REVIEW OF AVAILABLE INFORMATION ON DEPREDATION BY MARINE MAMMALS IN FISHING GEARS IN THE MEDITERRANEAN SEA, BLACK SEA AND CONTIGUOUS AREAS

ACCOBAMS

Review of Available Information on **Depredation by Marine Mammals in Fishing Gears** in the Mediterranean Sea, Black Sea, and Contiguous Atlantic Area

Draft version before editing

By

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Abstract

(To be completed)

Acronyms

ACCOBAMS - Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area

CPUE – Catch Per Unit of Effort

FAO - Food and Agriculture Organization of the United Nations

GFCM - General Fisheries Commission for the Mediterranean

IMMA - Important Marine Mammal Area

LEK - the local ecological knowledge

LIFE - *L'Instrument Financier pour l'Environnement* (French for "funding instrument for the environment")

SPA/RAC - The Regional Activity Centre for Specially Protected Areas

UNEP/MAP - Mediterranean Action Plan of the United Nations Environment Programme

WWF - World Wildlife Fund

Background

Depredation by cetaceans – when they partially or completely remove catches from fishing gear – is a growing cause for concern in several Mediterranean fisheries. In general, interactions between cetaceans and fisheries in the Mediterranean and the Black Sea involve mainly coastal fisheries and species such as common bottlenose dolphins (*Tursiops truncatus*), which are typically found on the continental shelf, common dolphins (*Delphinus delphis*), and the harbour porpoise (*Phocoena phocoena relicta*).

It has been recently suggested (Bearzi and Reeves, 2022) that the term "depredation", when referring to a marine mammal behaviour resulting from a response to the expansion of fisheries by modifying their behaviour to take advantage of the foraging opportunities provided by fishing, could strengthen misperception and misunderstanding, reinforcing, at least in some minds, the belief that fish and other marine resources "belong" only to humans. While the authors agree with Bearzi and Reeves (2022) that alternative wording may help to prevent ambiguity in communications, for the purpose of this review, largely based in scientific reports and peer-reviewed publications, it was considered more adequate to use primarily the term "depredation", as it was done in most of those papers. However, alternative terminology, such as "removing prey from fishing gear", "foraging from", "preying on" to describe the behaviour of free-ranging marine mammals interacting with fisheries has been also used as deemed necessary.

Static nets, the main fishing gear used by the small-scale Mediterranean and Black Sea fisheries, are prone to interaction with cetaceans. Reports of common bottlenose dolphins, hereafter referred as bottlenose dolphins, either removing or damaging the catch, damaging fishing gear and disturbing fishing activities and in some cases causing severe economic losses, come from several areas across the region.

The socio-economic impacts of damaged fishing gears and lost catches create conflicts between fishers and dolphins, undermining the conservation and sustainability efforts promoted by regional organizations such as the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) and the General Fisheries Commission for the Mediterranean (GFCM). The project 'Mitigating dolphin depredation in Mediterranean fisheries – Joining efforts for strengthening cetacean conservation and sustainable fisheries' (Depredation Project 2) is coordinated by ACCOBAMS and the GFCM, in collaboration with the Regional Activity Centre for Specially Protected Areas (SPA/RAC) and the LIFE platform. Between 2018 and 2020, these organizations have initiated activities at pilot sites in different Mediterranean areas that were aimed at assessing the depredation issue in different fishing gears with a view to a) pursue the identification of technical or management solutions to reduce the depredation pressure and b) to expand the regional network of expertise on depredation. This increase in scale will allow for comparison among experiences and results from the different pilot sites, to consolidate lessons learnt and best practices that will be disseminated at the regional level at the end of the project. The project has built on all these experiences to develop a standardized monitoring

methodology of depredation impact (Carpentieri and Gonzalvo, 2022), with a view to providing a harmonized framework to increase knowledge on depredation in the Mediterranean and the Black Sea. It is in this same context that the present *Review of Available Information on Depredation by Marine mammals in Fishing Gears in the Mediterranean Sea, Black Sea, and Contiguous Atlantic Area* is taking place.

Introduction

Cetaceans have long held great significance in the lives of humans. This significance has been both practical and spiritual and is reflected in artefacts dating back some 10,000 years, in spoken myths and legends and in the writings of Greek and Roman philosophers (Allen, 2014). Interactions between cetaceans and fisheries in the Mediterranean Sea are probably as old as the first human attempts to catch fish with a net. The earliest reports describe idyllic relationships between dolphins and people, but things changed as fisheries developed (Bearzi, 2002).

Conflicts between fisheries and cetaceans generally take one or both of two forms. These are the accidental capture of cetaceans in fishing operations (i.e., bycatch) and the depredation of fishing gear by cetaceans, who have learnt to adapt to a human activity (i.e., fishing) to enhance foraging, leading to loss of catch and damage to fishing gear. In many cases, these two problems occur in the same fisheries, and resolving the latter problem may help resolve the former. As it will be shown in the present review, there is increasing evidence from a number of studies, and from fishers' observations, that in the Mediterranean, Black Sea, and Contiguous Atlantic Area, coastal dolphins use fishing nets as an easily accessible feeding source, damaging or depredating fish caught in the nets.

Cetaceans are well known for their advanced learning abilities and the fast knowledge transfer within populations, enabling them to quickly discover new foraging grounds and opportunities (Whitehead *et al.,* 2004). Cetacean adaptations to fishing are certainly not limited to depredation, nor are they always to the detriment of the fishery (Bearzi *et al.*, 2019). For instance, Rocklin *et al.* (2009) reported that dolphin attacks in the Bonifacio Strait Natural Reserve in South Corsica were significantly associated with higher values of Catch Per Unit of Effort (CPUE), which could be explained by the fact that dolphins either only attack nets when catches are notable, or drive the fish into the nets, thereby increasing fish catches and CPUE. If the latter was true, dolphin predation may be benefitting fishers. However, as Rocklin and colleagues (2009) also pointed out, although the quantity of fish caught in attacked nets was higher, dolphins preying on free-swimming fish close to these nets may also result in a lost opportunity by fishers (hard to establish), and secondly, depredation often causes damage to the nets reducing catching efficiency and capacity, leading to increased repair time and fishing gear costs (Reeves *et al.,* 2001).

Depredation by cetaceans on fisheries is a major issue globally, both in terms of conservation and fisheries economics. Fish depredation by dolphins appears to be

recurrently perceived by Mediterranean fishers to be causing economic hardship, particularly as far as small-scale fisheries are concerned (Bearzi, 2002). Bottlenose dolphins are the main species involved in interactions with coastal fisheries. Depredation by bottlenose dolphins affects primarily gill and trammel nets, and different estimates on the resulting economic impact to fishers has been reported (Bearzi *et al.,* 2011; Brotons *et al.,* 2008a, 2008b; Gazo *et al.,* 2008; Lauriano *et al.,* 2004, 2008). For instance, Bearzi *et al.,* (2011) estimated the mean economic loss of artisanal trammel net fishers as 2,561 EUR per year, and Brotons *et al.,* (2008a) calculated that trammel-net fishers may lose around 5.3% of their total catch value due to interactions with cetaceans. However, dolphin depredation is not limited exclusively to small-scale fisheries and has been also reported, for instance, in purse seiners (Benmessaoud *et al.,* 2018) and in bottom trawlers (global review by Bonizoni *et al.,* 2022; Genov *et al.,* 2018; Gonzalvo *et al.,* 2008; Scheinin, 2010). Ecosystem damage resulting from overfishing and habitat degradation in the Mediterranean Sea has probably exacerbated the perception that dolphins reduce fishery yields (Reeves *et al.,* 2001). Therefore, the economic damage caused by dolphins generates conflict with fishers and, although rarely, may lead to intentional kills in retaliation, as well as to occasional demands for organized culls in some places (Gonzalvo *et al.,* 2014).

In recent years, several organizations (e.g. ACCOBAMS, GFCM, UNEP-MAP/SPA-RAC, WWF) are trying to address this issue through different projects (e.g., "Mitigating dolphin depredation in Mediterranean fisheries – Joining efforts for strengthening cetacean conservation and sustainable fisheries"), initiating activities in different Mediterranean areas and fisheries (e.g., monitoring programmes, testing mitigation measures).

However, to better understand to what extent dolphin's depredation occurs in fisheries in the Mediterranean and Black Sea, it is necessary to develop more robust data collection monitoring programmes increasing temporal and spatial coverage and involving all the different countries. This information may help to identify hot-spot of depredation and, in turn, be useful in applying adequate mitigation measures to reduce the negative impacts on both marine mammals and fishing industry (Carpentieri and Gonzalvo, 2022).

Unfortunately, even if consideration on direct interaction (i.e., depredation) between marine mammals and fishing gears is increasing, there is a lack of detailed and robust information on the nature and scale of the depredation problem throughout the Mediterranean and Black seas. This document intends to shed some light by reviewing the available information on depredation studies conducted across the Mediterranean Sea, Black Sea, and Contiguous Atlantic waters.

Cetacean species occurring, or having occurred, in the Mediterranean Sea, Black Sea and adjacent areas

Regular species outlined in grey; species reportedly involved in depredation in **RED**

MED = Mediterranean Sea; BS = Black Sea and Turkish Straits System; CAA = Contiguous Atlantic Area

Habitat (preferred in bold) and status are indicated only for species recognised as regular.

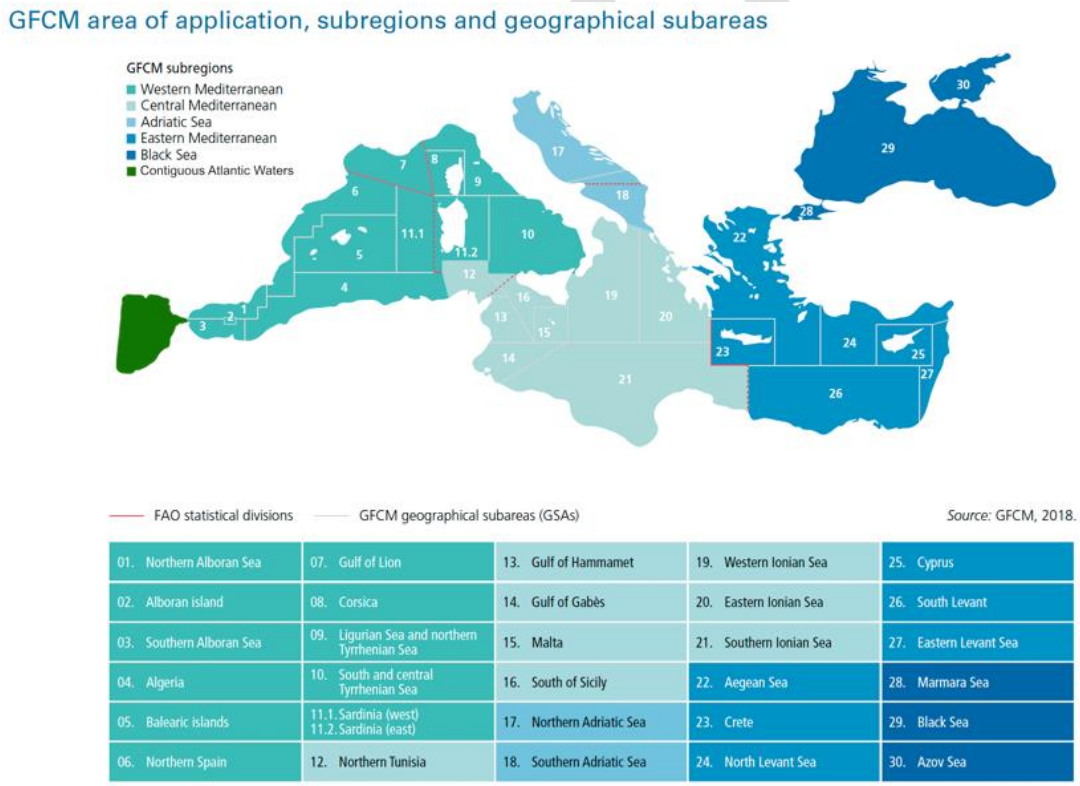
	Species/subspecies	English name	Classification	Sub-Area	Presence	Habitat	Current or proposed status (IUCN)
1	*Eubalaena glacialis*	North Atlantic right whale	Mysticeti, Balaenidae	MED, CAA	very rare		
2	*Balaenoptera a. acutorostrata*	North Atlantic minke whale	Mysticeti, Balaenopteridae	MED, CAA	visitor		
3	*Balaenoptera b. borealis*	Northern Sei whale	Mysticeti, Balaenopteridae	MED, CAA	very rare		
4	*Balaenoptera p. physalus*	North Atlantic fin whale	Mysticeti, Balaenopteridae	MED, CAA	regular	**oceanic**, slope, neritic	Endangered
5	*Megaptera n. novaeangliae*	North Atlantic humpback whale	Mysticeti, Balaenopteridae	MED, CAA	visitor		
6	*Eschrichtius robustus*	grey whale	Mysticeti, Eschrichtiidae	MED, CAA	very rare		
7	***Physeter macrocephalus***	**sperm whale**	Odontoceti, Physeteridae	MED, CAA	regular	**slope**, oceanic	Endangered
8	*Kogia sima*	dwarf sperm whale	Odontoceti, Kogiidae	MED, CAA	very rare		
9	*Hyperoodon ampullatus*	northern bottlenose whale	Odontoceti, Ziphiidae	MED, CAA	very rare		
10	*Mesoplodon bidens*	Sowerby's beaked whale	Odontoceti, Ziphiidae	MED, CAA	very rare		
11	*Mesoplodon densirostris*	Blainville's beaked whale	Odontoceti, Ziphiidae	MED, CAA	very rare		
12	*Mesoplodon europaeus*	Gervais' beaked whale	Odontoceti, Ziphiidae	MED, CAA	very rare		
13	*Ziphius cavirostris*	Cuvier's beaked whale	Odontoceti, Ziphiidae	MED, CAA	regular	**slope**, oceanic	Vulnerable
14	***Delphinus d. delphis***	**common dolphin**	Odontoceti, Delphinidae	MED, CAA	regular	**neritic, slope, oceanic**	Endangered
15	***Delphinus d. ponticus***	**Black Sea common dolphin**		BS	regular	**neritic, slope, oceanic**	Vulnerable
16	*Globicephala macrorhynchus*	short-finned pilot whale	Odontoceti, Delphinidae	MED, CAA	very rare		
17	*Globicephala m. melas*	North Atlantic long-finned pilot whale	Odontoceti, Delphinidae	MED, CAA	regular	**oceanic**, slope, neritic	Endangered
18	***Grampus griseus***	**Risso's dolphin**	Odontoceti, Delphinidae	MED, CAA	regular	**slope**, oceanic	Endangered
19	***Orcinus orca***	**orca**	Odontoceti, Delphinidae	MED, CAA	regular in CAA, visitor in MED	**neritic, slope, oceanic**	Critically Endangered
20	*Pseudorca crassidens*	false killer whale	Odontoceti, Delphinidae	MED, CAA	visitor		
21	*Sousa plumbea*	Indian Ocean humpback dolphin	Odontoceti, Delphinidae	MED	very rare		
22	***Stenella coeruleoalba***	**striped dolphin**	Odontoceti, Delphinidae	MED, CAA	regular	**oceanic,** slope	Least Concern
23	***Steno bredanensis***	**rough-toothed dolphin**	Odontoceti, Delphinidae	MED, CAA	regular in the Levantine Sea, visitor elsewhere	**oceanic**, **slope**, neritic	Near Threatened
24	***Tursiops t. truncatus***	**North Atlantic bottlenose dolphin**	Odontoceti, Delphinidae	MED, CAA	regular	**neritic,** oceanic	Least Concern
25	***Tursiops t. ponticus***	**Black Sea bottlenose dolphin**	Odontoceti, Delphinidae	BS	regular	**neritic**	Endangered
26	*Phocoena p. phocoena*	North Atlantic harbour porpoise	Odontoceti, Phocoenidae	CAA, MED	regular in CAA, very rare in MED	**neritic**	Least Concern
27	*Phocoena p. relicta*	Black Sea harbour porpoise	Odontoceti, Phocoenidae	BS, MED	regular in BS and N. Aegean Sea	**neritic**	Endangered

(Adapted from ACCOBAMS, 2021. Conserving Whales, Dolphins and Porpoises in the Mediterranean Sea, Black Sea and adjacent areas: an ACCOBAMS status report, (2021). By: Notarbartolo di Sciara G., Tonay A.M. Ed. ACCOBAMS, Monaco. 160 p.)

Methodology

For the elaboration of this paper, we reviewed the bibliography available on dolphin depredation (mostly peer reviewed papers, but not exclusively) and produced a questionnaire (Annex 1). The latter was shared with researchers and conservationist currently dealing with studies relevant to this issue in order to collect the latest information possible, which in many cases had not been published yet. The results derived from the responses obtained to this questionnaire are provided in section *Currently on-going studies on cetacean depredation in the Black Sea, Mediterranean Sea and contiguous Atlantic area* below.

The information gathered through this exercise is presented in the five GFCM subregions, namely Black Sea, Eastern Mediterranean, Central Mediterranean, Adriatic Sea, Western Mediterranean and the Contiguous Atlantic waters.



Map with the zones used for structuring geographically this review (adapted for consistency from the zooning used in *Carpentieri, P., Nastasi, A., Sessa, M. & Srour, A., eds. 2021. Incidental catch of vulnerable species in Mediterranean and Black Sea fisheries – A review. Studies and Reviews No. 101 (General Fisheries Commission for the Mediterranean). Rome, FAO. https://doi.org/10.4060/cb5405en*)

Definitions of fishing gear categories mentioned in this document

Info adapted from He, P., Chopin, F., Suuronen, P., Ferro, R.S.T and Lansley, J. 2021. Classification and illustrated definition of fishing gears. FAO Fisheries and Aquaculture Technical Paper No. 672. Rome, FAO. https://doi.org/10.4060/cb4966en

Additional information can be found by searching FAO's Fishing Gear type Fact Sheets at https://www.fao.org/fishery/en/geartype/search using various tools available: a simple word search, an advanced search using name, standard abbreviation and code, and a browser organized by images or by list based on international standards.

> *"A fishing gear is any physical device or part thereof, or combination of items that may be placed on or in the water or on the seabed with the intended purpose of capturing or controlling for subsequent capture or harvesting marine or freshwater organisms."*

Bottom trawls

A bottom trawl is a cone-shaped net towed on the seabed and designed to catch fish living on or near the seabed. Bottom trawls often consist of components such as heavy-duty ropes, chains, discs, bobbins and/or weights to ensure that seabed contact is maintained during fishing while minimizing the risk of damage to the net. Otter boards (used in single boat bottom trawls) also assist in keeping the net in contact with the seabed. The horizontal opening of the net mouth may be maintained by a rigid beam (beam trawl), by a pair of otter boards (otter trawl), or by towing the net between two boats (pair trawl). Floats and weights or a rigid frame often maintain the vertical opening of the trawl net. Two or more trawl nets may be rigged adjacently between the otter boards (twin or multi-rig trawls). One trawl may have more than one codend that splits the catch to reduce fish damage and improve fish quality, and/or to facilitate the handling of large catches. Bottom trawls can be towed from the stern or from outriggers; in the latter case, an even number of trawls are towed to balance the load.

The bottom trawl is one of the most versatile gear types, capable of operating over many types of seabed and at depths in excess of 1000 m. However, the bottom trawl has also become the subject of controversy, in part due to its poor selectivity, high discards and physical impact to the benthos. The estimated discard rate for bottom trawls is above 20 percent of their total landings. Bottom trawls have been reported to modify the physical characteristics of the seabed and may impact benthic species and ecosystems.

(More detail at FAO 2022. Fishing Gear types. Bottom trawls. Technology Fact Sheets. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/geartype/205?lang=en)

Midwater trawls

A midwater trawl is a cone-shaped net towed in midwater by one or two boats to catch pelagic or semi-demersal fish in the water column. Midwater trawls are also called pelagic trawls whose components are not intended to have contacts with the seabed while fishing. The target species are often schooling species such as clupeids and scombrids, and catch rates are often very high. Towing speed usually ranges from 3 to 5 knots, but 6 knots may be required for faster swimming species. Midwater trawl nets are usually much larger than bottom trawl nets, especially their vertical opening. The front part of the net is usually made with very large meshes or ropes to reduce drag, but still herd the targeted fish. The vertical opening of a midwater trawl is often maintained with weights attached to the lower wingends, which are often called clump weights. As fish tire, they fall back and are overtaken by smaller meshes in the aft sections of the net and the codend. The codend may be designed to hold a large catch, with circumferential strengthening ropes to prevent bursting when the fish reach the surface with expanded swim bladders. Detecting schools of fish in midwater requires the use of an echo sounders and/or scanning sonars. Aiming the trawl to intercept the school requires the use of a net sounder (or called "netsonde") attached to the trawl's headrope in order to determine the position of the net relative to the depth of fish in real time. Careful adjustment of towing speed and/or the length of warp allows the boat operator to adjust the depth of the net to intercept the school. Midwater trawls may be towed by one or two boats.

(More detail at FAO 2022. Fishing Gear types. Midwater trawls (nei). Technology Fact Sheets. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/geartype/400/en)

Purse seines

A purse seine is a wall of netting designed to encircle a school of pelagic fish near the surface and use a purse line to close the bottom of the net. Purse seines use weights, lead lines or chain attached to the footrope, and dense netting materials such as polyamide or polyester, to increase the sinking velocity of the net to prevent fish from escaping horizontally. The purse seine is characterized by a purse line threaded through purse rings spaced along the bottom edge of the net, through which the purse line can be drawn tight – hence "purse seine". The middle sections of the netting are deepest and gradually taper towards the wing and the bunt where fish finally accumulate. The bunt can also be at the middle of the net; in this case, hauling starts from both wings.

When a target fish school is identified, the vessel manoeuvres into a favourable position and the seine net is prepared for deployment. The vessel follows a course around the edge of the school, attempting to encircle it. With the net fully deployed, ropes attached to the ends of the net are hauled in order to close the seine around the school. At the same time, the purse line is drawn to close the seine net beneath the school. Typically, the headrope is longer than the footrope so as to reduce tension and prevent it from submerging, which can result in fish escaping over it.

(More detail at FAO 2022. Fishing Gear types. Purse seines. Technology Fact Sheets. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/geartype/249/en)

Trammel nets

A trammel net is a gillnet that has three layers of netting, with two outer layers of large-mesh netting and one inner layer of slackly hung (i.e., with a low horizontal hanging ratio) small-mesh netting, either to entrap fish in a pocket or entangle them in the netting. When a fish pushes the small-mesh netting through one of the outer layers of large-mesh netting, the netting forms a bag that can retain the fish. Trammel nets are usually set on the bottom in a similar manner to set gillnets. Trammel nets are widely used as a small-scale fishing gear all over the world for various species.

(More detail at FAO 2022. Fishing Gear types. Trammel nets. Technology Fact Sheets. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/geartype/223/en)

Gill nets

Gillnets and entangling nets are long rectangular walls of netting that catch fish by gilling, wedging, snagging, entangling or entrapping them in pockets. These nets are kept open vertically by floats attached to the head rope (or float line, or cork line) and by weights added to the footrope, but they can also be held open vertically by hanging the net onto stakes. These nets are usually fished in long fleets with a number of nets tied together to form a long string of nets (which may extend up to several kilometres) but they can also be used singly. Depending on their design, they may be used to fish at the surface, in midwater or near the seabed. They may be anchored to the seabed or allowed to drift freely with marker buoys or with the boat attached to it. Several types of net may be combined in one gear (for example, a trammel net combined with a gillnet). With the introduction of synthetic materials in the 1950s and 1960s, and a subsequent reduction in prices, the use of gillnets made of synthetic materials has drastically increased. The increase in use is also attributable to the low visibility of monofilament twine, lightweight and rot resistance.

The set gillnet is the most common type of gillnet and is also referred to as the “bottom gillnet” or simply “gillnet”. A set gillnet is a long, rectangular single-walled netting anchored or otherwise fixed to the seabed, catching fish when they come in contact with it. The set gillnet is held open vertically in the water by a headrope, usually with floats, and by a footrope weighted with sinkers. Floatation and lead weights may be built into the ropes, which are often called floatrope and leadrope. The net is kept in position by anchors or other weights, usually at both ends, and marked on the surface with buoys and/or highflyers.

(More detail at FAO 2022. Fishing Gear types. Set gillnets (anchored). Technology Fact Sheets. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/geartype/219/en)

Longlines

A longline is a type of hook-and-line gear where hooks are connected to branch lines which are then attached to a long horizontal mainline at certain intervals. Longlines are usually baited and set in open water untended for a period of time. The number of hooks and the length of the mainline depend on the scale of the operation and the area of fishing grounds, ranging from a few hundred metres in coastal set longlines to more than 80 km in large-scale drift (pelagic) longlines. The basic longline gear units include the mainline, the branch line snood (or branch line or gangion), the hook and the bait. Hooks and branch lines can be attached to the mainline through conventional knots or through the use of mechanical crimps or clamps, which often incorporate swivels. Longlines may be hauled by hand or by powered reels or drums. The baiting of hooks may be done manually or by a machine.

(More detail at FAO 2022. Fishing Gear types. *Set longlines*. Technology Fact Sheets. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/geartype/232?lang=en & Fishing Gear types. *Drifting longlines*. Technology Fact Sheets. Fisheries and Aquaculture Division [online]. Rome. https://www.fao.org/fishery/en/geartype/233/en)

Black Sea

The first synoptic, collaborative and coordinated aerial survey for cetaceans in the Black Sea, carried out in summer 2019 under the umbrella of the ACCOBAMS Survey Initiative, within the framework of the CeNoBS project and through a collaboration with the EMBLAS-Plus projects, with support from the European Commission, yielded the first insights on global abundance, distribution and density for all three cetacean species of the Black Sea, namely common bottlenose dolphin (*Tursiops truncatus ponticus*), common dolphin (*Delphinus delphis ponticus*), and harbour porpoise (*Phocoena phocoena relicta*). Black Sea common dolphins resulted quite abundant in the southern part of the Blacks Sea, along the transects off the coasts of Türkiye and Bulgaria and rather scarce in the north-western part (i.e., Ukrainian and Romanian waters), while they were fairly abundant and evenly distributed along Russian waters. Sightings of the Bottlenose dolphin in the CeNoBS area were the less frequent, while they were the most observed species off the coast of Russia. Black Sea harbour porpoises were the most observed cetacean species during the CeNoBS survey, with sightings peaking in Bulgarian waters. By contrast, they were the least observed cetacean during the Russian survey (ACCOBAMS, 2021).

It is known from Ukrainian and Georgian fishers that marine fishing activities could be attractive for bottlenose and common dolphins, but, perhaps, not for harbour porpoises. Both dolphin species may use fisheries as additional food source and include their visits to fishing boats and stationary nets into their foraging strategy. Common dolphins reportedly interact predominantly with pelagic trawling of schooling fish; very often they hunt just in the immediate proximity to a hauling trawl. Bottlenose dolphins, by contrast, are interested in both active and passive fishing types operating inshore. Reportedly, solitary individuals of this species were seen foraging within trap nets in the Kerch Strait and with trammel nets set near Cape Meganom, southeast Crimea. During the latter depredation events, the dolphin fed on red mullet caught in the net, leaving behind in the mesh only the fish heads (Birkun, 2002). Recently, during opportunistic onboard observations on a bottom trawler, depredation by both common and bottlenose dolphins was observed. Dolphins were predating on fish discards during haul of trawl and occasionally they would bite the trawl (D. Popov; pers. comm.).

A study aimed at reviewing adverse fisheries impacts on cetacean populations in the Black Sea (Birkun *et al.,* 2014) interviewing leaders of 39 fishing associations, cooperatives and organizations representing more than 4,600 fishers (>2,100 fishing vessels/boats) operating in the Black and Azov Seas across the internal waters, territorial sea and EEZs of Bulgaria, Romania, Türkiye and Ukraine, reported that most leaders of fishing cooperatives and ordinary fishers from Ukraine, Russia, Bulgaria and Georgia, did not denounce militant dislike for cetaceans nor reported serious rivalry with them. Coastal fishers from those countries had no claims against common dolphins, but expressed discontent with incidental catches of harbour porpoises. Besides, they identified bottlenose dolphins as the species often damaging their nets or catch, or stealing caught fish from the nets. The same problem is known to be occurring on the Turkish coast and in Bulgaria. Very limited statistics are available on such conflicts and ensuing financial losses, and, as in most Mediterranean countries, no compensation is stipulated for fishers from their governments. Fishers interviewed in Bulgaria claim catch losses incurred, due to cetaceans in coastal pound nets, totalling up to 100 tonnes of fish per season (Mikhailov, 2008). In Sinop Bay (centre of the Turkish Black Sea coast) between April 2007 and February 2008 where red mullet (*Mullus barbatus*) fishing activities were conducted by use of commercial bottom gill nets, average loss was calculated for each fishing boat as 2,191.72 TL (approx. 125€) throughout the season due to depredation by bottlenose dolphins (Gönener and Özdemir, 2012). Moreover, a project testing acoustic deterrent devices (pingers) on the traditional Bulgarian static fishing gear called "dalyans"[1], in an attempt to reduce bycatch of small cetaceans and/or to reduce depredation in the Bulgarian Black Sea coast, reported severe damages with the fishers declaring meters of torn nets and loss of catch (Zaharieva *et al.,* 2016). When interviewed, bout 50% of Bulgarian fishers using dalyans unanimously confirmed that they had experienced dolphins entering their dalyans. Reportedly, cetaceans caused destruction and damage to fishing gear (e.g., holes torn in the nets) and reduction of

[1] The "dalyan" is a stationary fish trap net used for passive commercial fishing. It is attached to both the seabed and the beach and located at about 150 m from the shore. Its size varies from 25/30 to 35/50 m. It is deployed at about 12 m of depth, and the net usually reaches above the waterline with the trap open at the surface. The opening of mesh is 6 mm. The main fish caught are pelagic species. Used mainly in Bulgaria, Greece, and Türkiye (Zaharieva *et al.,* 2020).

fish captures both by direct consumption and by scaring the fish. All interviewed fishers noted that fish stocks had fallen sharply over the last 10 years and this may be one of the reasons why marine mammals attack their fishing gear Most of them manifested strong concerns about their livelihood because not being compensated for damages caused by cetaceans (Zaharieva *et al.,* 2020).

Eastern Mediterranean

The interaction of the bottlenose dolphins and the bottom trawl fishery is very strong in Israel and depredation is occurring too on a regular basis. The estimated bottlenose dolphin population along the Israeli coastline consumes roughly 1,280 t of prey annually, similar to the mean annual trawl-fishery yield of 1,300 t (Scheinin *et al.,* 2014). Fishers operating bottom trawlers claim that dolphins, probably bottlenose dolphins, cause severe damage to their gear. These has led them to secure an additional loose net with large mesh size around the trawl, which they refer to as “dolphinera” (A Scheinin; pers. comm.). Not only bottlenose dolphins are known to forage in association with bottom trawlers in Israel; common dolphins in addition to their association with purse seiners have been also documented accompanying bottom trawlers, by both day and night. The slender Balearic eels (*Ariosoma balearicum*) are frequently found protruding from the net's eyes, presumably making easy prey for both dolphin species (Barnd *et al.,* 2021). Kerem *et al.,* (2012) reported that trawl-boat skippers easily distinguish between the "regular" large grey stout-beaked dolphins (i.e., bottlenose dolphin) and the less frequent small, black or bicoloured and slender-beaked dolphins (a description that may easily apply to either striped or common dolphin, without being able to distinguish between the two).

Depredation of gill nets is common too by both bottlenose and common dolphins. It is not rare that young animals get caught in nets accordingly, probably while trying to depredate (A Scheinin; pers. comm.). Levy and colleagues (2009) reported laryngeal snaring by ingested fishing net in a female bottlenose dolphin found stranded dead off the Israeli shoreline. Although we cannot be sure about the circumstances under which the netting material was ingested by this dolphin, a feasible explanation may be that it happened while wresting prey items from active fishing gear.

It seems that in Israel there were low levels of direct killings (e.g., shooting or harpooning) as a consequence of retaliation measures taken by aggravated fishers as result of depredation. However, this info dates back to a decade ago. More recently, fishers in Israel have started to report and protest against depredation of fishing gear by dolphins, which potentially may result in retaliation (Bearzi, 2017)

A recent study conducted in Cyprus, aimed to understand the extent, level, and type of cetacean depredation on the albacore tuna pelagic longline fishery, through data obtained from fisher’s logbooks, interviews and onboard observations between June and August 2018, revealed that there is an estimated economic loss per fishing trip of 313.07± 486.19€ and an estimated annual economic loss for the entire fleet of 259,272€ from depredation caused by cetaceans (Papageorgiou *et al.,* 2022). The study also

estimated a mean depredation rate of 17% per fishing trip. Depredation by the common bottlenose dolphin and striped dolphin was reported in more than 50% of their fishing trips and occasionally by Risso's dolphin.

A study combining questionnaires, acoustic monitoring, and participatory experiments in Cyprus, looking at occurrence of bottlenose dolphins in the fisheries and the extent of their conflict with set-nets (i.e., trammel nets) found that dolphins were present in fishing grounds throughout the year and detected them in 28% of sets (Snape *et al.,* 2018). Although no precise estimate was produced, the authors manifested that net damage resulting from dolphin depredation can certainly be very costly. As an example, they reported one set suffering a net loss of 79% of its area and resulting beyond repair.

During interviews produced to gather information for the preparation of the Action Plan for the conservation of cetaceans in Syria (Gonzalvo and Bearzi, 2008), fishers regularly reported gear damage and depredation by dolphins, they consistently identified bottlenose dolphins as the species involved and claimed higher net damage occurring when targeting red mullet. Besides these complaints, there were also claims that catches may also increase due to dolphins occasionally herding fish into the nets. Likewise, in Lebanon bottlenose dolphins were reported as the species regularly involved in gear damage and depredation. In addition, there have been reports of fishers using dynamite to deter dolphins from approaching their nets. However, although intentional killing of dolphins in retaliation may occur, it remains conjectural (Gonzalvo, 2009).

Anecdotal information on dolphin−fisheries interactions voluntarily provided by fishers during a survey monitoring the damage to coastal fisheries caused by dolphins along the northern Aegean Sea coastline, Greece, allowed Pardalou and Tsikliras (2018) to identify bottlenose dolphins as the species primarily interacting with coastal fisheries, followed by common dolphins. All fishers maintained that dolphins mainly interact with passive gear, specifically static bottom nets (i.e., gill and trammel nets), damaging them by creating large holes and tears, spoiling and devaluating the catch (Pardalou and Tsikliras, 2018). Also in this case, nets targeting red mullets were reported as the most heavily depredated due to dolphin preference for the species. Indeed, follow up studies by the same authors confirmed that the gears mostly depredated were gill nets and trammel nets with small mesh sizes, mainly targeting surmullet (*Mullus surmuletus*), red mullet (*Mullus barbatus*), common sole (*Solea solea*), European hake (*Merluccius merluccius*), and caramote prawn (*Melicertus kerathurus*) and that probability of depredation was also significantly dependent on the fishing area (Pardalou and Tsikliras, 2019). They also propose that fishers adapt their fishing tactics, turning towards the use of more selective fishing gear for all target species and do not use mesh sizes smaller than 22 mm (bar length), as well as to avoid high net concentration areas by selecting deeper fishing grounds, to further ameliorate interactions with dolphins (Pardalou *et al.,* 2022).

Finally, in the Gulf Corinth, Bonizzoni *et al.,* (2016) reported a perceived annual economic loss as result of dolphin depredation ranging from 81 to 1,398€ per boat. Their results suggested that depredation occurred primarily in the north, where bottlenose

dolphins and fishing effort overlap, while in the southern ports dolphin depredation was unlikely, despite a high abundance of striped dolphins.

Adriatic Sea

The northern Adriatic Sea has been identified as an Important Marine Mammal Area IMMA because of a regular occurrence of bottlenose dolphins, where they often follow midwater pair trawlers, bottom otter trawlers (Carlo *et al.,* 2012; Genov *et al.,* 2008, 2019; Fortuna *et al.,* 2010) and bottom beam "rapido" trawlers (Bonizzoni *et al.,* 2021, 2022). Reportedly, the chance of encountering bottlenose dolphins increased by about 30 times near active midwater pair trawlers, 16 times near bottom otter trawlers, and 5 times near bottom beam "rapido" trawlers (Bonizzoni *et al.,* 2021). Moreover, bottlenose dolphins have been observed in the area "switching" from one operating trawler to another, sometimes to approach a different type of trawl gear (Bonizzoni *et al.,* 2022). The social structure of bottlenose dolphins in the Gulf of Trieste and adjacent waters of the northern Adriatic Sea is composed of two mixed-sex clusters or social units; one that was regularly interacting with trawlers and the other did not (Genov *et al.,* 2019), showing how animal populations can interact differently with human activities (e.g., fisheries).

Gomerčić *et al.,* (2009) reported for the first-time bottlenose dolphin depredation resulting in ingestion of gill-net parts and larynx strangulation. They dealt with 12 bottlenose dolphins from the Adriatic Sea, where small-scale commercial and private fisheries use gill nets throughout the year. In Italy, depredation seems to represent a major problem in the northern and southern Adriatic Seas, corresponding to the Friuli and Apulia regions, where the set bottom trammel net is the most commonly used fishing gear to catch scorpion fish (*Scorpena spp*.), octopus (*Octopus vulgaris*), cuttlefish (*Sepia officinalis*), mullet *(Mullus spp*.), wrasse (*Labrus spp*.) and bogue (*Boops boops*), and conflicts frequently occur on a seasonal basis rather than year-round (Lauriano *et al.,* 2009). For instance, in the MPA of Torre Guaceto, Puglia, fishers complain about operational conflict between dolphins and their fishing activity and lament severe depredation and fishing gear damage caused by dolphins. A pilot study conducted in 2020, including interviews to fishers, fishing net damage monitoring and sea surveys, confirmed that depredation by bottlenose dolphins in trammel nets causes significant loss to local fishers. A follow up study is being at the moment set-up to estimate the impact of depredation in local small-scale fisheries and provide training to MPA staff on sea surveys and dolphin photoidentification (Gonzalvo; pers. comm.).

Central Mediterranean

Bottlenose dolphins co-exist with artisanal fisheries in Kerkennah Islands, in the Southern part of Tunisia, and are blamed for damage to some fisheries. The resulting catch loss engenders hostility from fishers and, as it happens elsewhere, interactions between dolphins and nets can result in bycatch mortality. A potential mitigation

measure, Aquamark 210 pingers, acoustic deterrent devices, on trammel nets was tested in 2010 during a short period, with inconclusive results. Ayadi et al. (2013) presumed that pingers possibly produced a diner-bell effect, which could probably explain the increase of the depredation rate and the fishery targeted species damage.

Bottlenose dolphin depredation is also being monitored in Tunisian purse seines by Benmessaoud and colleagues (2021), who have observed an average frequency of depredated fishing trips of about 14%. Reportedly, depredation tends to occur mainly during gathering fish under the lights and also during the encircling and pursing phase, inducing mostly circular or oval holes along the entire length of the seine but predominantly around the bunt and the under-bunt part. CPUE was found generally higher in the absence of depredation than in the presence of this event (see table on *Currently on-going studies on cetacean depredation in the Black Sea, Mediterranean Sea and contiguous Atlantic area* for further detail). Depredation causes considerable economic loss for purse-seiners, mostly due to direct fishing gear cost and as a consequence of days of no-fishing because fishers need to repair or replace damaged fishing gear. Total mending costs linked to depredation is in average 186€ (± 154€). Highest mending costs happening in April and November, while the lowest were reported in December (Benmessaoud *et al.,* 2021).

In Malta, fishers engage in small-scale fishing utilizing a variety of artisanal fishing gear, including surface longlines, which are mainly used to target swordfish and tuna; bottom-longlines; trammel nets and entangling nets, which are used to target groupers, various species of bream, red snappers and red porgies; and pots and traps which are generally used to captured octopus and bogue. However, the use of trammel nets remains by far the most popular gear type employed in Maltese waters. A recent study focused on fishers' perception about small-scale fisheries and cetaceans' interaction, showed that around 33% of the fishing gear deployed in the past year suffered damages, which costed in average 178.33€ per year to Maltese fishers and were caused exclusively by bottlenose dolphins (Laspina *et al.,* 2022).

An overview of dolphin depredation in Italian artisanal fisheries by Lauriano *et al.,* (2009), which included interviews with fishers in 49 Sicilian fishing ports, showed that 62.8% of Sicilian fishing boats reported net damage in set gillnet and/or trammel nets, while 81.2% reported fish damaged. Furthermore, amongst the fishing gear that might be subjected to depredation, there is also the jigging line for the mesopelagic squid, of minor economic importance, reported to interact with the bottlenose dolphin in Sicily (Lauriano, unpublished data). Interaction between bottlenose dolphins and fishing activity in the Egadi Archipelago, part of a Marine Protected Area, in west Sicily, Italy, is quite strong since at least 38% of fish catches occurred with dolphins present near the nets (Buscaino *et al.,* 2009). Moreover, in the Egadi Archipelago, the economic damage caused by the loss of fish due to bottlenose dolphin depredation in gill nets was found to be 77.65 € for 50 m of net (Maccarrone *et al.,* 2014).

A study looking at interaction of dolphins and whales with small-scale fisheries activities around eastern coast of Sicily and in the southern Tyrrhenian Sea, paying also attention to the Aeolian Islands area, showed that some individuals of striped dolphin and

bottlenose dolphin of the Gulf of Catania presented injured peduncles as evidence of surviving to prior fishery interactions with longlines. Moreover, 45% of the fishing trips in one year of monitoring were affected by negative interactions with cetaceans and the species involved in the observed attacks was the bottlenose dolphin. Moreover, one case of interaction of a sperm whale (*Physeter macrocephalus*) with a "totanara", used for fishing cuttlefish and squid also was recorded. Depredation events took place in every area of the Gulf where fishing activities are carried out, however, the most affected gear was the single wall type. The average daily loss for the entire fleet was calculated as 444€, excluding the costs associated with the purchase of new materials for the repair of the gears. (Monaco, 2020; see table on *Currently on-going studies on cetacean depredation in the Black Sea, Mediterranean Sea and contiguous Atlantic area* for detail and on a follow-up project).

In the MPA of Porto Cesareo, in Puglia, Gulf Taranto, southern Italy, Bearzi *et al.,* (2011) conducted boat surveys and interviews to investigate dolphin occurrence and interactions with fisheries, finding that 93% of the interviewed fishers operating bottom-set trammel and gill nets asserted that dolphins damage their fishing gear. Depredation was reported by 92% of the fishermen operating in or near the MPA, and 67% of them claimed an economic cost in excess of 1,000 € per year, with a mean reported cost of 2,561 €. However, in contradiction with the significant depredation reportedly suffered, more than 1,000 km of visual surveys resulted in no encounters with cetaceans. Moreover, a comparative analysis carried out in the wider Gulf of Taranto showed that fishing exploitation provides impacts on the investigated food web greater than those due to cetacean predation (Carlucci *et al.,* 2021).

In coastal waters of western Greece, in the semi-enclosed waters of the Gulf of Ambracia, the bottlenose dolphin is the only cetacean present. This increasingly degraded coastal ecosystem hosts one of the highest observed densities in the Mediterranean Sea for this species, which shows high levels of year-round site fidelity. (Bearzi *et al.,* 2008a; Gonzalvo *et al.,* 2016). The bottlenose dolphin Gulf of Ambracia subpopulation is classified as critically endangered in the IUCN Red List of Threatened Species. Local commercial fisheries are limited to about 300 small-scale artisanal vessels, working mainly with trammel and gill nets (Gonzalvo *et al.,* 2016). In stark contrast with the Gulf, the oligotrophic and heavily overfished waters of the neighbouring Inner Ionian Sea Archipelago, have a much lower dolphin density (Gonzalvo *et al.,* 2011). In recent times, common dolphins formerly abundant in the area, suffered a precipitous decline which was convincingly linked to overfishing of their main epipelagic prey, while bottlenose dolphins, also present in the area, are mostly transient with a few animals display high levels of residency (Bearzi *et al.,* 2008b; Piroddi *et al.,* 2011). Therefore, these areas, despite their geographic proximity are remarkably different in terms of environmental features, human activities, and dolphin species composition and densities. Nevertheless, according to information gathered through formal interviews with professional small-scale fishers (Gonzalvo *et al.,* 2016), damage as a consequence of dolphin predation was almost unanimously reported on both sites and there seems to be a genuinely interest in collaborating in future research initiatives to evaluate the damage caused by dolphins and to explore potential mitigation strategies among the fishing community. Dolphins were reported to damage fishing gear when stealing fish,

damage fish entangled in nets, and scare fish away from nets. While most fishers of the Gulf claimed to suffer a significant annual economic loss, almost one out of every four fishers of the Archipelago reported no net damage. In both areas the amount most frequently reported ranged between 500 € and 1000 €. Detail on the currently on-going project "Addressing the Interaction between Small-scale Fisheries and Marine Megafauna in Greece (INCA)", conducted by WWF Greece, which aims at estimating economic loss of small-scale fishers due to interactions with marine mammals as well as incidental catches of marine mammals, seabirds and marine reptiles, as well as elasmobranchs can be found at table on *Currently on-going studies on cetacean depredation in the Black Sea, Mediterranean Sea and contiguous Atlantic area*

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West Mediterranean

The West Mediterranean is probably the area where more research has been conducted on depredation. Staring with its eastern side, a study made in Italy during 2002, based on *in situ* interviews with fishers, aiming at determining the extent of the interaction between dolphins and artisanal fishery, evaluating the effects of such interaction on both fishing gear and on catches, and on deriving a regional depredation ranking table, showed that, in Italy, 72.2% of the fishing boats report fish damaged in the gill and trammel nets with corollary dolphin sightings (Lauriano *et al.,* 2008). The regions most affected were Sardinia and Campania with net damage frequencies of 75.8% and 83.1% for their fleet, respectively. Moreover, damage to catches was always recorded when dolphins were sighted. According to Lauriano *et al.,* (2008) the regional interaction ranking (i.e., interaction risk), for the Italian regions of the West Mediterranean area, in descending order are as follow: Campania 7, Sardegna 7, Sicilia 6, Toscana 6, Liguria 4, Calabria 3, and Lazio 2.

In the Aeolian Archipelago (Southern Italy), ecosystem degradation and overfishing have been increasing bottlenose dolphin and striped dolphin conflict with fishers (Bruno *et al.,* 2021). According to Blasi *et al.,* (2015) bottlenose dolphin encounter rates in the area are significantly higher in early summer, coinciding with the period when trammel nets are more abundant and dolphin residency times were spatially correlated to the mean number of trammel nets, which indicates a strong dolphin-small-scale fisheries interaction. Moreover, Leone *et al.,* (2019), used photo-identification data from 2005–2014 to estimate the skin mark pattern on resident bottlenose dolphins showed that the skin marks pattern of the Aeolian bottlenose dolphin population is not only strongly related to age and sex, but also to the degree of interaction with trammel nets.

In 1999, the Italian Central Institute for Applied Marine Research (ICRAM), in response to reports made by local fisheries, run a study into the interactions between bottlenose dolphins and the artisanal fishery in the Asinara Island National Park (Sardinia). Lauriano *et al.,* (2004) established that interactions occurred primarily with trammel nets targeting striped red mullet (*Mullus surmuletus*). Although considered negligible, they also occurred with trammel nets set for lobster (*Palinurus elephas*), cuttlefish (*Sepia*

officinalis) and scorpionfish (*Scorpaena spp*.). Loss of catch was found to be significant only in the case of nets deployed during the red striped mullet fishing season; the annual mean economic loss per boat per season was estimated in 1100€ (Lauriano *et al.,* 2004). It was suggested that bottlenose dolphins in this area take also advantage of the presence of trawlers (Lauriano, 1997). A first attempt at analysing interactions between bottlenose dolphins and gillnets along the northeastern coast of Sardinia (Italy) was conducted between October 1999 and December 2004. Another study along the coast of north-eastern Sardinia, combining interviews with fishers with boat-based direct observations and behavioural and group size analysis, established that gillnet damage was caused by bottlenose dolphins in 68.7% of the total fishing days, with no difference between seasons, and estimated a worrisome annual bottlenose dolphin by-catch estimate of 1.47 (0.98 immatures and 0.49 adults; Díaz-López, 2005). Bottlenose dolphin interactions on artisanal trammel nets were also examined by Pennino *et al.,* (2015) in waters of the Archipelago de La Maddalena, located in the northeast of the Island, finding that CPUE for fishing operations with no dolphin interactions was significantly higher than that for operations with dolphin interactions, although clearly this does not confirm a direct causal link, and associated economic loss was estimated to be non-significant. They also found that geographic location, season, depth of seabed, moon phase, and mesh size were all important factors affecting the amount and species composition of the catch, suggesting that these differences in species composition were not exclusively due to dolphin depredation, but also due to a mixture of habitat-induced effects (Pennino *et al.,* 2015).

Observations on coastal dolphins using fishing nets as an easily accessible feeding source, damaging or depredating fish caught in artisanal trammel nets has been also reported in the Bonifacio Strait Natural Reserve (France), where bottlenose dolphins attacked, on average, 12.4% of the nets and damaged 8.3% of the catch (Rocklin *et al.,* 2009). Results suggest that dolphins are attracted by high fish densities in the fishing area and/or nets, and their attacks induce specific fish-avoidance behaviour, according to the fish position in the water column. According to Rocklin and colleagues (2009), although dolphins depredate a small part of the catch, damage to nets, may weaken the benefits that the reserve provides to local artisanal fisheries.

In the Balearic Islands, interactions between artisanal fisheries and the local bottlenose dolphin population have been reported for decades. However, the frequency of interaction reported to the administration in terms of fish loss, net damage and by-catch has increased dramatically over the last two decades (Brotons et al., 2008a). In a study conducted in 2001 in Alcudia Bay, north-eastern Majorca, bottlenose dolphin depredation was reported with trammel nets targeting red mullet (*Mullus spp*.), which resulted in net damage, reduction in the value of the catch due to mutilation or removal of fish from nets, and decreased total amount of fish caught, probably due to the dolphins' presence causing fish to flee from the vicinity of the fishing nets (Gazo *et al.,* 2008). The economic cost attributed to loss of catch as result of dolphin depredation was estimated in about 1100 €, although a more realistic figure would be significantly larger if net damages were incorporated into the calculation (Gazo *et al.,* 2008). A latter study covering the complete Balearic Archipelago and all fishing gear estimated that these interactions would represent an economic cost, this time including both fish loss

and net damage, of 6.5% (95% CI: 1.6 – 12.3%) of the value of landed catch (Brotons *et al.,* 2008b). In the Balearic Islands, besides interacting with set nets, bottlenose dolphin approach operating trawlers while towing, hauling and discarding, while only a fraction of the group approach the trawlers once the net is hauled or during the release of discarded fish, indicating that different dolphins from a same group may differ in the resources they use (Gonzalvo *et al.,* 2008). Bottlenose dolphins and the local trawling fleet may be seen to behave as two sympatric species, where dolphins play a parasitic role over the fishing activity; Gonzalvo *et al.,* (2008) concluded that depth was the main factor ruling occurrence of this interaction. Moreover, no incidental capture was recorded during this study. Hence, the only negative impact of trawling on the bottlenose dolphin population off the Balearic Archipelago appears to be the alteration of the sea bottom and the reduction in food availability caused by overexploitation, a general problem occurring all over the Mediterranean (Bearzi, 2002).

A study on bycatch of marine mammals by the Spanish longline fleet operating in the western Mediterranean, by the Spanish Oceanographic Institute (IEO, Instituto Español de Oceanografía) aiming also at improving knowledge about the possible effects of the Spanish longline fisheries on cetacean populations, particularly Risso's dolphin, concluded that Risso's dolphin is the species most affected by the longline fishery (López *et al.,* 2012), which may indicate a significant depredation by this odontocete to longlines.

In the Strait of Gibraltar, where killer whales feed on tuna by actively hunting and through depredation on a drop-line fishery, recent changes in fishing effort have decreased tuna stocks and the complex balance between the bluefin tuna, killer whales, and human activities has been broken (Esteban *et al.,* 2016). Between 1999 and 2011, from a small community of 39 individuals observed in the Strait in spring and summer, all individuals displayed active hunting and 18 of them also depredated on the fishery. Esteban and colleagues (2016) established that the killer whale population growth rate was positive at 4% for interacting individuals, and no growth was observed for non-interacting individuals, which implies that whales benefit from access to larger tuna through depredation and therefore they need more tuna to cover their daily energy requirements while actively hunting.

Contiguous Atlantic waters

West of the Strait of Gibraltar, the contiguous Atlantic waters, the coastal waters off Western Iberian Peninsula are an important fishing ground and a marine megafauna foraging area. Overlap between fishery target species and the diet of several air breathing marine megafauna, including marine mammal species, can lead to negative interactions and consequently conservation and economic issues (Alexandre *et al.,* 2022). A recent study involving face-to-face interviews to fishers of the local and coastal artisanal fisheries fleets in the landing sites of the Portuguese mainland Southern coast (Algarve), was conducted by Alexandre *et al*. (2022) with the main goal of identifying

and evaluating problematic interactions causing bycatch or economic loss through depredation. The latter problems were mostly associated with cetaceans. Their results show that purse seines problems are associated with important bycatch numbers, especially of common dolphins, while bottom set-nets have considerable bycatch of all animal groups and depredation was highly associated with bottlenose dolphins. Reportedly, economic loss caused by depredation led to catch and gear damage and was widely denounced by bottom set-net fishers, ranging from 7% to 21% of their revenue. Moreover, interaction with bottlenose dolphins showed a significant area effect, with higher depredation rates reported by fishers from the leeward area.

Interactions between cetaceans and the purse seine fishery in coastal waters of mainland Portugal were investigated using onboard observations over a period of 15 years (2003–2018) by Dias *et al.* (2022), finding that in 10% of the fishing sets, there were interactions with one of three species of cetaceans, namely common dolphin, bottlenose dolphin and harbour porpoise. Their results indicated that common dolphins were most frequently observed, occurring in 89% of all interaction events, and the only species with observed mortality, which prompted them to focus their work exclusively on interactions with this species. Dias *et al.* (2022) suggest that the probability of interactions and the number of common dolphins interacting with the fishery were affected by the local abundance of sardine and chub mackerel. This study was covering all Portuguese coastal waters. However, when looking at information of the frequency of presence, interactions, accidental capture, and mortality of cetaceans with the purse seine fishery in relation to the total number of trips and fishing sets by region, it can be extracted that in the south of Portugal, out of 147 fishing trips (161 sets), 19% had presence of cetaceans, in 12% there was direct interaction, and 1.9% has accidental captures leading to a 1.2% of cetacean mortality.

Currently on-going studies on cetacean depredation in the *Black Sea, Mediterranean Sea and contiguous Atlantic area*

Country	Location/area	**Species** *(Scientific name)*	**Fishing gear**	Year start	Main questions addressed / research goals	Methods or technologies used / tested to collect data	ABSTRACT (as provided)	Data provider
CYPRUS	Within the EEZ of the Republic of Cyprus	***Tursiops truncatus***	Longliners, Trammel nets, gill nets,	2021	Impact on Fisheries economics	(1) Questionnaires on-board and harbours/landing sites (2) Monitoring of net and catch damage	Cyprus is in the eastern Mediterranean in the Levantine Basin and has the characteristics of an ultraoligotrophic area. The main interactions here with cetaceans are in two types of fisheries Albacore longline fishery- offshore, Set and gillnet fisher-coastal. Within the framework of the European Maritime and Fisheries Fund (EMFF) and through collaboration between fishers and scientist, a two-year study is being carried out to assess the interaction of cetacean in these two fisheries. The study will comprise of onboard, harbour interviews, questionnaires of both fisheries as well as collection of information from fisheries who have had interaction so that the economic assessment of the impact on the fisheries. Damage to gear and catches as well with activities such as measurement of net areas damaged etc. We aim to assess the usage of pingers that are already in use through onboard data collection at a future point in this work. Pingers already have been funded by the EMFF in Cyprus and are already showing encouraging results but no scientific assessment has thus been made. Both STM interactive and non interative pingers are in use in Cyprus at the moment as well as other models.	Antonis Petrou; AP Amrine Environmental Consultancy Ltd
		Delphinus delphis	Longliners, Trammel nets, gill nets,	2021				

Country	Location/area	**Species** *(Scientific name)*	**Fishing gear**	Year start	Main questions addressed / research goals	Methods or technologies used / tested to collect data	ABSTRACT (as provided)	Data provider
PORTUGAL	Algarve/ Atlantic Waters/Gulf of Cadiz	***Tursiops truncatus***	Gill nets, small longliners	2020	(1) What species are causing damage through depredation? (2) Which gears are most impacted? (3) What is the economic impact of depredation? (4) Is there any bycatch and what species are bycaught?	(1) Harbour questionnaires(2) onboard observation(3) logbooks to skippers	(The following abstract refers to the work done under the scope of project iNOVPESCA using harbor inquiries) This work aimed to assess marine megafauna (cetaceans, marine birds, and marine turtles) – fishery interactions through face-to-face interviews to fishers operating local and coastal artisanal fisheries in the most important fishing harbors of the Portuguese mainland Southern coast (Algarve). The main goal was to identify and quantify problematic interactions known to cause bycatch or economic loss through depredation. We found that depredation problems are mostly associated with cetaceans. Of the sampled artisanal fisheries (longlines, pots and traps, bottom set-nets, and purse seine), the fishing gears of most concern with depredation were coastal bottom set-net fisheries. and highly associated with bottlenose dolphins, *Tursiops truncatus*. Depredation was found to be species, gear, area, and vessel size dependent. Economic loss caused by depredation led to catch and gear damage and was widely pointed out by bottom set-net fishers from all vessels´ sizes, especially when targeting hake, *Merluccius merluccius* and red mullet, *Mullus surmuletus*.Validation of this work has been done with observers onboard.Work was also performed at the level of mitigation, which has been continued presently under a new project (CetAMBICion)	Ana Marçalo, Jorge M.S. Gonçalves; Center of Marine Sciences of Algarve (CCMAR)
GREECE	North Aegean Sea	***Tursiops truncatus***	Bottom trawlers, trammel nets, gill nets	2020	Vulnerable species interactions with fishing gear	Monitoring incidental catch of vulnerable species. FAO, 2019	Our ElasmoCatch project focuses on studying the interactions of elasmobranch species with fisheries and vulnerable species in general in the North Aegean, using an adapted protocol based on FAO, 2019. During 2020-2022, a systematic seasonal monitoring was conducted via direct monitoring onboard and fishers' interviews for nets, longlines, bottom trawls and purse seines recording data on bycatch and depredation.	Ioannis Giovos; iSea, Non-Profit Non-Governmental Organisation for the Preservation of the Aquatic Ecosystems

Country	Location/area	Species *(Scientific name)*	Fishing gear	Year start	Main questions addressed / research goals	Methods or technologies used / tested to collect data	ABSTRACT (as provided)	Data provider
GREECE	North Aegean Sea	***Delphinus delphis***	Bottom trawlers, purse seiners, trammel nets, gill nets	2020			(continues from above) Overall, 272 fishing trips (sets) were monitored with 7% being from Purse seines, 27% bottom trawls, 20% longlines, 26% trammel nets, 18% gillnets and 2% other gears. Depredation was recorded either by the on-board observer by observing the animals feeding from the gear, or by reports of fishers on the given day, accompanied with depredated fish. Bottom trawlers and netters had the highest depredation rate with 80% and 65%, repectively, and with longlines having the least records of depredation (<0.5%). The most common species to be depredating on the catches was *Tursiops truncatus* (95%) followed by a very small percentage of *Delphinus delphis* (4.9%) and finally by the Mediterranean monk seal *Monachus monachus* with 0.1%.	Ioannis Giovos; iSea, Non-Profit Non-Governmental Organisation for the Preservation of the Aquatic Ecosystems
		Monachus monachus	Trammel nets, gill nets	2020				
ITALY; CROATIA	Tyrrhenian Sea (Tuscany, Aelolian Archipelago MPA Tavolara, MPA Egadi Islands, MPA Punta Campanella), North and Central Adriatic Sea (Veneto, Marche, MPA Torre del	***Tursiops truncatus***	Bottom trawlers, pelagic trawlers, trammel nets, gill nets	2020	The main purpose of Life DELFI (LIFE18-NAT_IT_000942) is the reduction of dolphins' mortality caused by fishing activities. (1) Reduce interactions(2) Promote citizen science and increase public awareness(3) Engage fishers and train them on dealing with bycatch events(4) Investigate interactions through passive acoustic and visual monitoring	(1) Onboard observer, (2) self-reporting (logbooks) (3) and interviews	After the first year of their use and dissemination of deterrent and alternative devices, a total of 241 days at sea were spent monitoring the effectiveness of mitigation systems, more than 60 different fishers were directly involved in the on-board activities, and many more were reached by the meetings and dissemination carried out before and during the sea trials.The results on the efficiency of pingers are generally in line with the findings of the various studies on these devices. Mixed results were in fact obtained considering the catches, as an indirect indicator of prevention of the depredation. In fact, the catch data do not seem to vary significantly according to whether pingers are used or not. On the other hand, considering the effectiveness in reducing interactions in terms of damage to nets, interesting results emerge at least in some areas. (Continues from above) As regards visual deterrent devices, although the low number of observations does not allow to draw clear considerations on their effectiveness, net illumination systems remain one of the most promising and challenging	Alessandro Lucchetti; CNR-IRBIM

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ITALY; CROATIA	Cerrano, Cres e Lošinj)	***Stenella coeruleoalba***	Squid jigging	2020	(See above)		approach to reduce dolphin-fishery conflict. Lastly, the results on data obtained from the pots as alternative devices are promising. For example, the Squilla pots tested in the central Adriatic Sea were found to be very efficient at catching the target species. Also, the new prototypes tested by the CNR-IRBIM demonstrated how small technical modifications (e.g., the shift of the netting colour from black to white) can lead to a significantly increase of the catch efficiency. Again, further tests are required to better understand and improve the catch performance of these newly designed pots, also in other seasons and areas of the project.	Alessandro Lucchetti; CNR-IRBIM

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ITALY	Phase 1: North-eastern Sicily, with a focus in the Gulf of Catania. Phase 2: Gulf of Catania (coastal waters including the MPA "Isole Ciclopi")	***Tursiops truncatus*** *(**S. Coe**. Interacting with* gill nets, small longliners and "Totanara") (***P. macrocep***. with "Totanara")	Trammel nets, artisanal longlines, totanara, menaida, other single wall nets.	2019	Phase 1: assess the socio-economic and ecological impacts linked to the phenomenon of cetacean-fishery interaction; suggest new mitigation techniques. Phase 2: testing the usefulness of an acoustic alert system on the nets as mitigation measure.	Phase 1: face to face questionnaires to fishers, observers onboard fishing vessels to evaluate dolphins' presence and damages, fishers self-reporting (Floating Laboratories logbooks), direct observations (visual and acoustical) from a sentinel scientific boat during fishery-based surveys, photo-identification, ethogram, GIS. Phase 2: direct observations (visual and acoustical) from a sentinel scientific boat during fishery-based surveys, monitoring of net and catch damages, cameras onboard fishing vessels, simulation of mitigation measures.	Depredation 1: The study permitted to: describe interaction cases between cetaceans and fisheries, and existing strategies to mitigate this issue in the world, including an overview of the status of small-scale fisheries and of the presence of cetaceans in the Mediterranean; mention bioacoustics basics applied to cetaceans; describe the Italian and the Sicilian fishing fleets, including the *métiers* prevailing in the small-scale fisheries fleet of North-Eastern Sicily; create standardized research protocols and survey sheets on fisheries and depredation; collect and analyse survey data with a multidisciplinary approach in order to show results at environmental and socio-economic level, with reference to depredation and by-catch events involving cetaceans and others vulnerable species, fishing effort of small-scale fisheries in the Gulf of Catania, and incidence factors and consequences of depredation; create a specific ethogram referred to the "feeding in net" behaviour of the bottlenose dolphin; provide suggestions and conclusions linked to a follow up of the project. Additional information can be found in the final report https://lifeplatform.eu/wp-content/uploads/2021/02/Report_Sicily_updated-compressed.pdf Depredation 2: the Marecamp Association is carrying out a trial on an "Acoustic Alert System" or alarm indicating the presence of dolphins and the occurrence of feeding sounds emitted by them close to the nets. The detection of the vocalizations permits to alert the fisher and haul up the net in time. Visual and acoustic surveys are carried out in proximity of trammels and single wall nets deployed at sea during the fishing sets. Statistical analysis will evaluate the utility of the system in limiting the damages suffered by the fishers. First results indicate that such type of technology could be improved also to limit bycatch events of dolphins.	Clara Monaco; Marecamp Association

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MALTA	Within the 25 Nautical Mile Malta Fisheries Management Zone	***Tursiops truncatus***	Trammel nets	2019	(1) To analyse the interactions between cetaceans and small-scale fisheries around the central Mediterranean Maltese IslandsObjectives:(1) To understand the status of cetacean depredation in Maltese waters through integration of local ecological knowledge with scientific data;(2) To provide mitigation measures if/where cetacean depredation occurs;(3) To strengthen cetacean conservation and ensure sustainable fisheries.	(1) Questionnaires in different fishing ports around Malta and Gozo, to obtain the fishers' perspectives on the issue of depredation in the Maltese Islands (type of gear which is most depredated, monetary loss due to depredation, vessel characteristics, species type, depredation characteristics, nautical miles, species of fish depredated and general location of depredation). (2) Onboard surveys to identify cetacean depredation locations in the presence of trammel nets and to identify cetacean locations without the presence of trammel nets.	In Malta, the use of the local ecological knowledge (LEK) of fishers is being applied to understand the interaction occurrence between small-scale fisheries and cetaceans in the Mediterranean regions with the aim to conserve the cetacean populations, while at the same time ensuring sustainable fisheries. Locally, during the first phase of this project, interviews with small-scale fishers were conducted using a pre-defined questionnaire. These investigated interaction characteristics, and found that in coastal regions, including the Maltese Islands, such cetacean depredation often involved the bottlenose dolphin *Tursiops truncatus*. When asked about the situation over the past 5 years, 76% of the surveyed fishers agreed that the interaction increased over the past 5 years. The average reduction in catch sustained by fishers from one encounter is 59.22% suggesting that dolphin depredation does result in catch losses, a reality mostly experienced by those using trammel nets. During the second phase of the project, which is currently underway, onboard observers are joining fishers on a regular basis to determine the frequency, type, and location of the dolphin interactions. The factors that are leading to an increase in the incidence of depredation by dolphins and other vulnerable marine species in recent years is examined in depth. Such an integration of LEK and scientific data of the status of dolphin depredation and its effects on small-scale fisheries in the Maltese Islands provides a more holistic picture and allows for bottom-up management. This can subsequently be used in the compilation of regulations and mitigation measures for the sustainability of the fisheries sector and cetaceans alike.	Matthew Laspina, Kimberly Terribile; Department of Fisheries and Aquaculture; Centre of Agriculture, Aquatics and Animal Sciences, Institute of Applied Sciences, Malta College of Arts, Science and Technology

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SPAIN	Mediterranean Cetacean Migration Corridor	***Tursiops truncatus***	Bottom trawlers, purse seiners, trammel nets, gill nets	2019	(1) cetaceans' bycatch in different fishing gears in the Mediterranean Cetacean Migration Corridor MCMC, (2) maritime traffic and collisions of cetaceans with boats (3) Analysis of abundance and diversity of cetaceans in MCMC.	(1) Aerial surveys to stablish cetacean abundance and distribution (2) questionnaire to fishers in Valencian fishing ports (3) Identify the highest intensity traffic from official data (www.marinetraffic.com) and analyse the overlap with critical cetacean habitats in the south of MCMC.	Manuscript submitted to a peer-reviewed journal	Jose Antonio Raga; University of Valencia
		Stenella coeruleoalba	Bottom trawlers, purse seiners	2019				
BULGARIA	Bulgarian territorial waters in the Black Sea	***Tursiops truncatus***	Bottom trawlers	2019	Opportunistic observation on-board	Photo-identification	During opportunistic onboard observations on a bottom trawler interaction by dolphins were observed. Dolphins were predating on fish discard during haul of trawl including biting the trawl. Mostly bottlenose dolphins were involved in that interaction and to lower extent common dolphins. Normally the trawler performed 3-4 hauls per day and it was observed that interaction by dolphins was highest during first and last haul being lower or even absent in between. It should be noted that usually number of operating trawlers was from 2-3 to as much as 10 in the region.	Dimitar popov; Green Balkans
		Delphinus delphis	Bottom trawlers	2019				

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ITALY	Adriatic Sea; SIC IT3270025 Adriatico settentrionale Veneto - Delta del Po.	***Tursiops truncatus***	Bottom trawlers, pelagic trawlers, trammel nets, gill nets, small longliners	2018	(1) dolphin-fishery interaction assessment to create a local-population health status and human-induced mortality index, (2) identify seasonal hotspots, (3) mitigate specific fishing gears, (4) support conservation policy and establishment and monitoring of protected areas.	(1) forensic analysis of stranded dolphins; (2) fishery-based survey; (3) Photo-identification (4) Underwater camera and drone for behaviour assessment of free ranging Individuals. The project consists In a combination of a project network: TartaTur, INVASION, Life DELFI.	The monitoring of strandings and free-ranging common bottlenose dolphins in the north Adriatic Sea and in the Poriver mouth Natura 2000 site (SIC IT3270025) is helping the evaluation of the dolphin-fishery interaction. A stardardised method is in progress for a multidisciplinary assessment on the health status, create a local-population human-induced mortality index, identify seasonal hotspots, mitigate specific fishing gears, and support conservation policy and the establishment and monitoring of protected areas.	Sandro Mazzariol; Department of Comparative Biomedicine and Food Science, University of Padova

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ITALY	North-western Adriatic Sea	***Tursiops truncatus***	Bottom trawlers, pelagic trawlers	2018	(1) Types of trawlers involved. (2) Spatial and temporal distribution of interactions.(3) Foraging techniques (e.g. feeding on fish and other organisms outside of the net, or stuck in the net mesh; feeding on fish and other organisms within the net; scavenging on discarded organisms; targeting species that are attracted by or interacting with a trawler)(4) Potential impact on dolphins (e.g. effects on movements and distribution; effects on diet; effects on group size; effects on social behavior, social structure and culture; incidental mortality in trawl gear; exposure to the noise of trawlers; exposure to the noise of acoustic devices deployed on trawl nets; exposure to pollutants; environmental and global effects of trawling) (5) Potential impact on trawl fisheries (e.g. catch loss and gear damage).(6) Responses and attitudes of fishers.	(1) Visual surveys, (2) direct observations, (3) photo-identification, (4) spatial modelling, (5) use of AIS (Automatic Identification System) data	A combined generalized additive model and generalized estimation equation framework indicated that trawling—along with other physiographic, biological and anthropogenic variables—influenced dolphin distribution. In days of trawling, the chance of encountering dolphins increased by ~4.5 times (95% confidence interval 1.8–11.0) near active beam trawlers, by ~16.0 times (7.1–36.0) near otter trawlers, and by ~28.9 times (12.0–69.6) near midwater pair trawlers. Spatial modelling was used to create maps of predicted distribution, suggesting differences in habitat use between trawling and no-trawling days.	Silvia Bonizzoni; Dolphin Biology & Conservation, OceanCare

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SPAIN	Northwestern Mediterranean coast of Catalonia (MPA Cap de Creus Montgrí, Medes Islands and Baix Ter Natural Park)	***Tursiops truncatus***	Bottom trawlers	2017	Dolphin-bottom trawler interactions (including bycatch) occurrence in Catalan waters	(1) Sea surveys and collection of dolphin sightings and association with trawling activities (2) Dolphin behaviour and group size, (3) Photo-identification, (4) Cameras on the fishing gear (in progress)	Interaction with fisheries has been described as the most frequent cause of death among striped (*Stenella coeruleoalba*) and common bottlenose dolphins (CBD) stranded along the Catalan coast (North-East Spain). The study area (158644,294 ha) was surveyed from 2017 to 2020 conducting visual transect and photo-identification surveys. A total of 12445 nm of homogeneous effective effort was conducted in the study area. CBD were the most common cetacean detected, with a total of 77 sightings (ER=0.0242 sightings/nm). Most of the sightings (66%) were associated with trawl fishing activities indicating a strong association between CBDs and the trawling vessels presence and suggesting a potential CBD-fishing interaction in this MPA. The mean group size did not present any significant differences between seasons (Mann-Whitney U test: W= 709.5; n TTRU=77; p= 0.7417).Interviews with crew members of trawlers operating in this area were conducted between August and September 2021. Interviews covered 68,9% of the trawling fleet in the area (36 trawlers) and all fishers reported interactions with dolphins. Among the interviewed fishers, 79% noted that bottlenose dolphins follow trawlers aiming to seize fish from the net. Despite this, interactions were considered to be non-negative by 93% of the respondents due to an increase in their catch when dolphins are present, their playful behaviour or not causing any damage to their fishing gear. Just 7% considered the interaction as negative because it results in catch loss. While 95% of the fishers declared that they had caught occasionally dolphins in their nets, just 9% of them had ever caught an individual alive. The results of this study show that dolphin bycatch occurs in this area as observed in necropsy studies: however, it happens in relatively small numbers despite the high level of interaction.	Carla A. Chicote; Submon

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MOROCCO	Mediterranean Sea and Strait of Gibraltar	***Tursiops truncatus***	Bottom trawlers, purse seiners	2017	(1) What are the factors influencing the depredation between bottlenose dolphins and purseiners ? (2) What are the economic consequences of these depredation? (3) Abundance and distribution of the bottlenose dolphin in south Alboran sea.	(1) Questionnaires, (2) Boat surveys (photo-identification)	In general, the results of experiments with strengthened purse seines experimented by the INRH have shown that these seines present better fishing efficiency and better resistance to bottlenose dolphin attacks and represent much lower repair costs, compared to the ordinary seine. Nevertheless, taking into account feedback from professionals, the experts from Le Drezen and scientists from the INRH suggest to make some improvements to the reinforced seine, among which, use the wire of the reinforced seine only for the parencirclingows to encircle the fish and the bag and to arm the rest of the seine with string ordinary seine, to replace the lead of the braid by that of the seine purse seine and to use the floats of the purse seine. With regard to shares to In the longer term, the INRH will continue experiments with reinforced seines by making the improvements suggested in consultation with the experts, as well as the tests of potential additional devices that could limit the attacks, in addition to improving resistance and performance of the seine. The INRH in collaboration with experts from ACCOBAMS, has started a photo-identification study of cetaceans, in particular the bottlenose dolphin, to understand the size and distribution of the population of the species in Moroccan Mediterranean waters. The results of this study supplemented by the monitoring of the spatiotemporal dynamics of migration of small pelagic as well as fishing will provide a better understanding of this phenomenon of interaction between the bottlenose dolphin and purse seine fishing slider and to study the possibility of establishing fishing strategies by the level of risk allowing fishers to be directed towards the areas less risky fishmongers.	Malouli Idrissi Mohammed, Jghab Ayman; National Fisheries Research Institute (INRH)
		Globicephala melas	Longliners	2017				
		Orchinus orca	Longliners	2017				

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TUNISIA	North eastern of Tunisia	***Tursiops truncatus***	Purse seiners	2015	(1) Dolphin depredation and interaction with fisheries(2) Raise awareness on fisheries stakeholders(3) promote the introduction of fishing-tourism and opportunistic whale watching	(1) Dolphin monitoring around aquaculture farms(2) Depredation monitoring	Bottlenose dolphin depredation monitoring has shown an average frequency of depredated fishing trips of about 14%. Depredation induces holes which are mostly circular or oval in shape with irregular edges and are located along the entire length of the seine with a higher number around the pocket and the front pocket. The most observed holes class size is between 20 and 60 cm. Interference occurs mainly during the concentration phase under lights (32%) and the encircling of schools of fish (40.92%) and lead holes which requiring mending operations that are costly for the fishers to bear. Holes induced by bottlenose dolphins are more frequent in terms of occurrence (56%) but less costly than those induced by solid structures (247 ± 140Dt per boat per month). Depredation can be the cause of the reduction of the fishing effort of the sardine vessels (4% of the days of immobilization) Close monitoring of the catch-per-unit-effort (CPUE) variation shows that, for some months, when depredation occurs, the CPUE value can be higher than that in the absence of depredation. However, the CPUE follow-up shows that the CPUE is generally higher in the absence of depredation than in the presence of this phenomenon (CPUE abs. dep. =198.89 ± 62.28 Kg/100m/day; CPUE pres. dep. =149.96 ± 59.82 Kg/100m/day; p=0.05). The evolution of landings composition shows that the composition varies from one month to another and according to depredation ($p<0.05$). We noted an increase in the specific richness during certain months in the presence of the depredation phenomenon and an enrichment of the CPUE in squid and clupeiformes. However, no significant statistical variation was detected according to the prey groups ($p>0.05$).	Rimmel Benmessaoud; Tunisian National Institute of Agronomy

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SLOVENIA	Gulf of Trieste, all national waters of Slovenia	***Tursiops truncatus***	Bottom trawlers, pelagic trawlers, trammel nets, gill nets	2002	(1) Frequency of interactions (2) type of gear, behaviour, (3) diet, (4) injuries and fatal consequences.	(1) Boat-based and land-based observations, (2) photo-identification, (3) passive acoustic monitoring, (4) post-mortem examinations	Interactions between bottlenose dolphins and fishing gear are common in the Gulf of Trieste, mainly pertaining to bottom trawlers, mid-water pair trawlers (no longer operating in the area) and bottom-set gill and trammel nets. Absolute rates of interactions or the extent of any damage are unknown. Mortality associated to depredation (ingestion of gear) has been documented.	Tilen Genov; Morigenos – Slovenian Marine Mammal Society
ISRAEL	All Mediterranean Sea Israel national waters	***Tursiops truncatus***	Bottom trawlers, trammel nets, gill nets	2001	Health status of marine mammals in the Israeli waters	(1) fishers interviews (2) strandings network	The interaction of the bottlenose dolphins and the bottom trawl fishery is very strong (Scheinin et al. 2014) and depredation is occurring too on a regular basis. We have quite a few reports from bottom trawlers fishers that dolphins, probably bottlenose dolphin cause severe damage to their gear. Causing them to secure a loose net with large mesh size around the net calling it “DOLPHINERA”. Depredation of gill nets is common too, and young dolphins caught in nets accordingly, probably while trying to depredate. That is for bottlenose and common dolphins.	Aviad Scheinin; The Morris Kahn Marine Research Station, University of Haifa. Delphis NGO.
		Delphinus delphis	Trammel nets, gill nets	2001				

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SPAIN	South Iberian Peninsula, North of Alboran Sea	***Tursiops truncatus***	Trammel nets	2021	To understand the main environmental and technical conditions that favour damages of fishing trammel nets in the Alboran Sea due to dolphin predation. Moreover, different mitigation measures were tested.	Net monitoring in the port (548 sets)	The technical features of the fishing operation are the most important as was also the case in previous studies (Pennino et al. 2015; Snape et al. 2018; Pardalou and Tsikliras 2020). Target species, month, and longitudinal gradient were important variables, but due to the fishing strategy they had different effects. The different fishing strategies used, depending on the target species, also had a differential effect, although when the fishers went in search of the tiger prawn (*Penaeus kerathurus*) they did not suffer damage to their nets in either case. This could be due to the fact that the trammel net in these cases is set in deeper waters. Depending on the target species, the higher damage was associated to common cuttlefish (*Sepia officinalis*) and striped red mullet (*Mullus surmuletus*). Other studies also observed that the cuttlefish nets were less predated by dolphins (Lauriano et al. 2004; Pardalou and Tsikliras 2020), in opposition to our findings. This is a point to highlight, because perhaps the fishers of the south of Spain use some technical peculiarity for the trammel net targeting cuttlefish, different from other parts of the Mediterranean, or simply that culturally the dolphins of the Alboran Sea have become familiar with the taste of the cuttlefish. The fishing strategy during trammel fisheries targeting striped red mullet, imply setting the net in shallow water, and near stones, which attracts the dolphins.	José Carlos Báez; Instituto Español de Oceanografía (IEO-CSIC) & Asociación Herpetológica Española

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GREECE	(1) NE Aegean Sea (Thracian Sea, Alexandroupolis Gulf), (2) NW Aegean Sea (Thermaikos Gulf), (3) SW Aegean Sea, (Cyclades, Kythnos - Andros islands), (4) SE Aegean Sea (Dodecanese, Rhodes island), (5) Ionian Sea (Ionian	***Tursiops truncatus***	Trammel nets, gill nets	2020	Project Name: Addressing the interaction between small-scale fisheries and marine megafauna in Greece (INCA) Objectives a) Estimate economic loss of small-scale fishers due to interactions with marine mammals (gear damage and catch loss/devaluation due to depredation) in Greece b) Estimate incidental catches of marine mammals, seabirds and marine reptiles, as well as elasmobranchs in Greece (Continues from above) Overall research goals:	(1) Face to face questionnaires to determine the actual size and distribution of coastal SSF fleet, information on the métiers (combination of gear, target species, depth and area) during port visits, through in-situ interviews with SSF, (Continues from above) (2) Year-round on-board observations to collect	During the year-round on-board survey in the 5 study areas (Thracian Sea -Alexandroupolis Gulf, Thermaikos Gulf, Cyclades - Kythnos & Andros islands, Dodecanese - Rhodes island, Ionian Sea - Zakynthos island), no incidental catches of marine mammals were recorded. Regarding the extent of damages on small scale fishers' gear and catch, a seasonal and also spatial variation was identified among sites, largely determined by the fishing gear and the marine mammal species present in each area as well as their population densities. The overall final project results on the economic evaluation of damage and mortality rate of marine megafauna are currently being analyzed and will be used to feed into national advocacy work for developing a sustainable national financial compensatory system for SSF and provide the basis for future implementation of bycatch mitigation measures in Greece. (Continues from above) Project partners:	Amalia Alberini WWF-Greece

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	Islands, Zakynthos island)	***Monachus monachus***	Trammel nets, gill nets, small longliners	2020	a) Promote the development of a fair national compensatory system for small scale fishers b) Complement on-going advocacy work by proposing feasible and scientifically robust mitigation measures to local and national authorities to mitigate marine megafauna / SSF conflicts	evidence of depredation per operation per métier, the magnitude of depredation, and presence/absence of incidentally caught animals to small scale fishing vessels in key hotspot areas of interactions.	WWF Greece, Aristotle University of Thessaloniki (AUTH), Hellenic Centre for Marine Research (HCMR), Mediterranean Association to Save the Sea turtles (MEDASSET), Hellenic Ornithological Society (HOS), Pelagos Cetacean Research Institute.	Amalia Alberini WWF-Greece

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SPAIN	Northern Alboran Sea (GFCM GSA 01).	***Tursiops truncatus***	Purse seiners, trammel nets, gill nets, sardine trammel net	2018	(1) to estimate, in selected pilot fishing ports, Caleta de Velez and Fuengirola (Málaga), the depredation caused by cetaceans (in particular bottlenose dolphins) in artisanal nets fisheries, (2) and to accurately determine the number of vessels involved, main period and the marine areas (hot spots) where most interactions occur.	(1) Monitoring at ports/landing sites, (2) Port questionnaires, (3) Data on fishing production by fleet (SSF and PS) to better understand the evolution of these parameters with and without interactions (4) Put cameras on nets, (5) Testing different mitigation measures (e.g., shiny discs, pingers, chemosensory deterrents...)	A good part of the investigation has been addressed to depredation. Data about technical characteristics of the fishing fleet, catches, incidence of interaction with cetaceans, types of damage in case of depredation, losses and costs incurred, and mitigation measures employed were collected through interviews with fishers based on a common structured questionnaire including closed-ended and open-ended questions in all the three focal areas countries (Italy, Malta and Spain), that would revert into a shared database, easing comparison and shared data. During this second phase we have collected information on hundreds of sets (fishing operations) of artisanal fishing with a trammel net, of these sets 22% have been damaged by dolphins with an average cost for repairing the nets of 1200 Euros (including the hand work and replace the material). During October-December we analysed the data, and we designed the best strategy for the implementation of mitigation measures. Moreover, in this phase, four cameras were installed on the nets of two boats and two mullet trammel net fishing operations were recorded in two different fishing areas. Low-cost devices (Shiny Discs and empty plastic bottles) were used as deterrents. The project is on-going and final results are in progress.	Juan Antomnio Camiñas; Spanish Herpetological Association (AHE)

Country	Location/area	**Species** *(Scientific name)*	**Fishing gear**	Year start	Main questions addressed / research goals	Methods or technologies used / tested to collect data	ABSTRACT (as provided)	Data provider
SPAIN	Coastal waters of south east Spain: (1) between Cabo de Palos and Tabarca island, (2) north Alboran coast (between Malaga and Almeria).	***Tursiops truncatus***	Bottom trawlers, purse seiners, trammel nets, gill nets	2021	(1) Estimates of abundance and distribution of the population of *T. truncatus* in south east Spain.(2) Measuring depredation on artisanal trammel and gill nets with direct observations of the fishing activity from research boat.(3) Measuring depredation on small-scale fishing nets with passive acoustic detectors (C-POD and F-POD).	(1) Distance sampling(2) Mark-recapture models (photo ID)(3) Direct observations with fishing vessels(4) C-POD and F-POD placed in the fishing gear (trammel nets and gill nets)	Using data from this study and historical data from ANSE, the project shows the first estimates of abundance and distribution of T. truncatus in the study area (coastal waters of southeastern Spain). Both were estimated with a combination of line transect sampling and photo-identification methods. The results show a population growth, but more sightings are still needed to obtain a better CV. On the other hand, the project tried to measure depredation on small-scale nets using C-POD and F-POD on the gear, to better understand patterns of activity with the nets. This information was completed with direct observations from research boat, sailing alongside the fishing boats with the aim of collecting data on the individuals predating in the area (using photo-identification). We are still working on the publication of the data obtained.	Aixa Morata; ANSE - Asociación de Naturalistas del Sureste

Not only cetaceans…depredation in fishing gears by the Mediterranean monk seal (*Monachus monachus*)

Mediterranean monk seals (*Monachus monachus*) were once widely and continuously distributed in the Mediterranean and Black Seas, and in North Atlantic waters from Morocco to Mauritania, including the Cape Verde and the Canary Islands, Madeira, and the Azores (Johnson *et al.,* 2006). Today, fewer than 700 individuals are thought to survive in isolated subpopulations in the eastern Mediterranean, the archipelago of Madeira and the Cabo Blanco area in the north-eastern Atlantic Ocean (Karamanlidis *et al.,* 2015). The largest aggregations of Mediterranean monk seals are found near Cabo Blanco (González and Fernandez de Larrinoa, 2012; Martínez-Jauregui *et al.,* 2012). Principal sites in the Mediterranean are located in the Ionian and Aegean seas, including the National Marine Park of Alonissos (Trivourea *et al.,* 2011) and the Gyaros Marine Protected Area (Dendrinos *et al.,* 2008), both in Greece. This flagship species for marine conservation has teetered on the brink of extinction for about one-half century (Notarbartolo di Sciara and Kotomatas, 2016). After having been classified as Critically Endangered for almost two decades, their status was reassessed as Endangered on the IUCN's Red List (Karamanlidis and Dendrinos, 2015).

The diet of the Mediterranean monk seals consists largely of demersal fishes, cephalopods (the common octopus *Octopus vulgaris* being the most frequent prey item), and crustaceans (Salman *et al.,* 2001; Karamanlidis *et al.,* 2014; Pierce et al., 2011; Pinela et al., 2010, Kiraç and Ok, 2019). Body parts of green turtles (*Chelonia mydas*) were also found in the stomach of an adult seal stranded in Türkiye (Tonay *et al.,* 2016). To get access to such a varied diet Mediterranean monk seals interact frequently with small-scale fisheries. When depredation occurs, monk seals leave behind a characteristic three-hole pattern with one large hole (usually smaller than that caused by dolphins) and two smaller peripheral holes, presumably at the position at which the flippers grasped the net (Karavellas, 1994).

The main threats faced by Mediterranean monk seals include: (a) critical habitat deterioration, destruction, and fragmentation; (b) disturbance caused by tourists entering breeding caves during the reproductive season, as well as seal–boat interactions; (c) deliberate killings, mostly by fishers retaliating against net depredation and damage; and (d) bycatch in fishing gear, mainly of young inexperienced individuals (Androukaki *et al.,* 1999; Güçlüsoy *et al.,* 2004; Karamanlidis *et al.,* 2008, 2020; Karamanlidis and Dendrinos, 2015; Mpougas *et al.,* 2019, Notarbartolo di Sciara and Kotomatas, 2016).

In the Foça Pilot Monk Seal Conservation Area, an archipelago situated at the entrance of the Izmir Bay on the central Aegean coasts of Türkiye, between 1994 and 2002, through fishers' interviews and direct net inspections, Güçlüsoy (2008) gathered information on 142 direct interactions with monk seals around fishing gear. He recorded net damage in 90 of those cases, which was concentrated primarily in gill nets (53%) and trammel nets (37%), followed to a much lesser extent by longlines (9%) and lure (1%). Although, the damage inflicted by seals per occasion resulted to be substantial, as much

as 465,85€ per occasion, the overall annual economic impact on the artisanal fishery was considered modest. Güçlüsoy (2008) suggested limitation in net soaking time, concentrate fishing efforts with long-lines instead of nets, and low interest credits for fishers affected by seal depredation, as appropriate management practices. Mediterranean monk seals also attack fish on marine fish farms (Güçlüsoy and Savas, 2003); reportedly, these attacks occur at night, typically involving single seals causing damage both on cage netting and fish, and on most occasions result in fish escaping from the cages.

A study conducted in the Ionian islands of Kefalonia, Ithaca, and Lefkada, Greece, from July 1986 to April 1988, reported damage by seals to fishing gear in 136 of 1,864 (7.3%) monitored fishing trips and claimed that one seal may cause considerable damage in one night (Panou *et al.,* 1993). A series of fishers' interviews conducted over a decade later in the same area by Gonzalvo *et al.,* (2015) showed that, when asked about the species producing net damage caused by depredation, 85 % of fishers put the Mediterranean monk seal at the top of their list, followed to a much lesser extent by the Mediterranean moray *Muraena Helena*, dolphins and sea turtles. Similarly, in Greek waters of the North Aegean, Pardalou and Tsikliras (2018) found that depredation by monk seals on static nets as well as longlines was reported as a frequent and disturbing event by the fishers operating in areas of higher seal density (outer Thermaikos Gulf, Chalkidiki and Alonissos Island). A more recent nationwide questionnaire survey among fishers and port police authorities carried out in Greece to understand the nature and assess the magnitude of negative interactions between the monk seal and small-scale fisheries revealed that Mediterranean monk seals caused damage mainly during spring and summer, on average affected 21% of all fishing trips and 1% of nets deployed during a fishing trip, and got accidentally entangled in fishing gear throughout Greece (Karamanlidis *et al.,* 2020).

Discussion

The sustainable mitigation of human–wildlife conflicts has become a major societal and environmental challenge globally. Among these conflicts, large marine predators feeding on fisheries catches (i.e., depredation) has emerged concomitantly with the expansion of the world's fisheries (Tixier *et al.,* 2021). A recent global review on marine mammal interaction studies showed that marine mammal bycatch remains a major conservation concern, with 187 studies, followed by marine mammal depredation of fishing gear, with 56 studies (Jog *et al.,* 2022).

As the present review shows, depredation poses short-term benefits for marine mammals, creating new foraging opportunities directly facilitated by fishing operations. When looking at marine mammal depredation of fisheries, it is not rare to observe a relatively high disparity between reported and actual depredation levels, particularly for small-scale fisheries (Bearzi *et al.,* 2011; Gonzalvo *et al.,* 2015; Jog *et al.,* 2022), which may lead to an over-estimation of the economic damages due to depredation. Indeed, unsustainable fishing has contributed to dramatic ecological changes in the Mediterranean Sea (Coll *et al.,* 2010; Sala, 2004) and with small-scale fishing becoming

increasingly economically marginal, even relatively small losses to dolphin depredation can now have a proportionally large impact on a fisherman's livelihood. Consequently, this economic distress may be prompting fishers to complain more about depredations by marine mammals and to perceive these animals as competitors (Reeves *et al.,* 2001). Moreover, several other factors may cause gear damage and catch loss, for example, fish or other invertebrate species, or marine debris (Lauriano *et al.,* 2009; Gazo *et al., 2008*).

The works on marine mammal depredation reviewed in this document vary in the methodologies used, but most of them, include to some extend the following: interviews to fishers, direct observations on-board, fishing gear damage monitoring both on-board and landing sites, fish captures monitoring, local marine mammal population monitoring through sea surveys (e.g., line-transect) and photo-identification. Some studies incorporate also the use of new technologies such as passive acoustic monitoring and underwater cameras and drones for behaviour assessment of the species involved in the depredation. Stranding networks provide also a valuable source of information both on depredation and bycatch through forensic analysis of stranded marine mammals. The lack of uniformity in the approaches implemented in many of these studies makes difficult to compare their results and findings. In this regard, a recent document by Carpentieri and Gonzalvo (2022), prepared under the auspices of the GFCM of the Food and Agriculture Organization of the United Nations (FAO) and the ACCOBAMS, proposes a protocol for data collection on dolphin depredation with the aim of giving support to regional monitoring programmes and provide a framework for the development and implementation of an efficient, standardized data collection and monitoring system for depredation events.

Human behaviour and socioeconomics play a key role in marine mammal and fisheries interactions (Jog *et al.,* 2022) and, more specifically, in depredation. Considering these two factors will be key to move from a purely data-collection and *in-situ* analysis of the conflict to a management context and when trying to set marine mammal conservation priorities, as well as to try to secure the viability and livelihood of the fishing communities affected. The latter is particularly relevant in small-scale fisheries, those more largely affected by depredation, because they typically support large numbers of fishers compared with more industrialised fisheries (Jacquet and Pauly, 2008) and the economic impact of depredation is affecting single individuals and families.

Depredation impacts on fishers are primarily associated with catch losses and gear damage but often lack of accurate assessments. In many of the studies here reviewed, deterrence methods were also tested but with various degrees of effectiveness. Conflicts frequently occur on a seasonal basis rather than all year round. This must be also considered when envisaging possible mitigation strategies, which may need to be implemented during a specific season rather than throughout the year. The active participation of fishers is essential when dealing with depredation because it does not only provide improved localized knowledge on interactions between local fisheries and marine mammals, but also allows for the definition of specific management and mitigation strategies in agreement with key stakeholders.

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- Annex 1- Questionnaire for on-going Cetacean Depredation Studies

1. Name:
2. Surname:
3. Affiliation:
4. Country (where the marine mammal depredation research is conducted):
5. Location/area (e.g., All national waters, Gulf of Ambracia, Balearic Islands, XXX MPA,…):
6. Marine mammal species (if more than one, please list them all in separate lines adding as many lines in the table below as necessary) and fishing gear/s involved (indicate with an "X"). See example.

Species *(Scientific name)*	Bottom trawlers	Pelagic trawlers	Purse seiners	longliners	Tuna seiners	Small-scale fisheries			
						Trammel nets	Gill nets	Small longliners	Other (please, provide detail)
T. truncatus	X					X			
D. delphis			X						

7. Year start project:
8. Year end project (please, if the project is on-going, write "on-going" followed by the year when the project is expected to end)
9. Main questions addressed / research goals
10. Methods or technologies used / tested to collect data (Please, no references to mitigation measures)
11. PLEASE, facilitate a small abstract, with a summary of the results, on the research you are referring to

Feel free to facilitate, in addition to this questionnaire, any relevant report or document that you may consider relevant to your depredation work