gregarious, dolphins occupy areas already highly exploited by fishers. According to Laspina et al., (2022), dolphins exhibit foraging plasticity and utilize various foraging strategies to cover their cost of living. These species have also learned to use fishing gear to take advantage of gatherings of fish encircled in the nets, by feeding directly in the nets [Bearzi, 2002; Reeves, 2001) or on discards at a low energy cost (Rocklin et al., 2009). During the last decade, we witnessed a rise in dolphin depredation events. Benmessaoud et al., (2018) suggested that depredation is just a consequence of overlapping between dolphins' spatial distribution and fishing ground, competition for the same fishery resources, depletion of the fishery stock, and behavioral changes in dolphins. As the human population grows rapidly, fishing in coastal areas will continue to increase, generating more conflicts between fisheries and dolphin population. Depredation may be beneficial to dolphins through increased foraging success (Benmessaoud et al., 2018). However, dolphins-fisheries interactions are considered to be a persisting issue with negative impacts on dolphin population behavior, habitat and distribution (Reeves et al., 2001) and socio-economic with an ethical implication that further complicate fisheries management (Snape et al., 2018). Paradalis et al., (2021), Benmessaoud et al., (2022) and Laspina et al., (2022) have shown that depredation is major concern since reportedly result in gear damage and changes income, which causes an increase in fishing effort to cover economical losses.

In numerous Mediterranean states such as Italy, Greece, Spain, Morocco and Tunisia, dolphins are considered as a direct competitor for fishery resources (Quero, 2000; Gazo et al., 2001; Lauriano, 2004; Zahri et al., 2005; Benmessaoud et al., 2022]. The same for the port of Teboulba (Est of Tunisia), selected as a study area, where severe events of depredation have been recorded. This study delves into depredation and aim to fill a current gap of knowledge on the status of dolphin depredation in Teboulba port where fishing activity and fishing effort are diversified and intensive and existing data on dolphins are very limited. The port of Teboulba (**Fig.1**) has been chosen as a study area due to it high fishing potential. In fact, this port contributes with 76.03% of the Governorate of Monastir's production. It has also been chosen due to the numerous claims of fishermen regarding the severity of depredation events induced by dolphins in the region.

2. Materials and Methods

A minimum of 3 sea surveys were conducted per month throughout the study period from February 2020 to August 2021. These trips were carried out on board fishing boats in order to identify the most depredated fishing activity, to understand the depredation events and to specify which dolphin species are responsible for this type of interaction.

In parallel to sea trips, field work was conducted. Considering the diversity of fishing techniques used in the study area and the complexity of approaches to evaluate the impact of depredation caused by delphinids, we judged useful, to conduct surveys among fishermen in the area as mentioned by Coll et al., (2014). An initial questionnaire was conducted to update the inventory of delphinid species present in the study area and interfering with fishing gear, as well as to identify the most affected fishing activity by depredation.

A weekly monitoring of a sample of boats affected by depredation was carried out. This monitoring was done through a second questionnaire and through inspections of fishing net states. The investigation allowed to collect information related to the used fishing gears characteristics, the landings quantities and composition, the depredation rate and the resulting economic losses. Regarding the fishing net state, this operation was carried out every week in order to count the numbers, to measure the diameter, to determine the location and the origins of holes and to assess the repairing costs.

Based on the studies of Monaco (2020) and Benmessaoud et al., (2022), it is possible to recognize the species inducing perforations (**Fig.2**). In general, small holes are made by crabs, octopuses, spider crabs and moray eels. In the case of larger tears, dolphins and sharks are responsible. Distinction between dolphins and shark depredations was done based on the damages left on the fish. Dolphins' attacks lead to ragged wounds and torn flesh, leaving conical tooth marks on the prey. As for sharks, they leave several visible and clear bites on the fish body.

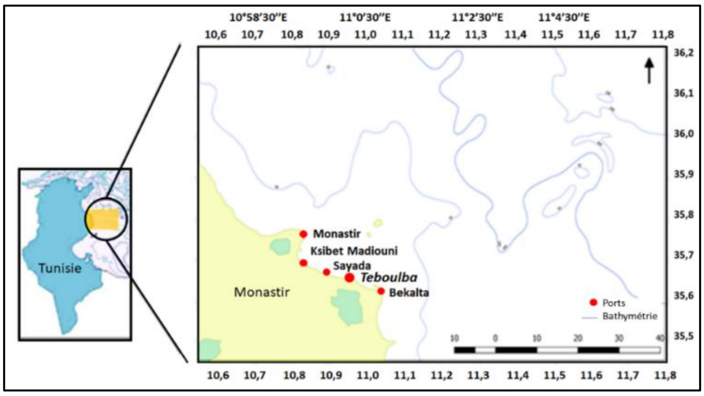

Figure 1: Map of study area

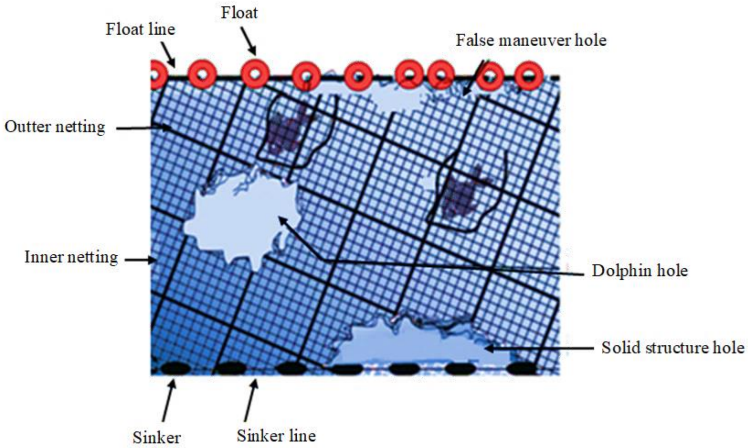

Figure 2: Different holes type encountered in fishing net

Table 1: Variables monitored before and after each sea trip

Variables	Categories
Perforations origin	O_1: Incorrect maneuver
	O_2: Other species (sharks, octopus, crab...)
	O_3: Dolphins
	O_4: Solid structures (wrecks, rocks, propeller)
	O_5:Undetermined
Perforations numbers	N_1<10
	10< N_2< 30
	N_3>30
Perforation size	T_1: Small (S< 25 cm)
	T_2: Medium (25cm ≤ S < 50cm)
	T_3: Large (S ≥50 cm)

Figure 3: Catch remains found in different fishing gear following depredation events

Table 1 summarizes the different ranges established for perforation monitoring. In order to determine whether or not there is a correlation between the type of gear, the number and the size of perforations, we used the statistical test ANOVA under the SPSS software.

Economic losses due to perforations were evaluated as reported by (Benmessaoud et al., 2018). This macro-economic approach is required considering that a more specific economic analysis taking into account both production costs and benefits could not be carried out due to the different patterns of remuneration, fishing effort and the large variability of expenses of each vessel. The approach adopted provides information on dolphins' damage by type of fishing gears and fishing vessel. The average cost of overtime for repairing fishing nets is based on the number and the salary of a mending net.

Some fishermen attributed the loss of a part of the catch to dolphins which fright the catch or damage the net by making some perforations which allow the escape of catch. The identification of the sources of the perforations, at dockside, allowed us to closely follow those attributable to dolphin's depredation.

This identification becomes easier in the presence of remains of the catch. As mentioned before, dolphin depredation leaves a prey with conical teeth marks and having a scraped flesh. These bites often leave the catch not saleable considering that only a portion of the catch remains hanging in the meshes. In order to assess catch damage, each specimen caught was analysed. The catch morphological damage was classified into five categories as described by Lauriano & Muccio (2002):

(a) "Bite", the specimen showed one or more parts removed; (b) "Fragment", only parts of the specimen remain; (c) “Head”, when only the head remained, the body removed at the level of the gills; (d) “Tail”, only the tail remained; (e) “Vestigial”, empty bodies with only the skin and bones left (**Fig. 3**).

In order to understand depredation, we tried to verify whether there is a link between the different species landed and the dolphins dietary preferences present in study area.

3. Results and Discussion

3.1. Questionnaire results

3.1.1. Dolphin inventory

Showing several pictures of cetaceans to fishermen in the study area, they were able to easily identify bottlenose dolphins *Tursiops truncatus* (Montagu, 1821) while confirming the fact that this species interferes with their boats and their fishing gear. 56% of respondents had difficulty distinguishing between the common dolphin *Delphinus delphis* (Linnaeus, 1758) and the striped dolphin *Stenella coeruleoalba* (Meyen, 1833). Respondents stated that there is an overlap between fishing ground and dolphin’s distribution areas. They explained that dolphin species have different habitat use and have different site fidelity. They mentioned that the three dolphin species encountered in study area have different behaviour in presence of fishing boats. Contrary to bottlenose dolphins, common and striped dolphins occupy some fishing ground but interact rarely with boats or fishing gear.

3.1.2. Fishing activity most affected by the depredation

In all, 122 surveys were carried out among the fishers of the Teboulba region. The first questionnaire provided an outline of depredation in study area. It seems that all fishing activities are suffering from interactions, although the severity differs from one activity to another. According to the respondents, the small-scale fisheries, mainly those using trammel nets and gillnets, is the most affected by depredation followed by those fishing the small pelagic fish.

The questionnaire allowed to conclude that depredation effect does not stop at the level of partially or completely catch losses, but also affects the catch landing prices making it less stable, which leads to a decrease in the income and in the commercial profit margin. All these consequences have pushed some professionals to move to other areas, which is likely to intensify the fishing effort in the new areas, and have pushed others to abandon fishing activity altogether.

3.2. Sea Trips results

71 sea trips were conducted during the study period. Dolphin monitoring began immediately after leaving the port and continued until arriving at the fishing area. The surveyed areas extended from the bay of Monastir to the Kuriat Islands.

During the sea survey, we have encountered just two species of dolphins; bottlenose dolphin and striped dolphin. These two species have a different demography and ethology patterns. It occupied two different ecotypes. This finding concurs with that reported by Benmessaoud et al., (2020). The same authors stated that they only observed *Tursiops* and *Stenella* in the same study area. They even indicated sympatric occurrence of mixed groups of these delphinids in order to increase protection against any threats and to improve habitat use. However, during our study this was not the case: there was no overlap between the two species ranges.

In all 45 groups of dolphins were observed: 38 groups of bottlenose dolphin and 7 groups of striped dolphins. *Tursiops* Groups size were small with size ranged from one singleton to 4 individuals per group ($\bar{x}$=2.5 ± 1.5 ind.). All individuals encountered were adults. For *Stenella* groups, they were larger. The average size was equal to 5.5 individuals per group (± 1.5 ind.). These results are inconsistent with those reported by Benmessaoud et al., (2020). These authors noted the existence of larger groups of *Tursiops* and *Stenella* ($\overline{x}_{Tursiops}$= 06.28 ± 2.89ind.; $\overline{x}_{Stenella}$= 9.64 ± 2.27 ind.). Depredation events were recorded in 43.66% of monitored trips. The depredation events were all induced by bottlenose dolphin. Interference between bottlenose dolphin and gillnets occurred in the vicinity of the Kuriat Islands at respective depths and distances from the coast ranging from 10 to 14 m and 3 to 4 nautical miles. Interactions with trammel nets, on the other hand, occurred mainly at coastal distances and at depths ranging from 2 to more than 10 nautical miles and from 10 to 50 meters deep respectively. *Stenella* groups were all observed in feeding or socializing behavior away from boats and fishing nets at 10MN from the coast of Teboulba and at a depth exceeding 100m. No depredation events were observed during the maintained sea trips. The same result was advanced by Bonizzoni et al., (2016), Monaco, (2020) and Paradalis et al., 2021]. Paradalis et al., (2021) mentioned that the depredation rate and net damage was higher in shallow waters (<200 m). Bonizzoni et al., (2016) and Monaco (2020) mentioned that despite the high abundance of common and striped dolphins in the vicinity of fishing nets in the Gulf of Corinth (Greece) and in Sicily (Italy), these dolphins were unlikely to depredate the nets. Depredation just occurred where bottlenose dolphins and fishing effort overlapped.

3.3. Monitoring of dolphin depredation impact on small scale fishery

According to the results of the first questionnaire, it appears that small scale fishery is the most affected by dolphin's depredation, followed by the small pelagic fishery. In this study we are only interested in small scale fishery. We have established a weekly follow-up of ten boats during the study period.

A total of 682 monitoring forms were compiled. The number of trips varied from one boat to another mainly due to weather conditions and due to both boat and net condition. During the study period, 818 fishing operations were monitored. Gillnets were used in 339 operations while trammel nets were used in 575 fishing operations. 63.20% of fishing operations made were depredated (n=517). Depredation rate did not vary statistically with net type (depredation rate $_{\text{Gillnet}}$ = 59.58%, n=202; depredation rate $_{\text{Trammel net}}$ = 54.70%, n= 315; p-value >0.05).

Depredation events happened in three different ways: (i) observation of dolphins in the vicinity of the nets while causing perforations, (ii) dolphins feeding directly from the nets without damaging the nets and (iii) occurrence of perforations without observing dolphins. The incidence of these types of events differs according to the type of net used (**Tab.2**).

Based on our observations, skippers prefer to maintain their fishing activity while dolphins are present and take the risk of depredation than waste time moving the fishing area. The same finding was described byMonaco et al., (2019).

According to this author, when fishermen observe bottlenose dolphin near the fishing gear they have two options: a) to hauled back the net before dolphins interfere and eventually change the fishing area (less catches because of the reduced time or more expenses for extra fuel and time/net save); b) to maintain the net underwater taking the risk of the interaction (net save/catches save; or net save/less catches because of scattering fish or partial prey depredation by dolphin; or net damaged/loss of most of the catch).

This finding is different to the one described by Monaco et al., (2019). According to this author, in presence of dolphin around the fishing ground, some fishermen hauled back the net before dolphins interfere and eventually change fishing area. They prefer to have less catches due to reduced fishing time and assume more expenses for extra fuel and time as long as they saved their net but with less catches due to scattering fish. Another part of fishermen prefers maintaining the net underwater taking the risk of the interaction. They think that there is a probability that dolphins not damage net either catch. They also think that there is a chance to have a saved net due to the abundance of prey near the net. The other part of fishermen prefers maintaining the net underwater taking the risk of the interaction. They think that there is a probability that dolphins not damage net either catch.

Table 2: Various aspects of depredation

	Depredation type	Gillnet		Trammel net	
		n	%	n	%
Nb of fishingoperat	**Occurrence of dolphins + perforations**	70	34.65	104	33.02
	Occurrence of perforations - dolphins	103	50.99	172	54.60
	Occurrence of dolphins - perforations	29	14.36	39	12.38
	Total of depredation event/ type of net	**202**	59.58	**315**	54.78
	Total of fishing operations/ type of net	**339**		**575**	

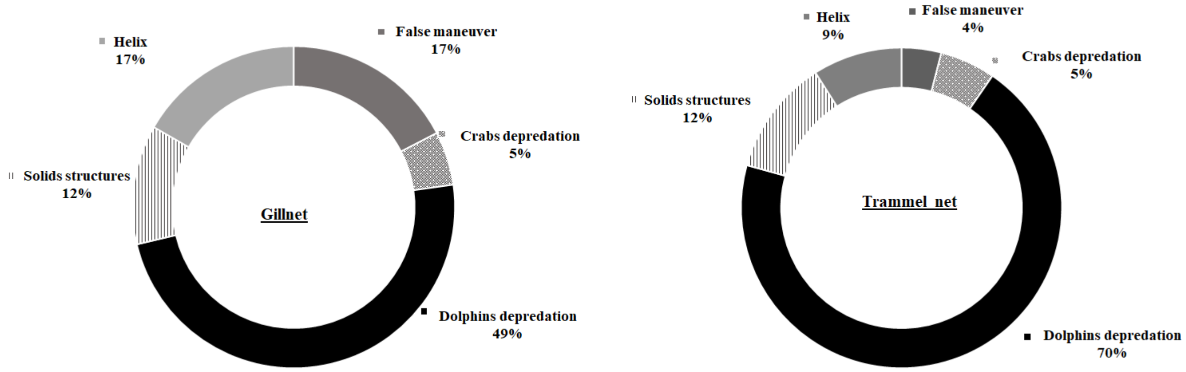

Figure 4: Pie chart of holes causes in monitored fishing nets

3.4. Perforation typology

An examination of fishing nets state allowed us to count the perforations and to evaluate the origin and the size. A total of 254 holes were recorded in the gillnets. The number of holes per net varied from 3 to 50. These tears were mostly caused by dolphin depredation (49.01%). The remaining perforations had other origins such as solid structure impact (12%), helix action (17%), depredation by other marine species such as crab (*Carcinus aestuarii*) (5%) and false manoeuvring (17%) when hauling or spinning the fishing net (**Fig. 4**).

In the case of trammel nets, 275 perforations were recorded with a number of perforations ranging from 2 to 40 per net. The assessment of the perforation's origins showed that 70% of holes are induced by dolphins (**Fig. 4**). Despite the fact that the number of perforations encountered in gillnets was lower than those in trammel nets, the ANOVA test showed no significant variation of dolphin depredation holes per type of net (F=0.208; p-value=0.672).

Figure 5 illustrates the variation the variation of size and holes number by different holes origin. The number of perforations induced by wrecks or due to the net rolling around the helix is smaller than those produced by *Tursiops*. However, it has a diameter larger than those established by a false maneuver, crab or dolphin, whose surface area did not exceed 40cm.

124 dolphins' perforations were counted on all the gillnets surveyed (N=254). 54.03% of These perforations are of the T2 type (n=102; **Fig.5**).

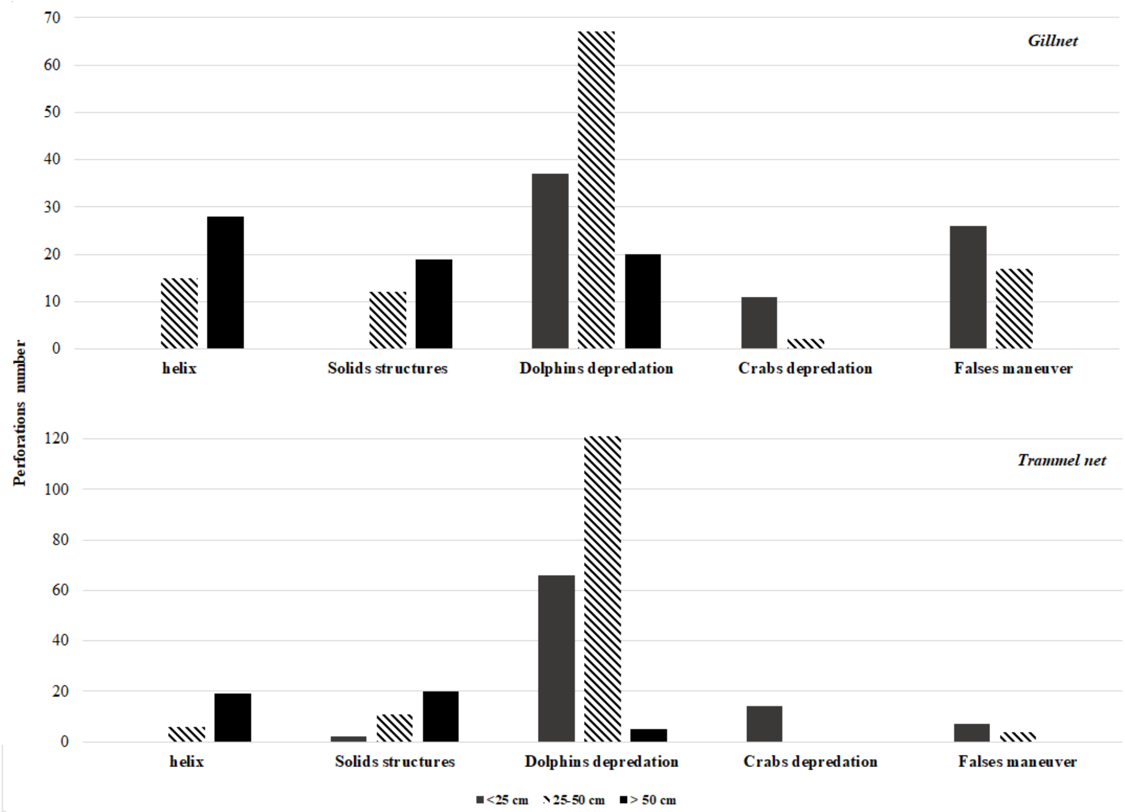

Figure 5: Perforations number and size variation by net type

There were 192 perforations resulting from the dolphin's depredation in monitored trammel net. These perforations were either of type T1 (34.38%) or T2 (63.02%). Despite the variation in hole size and number per net type, the ANOVA test performed did not detect any significant variation (p-value> 0.05).

Monaco (2020) reported that 30% of holes generated in nets used in Sicily (Italy), had an average size between 31 and 80 cm. Monaco (2020) indicated that more than 30 holes can be detected per piece of net. The author explained that in some cases, a small number of holes could produce greater damage due to large perforation size (120cm). The same author added that a depredation event can damage an average of 60% of the net which amortizes the effectiveness of this gear and requires replacement with a new one. Snape et al., (2018) reported that dolphin depredation can damage up to 1.4 m^2 for an 80 m net length, a loss of 1.5% of the total net surface.

We hypothesize that these holes are closely related to the dolphins' dietary preferences and to the net volume catch. This assumption was also raised by Benmessaoud et al., (2018; 2022) who reported severe bottlenose dolphin depredation at purse seines with volumes catch exceeding five tons. This raises the question of how a dolphins can recognize a well-fished net from a less well-fished one?

3.5. Fishing effort

The inactivity of the sampled fleet due to dolphins' holes mending does not exceed 8% of the total days of inactivity. A review of factors responsible for the inactivity of the vessels shows that inclement weather is the main cause of the reduction in fishing effort (54.12%) followed by vessel maintenance period (37.88%). The low percentage of days of immobilization due to mending holes explained by the fact that the majority of skippers repair their net during the period of bad weather or have at least two nets onboard.

Immobilization due to net mending can last from 2 to 7 days for a team of 2 to 4 fishermen at a cost of 45 to 60 dt/day. These results are in agreement with those of [20] who showed that in Sicily, the repair of nets can take from 2 to 10 days for 1 to 4 fishermen. The author reported that skippers in no case gave up their fishing activity. They continued their activity using another gear until the damaged one was repaired or replaced. We noted that despite the redundancy of inactivity day due to dolphin mending tears, the lack of manpower, the variation in the pay systems, the costs of ice, fuel and mechanical repairs remain the most burdensome expenses for a skipper. Moreover, when accounting for expenses, it was found that the skippers tended to ignore the time allocated to net repair as they considered it as a normal work routine.

3.6. Nets fixing costs

For both types of nets, the perforations required a mending operation. For wreck tears or solid structures and crabs, it required a mesh-by-mesh re-tapping operation. However, for dolphin holes, in 80% of the cases, these tears required the addition of a net patch or required a joining operation where the mending man tries to re-sew the meshes.

The total repairing costs were up to 940 Dt (±275 Dt) for gillnets and 1100 Dt/month (±525 Dt) for trammel nets. Total mending costs are higher in the case of pieces of net purchasing in order to repair wrecks or helixes holes. These costs can be doubled and even tripled in case of total loss of the net.

The dolphins mending holes were equal to 460 Dt/month (± 105Dt) for gillnets and 770 Dt/month (± 227.5Dt) for trammel nets. We noted that the cost of repairing trammel nets is higher than those of gillnets. This may be related to the technical characteristics of trammel nets where they are composed of a combination of three sets of nets and any depredation event would alter all three sets at once. The high mending costs of trammel net can be also related to the setting time. Indeed, Snape et al., (2018) demonstrated that the damage to the net was always significant at the time of setting. According to our observations, only 47% of the professionals fixed their ripped nets. The rest of the respondents preferred not to mend them, which reduced the efficiency and productivity of the fishing gear and increased the number of days of immobilization in case of mending. They preferred to replace damaged parts with new nets or to acquire new nets at the end of the fishing season, once the latter have been fully amortized. Preliminary studies indicate that the mending costs due to dolphin interaction with Mediterranean small-scale fisheries (SSF) amounts to €77.65 for 50 m of net per year (Goetz et al., 2014; Maccarrone et al., 2014), with a mean economic cost of €2,561 per vessel annually (Bearzi et al., 2011; Revuelta et al., 2018] while commercial fisheries claim annual economic damages caused by dolphin depredation up to €20,000 per vessel (Snape et al., snape2018).

3.7. Impact of depredation on production

The assessment of the effects of depredation on catch volume and composition began with the inspection of nets state, in order to quantify the discards attributable to delphinids. We then asked the skippers to bring back the catch which they doubted was damaged by depredation. However, this quantification did not reflect reality as it only assessed the depredated catch that remained in the net meshes. In addition, the skippers struggled to distinguish between dolphins and shark's depredation. Referring to Harwood (1992), entangled fish were exposed to predators by the tail or the head. However, delphinids have the ability to choose the most nutritious portion of the prey and they attacked more the abdominal part of the prey [28]. The same author added that the fish bitten from the abdominal part will not be retained in the net's meshes anymore and will thus be released from the nets.

According to Noureddine et al., (2017), a complete comprehensive damage estimate can be achieved by having landings and sales price data from the same sample of the fleet to compare the results of fishing trips based on the same gear, season and location. This will also allow the measurement of possible changes in the volume and composition of the catch following a dolphin depredation event.

The landings of the monitored vessels were mainly composed of demersal fish. For the fishermen using gillnets, the catch was composed mainly of Sparidae (59.69%), Mullidae (23.29%) and Serranidae (16.08%) (**Fig. 6**). The composition of trammel nets did not differ from gillnets except for cephalopods represented by octopus and cuttlefish (**Fig. 6**).

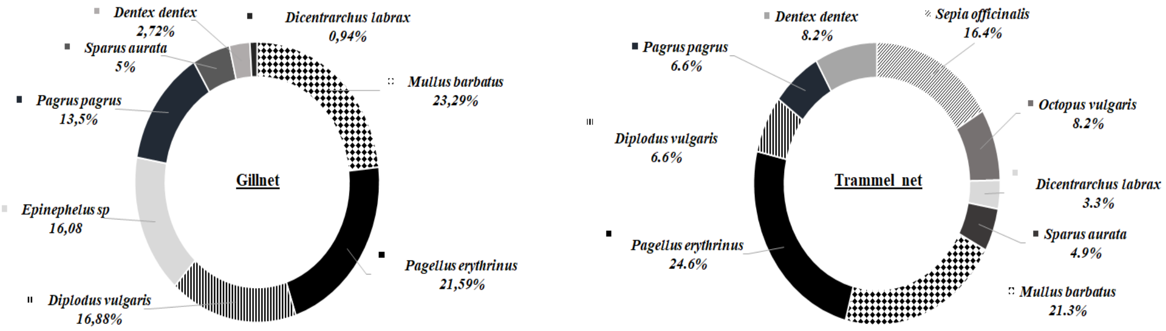

Figure 6: Pie chart of most represented species in gillnets and trammel nets landings of most represented species in gillnets and trammel nets landings

Figure 7: LPUE variation by fishing net type and by depredation occurrence

The monitoring of the landings per unit effort (LPUE) of sampled boats showed that those equipped with gillnets have a lower LPUE, especially in case of dolphin's depredation with LPUE equal to 15.5Kg/24h (±3.7Kg/24h) in absence of depredation and 5.9 Kg/24h (±2.5/24h) in presence of interaction, representing 38% of the normal LPUE (**Fig.7**). The trammel nets had an LPUE equal to 30.5 Kg/24h (±7.0Kg/24h) in the absence of depredation and an LPUE equal to 11.5 Kg/24h (±4.5Kg/24h) in the presence of a depredation event, which is only 37.7% of the normal LPUE (**Fig.7**). Our results are in accordance with those of Monaco (2020) who reported a 20% decrease in LPUE of gillnets depredated by *Tursiops* in Sicily (Italy). Pennino et al., (2015) also made the same conclusion regarding the decrease in LPUE of trammel nets used in the La Maddalena archipelago (Italy) following a bottlenose dolphin depredation.

231 fish, showing a trace of depredation, were collected during the monitoring period. 42.75% of this catch did not have missing parts but had detached flesh. The others had either multiple bites (45.25%) or were missing part of the head (46.33%). Only 4.67% of these preys presented only by the tail and 3.75% had the part of the abdomen remaining (**Fig. 8**). Among the species caught and showing bite marks, we mention: mullids and sparids. For gillnets, only 26.41% of the nets contained remains of red mullet (n=61). In trammel nets, evidence of depredation on preys was found in 73.59% of net monitored (n=170). Mainly remains of cuttlefish, mullet and red mullet were founded. This disproportion can be related to the technological specificities of trammel net. The creation of a bursa within the trammel net favors the entanglement and the retention of prey, even if there are remnants.

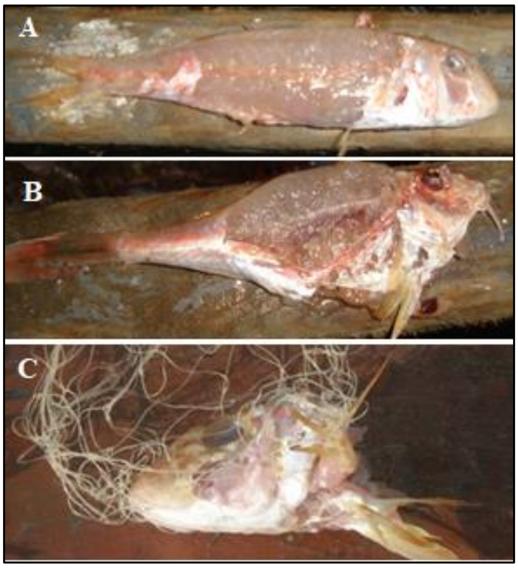

Figure 8*:* Example of prey depredated by dolphin *A: prey with scraped flesh; B -C: different parts of the body bitten*

Indeed, the species mentioned as *Pagellus erythrinus, Dicentrarchus labrax, Dentex dentex, Pagrus pagrus* and *Octopus vulgaris* are all species that are among the species targeted by bottlenose dolphin. These species are well represented in the diet of *Tursiops truncatus*. According to Lauriano (2004) and Larbi Boukara (2015), mentioned that *Tursiops* had a diet composed of benthic, demersal and mesopelagic fishes (Sparideae, Merluccidae, Clupeidae), neritic cephalopods (Loliginidae and Octopodidae) and accessorily crustaceans. In the same context, Benmessaoud et al., (2022) mentioned that the relative abundance index (IRI) of common pandora and octopus is respectively 17% and 2.5%. However, Silvani et al., (1992) and all the authors mentioned before, specified that *Tursiops* is also known for the feeding opportunistic behaviour, it feeds readily on fish caught in fishing nets.

We can thus conclude that the dolphin-induced perforations are not related to the type of net but to what they were entangling. Depredation is closely related to the availability and abundance of prey both in the study area and in the fishing gear. However, actually knowledge on dolphins' diet is too limited to be integrated into an environmental management model. There is a need to better understand the foraging strategies of delphinids, which will help to identify specific interactions.

4. Conclusions

Given the complexity of the subject, a multidisciplinary and systemic approach should be applied in order to better understand the impact of different factors which may have an influence on the occurrence of depredation events. A depredation event results in various costs. Costs derive from loss of catches, additional gear to compensate for losses, cost to repair gear, investment in mitigation devices, depredation avoidance measures such as leaving the fishing area and consequently increased fuel and crew cost. However, there is no indemnity expense for cases of depredation. The compensation to fishers should be proportional to the extent of the loss and defined by expert, distinguishing damages to equipment from damage to the catch. Every fisherman should be able to receive subsidies for the purchase of mitigation measures.

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