

## **Interactions between marine mammals and fisheries: case studies from the Eastern Aegean and the Levantine Sea**

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### **Abstract**

Anthropic presence is growing in the oceans worldwide, causing an alarming rise in dolphin-human interactions. The current report summarizes the results of fishery interactions with small marine mammal species, including the endangered Mediterranean monk seal (*Monachus monachus*), the Bottlenose dolphin (*Tursiops truncatus*) and the Common dolphin (*Delphinus delphis*). These species have been regularly sighted in the close vicinity of fishing vessels, while entanglement and depredation events in the artisanal fishing gear, purse seiners and trawlers have been recorded. Additionally, deliberate killing of striped dolphins (*Stenella coeruleoalba*) have been documented. Due to the increasing interaction rates within the last decades, direct consequences such as behavioral modifications, injuries and death are unavoidable. Similarly inevitable are the indirect effects like the growing hostility of fishermen to certain species due to the depredation of their nets but also due to the overall decrease of common prey stocks. Therefore, focused and joint studies on the short and long-term interactions between marine mammals and fishery activities in line with awareness campaigns are crucial to improve the understanding of the direct and indirect impacts resulting from fishery practices. This is an important prerequisite to develop effective conservation measures before this pressure causes significant effects on the entire Mediterranean populations of these data-deficient species at risk.

### **Introduction**

Anthropogenic pressure on marine mammal populations has substantially grown worldwide as a result of the intense and increasing demand for seafood in recent decades and certainly the Mediterranean Sea is no exception (Lotze *et al.*, 2006; Parsons *et al.*, 2015). Apart from fisheries, pressures from multiple other economic activities such as tourism, maritime transport, aquaculture and agriculture also cause a lasting footprint in all aspects of the fragile Mediterranean environment and biodiversity (UNEP/MAP-Plan Bleu, 2009). It is however the poorly regulated and uncontrolled fishery practices that are considered as the main cause of the alarming decline in fish stocks worldwide: around 90% of the world stocks are either fully or partially overfished (FAO, 2016), while the Mediterranean fish stocks are showing a severe decline since 1982 (Pauly & Zeller, 2016). According to a recent analysis, 93% of the assessed Mediterranean fish stocks are overexploited, while a number of them are on the verge of depletion in particular the Mediterranean Sea is estimated to have lost 41% of its marine mammals and 34% of the total fish population over the past 50 years (STECF 2017).

The dramatic overexploitation of fishery resources has resulted in numerous ecosystem impacts, but also in changes over time in the types and frequency of interactions between marine mammals and the various fisheries practices. As the fish stocks decline, it is becoming increasingly difficult for both fishermen and marine mammals to locate and capture adequate amounts of fish, which in return adds more pressure on the marine ecosystem, as the effort to catch fish increases both in artisanal and industrial fishing practices. The potential impacts of marine mammal predators on other species in the trophic chain include: reduced recovery of forage fish (Surma and Pitcher, 2015), increased competition between marine mammal species that share the same prey (Marshall *et al.*, 2015) and increased direct competition between marine mammal populations and fisheries (Gerber *et al.*, 2009). Increased fishing effort and therefore increased presence of fishing vessels results in entanglement and by-catch, but also provides a foraging opportunity for dolphins and seals that seek easy preys in fishing gear (Chilvers and Corkeron, 2001; Chilvers *et al.*, 2003), not without associated risks leading to injury or death (Christiansen *et al.*, 2015; 2016). There are several reports of foraging activities of marine mammals in the close vicinity of fishing vessels in the last decades (Mattson and Thomas, 2005; Siegel *et al.*, 2015; Pennino *et al.*, 2016; Bas *et al.*, 2016, Rios *et al.*, 2017, Maccarrone *et al.*, in this volume; Marcalo *et al.*, in this volume; Brotons *et al.*, in this volume and Kafaf, in this volume). This habituated behavior towards fishing vessels has been classified as new foraging strategies under begging, depredation and scavenging behaviours (Powel and Wells, 2010; Kovacs and Cox, 2013). These highly risky behavioral adaptations towards fishing vessels stand apart from the behavioural reactions towards the other vessel types, such as speedboats or ferries (Lusseau, 2003; Bas *et al.*, 2017; Oakley *et al.*, 2017). The interaction between the fishery practices and marine mammals brings about both short and long-term negative effects. Short-term effects include behavioral changes while long-term effects include physical stress, injury and even death (Genov *et al.*, 2008; Christiansen *et al.*, 2016).

The constant increase of interactions between human activities and marine mammals has resulted in the deterioration of the conservation status of the Mediterranean marine mammal subpopulations. Since 2001 more species have been listed as “vulnerable” and even “endangered” in the IUCN Red List (IUCN, 2017). The major threats include by-catch, fish depletion, habitat destruction, chemical and noise pollution, ship strikes and marine traffic (Bearzi 2003; Wright *et al.*, 2007; Birkun and Frantzis, 2008; Bailey *et al.*, 2010; Thompson *et al.*, 2010; Bearzi *et al.*, 2012; Birkun, 2012; Dunlop *et al.*, 2017; Bas *et al.*, 2017; Oakley *et al.*, 2017). Their impacts on the marine mammal populations are estimated to increase in the future, if effective conservation measures are not taken (Coll *et al.*, 2010).

Due to the lack of targeted monitoring programmes, there exists a large knowledge gap on the levels and types of interactions between marine mammals and the various fisheries practices in many parts of the Mediterranean, while the existing information is frequently scattered and unpublished. As a result it is difficult for management measures to be developed and implemented, in order for these interactions to be mitigated.

This paper provides a preliminary assessment of the marine mammal-fishery interactions in the regions of the Eastern Aegean Sea and Antalya Bay in the Levantine Sea, through the compilation of unpublished data and information gathered through different survey approaches (dedicated boat and land surveys, opportunistic surveys from research and fishing vessels, questionnaire-based surveys, and reports from marine mammal stranding network). In combination with the information provided in this Monograph on the interactions off Sicily (Maccarrone *et al.*, this volume), in Portuguese continental coast (Marçalo *et al.*, this volume), the Balearic sea (Brotons *et al.*, this volume) and the waters of Morocco (Kafaf, this volume), an understanding of the characteristics and frequency of marine mammal-fishery interactions in selected Mediterranean regions can be generated.

### Case Study 1. Marine mammals-fisheries interactions in the Eastern Aegean Sea, Greece

Between 2000 – 2018, the interactions between marine mammals and fisheries practices in the region of the eastern Aegean Sea, were assessed opportunistically, using direct observations during dedicated boat surveys monitoring marine mammal populations, a qualitative questionnaire based surveys addressed to artisanal fishermen, as well as reports from a marine mammal stranding network.

#### *Cetacean – Fisheries Interactions*

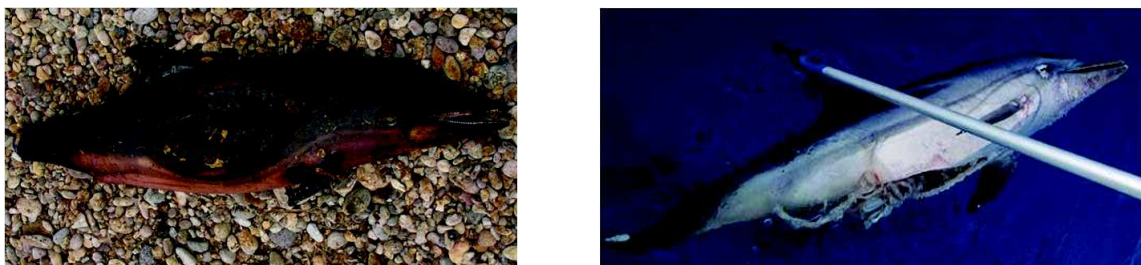
Between 2000 and 2010, the Bottlenose dolphin *Tursiops truncatus* was the only cetacean species that was recorded to depredate both artisanal fishing gear and trawlers. Depredation behavior on artisanal fishing gear was mainly recorded by solitary dolphins or small pods, rather than larger pods that rarely showed such a behavior. Since 2010, the Common dolphin *Delphinus delphis* was also observed to start demonstrating gradually a depredation behavior, initially interacting with benthic trawlers and since 2013 with artisanal nets.



**Figure 1.** Interaction of *T. truncatus* (left) and *D. delphis* (right) with trawlers

Since 2010, throughout the trawling season for Greek waters (October-May), there are regular sightings of *T. truncatus* and *D. delphis* interacting with trawlers, demonstrating scavenging or depredation behaviours (Fig. 1). No interaction has ever been observed nor reported between Striped dolphins *Stenella coeruleoalba* and any type of fisheries, although six of the *S. coeruleoalba* that were found stranded in the region had marks of deliberate killings inferred to be caused by interactions with fisheries activities (Fig. 2).

Risso's dolphins *Grampus griseus* have been reported to be entangled on surface long lines and this is the only form of depredation recorded for this species (Fig. 3). No evidence or information was reported in relation to interactions between the purse-seine and boat-seine fisheries with cetaceans. No interactions with fisheries activities has been reported or recorded between larger cetacean species found in the region (*Ziphius cavirostris*, *Physeter macrocephalus* and *Baleanoptera physalus*).



**Figure 2.** Stranded *S. coeruleoalba* with marks of deliberate killings.





**Figure 3.** Stranded *G. griseus* with marks of deliberate killing.

### ***Monk Seal– Fisheries Interactions***

The incidents of depredation of Mediterranean monk seals *Monachus monachus*, with artisanal fishing gear, and both nets and long-lines have been increasing since 2000, with more incidents being recorded and reported in the south-eastern Aegean Sea, than in the north-eastern Aegean Sea, likely reflecting the larger monk seal population in the SE Aegean. In a study carried out in 2014 assessing the interactions between monk seals and the artisanal fishery of the small island of Lipsi in the SE Aegean, (Rios *et al.*, 2017), evidence of depredation by monk seals was recorded in 19.1% of fishing journeys compared to 5% by cetaceans. Analysis of landings data showed that gear and depth were the variables most likely to influence the occurrence of depredation, whereas the total cost of monk seal depredation was estimated to be 21.33% of the mean annual income of the artisanal fishermen.



**Figure 4.** A juvenile *M. monachus* entangled in an artisanal fishing net

There has only been one incident where a young *M. monachus* was found entangled on a fishing net (Fig. 4) and such bycatch was not been reported in any other occasion. The incidents of *M. monachus* that were found stranded with evident marks of deliberate killings are considered to be caused by certain fishermen as a manner of reducing depredation on their fishing gear and the large loss of their income, but is certainly not a common practice among the local fishing communities.

### Case Study 2. Marine mammals-fisheries interactions in Antalya Bay

Through a combination of opportunistic surveys from artisanal fishing vessels and dedicated land surveys that took place in the coastal zone of Antalya Bay between 2015 and 2017, Bottlenose dolphins (*T. truncatus*) were recorded regularly in the close vicinity of fishing practices. Dolphin-fishery interactions were recorded in 106 of 119 sampling occasions (5 minutes) in close vicinity (less than 400m) of artisanal fishery and trawlers. In only three of these incidents interaction with trawlers was recorded, but it should be noted that the coastal zones of Antalya Bay are mainly free from the trawler pressure.

Additionally, an adult Mediterranean Monk Seal (*Monachus monachus*) was documented scavenging from an artisanal fishery boat on 28 August 2015 in Antalya Bay (Bas *et al.*, 2016). The event took place near a fishing net, and the seal spent over 30 min between diving and resurfacing around the net, often coming up with fish in its mouth, while in close proximity (less than 50 m) to a group of ten swimmers. No apparent reaction of the local seal to the swimmers was recorded (Bas *et al.*, 2016).

Pre-determined qualitative questionnaires were disseminated to 30 artisanal fishermen registered in the Antalya Fishery Cooperative. All fishermen interviewed reported depredation on their nets, assumingly from bottlenose dolphins.

### Conclusion

The current paper summarises the interactions between marine mammals and fisheries from two different locations in the Mediterranean, the Eastern Aegean and Northwestern Levantine Sea. In these areas, the scarce knowledge available on the marine mammal populations and the factors of threat poses an important barrier to effective conservation actions. In both regions, *T. truncatus* regularly demonstrated depredation behaviors from trawlers and artisanal vessels. The same scenario is also present off the Balearic Islands in Spain (Brotons *et al.*, this volume), off the Mediterranean coasts of Morocco (Kafaf, this volume), as well as in the Sicilian Channel in Italy, one of the most exploited fishing areas in the Mediterranean Sea, where the competition between fishermen and Bottlenose dolphins is estimated to have intensified due to the general decrease in pelagic and demersal fish stocks (Maccarrone *et al.*, this volume). In the eastern Aegean Sea, the interactions between *D. delphis* and fisheries activities were not recorded or reported until 2010. Since then small pods of the species were observed to start demonstrating gradually a depredation behavior. This initially involved interaction with trawlers and since 2013 also with artisanal nets. Fishery interactions of *D. delphis* are also recorded and studied since the beginning of the 20<sup>th</sup> century along the Portuguese continental coast, where this species is the most abundant and is often victim of bycatch in gill and trammel nets or of interaction with purse seiners (Sequeira and Ferreira, 1994; Silva, 1999; Silva and Siqueira, 2003; Wise *et al.*, 2007; Marçalo *et al.*, this volume).

In the Eastern Aegean Sea the six individuals of *S. coeruleoalba* that were found stranded with marks of deliberate killing, as well as the rare bycatch of *G. griseus* in longlines draws the attention to the wide range of unintentional catches during fishing practices. The endangered *M. monachus* was also recorded to have frequent interactions with artisanal fisheries in both regions. Such seal-fishery interactions are frequently reported in many parts of the Greek and Turkish seas, but are not common in other sectors of the Mediterranean, due to the limited distribution of the species.

Therefore, the negative impacts of fisheries, ranging from bycatch to behavioural modifications and direct hostility to the animals, were documented in the two study areas. While the results of entanglement and bycatch can be immediate, the consequences of behavioural modifications (such as area avoidance, development of risky foraging strategies), need to be addressed with caution. Their

effects include habituation, hostility of fishermen, intentional and unintentional injuries and death, as a result of following, approaching and staying with the vessels.

With the lack of efficient fisheries management measures, these interactions are only expected to exacerbate in coming years due to overfishing and related impacts.

It is important to highlight that the species exposed to these threats are currently classified at risk in part due to the high incidence of entanglement events (Bearzi, 2003; Birkun, 2008; Bearzi *et al.*, 2012). The human-dolphin interactions are not limited to fishing activities but also to tourist interactions such as dolphin watching activities and fish hand-outs offered to dolphins, even though laws and local regulations for the protection of wildlife do not allow such practices (Maccarrone *et al.*, this volume). Therefore, a focused investigation on the short and long-term interactions between marine mammals and fisheries, in line with awareness campaigns, is crucial to understand the extent of the threat posed by fisheries. Filling this knowledge gap is an important prerequisite for the development of effective conservation measures.

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