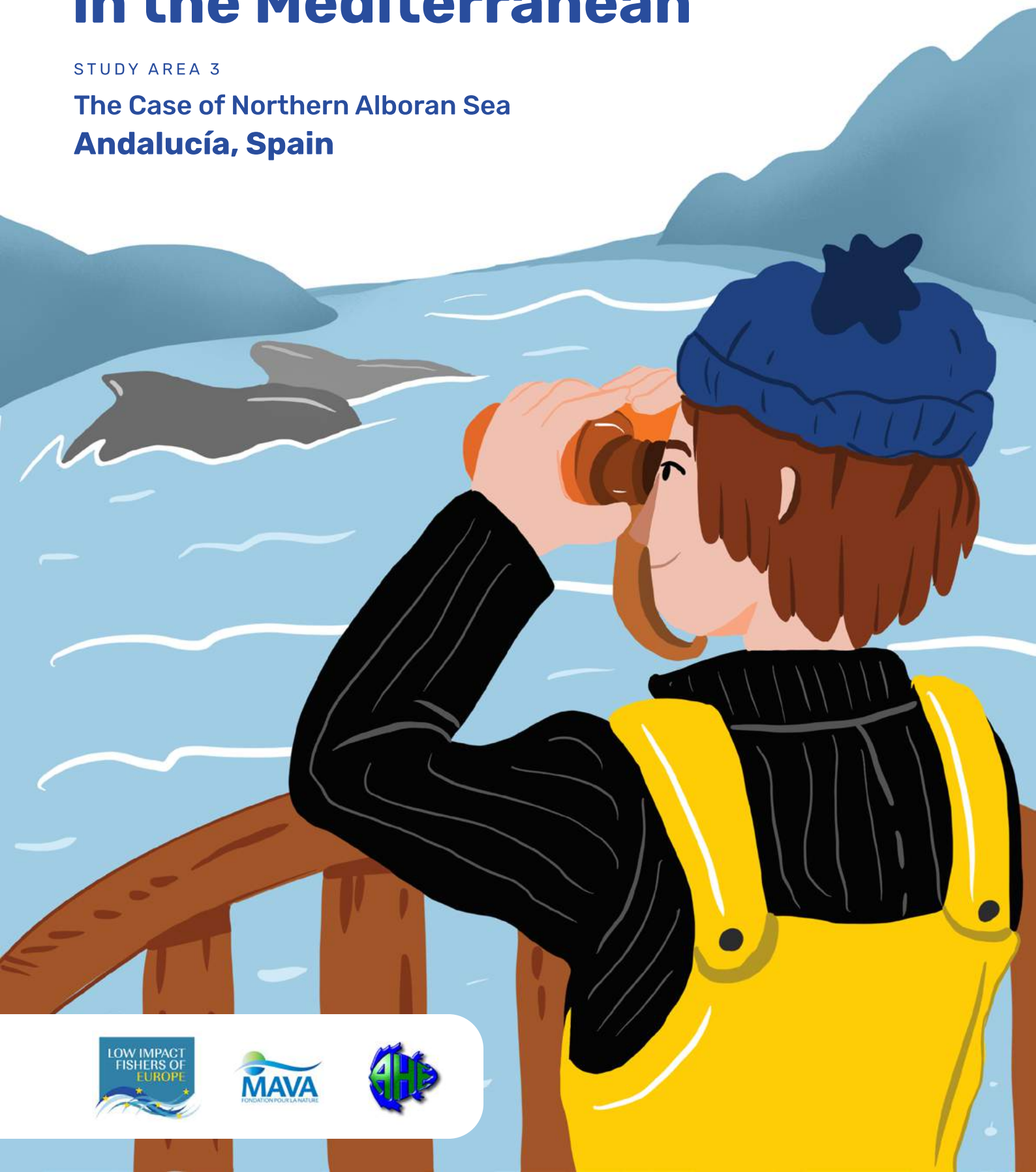
Interactions Between Cetaceans and Small-scale Fisheries in the Mediterranean

STUDY AREA 3

The Case of Northern Alboran Sea

Andalucía, Spain



LOW IMPACT FISHERS OF EUROPE

MAVA FONDATION POUR LA NATURE

Interaction Between Cetaceans and Small-Scale Fisheries in the Mediterranean

Study Area 3: The Case of Southwestern Mediterranean, Andalucia, Spain

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The present report is part of a Collection of Reports where interaction between cetaceans and small-scale fisheries in the Mediterranean has been analysed. This report shows the results in one out of three areas of study, concretely in Northern Alboran Sea, in the Andalucía coast, Spain. They all proceeded with a coordinated approach with common methodology and database. Please see the other two case study reports and "conclusive report" for further information.

This report has been prepared based on the Letters of Agreement between the Low Impact Fishers of Europe (LIFE), the Asociación Herpetológica Española and Raquel Aguilera.

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Introduction

Interactions between cetaceans and fisheries have become a major problem worldwide, which is reflected in the increasing number of reported cases during the last few decades, together with the difficulties in quantifying the impacts on cetacean populations and fisheries economy (Harwood, 1983; Goetz, 2014). These interactions usually occur when there is a spatial overlap between cetaceans' distribution and those areas where fishing takes place, in most cases because both cetaceans and humans share the same target species, such as the European pilchard (*Sardina pilchardus*) and anchovies (*Engraulis enccrasicholus*), (Zappes et al., 2016; Revuelta et al., 2018). Occasionally, the problem becomes more serious because some of these target species represent an important resource for dolphins inhabiting Mediterranean coastal waters (Lleonart, 2005), and at the same time they are largely caught by small-scale fisheries and present overexploited stocks.

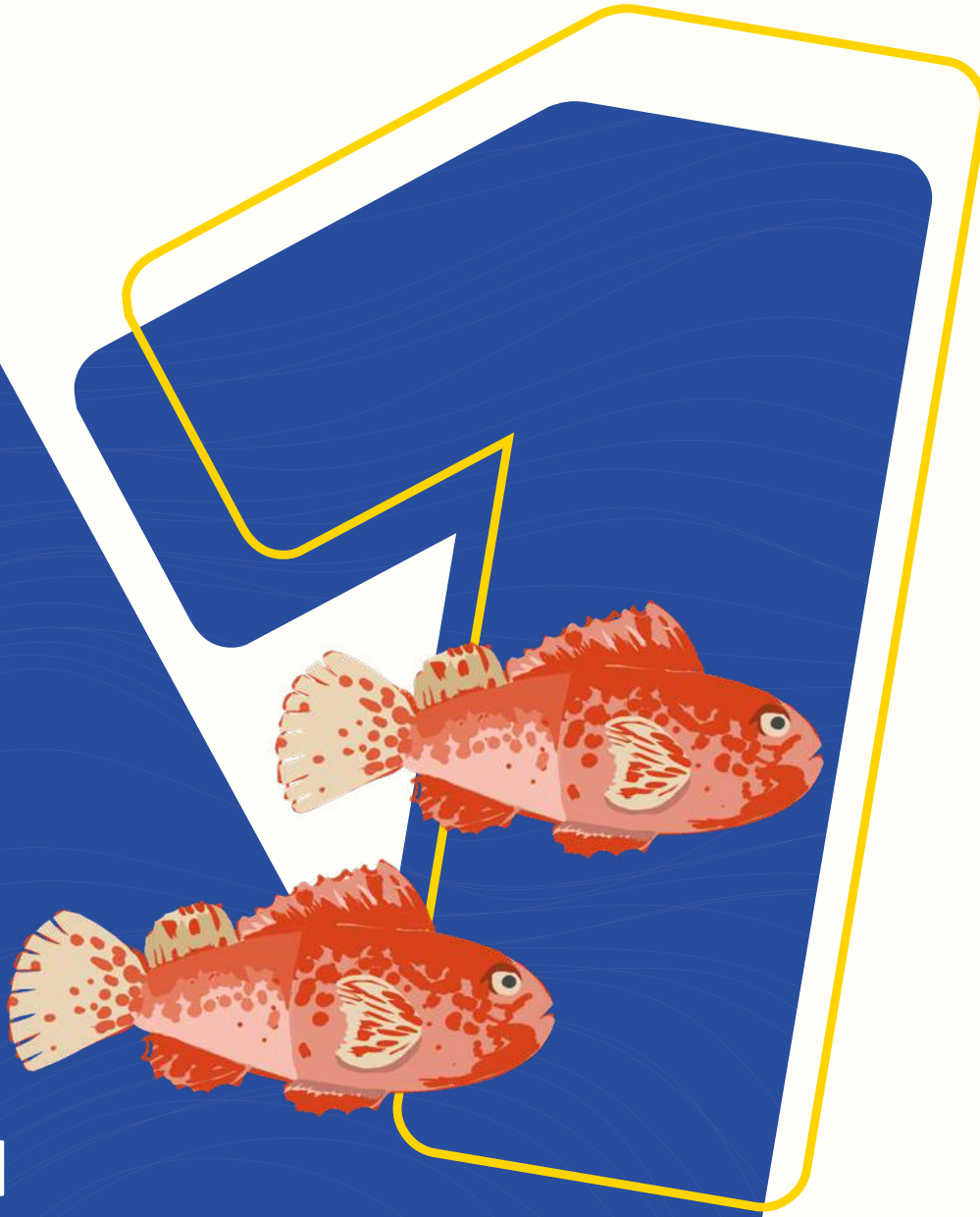
Interactions can be negative or positive, and beneficial effects would involve dolphins "co-operating" in fishing operations, increasing the chances of success in the capture of prey (Pryor et al., 1990; Bearzi, 2002). Nevertheless, most interactions have negative consequences for fisheries, including breaking of fishing nets and loss of capture. The main types of fishing gears affected by interactions between cetacean and fisheries in coastal Mediterranean waters are bottom-set trammel nets and gillnets, as well as trawl nets and purse seines to some extent (Reeves et al., 2001; Bearzi, 2002).

The main interaction between fisheries and dolphins consists in the total or partial depredation of the catch, which is concentrated in the fishing nets and represents an easy to exploit food resource for these cetaceans, this is particularly the case of fixed fishing gears with long soak times (Goetz, 2014). Coastal dolphins, particularly common bottlenose (*Tursiops truncatus*, Montagu, 1821), are often claimed to damage the catch and the fishing gear in order to steal the capture, also scaring the potential preys away (Notarbartolo di Sciara, 2002). In this line, most of the documented cases of predation of catch from fisheries in Mediterranean coastal water are due to the attack of bottlenose dolphins (Bearzi et al., 2010). This species can be observed in a wide variety of habitats, being the more common marine mammal in the continental shelf of the Mediterranean Sea (Notarbartolo di Sciara, 2002; Gonzalvo et al., 2014).

In the Alboran Sea, the bottlenose dolphin can be found in the continental shelf and the slope and in deep waters between 200 and 500 meters depth (Cañadas et al., 2005; Forcada et al., 2004). This species exhibit a highly varied diet throughout its distribution range, including mainly Sparidae species and a mixture of other species including European hake, mackerels, European conger and European pilchard (Giménez et al., 2017). The bottlenose dolphin is, according to the IUCN Red List of Threatened Species (Bearzi et al., 2012), a vulnerable species.

Furthermore, it is included within the Annexes II (animal species of Community interest) and IV (strictly protected species) of the EU Habitats Directive (Council Directive 92/43/EEC), within the Barcelona (endangered or at-risk species) and Bern (strictly protected fauna) Conventions and the ACCOBAMS agreement (Bonn Convention), and locally within the Spanish National Catalogue of Threatened Species.

This work is part of the project INTERACTION BETWEEN CETACEANS AND SMALL-SCALE FISHERIES IN THE MEDITERRANEAN SEA which studies the Interaction between cetaceans and small-scale fisheries in southern Spain, Maltese islands and Sicily (Italy). The main aims of this study are to show the existence of dolphin-fisheries interaction in the northern margin of the Alboran Sea study and to provide data on the different types of interaction (mainly “depredation”) that occur in this area. Collected data from the field will help to investigate the occurrence/incidence of cases of interaction of cetaceans with the SSF fishing fleets, to evaluate the extension of the interactions, to estimate the economic damage that fishers endure, and any potential risk to safety at sea. The study should be also useful to explore the issue of by-catch of vulnerable species. Finally, it will support a better understanding on gear depredation dynamics in order to provide further information on possible mitigation measures to be used, hopefully moving beyond the use of pingers, and to raise awareness among the administrations and decision-makers on the issue and to favor practical solutions.



CHAPTER 01

Background Information

INTERACTION BETWEEN CETACEANS AND SMALL-SCALE FISHERIES IN THE MEDITERRANEAN

Study Area 3:
The Case of Northern Alboran Sea
Andalucia, Spain

1.1 - Cetaceans in Alboran Sea

It is well documented the presence from ancient times of common bottlenose dolphin in the northern Alboran region. Archeological excavations demonstrated that human communities of the Upper Pleistocene and Holocene exploited marine resources from Nerja (Málaga) to Gibraltar strait and in locations in North Africa, including mammals such as *Monachus monachus*, *Delphinus delphis* and *Tursiops truncatus* (Stringer et al. 2008). Particularly mammals had a prominent presence in the Nerja cave (Pérez y Raga 1998; Morales-Pérez et al 2019).

The Alboran Sea has been recognized as one of the Mediterranean important areas with high cetacean diversity (Cañadas et al., 2002) and for the conservation of common dolphins in the sea (Bearzi et al., 2004). Marine research in the area began in the 19th century (Pérez de Rubín, 2012), including the observations of cetaceans, as registered in the campaigns of the Hirondellle and Princesse Alice I and II, the vessels of Albert the 1st of Monaco (1885-1899) in the Alboran sea and Strait of Gibraltar (Richard, 1904). From 2006 the Annual report on the Management of the Marine Areas in Andalucía (Junta de Andalucía, 2019) compile information on stranded cetaceans in northern Alboran Sea, including bottlenose dolphin in the dataset. This specie represents the 3rd in number of annual strandings observations of cetaceans in the region, after *Stenella coerueoalba* and *Delphinus delphis*.

According to Cañadas (2006) the gradual regression is observed, manifested mainly in the form of fragmentation of the populations of the bottlenose dolphin in the Mediterranean basin (Notarbartolo di Sciara and Gordon 1996; Notarbartolo di Sciara 2002); the regression of the common dolphin throughout the northern Mediterranean area (Bearzi et al. 2003). Andalusia is the gateway to and from the Mediterranean Sea. Its more than 800 km of coastline make it one of the regions with the highest marine biodiversity in Europe. There are resident populations of several cetacean species: Bottlenose dolphin, Pilot whale, Striped dolphin and Common

dolphin. It is also a transit or feeding area for other species of marine mammals: Orcas, Sperm whales, Fin whales, Yubartas, among others. (Junta de Andalucía, 2017). For the proper conservation, management and planning of marine and coastal ecosystems, it is vitally important to know their biological diversity, for which, within the Program for Sustainable Management of the Andalusian Marine Environment, samples of the different species of marine fauna that inhabit the area are carried out. A map accessible at the following link (http://www.juntadeandalucia.es/medioambiente/site/rediam/menuitem.04dc44281e5d53cf8ca78ca731525ea0/?vgnextoid=e191794f353b2410VgnVCM2000000624e50aRCRD&vgnextchannel=cd6f726c4d6af310VgnVCM1000001325e50aRCRD&lr=lang_es) represents the distribution (using 1 Km2 grids) of cetacean species sampled on the Andalusian coast and marine waters of influence, between 2005 and 2011, include: *Balaenoptera physalus, Balaenoptera acutorostrata, Delphinus delphis, Globicephala melas, Grampus griseus, Kogia breviceps, Megaptera novaeangliae, Orcinus orca, Phocoena phocoena, Physeter microcephalus, Stenella coeruleoalba, Tursiops truncatus* and *Ziphius cavirostris*.

Although no trends of the cetacean populations in the Alboran Sea were found, Báez eta l., (2019) stated that Alboran Sea has a high presence of Cuvier's beaked whale (Ziphius cavirostris). Three Mediterranean subpopulations of dolphins (Delphinus delphis, Stenella coeruleoalba and Tursiops truncatus) are listed in the IUCN Redlist (IUCN 2019) and their results showed that there were more opportunistic sightings of these species in the Alboran Sea than in the rest of the Western Mediterranean.

Since 1993, the Spanish Institute of Oceanography (IEO) has compiled a dataset of Opportunistic Observations of nine species of cetaceans in the western Mediterranean Sea and adjacent waters, including observations of bottlenose dolphin in Alboran Sea, elaborating different documents on spatial analysis of cetaceans (Báez, Torreblanca & Camiñas, 2007),

and other cetaceans' distribution and sighting (Torreblanca et al., 2019). Although different authors reveal the presence of the cetacean species in Alboran, bycatch in fisheries in the area as for example surface pelagic longline targeting bluefin tuna and swordfish don't include bottlenose dolphins (Macías et al, 2012).

Scientific surveys from 1992 to 2011 were carried out to evaluate the abundance and distribution (Figure 1) of the species in the framework of different projects (Cañadas et al., 2005). Recent model of analysis (Cañadas & Vázquez, 2017) consider that the increase in sea surface temperature will potentially yield a reduction in the suitable habitat for the common dolphins in Alboran Sea, with a progressive reduction in density from east to west.

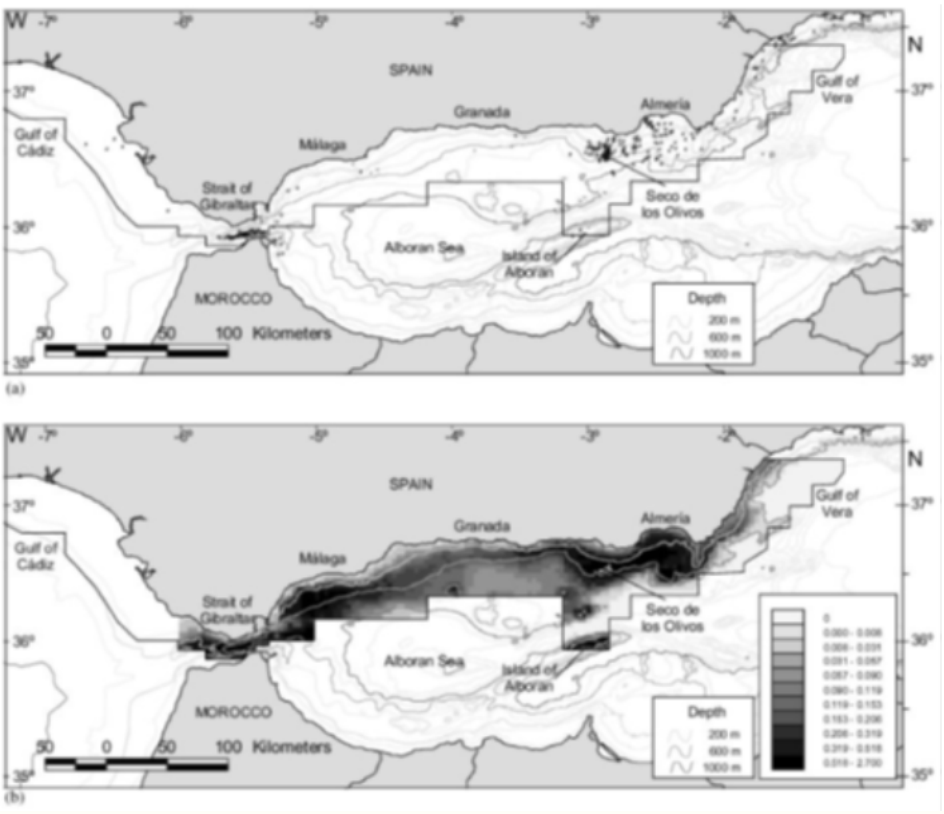


Figure 1. Sightings of common bottlenose dolphins (b) Prediction of relative density of common bottlenose dolphin (Cañadas et al., 2005).

PROMAR, a Spanish NGO, carried out in 2014 an evaluation of the interactions of bottlenose dolphins and local fisheries from Adra, an important fishing port in northern Alboran Sea, by working on the field with the fishermen from different fisheries. PROMAR stated the interactions between bottlenose dolphin and small pelagic purse seiners and trammel nets, and reported losses in occasions over 5000€ by boat and total over 50.000€ in the whole fleet in this port.

CHAPTER 02

Safeguard of Cetaceans in the Mediterranean Sea

INTERACTION BETWEEN CETACEANS AND SMALL-SCALE FISHERIES IN THE MEDITERRANEAN

Study Area 3:
The Case of Northern Alboran Sea
Andalucia, Spain

2.1 - Study Area

The Alboran Sea represents the westernmost part of the Mediterranean Sea. It opens to the Atlantic Ocean through the Strait of Gibraltar, becoming a transition area between the Atlantic and the Mediterranean basins, and presents contrasting oceanographic characteristics (Parrilla & Kinder, 1987; Tintoré et al., 1988). The Alboran basin is located between southern Spain, northeastern Morocco and northwestern Algeria, and it extends from the Strait of Gibraltar to an adopted line conformed by a large-scale strong ocean density front between Almeria (Spain) and Oran (Algeria), running from Cape of Gata (Spain) to Cape Fegalo (Algeria) (Figure 2). The physical oceanographic features of the Alboran Sea (e.g. enriched nutrient upwellings) support one of the highest biological productivity areas within the Mediterranean basin (Rodríguez, 1995; Sarhan et al., 2000), promoting a great fishing activity due to the great diversity of marine resources (Camiñas et al. 2004), with a high number of fishing ports located at both seashores (Figure 2). The study area consisted of the waters and ports of the Autonomous Community of Andalucía in southern Spain, a region of great oceanographic importance for the Mediterranean considered “the hydrological motor of the Mediterranean Sea” (Rodríguez, 1982) and with high cetacean diversity (Cañadas et al., 2002).

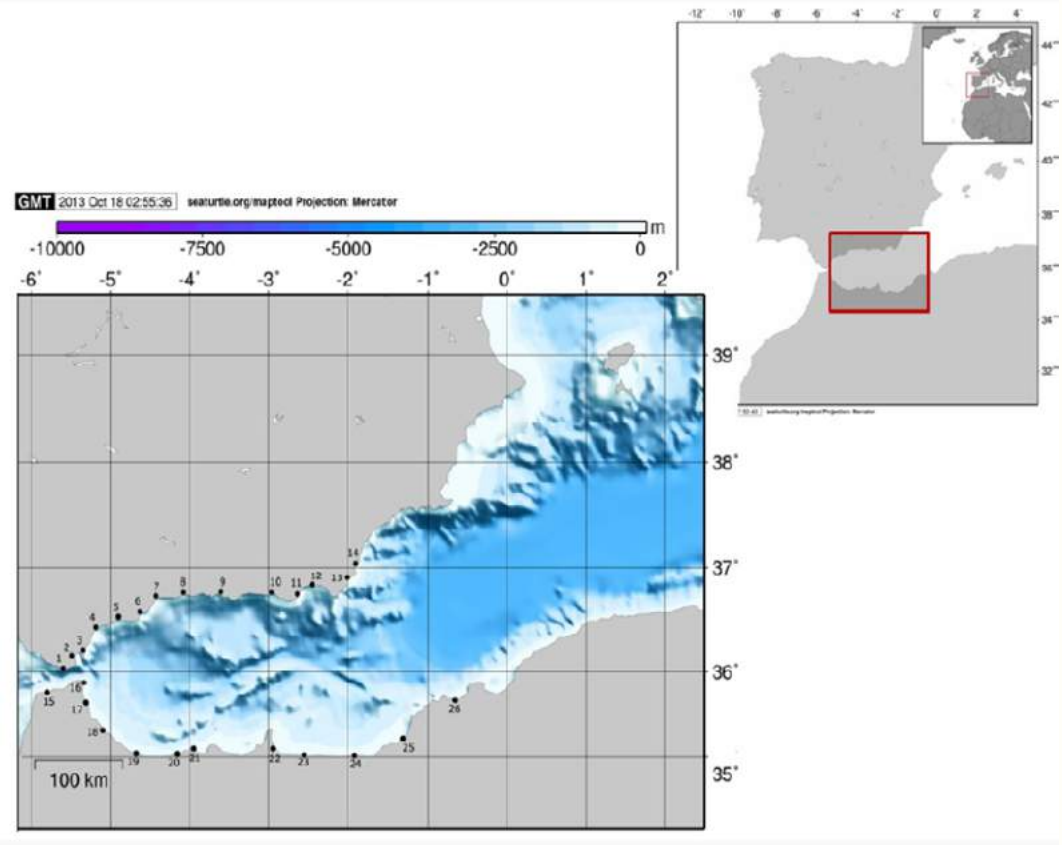


Figure 2. Map of Alboran Sea with the location of the most important landing ports: (1) Tarifa, (2) Algeciras, (3) La Línea de la Concepción, (4) Estepona, (5) Marbella, (6) Fuengirola, (7) Málaga, (8) Caleta de Vélez, (9) Motril, (10) Adra, (11) Roquetas de Mar, (12) Almería, (13) Carboneras and (14) Garrucha are out of the Alboran Sea in sensu stricto), (15) Tanger, (16) Ceuta, (17) M´diq, (18) Stehat, (19) Jebha, (20) Cala Iris, (21) Al Hoceïma, (22) Beni Ansar (Nador), (23) Ras El Ma, (24) Ghazaouet (Tlemecen), (25) Bouzed jar (Ain Témouchent), and (26) Oran (data from UNEP-MAP-RAC/SPA, 2015).

The diverse seafloor morphology and the location and peculiar hydrodynamic features of the Alboran Sea, with the mixing of cold and less saline Atlantic surface waters and little saltier deep Mediterranean waters, promote a wide diversity of habitats and associated biota that is supported by the high biological productivity of the area, being considered a biodiversity hotspot within the European context (Templado, 2011). In the Alboran basin, the plankton productivity peaks occur from spring to autumn (Camiñas, 1983; García & Camiñas, 1985), which coincides with spawning season of many fish species of commercial importance including the highly demanded European pilchard and anchovy. Besides coastal areas, there are important areas for the reproduction

and spawning of many demersal fish species in submarine canyons of the Alboran Sea, which enhance the ecological importance of this basin (UNEP/MAP, 2015). Furthermore, the Alboran Sea represents a place of passage and transition between the Atlantic and the Mediterranean for migratory large vertebrate species including cetaceans, turtles and large pelagic species (e.g. bluefin and red tuna). Due to the importance of this basin, different coastal and off-shore areas have been declared with different levels of protection (Figure 3).

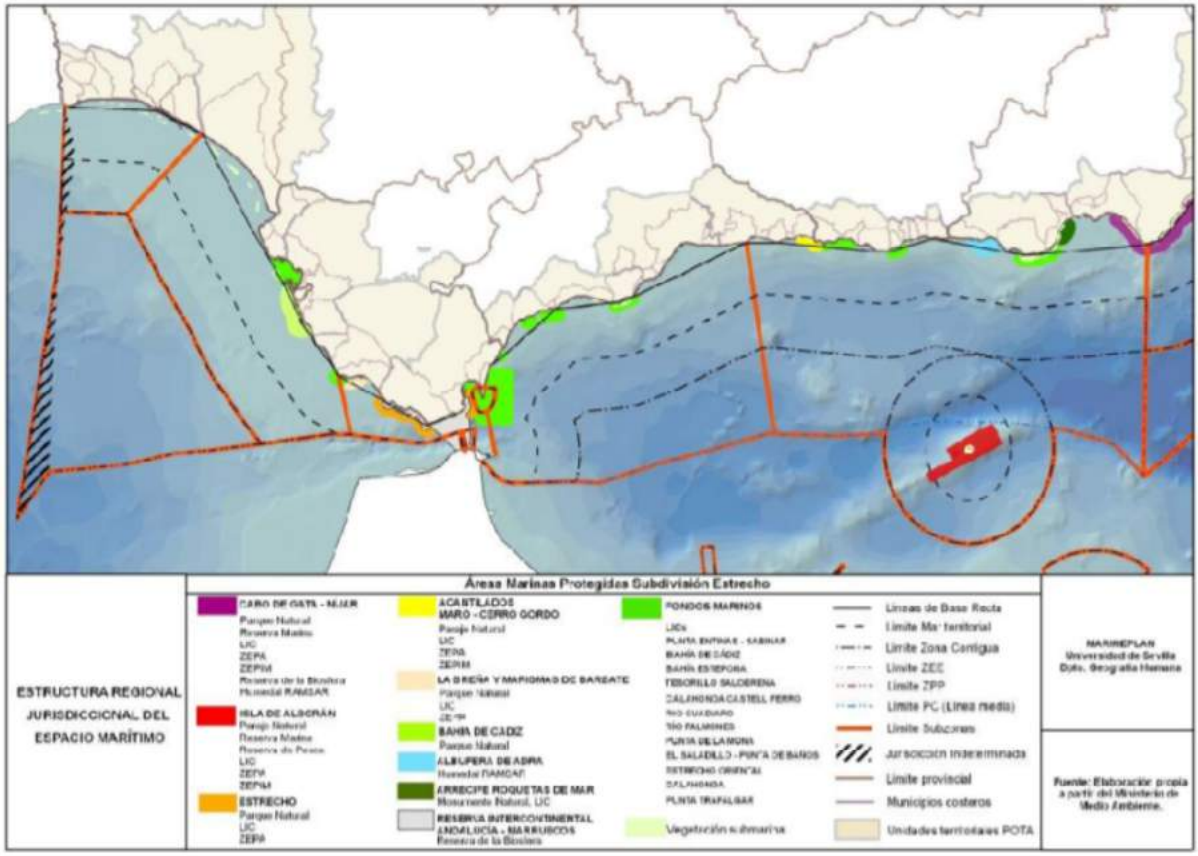


Figure 3. Protected marine areas in Andalucía. Source: University of Seville.

The area considered in this study is located between the Strait of Gibraltar (Tarifa) and Garrucha (Almería) (Figure 4), which is located within the fishing management subarea of the North Alboran Sea (GSA01), established by the General Fisheries Commission for the Mediterranean (GFCM).

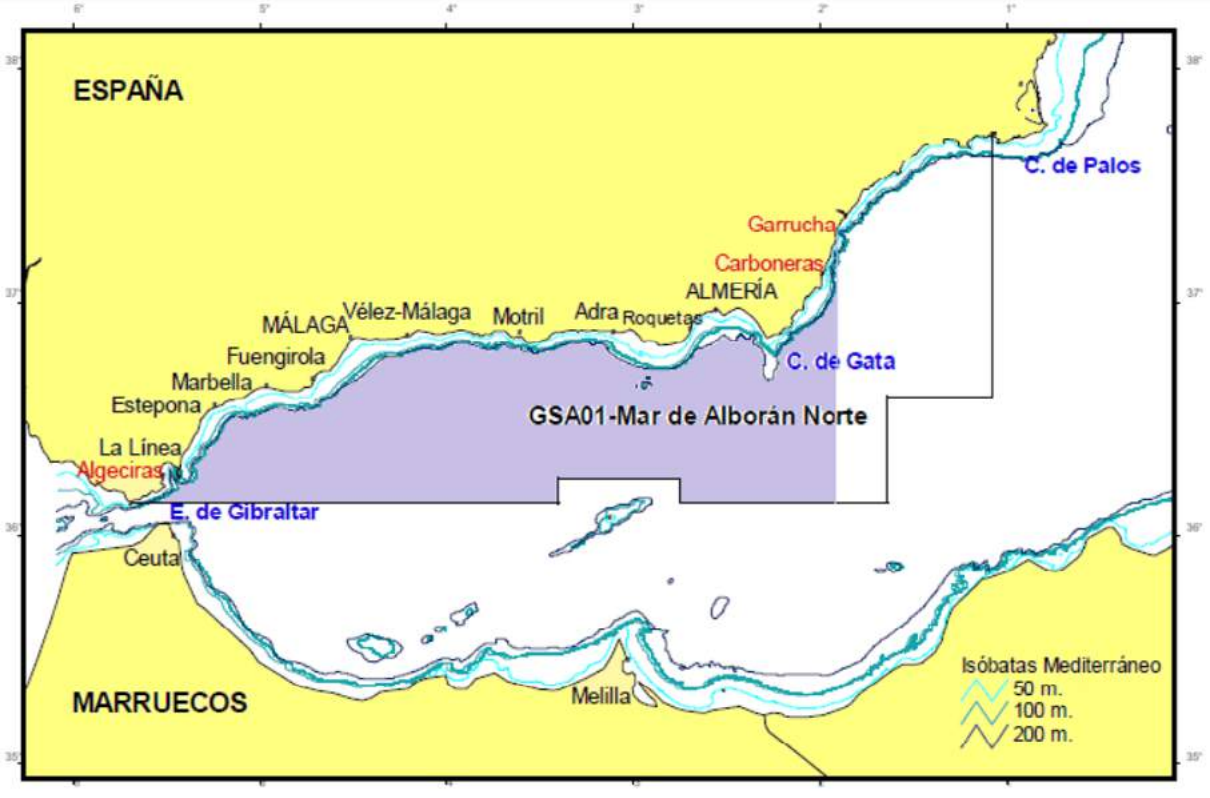


Figure 4. Location map of the study area (blue color) within the North Alboran Sea (GSA01) fishing management subarea.

2.2 - Description of the small-scale fleet

The fishing ports considered in this study are located in four provinces, Cádiz (Tarifa, Algeciras and La Línea de la Concepción), Málaga (Estepona, Marbella, Fuengirola, Málaga, Caleta de Vélez), Granada (Motril) and Almería (Adra, Roquetas de Mar, Almería, Carboneras and Garrucha), within the Mediterranean coasts of Andalucía (Figure 5).

Figure 5. Fishing ports of Andalucia considered in this study. (1) Tarifa, (2) Algeciras, (3) La Línea de la Concepción, (4) Estepona, (5) Marbella, (6) Fuengirola, (7) Málaga, (8) Caleta de Vélez, (9) Motril, (10) Adra, (11) Roquetas de Mar, (12) Almería, (13) Carboneras and (14) Garrucha.

The most important fishing ports in relation to the number of vessels registered are those of Estepona, Caleta de Vélez, La Linea de la Concepción, Tarifa and Almería, which provide more than 50% of the Andalusian small-scale fleet that operates in the Mediterranean Sea. Within our study ports, the province of Málaga presents the largest small-scale fleet (43.6% of the total), followed by Cádiz (27.39%), Almería (25%) and Granada (3.99%), according to the data of the active fleet published by the Secretaría General de Pesca of the Ministry of Agriculture, Fisheries and Food (Ministerio de Agricultura, Pesca y Alimentación,(2019) (Table 1).

Province	Port	Nº SS vessels	%
Almería	Garrucha	16	4,2
	Carboneras	15	4,0
	Almería	36	9,6
	Roquetas	10	2,6
	Adra	17	4,5
Granada	Motril	15	3,99
Málaga	Caleta de Vélez	42	11,2
	Málaga	22	5,8
	Fuengirola	28	7,4
	Marbella	25	6.6
	Estepona	47	12,5
Cádiz	La Línea	42	11,1
	Tarifa	38	10,1
	Algeciras	23	6,1

Table 1. Andalusian small-scale fleet per port (Secretaría General de Pesca, 2019).

Figure 6. View of the Fishing port of Garrucha (Almeria)
Source: https://www.desarrollopesqueroalmeria.es/almeria-a-levante/catalejos

Figure 7. View of the Fishing port of Carboneras (Almeria).
Source: https://www.desarrollopesqueroalmeria.es/almeria-a-levante/catalejos/

Figure 8. View of the Fishing port of Almeria.
Source: https://www.desarrollopesqueroalmeria.es/almeria-a-levante/catalejos

Figure 9. View of the Fishing port of Roquetas de Mar (Almeria)
Source : https://www.facebook.com/Deponiente/photos

Figure 10. View of the Fishing port of Carboneras (Almeria).
Source: https://www.desarrollopesqueroalmeria.es/almeria-a-levante/catalejos/

Figure 11. View of the Fishing port of Algeciras (Cádiz).
Source: http://www.rac-spa.org/sites/default/files/doc_open_seas/alboran_sea_fisheries.pdf

Figure 12. View of the Fishing port of La Línea de la Concepción (Cádiz)

Figure 13. View of the Fishing port of Tarifa (Cádiz)
Source: http://www.conteymar.com/euvres-realisees/reflotamiento-barco-pesquero-puerto-tarifa-cadiz/

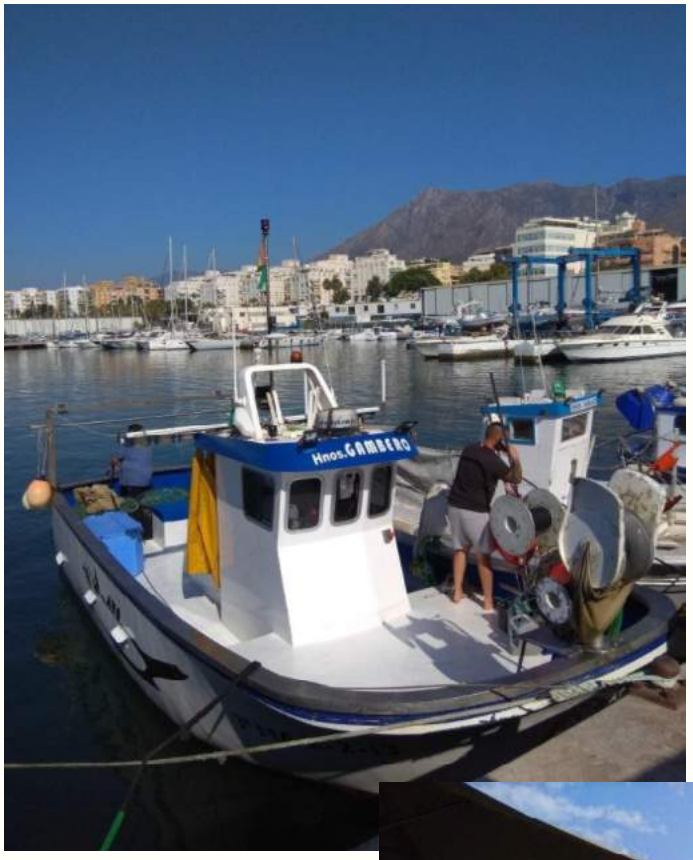


Figure 14. View of the Fishing port of Marbella (Málaga)

Figure 15. View of the Fishing port of Fuengirola (Málaga)

Figure 16. View of the Fishing port of Caleta de Vélez (Málaga).
Source: https://www.flickr.com/photos/portalealba/43320452060

Figure 17. View of the Fishing port of Estepona (Málaga). Source: https://www.diariosur.es/marbella-estepona/201412/16/puerto-estepona-contara-2015-20141216002549-v.html

Figure 18. View of the Fishing port of Motril (Granada). Source:https://telemotril.com/el-grupo-de-accion-local-de-pesca-de-la-costa-de-granada-presenta-su-candidatura-para-la-obtencion-de-fondos-europeos-maritimo-pesqueros/

Small-scale fisheries are traditional fisheries involving fishing households and relatively small fishing vessels (Tietze, 2016). The fleet is generally composed of a large number of boats, operating mainly on the continental shelf with a small capital investment and the exploiting areas are located a few hours from the based ports (Colloca et al., 2004). Regardless of these common characteristics, the small-scale fleet tends to be highly heterogeneous in space (Revuelta et al., 2018), being characterized by an alternation in the use of fishing gears fishing (pots, nets and mechanised dredges) and techniques both spatially and seasonally in order to optimize the catch and maximize profitability (Camiñas et al., 2004; Tzanatos et al., 2006). This is based primarily on the abundance of the target species, demand and the market price. These characteristics increase the heterogeneity of small-scale fisheries, making them complex to assess, monitor and manage (Tzanatos et al., 2006; Forcada et al., 2010).

The following figure shows the evolution of the small-scale fishing fleet in the Andalusian Mediterranean from 2014 to 2018 (Junta de Andalucía, 2019).

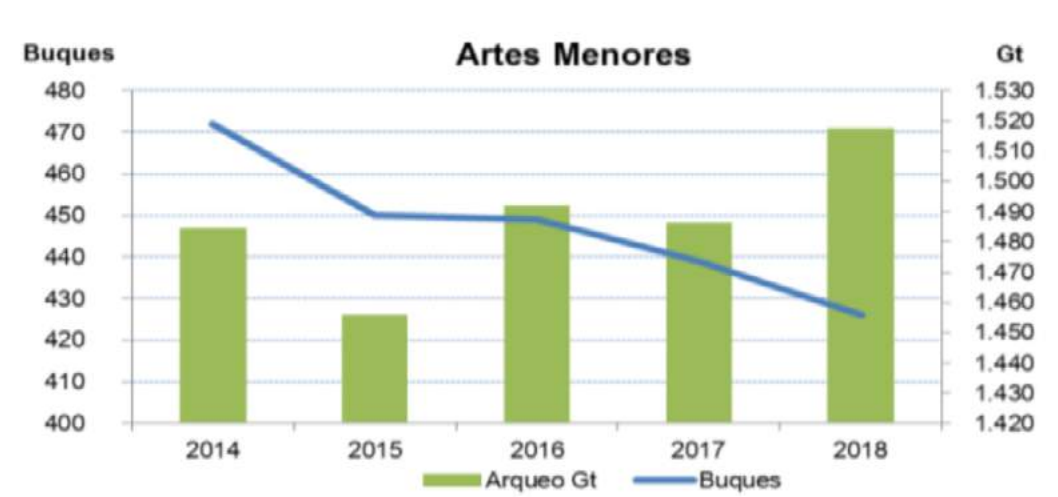


Figure 19. Evolution in Number and Gt of the small-scale fishing fleet in the Andalusian Mediterranean (2014-2018).

2.3 - Types of fishing gears

The fishing gears used by SSF in the Mediterranean, which are affected by interactions with cetacean, are trammel nets and gillnets (Reeves et al., 2001; Bearzi, 2002, Promar, 2014, etc). The set SSF nets are used to capture mostly fish that are gilled, entangled or enmeshed in the net (Figure 15) (FAO, 1990). They are made with a thin and transparent material that is invisible to the fish (Oxvig & Hansen, 2007), which can be arranged as single (gillnets), triple (trammel nets) or combined nets. Moreover, the gear must be placed near the bottom, at middle waters or near the surface depending the target species. These nets can be used either deploying a single piece or in large numbers placed in line according to their design, ballast and buoyancy, and are used to catch fish on the surface, in mid water or on the bottom (FAO, 1990).

Figure 20. Red mulled captured with gillnet.
Source: http://grupos.us.es/puertosandaluces/p10_32pesquerias.html#_

Gillnets

A set gillnet type consists of a single netting wall kept more or less vertical by a float line and a weighted ground line. The floats are usually made of plastic and either cylindrical or egg-shaped, being attached to the headline, whereas lead weights are evenly distributed along the ground line (FAO, 2001). In the latest designs the floats and weights are usually incorporated into the ropes, situated above and below the net, respectively. The set gillnet can be set near the seabed or anywhere between the seabed and the surface (Oxvig & Hansen, 2007), and it is kept stationary by anchors or weights on both ends. The net is made of multi-filament nylon, monofilament or multi-monofilament fibers with the aim to make it less visible (FAO, 2001). The species captured and the size distribution of the catch is dependent on the mesh size.

Different types of surface set gillnet are used along the Mediterranean waters of Andalusia depending on the target species and the area, such as the “Bonitera” targeting Sarda sarda, or “Agujetera” targeting Belone belone and the “Sardinal” targeting Sardina pilchardus which have a width fixe. Other suface gillnets are the “Melvera” targeting Auxis sp. and the “Volaera” targeting Cheilopogon heterurus (Junta de Andalucía, 2014), which have a filament width that increases progressively; for this reason this type of fishing gear has to be located in a perpendicular way to the coast line.

Figure 21. Bottom set gill net.
Source: http://agritech.tnau.ac.in/fishery/fish_fishingtech_passivegears.htm

Figure 22. Set gillnets, harbour of La Línea de la Concepción, Cádiz.

Trammel nets

The trammel net is a bottom-set fishing gear that consists of two/three layers of netting with a slack small mesh inner netting between two layers of large mesh netting within which fish will entangle (FAO, 2001) after passing through the outer wall (Oxvig & Hansen, 2007). The trammel nets that are most used along the Mediterranean waters of Andalusia are aimed to capture cuttlefish (Sepia officinalis) and red mullet (Mullus sps) being highly effective at retaining many different sizes and types of fishes (Junta de Andalucia, 2014).

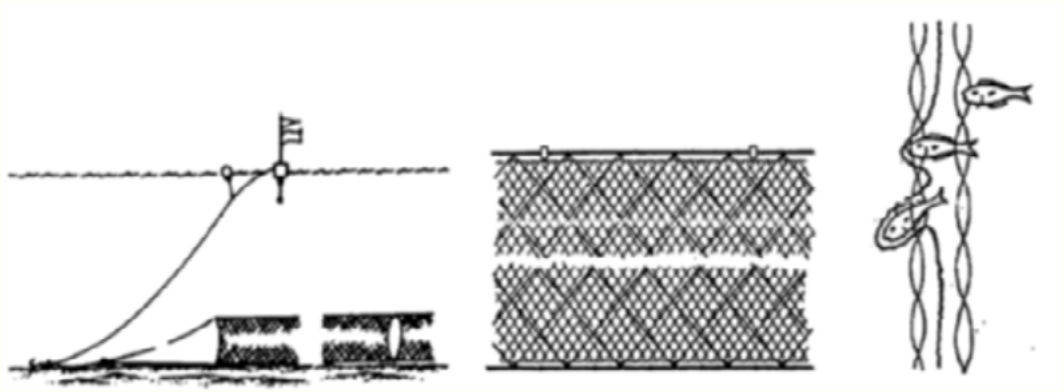


Figure 23. Trammel net. Source: FAO-Fish.Tech.Pap.222, p. 42.

Figure 24. Trammel nets damaged by a bottlenose dolphin, harbour of Motril (Granada).

2.4 - Target species

Gillnets represent a large diversity of fishing methods used throughout the year in all the fishing ports. Their use at each time of the year does not depend only on the legal aspects, but is largely conditioned by the biology of the target species (Camiñas, 1990).

One of the most widely used gillnets is the fine trammel ("Trasmallo de salmonete"), which can be used all year round, but as it is mainly used to fish for red mullet (*Mullus barbatus*), for a fishing period from May to September (Camiñas, 1990; Abeda, 1985). At this time the species comes close to the coast to lay their eggs. It is also used to catch common pandora (*Pagellus erythrinus*), striped seabream (*Lithognatus mormyrus*), and common sole (*Solea solea*), among other species. Another of the most used fishing gear is the light trammel ("Trasmallo de jibia"), used in winter and early spring, from January to April. It is mainly used to catch common cuttlefish, Sepia officinalis, although it can also catch common sole (Abeda, 1985).

Gillnets build with a single net are present throughout the Andalusian Mediterranean coast but its use is not as widespread as the trammels (Camiñas, 1990). Among these fishing gears an important one is the "Melvera", targeting bullet tuna (Auxis sp.). This gear is limited from September to November when the tuna-like fish passes close to the coasts, since it is a migratory fish. Another single net widely used in the province of Cádiz, where is the highest volume of catches (Junta de Andalucía, 2001), is the Voladera or Volaera targeting the flying fish (*Cheilopogon heterurus*). It is used during May and June, when the flying fish goes to the Mediterranean to spawn, it is also used in the months of July and August when the flying fish goes back to the Atlantic after the spawning.

Annex I includes a summary table of the closure periods established by the Consejería de Agricultura, ganadería, pesca y desarrollo sostenible (2020) to protect the fishing resources, by fishing modality and species. The species involved in the closures of the small-scale fishery are mainly octopus and molluscs.

The backspot seabream (*Pagellus bogaraveo*), red mullet, horse mackerel and red porgy (*Pagrus pagrus*), are the species that represent 80% of the economic value of species with landing obligation on the Mediterranean coast of Andalusia and they are captured by small-scale fishing fleets, excluding shell fishing (Table 2). However, with regard to the volume of landings, blackspot seabream (*Pagellus bogaraveo*), red mullet (*Mullus spp*), sardine (*Sardina pilchardus*), white sea bream (*Diplodus sargus sargus*) and common pandora (*Pagellus erythrinus*) are the main species.

FIRST SALE (SMALL-SCALE FISHING GEAR) 2005-2015 EUROS

FAO	SPECIE	KILOS (TOTAL)	EUROS (TOTAL)	% EUROS
SBR	*Pagellus bogaraveo*	2.042.007,15	30.811.913,17	28,96%
OCC	*Octopus vulgaris*	3.381.068,73	15.232.068,50	14,32%
BFT	*Thunnus thynnus*	677.224,25	6.114.103,99	5,75%
MUX	*Mullus* spp	486.789,96	5.229.026,88	4,91%
SFS	*Lepidopus caudatus*	2.461.552,43	5.128.778,11	4,82%
KTT	*Acanthocardia tuberculata*	5.314.342,14	4.111.141,38	3,86%
FRZ	*Auxis rochei/Auxis thazard*	3.448.163,85	3.551.520,84	3,34%
SWO	*Xiphias gladius*	453.118,90	3.263.960,27	3,07%
CTC	*Sepia officinalis*	478.738,57	2.855.248,05	2,68%
LKW	*Plesionika edwardsii*	122.117,85	2.818.587,65	2,65%
JAX	*Trachurus* ssp	1.404.657,58	2.418.110,13	2,27%
RPG	*Pagrus pagrus*	168.355,39	2.033.344,50	1,91%
KLK	*Callista chione*	1.002.021,04	2.028.427,92	1,91%

Table 2. Data of the economic value of the main species landed by the small-scale fishing fleets of the Andalusian Mediterranean ports. Those species with landing obligation and representing 80% of the volume of landings are coloured in blue ports (Junta de Andalucía, 2016).

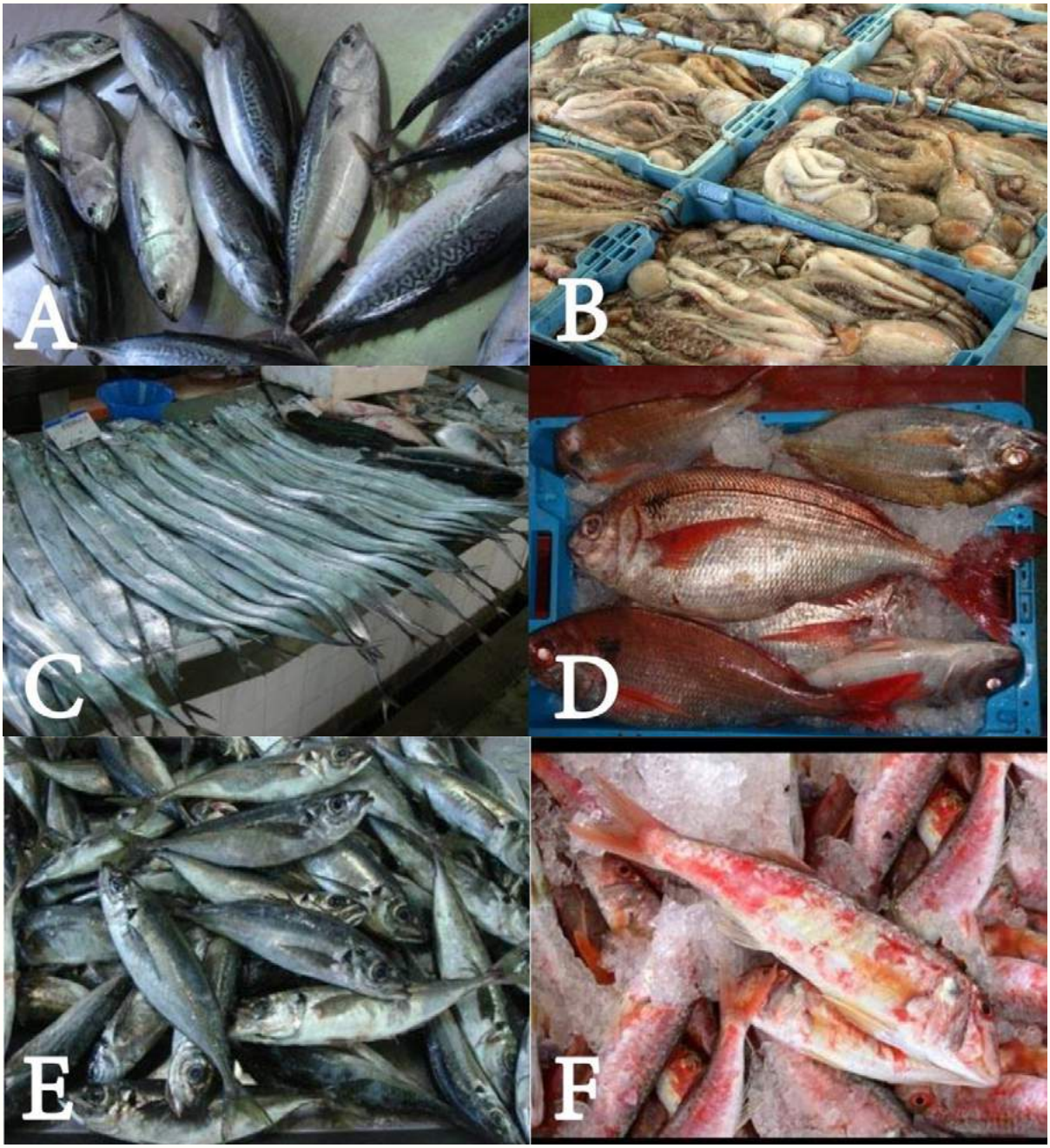


Figure 25. Main species landed by the small-scale fishing fleet (excluding the shellfish fleet) along the Mediterranean waters of Andalucía. A: Auxis rochei, B: Octopus vulgaris, C: Lepidopus caudatus, D: Pagellus bogaraveo, E: Trachurus spp., F: Mullus barbatus. Source: http://www.ictioterm.es/ (A. M. Arias)

The Common Fisheries Policy (CFP) introduces the obligation of landing unwanted catches for certain species; in the case of the fisheries of the Mediterranean Sea, this obligation also applies to those species subjected to catch limits, as listed in Annex III of COUNCIL REGULATION (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea.

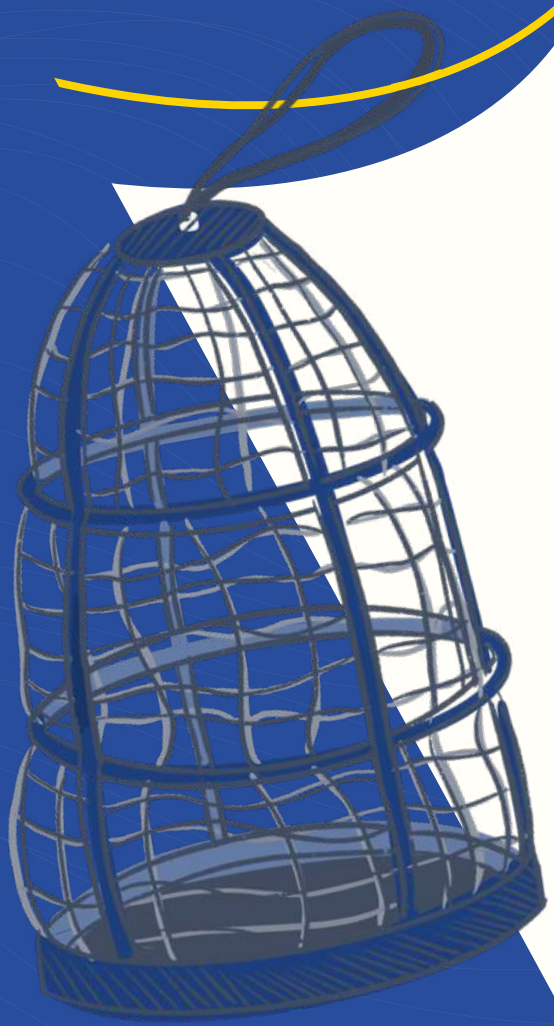
1. Peces	
Dicentrarchus labrax	*Lubina*
Diplodus annularis	*Raspallón*
Diplodus puntazzo	*Sargo picudo*
Diplodus sargus	*Sargo marroquí*
Diplodus vulgaris	*Sargo mojarra*
*Engraulis encrasicolus**	*Anchoa europea*
Epinephelus spp.	*Mero*
Lithognathus mormyrus	*Herrero*
*Merluccius merluccius****	*Merluza europea*
Mullus spp.	*Salmonete*
Pagellus acarne	*Aligote*
Pagellus bogaraveo	*Besugo*
Pagellus erythrinus	*Breca*
Pagrus pagrus	*Pargo*
Polyprion americanus	*Cherna*
*Sardina pilchardus***	*Sardina*
Scomber spp.	*Estornino*
Solea vulgaris	*Lenguado común*
Sparus aurata	*Dorada*
Trachurus spp.	*Jurel*

2. Crustáceos	
Homarus gammarus	*Bogavante*
Nephrops norvegicus	*Cigala*
Palinuridae	*Langostas*
Parapenaeus longirostris	*Camarón de altura*
3. Moluscos bivalvos	
Pecten jacobeus	*Venera*
Venerupis spp.	*Almejas*
Venus spp.	*Chirlas*

Table 3. Mediterranean species with minimum sizes and landing obligation at Mediterranean ports (Junta de Andalucía, 2016).

CHAPTER 03

Methods



INTERACTION BETWEEN CETACEANS AND SMALL-SCALE FISHERIES IN THE MEDITERRANEAN

Study Area 3:
The Case of Northern Alboran Sea
Andalucia, Spain

3.1 - Interview surveys

Surveys offer the opportunity to actively involve fishermen, into data collection activities, making possible to use their detailed knowledge on the local resources, the marine environment and fishing practices, which can be a useful additional source of information to scientific research (Johannes et al., 2000; Goetz, 2014; Camiñas et al., 2018). Cooperation and trust between scientists and fishermen are essential for fisheries research, allowing the establishment of partnerships between both sectors and supporting local fishermen in future fisheries management strategies (Johnson & van Densen, 2007).

Personal surveys were performed in fishing harbours along the Mediterranean coasts of Andalusia in order to collect data related to the experiences and opinions of small-scale fishermen. Surveys were always conducted face-to-face, since personal interviews allow creating more confidence between the interviewer and respondents. This is a very useful methodology in order to ensure a good quality of data (White et al., 2005; Goetz, 2014; Camiñas et al., 2018). A map was provided to fishermen for identifying the location of fishing grounds during each season (Goetz, 2014). As a first step before conducting the interviews, we had previous contact with local professional fishing associations and port authorities to know each other and to explain the project (Revuelta et al., 2018).

The questionnaire used in this study (Annex II) included open and close-ended questions designed specially to identify the interactions between bottlenose dolphins and small-scale gillnet fisheries. Overall, survey questions were divided in the following categories:

1. Technical characteristics (boat and licenses)
2. Perceptions about interactions with bottlenose
3. Mitigation measures employed by fishermen and their suggestions on solutions in order to avoid negative interactions with bottlenose

4. Information about the fishery affected by interactions with bottlenose dolphins: type of fishing gear used, target species and spatial information about the location of fishing activities.
5. Information on incidental capture of marine species (bottlenose and other protected species)
6. Information on the interactions between bottlenose dolphin and fishing gear: Description and level of damage, including catch loss (depredation and scattering of fish), gear damage and associated economic loss.

Information regarding the adequate sample size for fisheries assessment from personal interviews is very limited, making this methodology very complex (Malterud et al., 2016; Revuelta et al., 2018). In order to ensure an adequate sample size, the sample must include 10±3% of the operative (i.e. active) artisanal fleet of the investigated area. The protocol used in this study is included in Annex III and to complete the data on small-scale fishing activity the website of the Junta de Andalucía was consulted.

3.2 - Data analysis

From the tables of data obtained through the interviews, we used a binary logistic regression to estimate the probability to obtain a cetacean interaction in relation to technical and geographical interactions. Binary logistic regression is widely used for establishing relationships between environmental independent variables and the probability of response of target variables (for example Báez et al., 2013). Consequently, we assigned the value 1 when interviewed persons declare cetacean interaction, while we assigned the value 0 when the interviewed persons declare no interaction. The explanatory variables were: home-based port, size, gear type, fishing time, target species and boat length. We performed forward-backward stepwise logistic regression to obtain a final multivariate logistic model. To evaluate the models we assessed their parsimony, and goodness-of-fit, and discrimination capacity. Model goodness-of-fit was assessed by means of the Hosmer & Lemeshow test.

CHAPTER 04

Results

INTERACTION BETWEEN CETACEANS AND SMALL-SCALE FISHERIES IN THE MEDITERRANEAN

Study Area 3:
The Case of Northern Alboran Sea
Andalucia, Spain

4.1 - Results of the surveys on the field

During the period August-September 2019, a face-to-face interview survey was conducted to the professional small-scale fishermen in the 14 harbours of four provinces in the Andalusian region (Table 4). It was performed at the landing places, when the fishermen were maintaining the fishing gear and their boats, since many fishermen have time limited (Moore et al., 2010). A total 33 interviews were carried out, the persons interviewed were exclusively men and professionally active skippers, and only one interview by vessel was done.

No women were observed onboard the SS fleet, but one active woman in the port of Motril during the landing process and repairing gears was noted. Moreover, the only woman involved in the surveys and the arrangements with fishermen was the chief patron of the Fisher folk's Associations of Caleta de Velez, in Málaga. This person is also the Chairperson of the Federation of Fisher folk's Associations of the province of Malaga.

Figure 26. Interviews with fishermen (Port of Motril)

Figure 27. Interviews with fishermen (Port of Fuengirola)

Figure 28. Interviews with fishermen (Port of Fuengirola)

Base Port	Artisanal vessels	Number of Vessels interviews	% of vessels interviews per port
ALMERIA			
GARRUCHA	16	1	6,25
CARBONERAS	15	2	13,3
ALMERIA	36	4	11,1
ROQUETAS	10	1	10
ADRA	17	2	11,8
GRANADA			
MOTRIL	15	2	13,3
MÁLAGA			
CALETADE VELEZ	42	4	9,5
MALAGA	22	2	9,1
FUENGIROLA	28	3	10,7
MARBELLA	25	3	12
ESTEPONA	47	1	2,1
CÁDIZ			
LA LINEA	42	4	9,5
ALGECIRAS	23	2	8,7
TARIFA	38	2	5,3
TOTAL	376	**33**	

Table 4. Artisanal fishery fleet of the Andalusian in the Mediterranean sea (SGPM, 2019) and number of interviews. Ports from east to west in Andalucía: Garrucha, Carboneras, Almería, Roquetas, Adra, Motril, Caleta de Vélez, Málaga, Fuengirola, Marbella, Estepona, La Línea, Algeciras and Tarifa.

All the required surveys (according to the protocol) could not be carried out in the ports of Estepona and Tarifa, because gillnet fishing activity has been drastically reduced by the presence of the exotic seaweed *Rugulopteryx okamura*. The information about this problem has been collected in the section 5.4 of this work, entitled: "An emerging problem in the Alboran Sea affecting the artisanal fisheries that overlaps with dolphin interaction: the invasive seaweed *Rugulopteryx okamura*."

4.2 - Characteristics of the sampled fleet

The technical characteristics of the artisanal vessels (see Table 5) whose skippers or sailors have collaborated in this study have an average of 8.6 m in length (LOA) and 40.4 HP these values are slightly higher than those corresponding to the average values of the total small-scale fishery of the Andalusian Mediterranean. However, the GT (tonnage) is 3.1, slightly below of the total value of the artisanal fleet. The average values of all the Mediterranean artisanal fleet are 8.3 m length, 38 CV and 3.6 GT (Junta de Andalucía, 2018).

Surveyed vessel	Base port	GT tonnage	LOA	Horse Power	Year of construction
1	GARRUCHA	2,6	9,15	50	2008
2	CARBONERAS	1,74	9,06	33	2015
3	CARBONERAS	3,98	9,98	110	2002
4	ALMERIA	1,02	5,2	9	1963
5	ALMERIA	1,8	8,7	26	2001
6	ALMERIA	0,94	5,8	19,11	1958
7	ALMERIA	2,77	8,9	30	1985
8	ROQUETAS	6,7	13	101	2004
9	ADRA	2,58	9	25	2002
10	ADRA	5,08	9,61	47,99	2007
11	MOTRIL	6,25	11,2	20	1998
12	MOTRIL	1,81	7,8	22,06	1986
13	CALETA DE VELEZ	4,04	9,5	69	2005
14	CALETA DE VELEZ	9	11	80	1997
15	CALETA DE VELEZ	3,2	9,44	36	2010
16	CALETA DE VELEZ	0,87	6,97	20	2005
17	MÁLAGA	2,49	7,7	28	1989
18	MÁLAGA	1,92	8	30	1986
19	FUENGIROLA	1,5	6,5	70	1998
20	FUENGIROLA	1,69	9,15	36	2009
21	FUENGIROLA	1,46	6	50	1997
22	MARBELLA	3,7	8,4	30	1989
23	MARBELLA	1,23	8,98	23	2013
24	MARBELLA	3,3	8,5	28	1989
25	ESTEPONA	4,9	9	16	2000
26	LA LINEA	2,16	9	20	2007
27	LA LINEA	2,2	9	24	2005
28	LA LÍNEA	2	7,35	24	1989
29	LA LÍNEA	1,92	7,35	25	1989
30	ALGECIRAS	2,01	8	40	2003
31	ALGECIRAS	2,64	7,9	27	1989
32	TARIFA	5,91	9	37	1990
33	TARIFA	5,86	11	128	1989

Table 5. Technical characteristics of the vessels interviewed. Ports from east to west in Andalucía: Garrucha, Carboneras, Almería, Roquetas, Adra, Motril, Caleta de Vélez, Málaga, Fuengirola, Marbella, Estepona, La Línea, Algeciras and Tarifa.

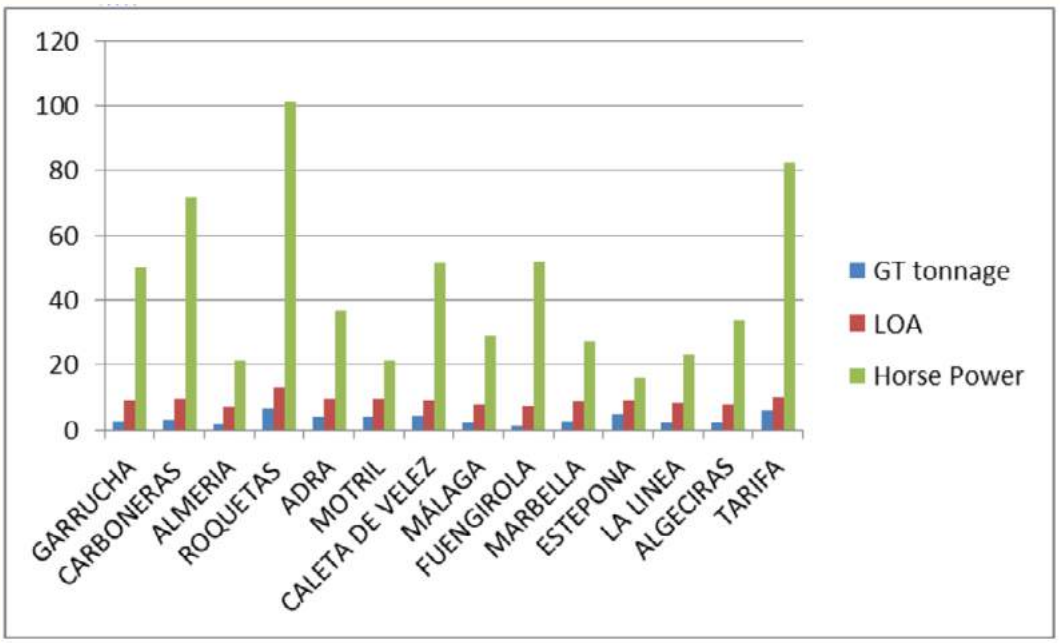


Figure 29. Technical characteristics of the vessels interviewed per port. Ports from east to west in Andalucía: Garrucha, Carboneras, Almería, Roquetas, Adra, Motril, Caleta de Vélez, Málaga, Fuengirola, Marbella, Estepona, La Línea, Algeciras and Tarifa.

The importance of the different fishing gears of interest to our study versus the different gears used in a fishing port is very variable, depending on the base port (Figure 25). The artisanal gears used are: mechanized dredges, gillnets, longlines and traps.

According to the census of the Junta de Andalucía (2020), the 67 percent of the surveyed fleet has a license for octopus using ad hoc trap gears and 39 percent has a license for bivalve fishing, using different dredges type.

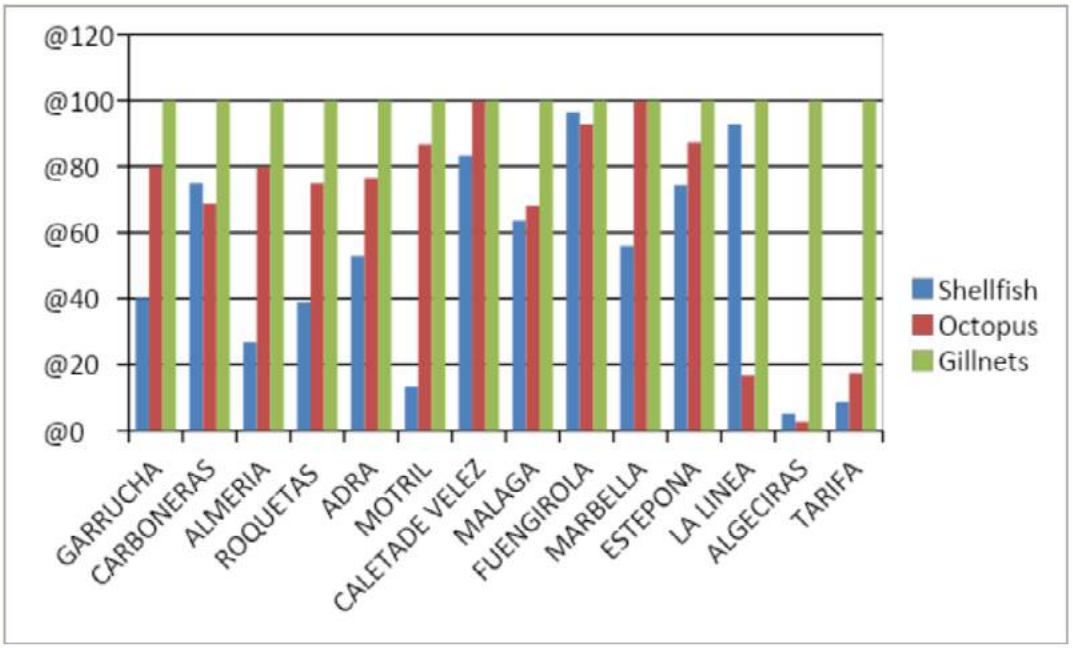


Figure 30. Licenses per port (excluding longline fishing) according to the census of the Junta de Andalucía (2020). Ports from east to west in Andalucía: Garrucha, Carboneras, Almería, Roquetas, Adra, Motril, Caleta de Vélez, Málaga, Fuengirola, Marbella, Estepona, La Línea, Algeciras and Tarifa.

Figure 30 shows the relative importance (in number of licences per gear) of the different fishing port (the longline is not included). The ports of Tarifa, Algeciras and Motril have a low shellfish activity, compared to the ports of Fuengirola, La Línea de la Concepción and Caleta de Vélez, where the activity with mechanized dredges is widely used. The octopus fishing with traps is very widespread in all the Andalusian ports, excepting the ports of Tarifa, La Linea and Algeciras.

This information should only be considered as an approach to characterize the artisanal fishery in the different ports of study, since it has to be taken into account that a vessel can be licensed to fish with a gear and do not use it in a specific year or never. To carry out an exhaustive quantification of the economic losses caused by dolphins, it is of vital importance to know the real fishing effort (number of days fishing) by gear, as well as the number of months (and days/month) in which each one is used.

4.3 - Results of the Interactions with cetaceans

4.3.1 - Results Logistic Regression

We found that the probability of observing cetacean interactions was significatively related to the home-based port of the target SSF fleets in function to a W-E gradient. Thus, the skypers/crews from Algeciras and Tarifa home-based boats do not declare any interaction, while in La Linea they declared scarce interaction. We do not found significant differences in the other ports cases, within the coast of Andalucia-Mediterranean Sea. The result tables of this analysis are included in the Annex IV.

4.3.2 - Fishing gear

The following tables show the data corresponding to the fishing gear used by each vessel surveyed by port. This information has been collected for fishing gears that have interactions with cetaceans. The tables include: Base port, vessel (number), gear type (ISSCFG: International Standard Statistical Classification of Fishing Gear, 1980), the name of the gear and target species. Regarding the nets fishing gear under study (GTR: Trammel nets; GNS: Set gillnets) we have collected other information as the size of the gear (metres in length), fishing period, fishing depth (meters), fishing time, distance to shore (nautical miles), coordinates of the fishing place, name of the site.

The acronyms used for the different types of fishing gears are: FPO: Pots, GNS: Set gillnets (anchored), GTN: Combined gillnets-trammel nets, GTR: Trammel nets, HMD: Mechanised dredges including suction dredges, LHM: Handlines and polelines (mechanised), LLS: Set longlines, LNS: Shore-operated stationary lift nets and NK: NOT KNOWN).

Base Port	Vessel	Gear type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interation	Coordinates (fishing place)	Name (Fishing place)
GARRUCHA	01	FPO	Nasa	Octopus	200	October to June	30-40	24	6-7	No	37°11'2.25" N, 1°40'7.5" W	Mojacar-Villaricos
		GTR	Trasmallo salmonete	Red mullet	2000	June to September	20-30	10	7	yes	37°11' 24" N, 1°48' 36" W	
		GNS	Pijotera	Albacore, prick	1400	January to December	100-300	10	7	yes	37° 16' 48" N, 1°43' 48" W	

Table 1. Data from the port of Garrucha (Almería) Roquetas, Adra, Motril, Caleta de Vélez, Málaga, Fuengirola, Marbella, Estepona, La Línea, Algeciras and Tarifa.

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interation	Coordinates (fishing place)	Name (Fishing place)
CARBONERAS	02	GTR	Trasmallo salmonete	Red mullet	2000	From June to September	0-23	8:00	10	yes	37°0'5.51"N 01°55'16.5"W	Carboneras
		GTR	Trasmallo de jibia	Common cuttlefish	1000	From February to May	0-160	8:00	10	yes	37°0'5.51"N 01°55'16.5"W	Carboneras
		FPO	Nasa	octopus	200	From October to June	72-90	24.00	10	no	37°0'5.51"N 01°55'16.5"W	Carboneras
CARBONERAS	03	GTR	Trasmallo de jibia	Common cuttlefish	1000	From February to May	0-23	8:00	10	yes	37°0'5.51"N 01°55'16.5"W	Carboneras
		GNS	Pijotera	Prick	1400	From July to September	0-90	8:00	10	yes	37°0'5.51"N 01°55'16.5"W	Carboneras
		GTR	Trasmallo	Red mullet	2200	From June to September	0-17	8:00	10	yes	37°0'5.51"N 01°55'16.5"W	Carboneras
		GTR	Trasmallo de jibia	Locust,perch, John Dory, common cuttlefish	800	From February to May	40-50	8:00	10	yes	37°0'5.51"N 01°55'16.5"W	Carboneras
		FPO	Nasa	octopus	200	From October to June	70-90	24.00	10	no	37°0'5.51"N 01°55'16.5"W	Carboneras

Table 2. Date from the port of Carboneras

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interation	Coordinates (fishing place)	Name (Fishing place)
ALMERIA	04	GTR	Trasmallo de jibia	Common cuttlefish	1000	From January to May	10-20	10:00	5	Yes	36° 51' 44,73"N 2° 0' 20,21"W	Cabo de Gata
		GTR	Trasmallo de salmonete	Red mullet	2000	From june to september	10-40	10:00	5	Yes	36° 51' 44,73"N 2° 0' 20,21"W	
		FPO	Nasa	Octopus	200	From October to June	8-27	24:00	5	No	36° 51' 44,73"N 2° 0' 20,21"W	
		GNS	Solta	Sea bass	900	From October to March	0-4	10:00	3	No	36° 51' 44,73"N 2° 0' 20,21"W	
ALMERIA	05	GTR	Trasmallo de jibia	Common cuttlefish	1000	From January to May	3-12	10:00	5	Yes	36° 51' 44,73"N 2° 0' 20,21"W	Cabo de Gata
		GTR	Trasmallo	Sea bream, sole, moray eel	800	From June to August	36-54	10:00	5	yes	36° 51' 44,73"N 2° 0' 20,21"W	
		GTR	Trasmallo de salmonete	Red mullet	2000	From June to September	10-40	10:00	5	Yes	36° 51' 44,73"N 2° 0' 20,21"W	
		FPO	Nasa	Octopus	200	From October to June	25-45	24:00	5	No	36° 51' 44,73"N 2° 0' 20,21"W	
		LNS	Moruna	soft roe, yellowtail		From May to June	0-10	24:00	2	No	36° 51' 44,73"N 2° 0' 20,21"W	
		NK	Palangre	Snapper, perch, fish sprout	700	From November to January	27 -44	10:00	5	no	36° 51' 44,73"N 2° 0' 20,21"W	
ALMERIA	06	GTR	Trasmallo de salmonete	Red mullet	2200	From June to September	10_52	9:00	6	yes	36° 51´ 10"N 2° 21´18"W	El Alquián
		GTR	Trasmallo de jibia	Common cuttlefish	1200	From January to May	4 _15	9:00	6	Yes	36° 51´ 10"N 2° 21´18"W	
		GTR	Trasmallo	Bream, bleak, bass	900	From October to December	10_52	9:00	6	Yes	36° 51´ 10"N 2° 21´18"W	
ALMERIA	07	GTR	Trasmallo de salmonete	Red mullet	2000	From July to September	7_45	7:00	7	yes	36° 50' 01"N 2° 28' 01"W	Almería
		FPO	nasa	Octopus	200	From October to June	10_30	24:00	7	No	36° 50' 01"N 2° 28' 01"W	
		NK	Palangre	Snapper	700	From October to January	40_120	7:00	12	no	36° 50' 01"N 2° 28' 01"W	
		GTR	Trasmallo de jibia	Common cuttlefish	1000	From November to May	2_15	7:00	10	Yes	36° 50' 01"N 2° 28' 01"W	

Table 3. Data from the port of Almería

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interation	Coordinates (fishing place)	Name (Fishing place)
ROQUETAS DE MAR	08	GTR	Trasmallo de salmonete	Red mullet	2000	Fron June to September	15 -20	10	18 20	Yes	36°45'51.08"N 02°36'53.1"W	Roquetas
		GTR	Trasmallo de jibia	Common cuttlefish	1000	From December to June	15-20	10	18-20	yes	36°45'51.08"N 02°36'53.1"W	Roquetas
		GTR	Trasmallo de jibia	Common cuttlefish	800	From December to June	15-20	10	18-20	yes	36°45'51.08"N 02°36'53.1"W	Roquetas

Table 4. Data from port of Roquetas de Mar

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interation	Coordinates (fishing place)	Name (Fishing place)
ADRA	09	GTR	Trasmallo de jibia	Common cuttlefish	1000	From November to May	2_13	8:00	2_22	Yes	36°44'53"N 3°01'52"W	Adra
		GTR	Trasmallo de salmonete	Red mullet	2000	From July to September	7 _30	8:00	2 _22	No	36°44'53"N 3°01'52"W	
		FPO	Nasa	Octopus	200	From October to June	8_27	24:00	8_27	No	36°44'53"N 3°01'52"W	
ADRA	10	GTR	Trasmallo de salmonete	Red mullet	2000	From July to September	7 _30	9:00	2 _22	yes	36°44'53"N 3°01'52"W	Adra
		GTR	Trasmallo de jibia	Common cuttlefish	1000	From November to May	5_22	9:00	5 _22	no	36°44'53"N 3°01'52"W	
		FPO	Nasa	Octopus	200	From October to June	8_27	24:00	6_22	no	36°44'53"N 3°01'52"W	

Table 5. Data from the port of Adrar

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
MOTRIL	11	GTR	Trasmallo de salmonete	Red mullet	1500	All year	9 -36	2:00	1,5-2	yes	36°41'34.8"N 3°28'04.8"W 36°43'36.1"N 3°41'25.3"W	Cabo de Sacratif -Almuñecar
		FPO	Nasa	Octopus						no		
MOTRIL	12	GTR	Trasmallo de salmonete	Red mullet	2000	July-September	9-42	2:00 or 3:00	6	yes	36°41'34.8"N 3°28'04.8"W 36°43'36.1"N 3°41'25.3"W	Cabo de Sacratif -Almuñecar
		FPO	Nasa	Octopus						no		

Table 6. Data from the port of Motril (Granada).

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
CALETA	13	HMD	Draga	Bivalves						no		
		GNS	Bonitera	Atlantic bonito	2000	September	surface	1:00	From the coast	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo - Cala del Moral
		GTR	Trasmallo de jibia	Common cuttlefish	2000	February-May	5	23:00	0-5	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo - Cala del Moral
		GTR	Trasmallo de salmonete	Red mullet	2000	June-August	5-100	1:00	0-5	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo - Cala del Moral
		GNS	Sardinal	Sardine	700	June-August	surface	4:00 or 5:00 nig	0-5	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo - Cala del Moral
CALETA	14	GTR	Trasmallo de jibia	Common cuttlefish	2000	January-June	6-20	8:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GTR	Trasmallo de salmonete	Red mullet	2000	June-August	5-20	1:00 or 2:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GNS	Sardinal	Sardine	300	December, July and August	0-18	1	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GNS	Solta	Atlantic bonito	1000	All year	8-10	1:00 or 2:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		FPO	Nasa	Octopus						no		
		HMD	Draga	Bivalves						no		
CALETA	15	GTR	Trasmallo de jibia	Common cuttlefish	2000	January-June	6-20	8:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GTR	Trasmallo de salmonete	Red mullet	2000	June-August	5-20	1:00 or 2:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GNS	Sardinal	Sardine	300	December, July and August	0-18	1:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GNS	Solta	Atlantic bonito	1000	All year	8-10	1:00 or2:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		FPO	Nasa	Octopus						no		
		HMD	Draga	Bivalves						no		
CALETA	16	GTR	Trasmallo de jibia	Common cuttlefish	2000	January-June	6-20	7:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GTR	Trasmallo de salmonete	Red mullet	2000	June-August	5-20	1:30 or 2:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		GNS	Sardinal	Sardine	300	December, July and August	0-18	1:00	0-5	yes	36°42'31.5"N 3°31'23.8"W 36°37'18.2"N 4°29'29.2"W	Motril- Torremolinos
		FPO	Nasa	Octopus						no		
		LHM	Linea de mano	Tuna						no		

Table 7. Data from the port of Caleta de Vélez (Málaga).

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
MÁLAGA	17	GTR	Trasmallo de salmonete	Red mullet	1000	July-September	22-28	3:00	1-13	yes	36°37'18.2"N 4°29'29.2"W 36°44'42.7"N 4°04'16.6"W	Torremolinos- Caleta de Velez
		GNS	Solta	Common pandora/S	200	July-August	26-33	7:00 or 8:00	1-13	yes	36°37'18.2"N 4°29'29.2"W 36°44'42.7"N 4°04'16.6"W	Torremolinos- Caleta de Velez
		GTR	Trasmallo de jibia	Common cuttlefish	1000	May-July	7	24:00:00	1-13	yes	36°37'18.2"N 4°29'29.2"W 36°44'42.7"N 4°04'16.6"W	Torremolinos- Caleta de Velez
		FPO	Nasa	Octopus						no		
		HMD	Draga	Bivalves						no		
MÁLAGA	18	HMD	Draga	Bivalves						no		
		FPO	Nasa	Octopus		October-July						
		GNS	Bonitera	Atlantic bonito	3000	September-November	surface	1:00	From the coast	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo- Cala del Moral
		GTR	Trasmallo de jibia	Common cuttlefish	3000	February-May	5	23:00	0-5	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo- Cala del Moral
		GTR	Trasmallo de salmonete	Red mullet	3000	June-August	5-100	1:00	0-5	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo- Cala del Moral
		GNS	Sardinal	Sardine	700	June-August	surface	4:00 or 5:00	0-5	yes	36°44'40.2"N 4°03'18.7"W 36°42'41.7"N 4°18'09.6"W	Algarrobo- Cala del Moral

Table 8. Data from the port of Málaga

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
FUENGIROLA	19	GTR	Trasmallo de salmonete	Red mullet	2000	July-October	25-30	3:00 or 4:00	4-5	yes	36°29'01.4"N 4°43'27.5"W 36°32'23.6"N 4°36'49.0"W	Calahonda -Fuengirola
		GTR	Trasmallo de jibia	Common cuttlefish	2000	Febrerary-July	4 -5	10:00 or 12:00	43955	yes	36°29'01.4"N 4°43'27.5"W 36°32'23.6"N 4°36'49.0"W	Calahonda -Fuengirola
FUENGIROLA	20	GTR	Trasmallo de salmonete	Red mullet	1000	July- September	12-36	2:00	1,5-2	yes	36°32'23.6"N 4°36'49.0"W 36°29'59.3"N 4°40'51.3"W	Fuengirola -Cala de Mijas
		FPO	Nasa	Octopus						no		
FUENGIROLA	21	GTR	Trasmallo de salmonete	Red mullet	2000	August-September	20	2:00	14-15	yes	36°42'22.9"N 4°24'31.5"W 36°30'15.9"N 4°52'54.6"W	Málaga- Marbella
		GTR	Trasmallo de jibia	Common cuttlefish	2000	March-August	6-7	24:00:00	14-15	yes	36°42'22.9"N 4°24'31.5"W 36°30'15.9"N 4°52'54.6"W	Málaga- Marbella

Table 9. Data from the port of Fuengirola (Málaga).

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
MARBELLA	22	GTR	Trasmallo de salmonete	Red mullet	600	June-August	18	3:00 or 4:00	1	yes	36°30'27.2"N 4°38'13.1"W 36°28'07.1"N 4°59'04.1"W	Faro de Calaburra- San Pedro
		GNS	Melvera	Bullet tuna	900	June-August	50-60	4:00 or 5:00	1	yes	36°30'27.2"N 4°38'13.1"W 36°28'07.1"N 4°59'04.1"W	Faro de Calaburra- San Pedro
		FPO	Nasa	Octopus						no		
		HMD	Draga	Bivalves						no		
MARBELLA	23	GTR	Trasmallo de salmonete	Red mullet	2000	July-September	9-55	1:00	1	yes	36°30'27.2"N 4°38'13.1"W 36°29'59.3"N 4°40'51.3"W	Faro de Calaburra- Cala de Mijas
		GTR	Trasmallo de jibia	Common cuttlefish	2500	January-March	5-7	12:00	1	yes	36°30'27.2"N 4°38'13.1"W 36°29'59.3"N 4°40'51.3"W	Faro de Calaburra- Cala de Mijas
		FPO	Nasa	Octopus						no		
		HMD	Draga	Bivalves						no		
MARBELLA	24	GTR	Trasmallo de salmonete	Red mullet	2000	July-September	9-55	1:00	1	yes	36°30'27.2"N 4°38'13.1"W 36°29'59.3"N 4°40'51.3"W	Faro de Calaburra- Cala de Mijas
		HMD	Draga	Bivalves						no		

Table 10. Data from the port of Marbella (Málaga).

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
ESTEPONA	25	GTR	Trasmallo de salmonete	Red mullet	2000	July- September	90-100	1:00 or 2:00		yes		
		FPO	Nasa	Octopus						no		
		HMD	Draga	Bivalves						no		

Table 11. Data from the port of Estepona (Málaga).

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
LA LINEA	26	GNS	Melvera	Bullet tuna	600	September	3-22	3:00 or 4:00	1,5	yes	36°09'54.7"N 5°20'04.2"W 36°22'02.8"N 5°13'21.2"W	La Línea- Sabinillas
		GNS	Volaera	Mediterranean flyingfish	600	July-September	3-20	3:00 or 5:00	1	yes	36°09'54.7"N 5°20'04.2"W 36°22'02.8"N 5°13'21.2"W	La Línea- Sabinillas
		GTR	Trasmallo de salmonete	Red mullet	1000	All year	7-40	3:00		no		
		FPO	Nasa	Octopus						no		
		HMD	Draga	Bivalves						no		
LA LINEA	27	GNS	Melvera	Bullet tuna	450	August-October	36-55	1:00 or 2:00	1	yes	36°10'49.7"N 5°19'44.9"W 36°16'26.8"N 5°16'49.7"W	Puerto pesquero de la Línea- Sotogrande
		GTR	Trasmallo de salmonete	Red mullet	1000	All year		1:00 or 2:00		no		
		HMD	Draga	Bivalves						no		
LA LÍNEA	28	GNS	Melvera	Bullet tuna	1000	September-October	3-500	7:00 or 8:00	0,2_15	yes	36°08'17.6"N 5°25'26.1"W 36°22'02.8"N 5°13'21.2"W	Algeciras- Sabinillas
		GTR	Trasmallo de salmonete	Red mulleT/Trachurus sp.	1000	All year	30-50	24:00:00	0,2_2	yes	36°08'17.6"N 5°25'26.1"W 36°22'02.8"N 5°13'21.2"W	Algeciras- Sabinillas
		GNS	Volaera	Mediterranean flyingfish	1000	August	3-500	7:00 or 8:00	0,2_15	yes	36°08'17.6"N 5°25'26.1"W 36°22'02.8"N 5°13'21.2"W	Algeciras- Sabinillas
		HMD	Draga	Bivalves						no		
LA LÍNEA	29	GTR	Trasmallo de salmonete	Red mullet	1000	All year		1:00		no		
		GNS	Melvera	Bullet tuna	650	August- October	0-20	1:00 or 4:00	4_5	yes	36°11'51.0"N 5°19'36.6"W 36°09'07.3"N 5°20'08.2"W	San Roque- Gibraltar
		GNS	Volaera	Mediterranean flyingfish	550	July-September	2-10	1:00 or 4:00	1	yes	36°11'51.0"N 5°19'36.6"W 36°09'07.3"N 5°20'08.2"W	San Roque- Gibraltar
		HMD	Draga	Bivalves						no		
		GTR	Trasmallo de jibia	Common cuttlefish	1000	Febrerary-April		24:00		no		

Table 12. Data from de port of La Línea de la Concepción (Cádiz).

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
ALGECIRAS	30	FPO	Nasa	Octopus						no	36°08'17.6"N 5°25'26.1"W 36°01'46.3"N 5°31'00.2"W	Bahía de Algeciras- Guadamesi
		GTR	Trasmallo de salmonete	Red mullet	1000	All year	3-70	0:30 or 1:30	1_1,5	no		
		GTR	Trasmallo	Common pandora/Greater forkbeard	1000	July-September	36-90	12:00	1_1,5	no		
		GNS	Enmalle	Red mullet/Blackspot seabream/Trachurus	1500	September-February	40	1:00	1_1,5	no		
ALGECIRAS	31	FPO	Nasa	Octopus						no	36°08'17.6"N 5°25'26.1"W	Bahía de Algeciras
		GNS	Enmalle	Red mullet	1700	All year	25-40	1:30	0,5	no		
		GTR	Trasmallo	Common sole/Common cuttlefish	2000	December-March	7	16:00	0,5	no		

Table 13. Data from the port of Algeciras (Cádiz).

Base Port	Vessel	Gears type	Gear name	Target species	Size (m)	Period	Depth (m)	Time of fishing	Distance (NM)	Interaction	Coordinartes (fishing place)	Name (Fishing place)
TARIFA	32	LLS	Voracera	Pagellus bogaraveo		All year	80-800	0:15	12_14	no		
		GTR	Trasmallo de salmonete	Red mullet	2500	All year	7-40	3:00	6_7	no		
		GNS	Red clara	Rubberlip grunt/Redbanded seabream	2500	All year	7-70	3:00	6_7	no		
TARIFA	33	LLS	Voracera	Pagellus bogaraveo		All year	80-800	0:15	12_14	no		
		GTR	Trasmallo de salmonete	Red mullet	2000	All year	7-40	2:00	6_7	no		
		GNS	Red clara	Rubberlip grunt/Redbanded seabream	2000	All year	7-70	2:00	6_7	no		

Table 14. Data from de port of Tarifa (Cádiz).

As observed in these tables, the fishing period at each port is very variable, even being the same fishing gear type, for example, the mullet trammel net, depending on the boat and port, they use it only during the summer months or all year round, similarly, the data obtained in the surveys in depth and distance are also very variable.

The fishing areas indicated in the tables (6-14) are per vessel, regardless of the time of year and the netting gear used. The fishing areas of the fleet in each port are traditional fishing grounds and do not usually overlap with those of other ports, except for some boats that have their base port Malaga and fish and landing the capture in Caleta de Velez. We do not include information about the fishing grounds of Estepona and Tarifa. In both cases they couldn't fish at the time of the inquiry due to the presence in their fishing grounds of the mentioned invasive algae. In addition, in Tarifa the fishermen indicated that they never have had problems with bottlenose dolphins.

The following Figure (26) shows the landing ports where damage by bottlenose dolphins has been reported during the project inquire, from the data collected in the tables above.

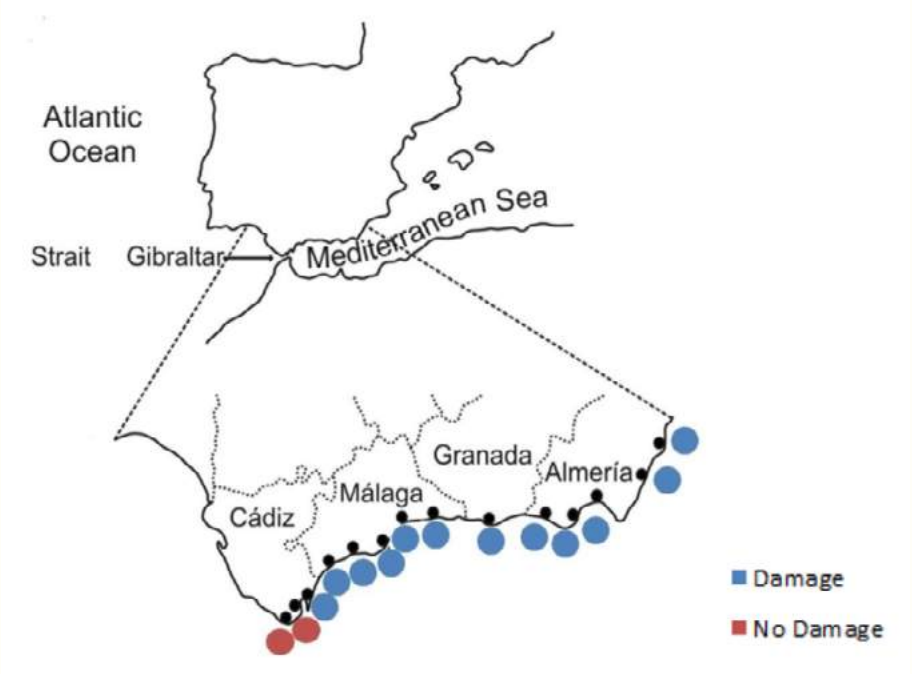


Figure 31. Small-scale fishery with negative interactions with bottlenose dolphins. From left to right: Tarifa, Algeciras, La Línea de la Concepción, Estepona, Marbella, Fuengirola, Málaga, Motril, Adra, Roquetas, Almería, Carboneras and Garrucha.

All the small-scale fishermen interviewed from the Andalusian Mediterranean area use gillnets. The next table (15) and figure (27) show the fishing gears affected by bottlenose dolphins, the most involved are "Trasmallo de salmonete=red mullet trammel net" (37%) and "Trasmallo de jibia=cuttlefish trammel net" (26%). The remaining thirty-seven percent of the fishing gears concerned are: "Trasmallo=trammel net" (for diverse species), "Melvera= bullet tuna set gillnet", "Sardinal= sardine set gillnet", "Solta= set gillnet" (for diverse species), "Volaera"or "Voladera= mediterranean flyingfish set gillnet", "Bonitera= Atlantic bonito set gillnet" and "Pijotera= albacore set gillnet".

Fishing code	Target species	Fishing gear local name	%
GTR	Red mullet	Trasmallo de salmonete	37
GTR	Common cuttlefish	Trasmallo de jibia	26
GNS	Bullet tuna	Melvera	8
GNS	Sardine	Sardinal	8
GTR	Common pandora, greater forkbeard, common sole, common cuttlefish, sea bream, sole, Moray eel.	Trasmallo	5
GNS	Atlantic bonito, Common pandora, Striped seabream	Solta	5
GNS	Mediterranean flyingfish	Volaera	5
GNS	Atlantic bonito	Bonitera	3
GNS	Albacore, prick	Pijotera	3

Table 15. Fishing gear affected by bottlenose dolphins according to directs enquires: Fishing gear code (GTR: Trammel nets; GNS: Set gillnets), Target species, Fishing gear local name and percentage per gear.

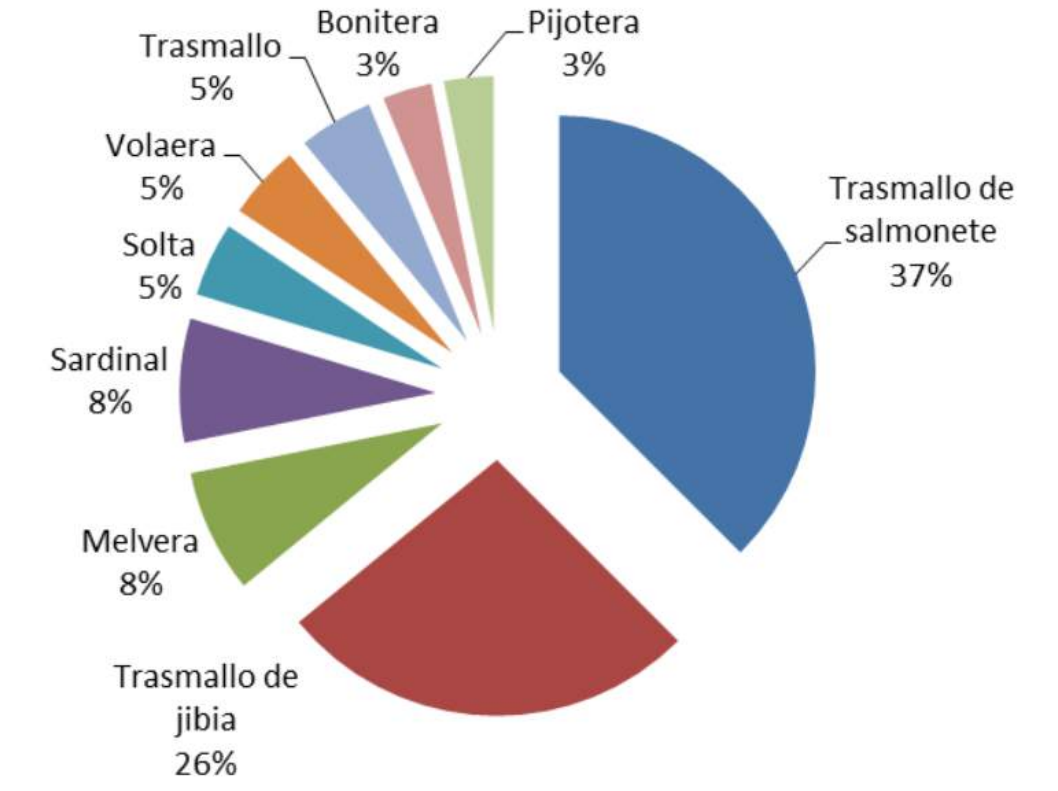


Figure 32. Fishing gear (nets) most affected by bottlenose dolphins in the Andalusian Mediterranean (according to the surveys). ("Trasmallo de salmonete=red mullet trammel net", "Trasmallo de jibia=cuttlefish trammel net", "Melvera= bullet tuna set gillnet", "Sardinal= sardine set gillnet", "Solta= set gillnet" (for diverse species), "Volaera"or "Voladera= mediterranean flyingfish set gillnet", "Bonitera= Atlantic bonito set gillnet" and "Pijotera= albacore set gillnet".

The figure below (Figure 33) represents the fishing gears affected at each port. The ports of Tarifa and Algeciras have not been included because the fishermen in these ports have not reported interactions in inquires. Generally, the trammel nets are the gears more damaged by the bottlenose dolphins, mainly "trasmallo de salmonete= red mullet trammel net" and then "trasmallo de jibia= cuttlefish trammel net". By contrast, in the port of the La Línea de la Concepción, the gears more affected are the set gillnets as the Melvera and the Volaera.

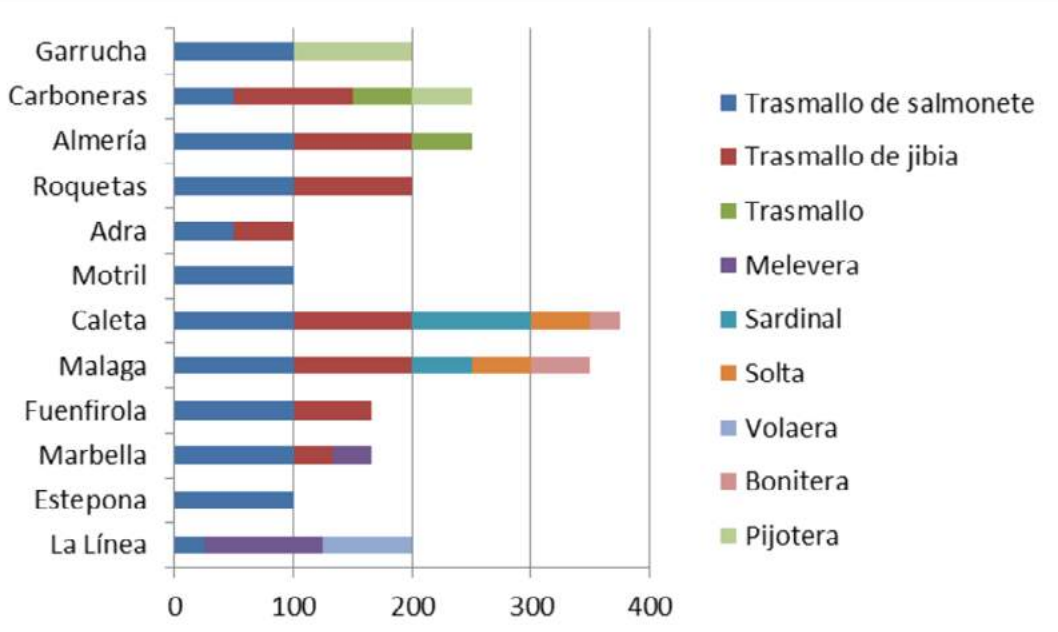


Figure 33. Fishing gears affected at each port in the Mediterranean small-scale fleet. ("Trasmallo de salmonete=red mullet trammel net", "Trasmallo de jibia=cuttlefish trammel net", "Melvera= bullet tuna set gillnet", "Sardinal= sardine set gillnet", "Solta= set gillnet" (for diverse species), "Volaera"or "Voladera= mediterranean flyingfish set gillnet", "Bonitera= Atlantic bonito set gillnet" and "Pijotera= albacore set gillnet".

4.3.3 - General perception from the fishers about the interaction with cetaceans

All respondents except in the ports of Tarifa and Algeciras, considered that the presence of the bottlenose dolphin has increased in the last 5 years. In the ports of Tarifa and Algeciras, they reported that the presence of this cetacean has remained stable and do not consider it as a problem, because they do not suffer negative interactions.

All those interviewed believe that the area of distribution of the bottlenose dolphin is homogeneous, being equally distributed throughout the fishing area, without finding any seasonal differences in its presence.

The increase in interactions is attributed by some of the fishermen interviewed to the increase in the population of tuna, a species that competes with dolphins for food and has made them look for other alternatives

None of the skippers are aware of any mitigation measures employed and do not apply any, because they do not know efficient solutions to this problem.

Most of them are interested in participating in pilot actions that could be developed in the future to reduce these interactions.

4.3.4 - Metier experienced in interaction with cetaceans

The data (Table 16) describes the gears most affected by bottlenose dolphins, it includes the name of the fishing gear, nets´ material, dimensions of the gear (length and height), number of pieces, fishing days (approximate days used per year), age of the net, its price and nets´ mesh size.

Fishing gear	Material	Length	Height	Number of pieces	Fishing days	Age	Price
Trasmallo de salmonete	Nylon	2002	1.6	41	61	1.2	5636
Trasmallo de jibia	Nylon	2433	1.45	48	73	1.8	6175
Melvera	Monofilament	720	2-55	10	40	1.4	2850
Volaera	Monofilament	717	2-11	12	40	2	2167

Table 16. Description of the main fishing gear affected by bottelnose dolphins (average data of the surveys). ("Trasmallo de salmonete=red mullet trammel net", "Trasmallo de jibia=cuttlefish trammel net", "Melvera= bullet tuna set gillnet" and "Volaera or Voladera= mediterranean flyingfish set gillnet")

4.3.5 - Bycatch and interactions

In the surveys conducted, fishermen reported no bycatch events for any species (dolphin, whale, shark, turtle, bird and other), they consider bycatch is not a problem for their fishery (100%).

The following table (Table 17) summarise the responses to the surveys regarding the interactions (positive, indifferent and negative) of dolphins with the different gillnets fishing gears, as well as the percentage of the events of these interactions during the fishing maneuvers.

Interaction	Interactions		% of interactions in fishing operations	Type of interaction
Positive	YES	6%	50%	
	NO	94%		
Indifferent	YES	82%	53%	
	NO	18%		
Negative	YES	88%	46%	Reduction of the captures: 100% of events/76% reduction in catches
				Total loss of the captures: 34% of events
				Damaged net: 100% of events/67% of the gear concerned
	NO	12%		

Table 17. Interactions´report and average percentage of interactions in the fishing operations with gillnets.

Positive interactions were mostly associated with common dolphins (*Delphinus delphis*) and striped dolphin (*Stenella coeruleoalba*), the fishermen did not differentiate these two species and they identified them as small dolphins. The 94% (31 respondents) of the fishermen considered that they did not have positive interactions; however, the 6% (2 respondents) claimed to have it. They explained that small dolphins lead the target species into the nets. The two vessels that reported to have positive interactions belong to the Linea de la Conception (home port) fishing with set gillnets. One of the boats fished with Melvera and the other vessel fished with Melvera and Volaera, for these vessels positive interactions occur on average in 50% of the fishing operations.

Most fishermen (82%) reported seeing small dolphins during fishing manoeuvres. These encounters are considered as **indifferent interactions** and happen to them on average in 53% of the fishing manoeuvres, this percentage being the same with the different net fishing gears used. In all cases the fishermen answer that this type of interaction occurred with small dolphins. The remaining 18 % answer that they did not have indifferent interactions with dolphins, these data correspond to the base ports of La Línea de la Concepción (2 vessels), Málaga (1), Estepona (1) and Almería (2).

The 12% of the respondents said they did not have **negative interactions** with dolphins, these answers correspond to the ports of Tarifa and Algeciras. However, in this last port they

acknowledged that bottlenose dolphins may be problematic for other gears, as purse seiners targeting sardine. The remaining 88% (29 respondents) reported having negative interactions with bottlenose dolphins.

Among the fishermen who had reported negative interactions, they considered that this occurred on average in 46% of the fishing manoeuvres. During such interactions, the fishermen suffer damage/loss of catch (depredation and scattering of fish), in the 100% of each negative event. The fishing equipment is also damaged by bottlenose dolphins, this cetacean breaks the fishing gear when it takes out the captured fish, making holes in the nets in 100% of the negative events. The percentage of the fishing gear damaged can be 76% in average. The fishermen were not able to specify in most cases the exact size and number of holes caused by bottlenose dolphins, since according to the answers, there is an enormous variability in each event. The holes can be, from: small (0-30 cm), medium (31-80 cm), big (81-120 cm), very big (>120cm). Regarding the reduction of catch by the interactions, it represents an average of 76% per negative event, moreover the 34% of the fishermen claimed to suffer complete losses of catches when the interaction occurs.

Figure 34. Damage (holes) caused to nets by bottlenose dolphins.

Figure 35. Damage (very big holes) caused to nets by bottlenose dolphins

Regarding the economic losses, the fishermen reported a mean of 582 € (SD=341) per one event of negative interaction; the cost was estimated considering both gear damage and catch loss. The total cost declared by the fishermen of a failed fishing trip (considering the elements above and also indirect costs such as the number of operators paid, fuel consumed, missing catch, etc.) is 871€ (SD= 1130).

Within the group of fishermen who reported negative interactions, considered damage to catch and gear caused by cetacean, they considered that in all cases these damages were caused by bottlenose dolphin (100%).

The fishers reported that in occasions some interactions and damage could be due to other animals (13.8%). These are the european conger (*Conger conger*) that they can identify because it makes holes and tangles, different from bottlenose dolphins that only make holes. Swordfish (*Xiphias gladius*) and bluefin tuna (*Thunnus thynnus*) also cause damage, it can be identified because is possible to observe them directly. Cormorants can also damage nets by making small holes in the net when they steal the catch. Fishermen can see this seabird, a situation that only happens in January, according to the affected fisherman.

4.4 - An emerging problem in the Alboran Sea affecting the artisanal fisheries that overlap with dolphin interaction: the invasive seaweed Rugulopteryx okamura

In 2015, the exotic seaweed *Rugulopteryx okamura* was detected for the first time in Ceuta, south of the Gibraltar Strait area, probably transported in ballast waters by a ship from Asian origin (Rosas Guerrero et al., 2018). Since then it has shown a surprising growth and dispersion almost completely displacing the local biota and producing important negative effects on the local fishermen. This invasive brown seaweed affects, also, the community of native fish. Recently, some fishermen of the harbour of Tarifa and Algeciras (Spain) have claimed the fall of their catches by the abundant presence of this seaweed in the fishing area. The seaweed affects also the tourism in the area because hundreds of tons of the alga appear along the beaches in tourism period: lately it was mentioned the effects of the alga on the underwater system used by the desalination plant in Marbella.

Rugulopteryx okamurae (Dictyotales, Ochrophyta), is a common *Phaeophyceae* in the temperate areas of the Northwest Pacific (e.g., Philippines, Taiwan, China, Korea, and Japan – see Huang, 1994) but it ranges from tropical areas of the Gulf of California (In: García-Gómez et al., 2020). In the Mediterranean, this exotic seaweed that has been recorded since 2002 in France, where it was accidentally introduced in

the Thau lagoon through seed importation of Japanese oyster (*Crassostrea gigas*). In 2016, (Altamirano et al., 2016; Ocaña et al. 2016) confirmed presence, since July 2016, of abundant biomass of a new species of exotic macro algae on the beaches of Ceuta (Noth Africa) and Tarifa (south Spain) in the strait of Gibraltar. The morphological and anatomical identification of the samples revealed the presence of *Rugulopteryx okamurae*. This is the first reference of this species in the Atlantic and in Spain, and the second for the Mediterranean Sea. In 2017 an alert about this invasive seaweed was published in Quercus (Altamirano et al., 2017). Also in August 2017 this seaweed was observed in the south of Alboran, first in the Moroccan part of Gibraltar Strait and extending along the Moroccan Mediterranean coast in 2018 (El AAmri et al., 2018; García-Gómez et al., 2018).

On December 20th, 2019, the Sub-Directorate General for Biodiversity and Natural Environment received the proposal for cataloguing Rugulopteryx as an invasive species, which includes the risk analysis prepared by the University of Malaga (Ideal of Granada, 10012020).

At present, masses of the species have already been found in the provinces of Huelva, Cádiz, Málaga, Granada and Almería. Algae biomass accumulations are having an important economic impact on the fishing sector in the affected areas, as fishing gear collapses and catches are reduced (Altamirano et al., 2019). Floating debris and 100% colonization of the rocky underwater bottom between 0 and 45 meters deep make fishing gear useless.

García-Gomez et al, (2020) described the possible linking with global warming "*the bloom of R. okamurae exhibited an initial geographical expansion (2015–2017) to the northern coastal area of the Strait of Gibraltar (Tarifa-Gibraltar) and subsequent extension in the south of the Iberian Peninsula, towards the Atlantic coast (2018) and the Mediterranean coast (2019).*

This bloom could have been associated with the temperature peak in July 2015 and was thus possibly linked to global warming".

Results from the surveys to artisanal vessel skippers in Málaga province (Ports: Estepona, Marbella, Fuengirola, Málaga, Caleta de Vélez).

Observations of this seaweed and interferences with local fisheries in the northern Alboran Sea, the project area in Spain, have been referenced from 2016 onward in scientific journals and from 2019 in the local press. In both types of sources were underlined the problems caused to the fisheries because the continuous expansion of the species from the Strait of Gibraltar and Atlantic localities along the northern Alboran coast until areas situated in Almeria, the easternmost of the Alboran Sea.

During our surveys of the fishing ports we observed:

In **Estepona** we interviewed a boat owner (only 1-2 boats, San Bernabe and Mis Niños, were fishing out sporadically, according to the skippers interviewed. Before the appearance of the seaweed there were 10-12 boats fishing with trammel nets). They have been affected by the algae for years (In 2015 it was detected in Ceuta. Possibly it appeared in Estepona at the end of 2016 / beginning of 2017). The fishermen also mentioned problems to work with traps targeting fishes and octopus because, from the beginning of 2019, the parts of the seaweed removed by the storms along the sea bottom clogging the pots and reducing the captures. The distribution of *Rugulopteryx* extends affecting the fishing vessel activities from the coast to around 300 m depth. Previously, if they suffered negative interactions with bottlenose dolphins, but currently it is a secondary problem, since they cannot work, and are suffering great losses because they cannot fish with nets.

In **Marbella**, we conducted 3 surveys, but we found that there were fewer boats fishing as a result of the effects of the algae. The three artisanal vessels enquired referred the presence of the seaweed in the fishing area from the eastern fishing ground to the eastern finding the algae close to Fuengirola. Moreover, they explained that most of the vessels

were not fishing nowadays as a consequence of the important presence of the exotic seaweed and the reduced captures of target species. Also, they came back to the base ports with their nets (trammel nets) clogging, arriving from the sea with practically no captures and not income. Two of the three enquired vessel decided not to fish more with these gears and wait to the use of alternative ones (hooks).

Cádiz province (Ports: Tarifa, Algeciras, La Linea)

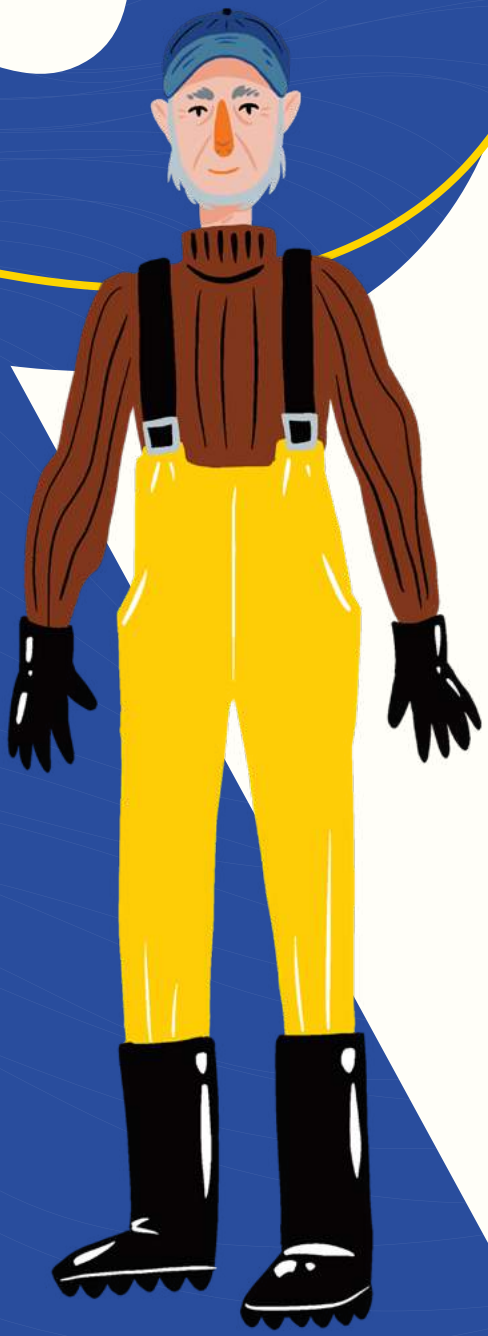
Tarifa: They do not go fishing due to the presence of the algae; only 1 boat does it sporadically. They do not consider that they have negative interactions with cetaceans.

Algeciras: They say there are NO negative interactions with cetaceans. Problems with the algae.

La Línea de la Concepción: Yes, they have negative interactions with bottlenose dolphins; Fishing is restricted to certain areas to avoid algae.

CHAPTER 05

Conclusions and Recomendations



INTERACTION BETWEEN CETACEANS AND SMALL-SCALE FISHERIES IN THE MEDITERRANEAN

Study Area 3:
The Case of Northern Alboran Sea
Andalucia, Spain

5.1 - Main conclusions

By examining the results of the interviews, it is clear that bottlenose dolphins are present in western Mediterranean all year round and increased its presence in the last 5 years. By examining the results of the interviews, it is clear that bottlenose dolphins are present in western Mediterranean all year round and increased its presence in the last 5 years. Their abundance could be affected by global climate change, as recent analytical models have shown in the case of common dolphins (Lambert et al. 2011; Cañadas & Vázquez, 2017)

The data derived from our interview surveys indicate that cetacean interactions with gillnet small-scale fishery are frequent in the Andalusian Mediterranean Sea.

Bottlenose dolphin was the main species associated with depredation on catch because of this fact, fishermen in the affected areas perceive these animals as competitors.

The negative interactions with bottlenose dolphins have been reported in twelve of the fourteen study ports. This is probably due because dolphins find probably an easier way to feed because the source is concentrated in the gillnet and provide them an alternative foraging method. Although dolphins benefit from taking fish entangled in gillnets, this method of feeding could increase the bycatch risk (Díaz, 2006). However, all the fishermen interviewed (100%) answer that they had never had an event of this kind.

The increase in interactions is attributed by some of the fishermen interviewed to the increase in the population of tuna, a species that competes with dolphins for food and has made them look for other alternatives.

Two ports, Tarifa and Algeciras, situated in the western part of the study area declare not having interactions, although the presence of bottlenose dolphin in this area and their density is important. From the interviews we haven't obtained information of what could be the behaviour of dolphins, the reasons behind this, nor what could be the fishing strategy used in these two ports to avoid interactions.

We found that the probability of observing cetacean interactions was significatively related to the home-based port of the fleets in function to a W-E gradient.

The fishing area of the SSF fleet based in both Tarifa and Algeciras ports coincide with the area most affected by the invasive algae *Rugulopteryx okamura*, so we cannot know exactly if they are prioritizing this problem, as they expressed great concern about it having seen their activity reduced.

Currently it is not possible to accurately quantify the economic impact of bottlenose dolphins on the gillnet fishery. The average total cost reported by fishermen of 871€ (SD= 1130) per one event of negative interaction.

The 88% of fishermen report negative interactions, representing the 46% of fishing days with gillnet damage. These losses could have a relatively large impact on a fisher's livelihood.

5.2 - Recommendations

Recommendations are based on the analysis of the results obtained in the forms completed following the methodology of the project, with the persons interviewed at the docks and landing ports, mainly carried out to the skippers of the artisanal vessels.

The main recommendation at this stage is that from our results, it is not clear the causes of the increasing interactions in the area, if it is the effect of an increase in the number of bottlenose dolphins in the study area or because the learning effect in the families of this species increase the efficacy in their attacks/interactions with SS fishing gears.

Stablish a mean value of losses by fishermen or gear nor the total by year or fishing port was possible. Data on the first sell values for the main target species by port, the total sell by vessel and year, fishing days with related sell of the captures at the landing ports and other official data should be available to a more in deep analysis. For that reasons we suggest to extend the study to such other information sources and to extend the study to other fisheries in the same ports, mainly the small pelagic purse seine, in order to contrast the information and results obtained with the artisanal fleet, since both fleets are affected by the same interactions with dolphins and so appropriate mitigation measures for the two fleets can be developed.

Possible actions to be taken after the completion of the first phase of the project are:

1) Consultation the catches in the official auction sheets

Small-scale fishing is characterised, inter alia, by the alternating use of fishing gears based primarily on the abundance of target species and the market price. The use of gears affected by interactions with dolphins included in this study depends of some other factors such as the closure of the bivalve mollusc fishing grounds by natural biotoxins. During such period the fleet target other species, such as octopus, which they prefer because of their higher price. Octopus fishery with pots is active in the area even when the fishing grounds for shellfish are open (no toxins). With the information obtained from our surveys it is not possible to know precisely the alternation of fishing gears due to official closures or even used each day, and therefore neither the fishing effort and real revenues and losses.

From the consultation of the auction sheets and subsequent analysis of the landings and prices computed in the sheets, it would be possible to know the gear really used by the fleets and the fishing effort at each period of the year (traps, nets, longlines and trawls or dredges). Also, that consultation could help to obtain precise information on the substitution of gears along the year and the distribution of the fishing grounds of the artisanal local fleet according to the fishing

gear really used and then allocate interactions to specific fishing grounds. In such approach we could focus on fishing with gillnets, to determine the number of daily fishing time units (mareas) carried out at each fishing port of the Andalusian Mediterranean coast and therefore, determine the effort by vessel and daily sales prices of each species, and consequently, be able to estimate the economic losses produced by bottlenose dolphins.

Another alternative to get the information about catches and fishing effort is the consultation of the data obtained from fishing statistics prepared in IDAPES (the Andalusian Fisheries Statistics System). It is based on fishing sales and production data of the Directorate General of Fisheries and Aquaculture of the Regional Government of Andalusia, which manages records of first sales at auctions, recording daily catches landed per species and vessel.

2) Consultation of Green boxes ("Cajas Verdes") information

Great advantage could be taken by consulting the green boxes of the boats, the number of boats that are operating could be known, identify the fishing grounds of the small-scale fleet, the fishing effort (fishing days) and their distribution, both by area and by month.

The "Green boxes" are the Andalusian Fishing Vessel Monitoring System (Sistema de Localización y Seguimiento de Embarcaciones Pesqueras Andaluzas: SLSEPA), it is used for tracking and monitoring fishing vessels under 15 m in length. It is a GPS-based vessel tracking system used by the Administration of the Autonomous Community of Andalusia to monitor the activities of the Andalusian fishing fleet. This system allows the collection of information on Vessel identification,

geographical position, course, speed and date and time of the maneuver. This system is regulated by the decree 64/2012, of 13th of March (Consejería de Agricultura y pesca), which also regulates the days and hours of shellfish and professional fishing activities.

In addition, if an application is developed for fishermen to voluntarily report negative interactions with bottlenose dolphins, this data collected could be linked to that from sales sheets and green boxes, which would provide great accuracy on the equipment used, target species, depth and time of year.

3) Direct observations onboard

Direct observations by experts onboard of the small-scale artisanal fleet may be a good procedure for observing the interactions of bottlenose dolphins with this fishery and it is a tool used by many fisheries within the EU. It would allow to contrast the information collected in the surveys and also to obtain more accurate data about the negative impacts of dolphins on gear, catch as well as fisher's revenue losses.

Observers onboard will make possible to obtain data to relate the cetaceans' interactions with the different fishing gears, their attitudes on fishing manoeuvers, target species, and various characteristics of the manoeuvres such as the soaking time of the net, depths and distance to the coast/port, differences relation with the schedules, time of year, etc. In addition, observations on board would allow to have better information about the catches composition, being able to have a control over the species caught and not only those landed/declared in the fish market, we could also know the size distribution of the species caught and relate it to the interactions and to accurate the losses. Moreover, additional environmental and fishing information could be collected.

In order to learn about the overlapping of dolphins distribution and the fishing grounds, on-board observation allow also to realize dolphin watching to assessing their abundance and fidelity to the fishing areas, and to improve knowledge on groups dynamic and reproduction, site fidelity, and movement patterns.

Onboard observer's implementation would require the development of a sampling plan for all ports in Andalucía, including those ports that have not reported interactions, in order to corroborate this information and understand its causes. Regarding the ports where there are interactions with bottlenose dolphins, observers should focus on the main fishing gears and fishing periods affected in each port. These observations should be made at different time periods of the year, to analyse the seasonal variability of the interactions and to be able to observe different fishing gears, which as we have verified in the case of some of them, their use is reduced to specific times of the year.

4) Great participation of the fishing sector

Participatory meetings with stakeholders (fishers, fishing associations, administrations, scientists, etc.) to present the goals and results at the end of the project. These meetings would promote the integrating knowledge among fishermen and scientists for better management. The preparation of easy to understand products (leaflets, triptychs, banners, etc.) could led to approach the situation to all fishermen at the ports and not only to those affected (SSF).

5) Acoustic deterrents and cameras

If fishermen agree to do it, experiments could be carried out using different acoustic deterrents in Andalucía, although bottlenose dolphins may react to pingers, their reaction may not always be repellence, they may habituate rapidly (e.g. see results a field experiment with harbour porpoises; Cox et al. 2001) (Reeves et al., 2001).

Other useful tools, could be to put cameras on nets to verify the cetacean species that cause damage to gear, the kind of fishing damage of the nets, how many fish are removed or damaged, in order to direct research and mitigation measures on a more species- and gear-specific basis (Goetz et al., 2014).

6) Evaluation of emerging problems

Evaluate how the presence of the invasive algae (Rugulopteryx okamurae) affects the artisanal fleet under study is a real problem to approach and follow up since a large part of the vessels (gillnets) are not currently working due to this presence, causing the algae great economic losses and probably changes in the gears to be used and in consequence, the interactions with dolphins could reduce. This algae is mainly present on the coast of Cadiz and Malaga, although recently it has also been found in Granada and mentioned in Almeria coasts.

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Annexes

Annex I: Summary table of the closures established by the Consejería de Agricultura, ganadería, pesca y desarrollo sostenible (2020), by fishing modality and species.

Annex II: Questionnaire

Annex III: Sampling protocol

Annex IV: Results Logistic Regression

Annex I: Summary table of the closures established by the Consejería de Agricultura, ganadería, pesca y desarrollo sostenible (2020), by fishing modality and species.

VEDAS PESQUERÍAS POR ESPECIES
REGLAMENTO (UE) nº 1343/2011 del Parlamento Europeo y del Consejo de 13 de diciembre de 2011 sobre determinadas disposiciones aplicables a la pesca en la zona del Acuerdo CGPM (Comisión General de Pesca del Mediterráneo)
REGLAMENTO (UE) 2016/1627 del Parlamento Europeo y del Consejo, de 14 de septiembre de 2016, por el que se establece un plan de recuperación plurianual para el atún rojo del Atlántico oriental y el Mediterráneo.
REGLAMENTO (UE) 2017/2107 del Parlamento Europeo y del Consejo de 15 de noviembre de 2017 por el que se establecen medidas de gestión, conservación y control aplicables en la zona del Convenio de la Comisión Internacional para la Conservación del Atún Atlántico (CICAA)
REGLAMENTO (UE) 2019/124 del Consejo de 30 de enero de 2019 por el que se establecen, para 2019, las posibilidades de pesca para determinadas poblaciones y grupos de poblaciones de peces, aplicables en aguas de la Unión y, en el caso de los buques pesqueros de la Unión, en determinadas aguas no pertenecientes a la Unión
REAL DECRETO 139/2011, de 4 de febrero, para el desarrollo del Listado de Especies Silvestres en Régimen de Protección Especial y del Catálogo Español de Especies Amenazadas.
REAL DECRETO 48/2019, de 8 de febrero, por el que se regula la pesquería de atún rojo en el Atlántico Oriental y el Mediterráneo.
ORDEN ARM/2689/2009, de 28 de septiembre, por la que se prohibe la captura de tiburones zorro (familia *Alopiidae*) y tiburones martillo o comudas (familia *Sphyrnidae*).
ORDEN AAA/75/2012, de 12 de enero, por la que se incluyen distintas especies en el Listado de Especies Silvestres en Régimen de Protección Especial para su adaptación al Anexo II del Protocolo sobre zonas especialmente protegidas y la diversidad biológica en el Mediterráneo.
ORDEN AAA/1589/2012, de 17 de julio, por la que se regula la pesquería del voraz (*Pagellus bogaraveo*) con el arte de la voracera en el Estrecho de Gibraltar.
ORDEN AAA/658/2014, de 22 de abril, por la que se regula la pesca con el arte de palangre de superficie para la captura de especies altamente migratorias.
ORDEN AAA/1771/2015, de 31 de agosto, por la que se modifica el anexo del Real Decreto 139/2011, de 4 de febrero, para el desarrollo del Listado de Especies Silvestres en Régimen de Protección Especial y del Catálogo Español de Especies Amenazadas.
ORDEN AAA/1408/2016, de 18 de agosto, por la que se establece un Plan de gestión para los buques de los censos del Caladero Nacional del Golfo de Cádiz.
ORDEN de 19 de febrero de 2016, por la que se regulan los artes de trampa para la captura de pulpo (*Octopus vulgaris*) en el litoral mediterráneo de Andalucía y se crea el censo de embarcaciones autorizadas para dicha modalidad.
ORDEN de 24 de febrero de 2016, por la que se establecen medidas para la conservación del pulpo (*Octopus vulgaris*) en las aguas interiores del litoral mediterráneo de Andalucía.
ORDEN de 25 de abril de 2017, por la que se regula la captura de pulpo (*Octopus vulgaris*) con artes específicos en el caladero nacional del Golfo de Cádiz y se crea el Censo de embarcaciones autorizadas para dicha actividad.
RESOLUCIÓN de 20 de junio de 1988, de la Dirección General de Pesca, por la que se establece una veda indefinida para la pesca del *Aphia minuta* (chanquete) y similares.
RESOLUCIÓN de 10 de septiembre de 2010, de la Dirección General de Pesca y Acuicultura, por la que se establece una veda para la pesca de pulpo (*Octopus vulgaris*), en las aguas interiores del Golfo de Cádiz, y un horario de entrada y salida de puerto para la flota de artes menores dedicada a esta pesquería.
VEDAS PESQUERÍAS POR MODALIDAD
REGLAMENTO (CE) nº 1967/2006, del Consejo, de 21 de diciembre de 2006, relativos a las medidas de gestión para la explotación sostenible de los recursos pesqueros en el mar Mediterráneo.
REAL DECRETO 1440/1999, de 19 de septiembre, por el que se regula el ejercicio de la pesca con con artes de arrastre de fondo en el caladero nacional del Mediterráneo.
ORDEN ARM/2529/2011, de 21 de septiembre, por la que se regula la pesca con artes de cerco en el caladero Mediterráneo.
ORDEN AAA/1408/2016, de 18 de agosto, por la que se establece un Plan de gestión para los buques de los censos del Caladero Nacional del Golfo de Cádiz.
ORDEN APA/8/2020, de 14 de enero, por la que se regulan las paradas temporales para la modalidad de arrastre de fondo y cerco en determinadas zonas del litoral mediterráneo para el periodo 2020-2021.
ORDEN de 5 de junio de 2006, por la que se establecen los fondos mínimos para el ejercicio de la actividad pesquera de arrastre de fondo cerco y en las aguas interiores del litoral Mediterráneo de Andalucía.
VEDAS MARISQUEO ATLÁNTICO
ORDEN de 22 de febrero de 2018, por la que por la que se establecen las tallas mínimas de captura y épocas de veda para los moluscos bivalvos y gasterópodos de la Comunidad Autónoma de Andalucía.
ORDEN de 24 de abril de 2003, por la que se regula la pesca del Erizo y la Anémona de Mar en el Litoral Andaluz.
RESOLUCIÓN de 18 de marzo de 2019, de la Dirección General de Pesca y Acuicultura, por la que se modifica la época de veda para la captura de coquina de fango (*Scrobicularia plana*) en la Comunidad Autónoma de Andalucía.
VEDAS MARISQUEO MEDITERRÁNEO
ORDEN de 22 de febrero de 2018, por la que por la que se establecen las tallas mínimas de captura y épocas de veda para los moluscos bivalvos y gasterópodos de la Comunidad Autónoma de Andalucía.
ORDEN de 24 de abril de 2003, por la que se regula la pesca del Erizo y la Anémona de Mar en el Litoral Andaluz.

Single general module

Technical characteristics

Ext. Marking _____ , Name of the vessel _____ *(optional)*

or Port _____ , GT tonnage ___ , LOA ___ , Main Power ___ , Year of construction _____

Licenses *(gear type acronym)* _____

Segment _____ , Permission _____

WHAT FISHING GEARS (**METIERS**) DO YOU USE ALONG THE YEAR:

Put an "X" on the number of the metier with which you have had any interaction with cetaceans

N.	Name of the gear, mesh size	Target species	Period (months)	Depth	Time of fishing	Distance from the base port
1						
2						
3						
4						
5						

In the last 5 years, interference with cetaceans or any other vulnerable species is

☐ increased ☐ the same ☐ decreased Specify what other species

_____

Does any fishing area you use more subject of interference? ☐ No ☐ Yes

If Yes, specify

_____

Do you know solutions implemented in other fisheries to reduce the interactions?

_____

_

Personal suggested solutions

_____

_____

Are you able to implement in your own vessel some interactions reducer devices and/or alternative fishing gears if a pilot project could be applied in your area/port of activity?

☐ No ☐ Yes ☐ Maybe ☐ Why

_____

Notes and other opinions

_____

_____

_

_____

_

_____

_

_____

_

Would you like to participate in a permanent voluntary on-line survey for fishers to report SSF-Cetaceans interactions and cost-damages incurred during your fishing trips?

If yes, give our preferential contacts

_____

INDICATE THE AREAS SUBJECTED TO NEGATIVE INTERACTION DURING THE SEASONS

Winter	Spring
Repeat 4 times a map of the investigated area in your country. *Preferable with indication of the North, the scale used and the bathymetries.*	
Summer	Autumn

Metier N.___ Gear type _____ Common names _____

Material _____ Mesh size _____ Length _____ Height _____ Age _____

Number of pieces or hooks _____ Size _____ Quantity of other parts _____

When using lures, specify if ☐ artificial baits or ☐ natural (species) _____

Number of days using this gear in one year ____ , Number of times using this gear in one day ____

Bottom _____ , Price of a complete new gear €

Kg of catch per day: Minimum ____ Maximum _____ Average value of the catch €/kg _____

Number of bycatch events per species in one year ☐ dolphin ___ ☐ whale ___ ☐ shark ____ ☐ turtle ____ ☐ bird ____ ☐ _____

Incidence of **positive or cooperative interaction** with cetaceans _____ */100 times*

Type _____
Incidence of **indifferent presence** of cetaceans _____ */100 times*

Incidence of **negative interaction** (damage for fishermen) _____ */100 times*

Types of **damage** ☐ depredation on catch → If yes, specify if leaving:

(per one event) ☐ bite marks ☐ fish head in the gear ☐ *other signs*
☐ scattering prey
☐ lures depredated → If yes, specify _____

☐ holes → If yes, specify size and number: ☐ small (0-30 cm) ____ ☐ medium (31-80 cm) ____
☐ big (81-120 cm) _____ ☐ very big (>120cm) _____

Losses incurred: ☐ reducing catch How much _____ *%*
(per one event) ☐ complete loss of the catch

Costs incurred per one event of negative interaction (€ or time):
Medium percentage of the fishing gear damaged _____ % Fishing days not worked _____
Number of people working in for fixing up the gear _____ Number of days in which they are involved to repair _____ Material used _____

Price of the piece to substitute (€ per piece) _____

Price of the other parts to substitute _____

Total cost of a failed fishing trip (*considering n. of operators, fuel consumed, missing catch etc.)*

_____

Number of pieces necessary to eliminate after one event of interactions _____

During one year, are you sure that all the damages have been caused only by cetaceans?

☐ No ☐ Yes ☐ Other suggestion? _____

How many times animals different to cetacean damage your fishing gear? ____ */100*

How do you recognise differences? _____

If responsible are cetaceans, what species? (name and %) _____

Generally, how many individuals of cetacean interact with the same gear? _____

Do you usually continue to fish with a damaged gear? ☐ No ☐ Yes If yes, how many times? ____

In the case above, describe the entity of the damage of the fishing gear _____

Amount of reducing catch using a damaged fishing gear _____ *%*

Mitigation measures employed ☐ No ☐ Yes What → Results

_____

What and how many parts do you lose in one year? _____

Return at the first page if you have any other comment to do.

INTERACTION BETWEEN CETACEANS AND SMALL-SCALE FISHERIES IN THE MEDITERRANEAN SEA

A PROTOCOL TO STRATIFY THE SAMPLE OF FISHERMEN FOR PRELIMINARY FACE TO FACE INTERVIEWS

1. **List** of the active vessels with regular licenses operating in the investigated area, consulting the local or the European **fishing fleet register**.
2. **Extrapolation** of the vessels belonging to **small-scale** fisheries operating in coastal waters.
3. **Calculate** the **10%** of the total number of the vessels resulting from the previous steps.
4. **Divide** the result for the **total number of harbours** in the study area which are far from the nearest one more than 10 km. The **result is the average number** of fishing units to be interviewed **in each harbour**/fleet. (In case of two harbours far from the nearest one less than 10 km, consider only the biggest one for the count).
5. **Check** the presence of fishing units registered in a harbour and operating near another one. Considerate these cases as belonged to the second harbour/fleet.
6. For each harbour/fleet at the point n. 4, **list the number of licences** for each fishing gear.
7. Consider for the sample one fishing unit for each type of gear in each harbour. If this selection gives a smaller number than the result at the point n. 4, add new fishing units starting repeating the category most representative and then the others, giving priority to vessels using the same fishing gear but in different areas or times.

   If this selection give a bigger number than the result at the point n. 4, reduce the number of units having the same fishing gears in nearby fleets or, lacking of these, eliminate fishermen that are not full-time/year-round involved.
8. Going in the field, **verify the status** of the vessels included in the registers. In case of differences, update the initial total number and recalculate the sample starting from the step 1.
9. **Add up** all the fishing boats resulting from the point n. 7.
10. If the result at the point n. 9 is lower than the expected 10% at the point n. 3, add one or more fishing units for each little harbour not yet considered, choosing possible peculiar cases or, lacking of these, the most subjected to depredation events.

If the result at the point n. 9 is greater than the expected 10% at the point n. 3, eliminate one or more fishing units that are not full-time/year-round involved.

- The final sample should be 10%±3 of the total fleet active in the investigated area.

- Fishing unit: fisherman with his vessel.

- Fishermen interviewed will give information on their main fishing gear and also on the others he uses. In this way, the technical polyvalence will acquire the right value.

- No data will be collected on fishing gears for which a fisherman has a license but he doesn't use it.

Categorical Variables Codings

		Frequency	Parameter coding														
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Puerto2	ADRA	2	1,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	ALGECIRA	2	,000	1,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	ALMERIA	3	,000	,000	1,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	ALMERÍA	1	,000	,000	,000	1,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	CALETA D	4	,000	,000	,000	,000	1,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	CARBONER	2	,000	,000	,000	,000	,000	1,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	ESTEPONA	1	,000	,000	,000	,000	,000	,000	1,000	,000	,000	,000	,000	,000	,000	,000	,000
	FUENGIRO	3	,000	,000	,000	,000	,000	,000	,000	1,000	,000	,000	,000	,000	,000	,000	,000
	GARRUCHA	1	,000	,000	,000	,000	,000	,000	,000	,000	1,000	,000	,000	,000	,000	,000	,000
	LA LINEA	2	,000	,000	,000	,000	,000	,000	,000	,000	,000	1,000	,000	,000	,000	,000	,000
	LA LÍNEA	2	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	1,000	,000	,000	,000	,000
	MÁLAGA	2	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	1,000	,000	,000	,000
	MARBELLA	3	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	1,000	,000	,000
	MOTRIL	2	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	1,000	,000
	ROQUETAS	1	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	1,000
	TARIFA	2	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
Gear2	GNS	6	1,000														
	GTR	27	,000														

Block 1: Method = Forward Stepwise (Conditional)

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	25,299	15	,046
	Block	25,299	15	,046
	Model	25,299	15	,046

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	2,773[a]	,535	,935

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	,000	1	1,000

Contingency Table for Hosmer and Lemeshow Test

		Diana2 = ,00		Diana2 = 1,00		
		Observed	Expected	Observed	Expected	Total
Step 1	1	4	4,000	0	,000	4
	2	1	1,000	1	1,000	2
	3	0	,000	27	27,000	27

Classification Table[a]

			Predicted		
			Diana2		
	Observed		,00	1,00	Percentage Correct
Step 1	Diana2	,00	4	1	80,0
		1,00	0	28	100,0
	Overall Percentage				97,0

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Puerto2			,000	15	1,000	
	Puerto2(1)	42,406	40192,966	,000	1	,999	2,610E18
	Puerto2(2)	,000	40192,966	,000	1	1,000	1,000
	Puerto2(3)	42,406	36690,990	,000	1	,999	2,610E18
	Puerto2(4)	42,406	49226,131	,000	1	,999	2,610E18
	Puerto2(5)	42,406	34808,129	,000	1	,999	2,610E18
	Puerto2(6)	42,406	40192,966	,000	1	,999	2,610E18
	Puerto2(7)	42,406	49226,131	,000	1	,999	2,610E18
	Puerto2(8)	42,406	36690,990	,000	1	,999	2,610E18
	Puerto2(9)	42,406	49226,131	,000	1	,999	2,610E18
	Puerto2(10)	42,406	40192,966	,000	1	,999	2,610E18
	Puerto2(11)	21,203	28420,716	,000	1	,999	1,615E9
	Puerto2(12)	42,406	40192,966	,000	1	,999	2,610E18
	Puerto2(13)	42,406	36690,990	,000	1	,999	2,610E18
	Puerto2(14)	42,406	40192,966	,000	1	,999	2,610E18
	Puerto2(15)	42,406	49226,131	,000	1	,999	2,610E18
	Constant	-21,203	28420,716	,000	1	,999	,000

a. Variable(s) entered on step 1: Puerto2.


LOW IMPACT
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EUROPE


MAVA
FONDATION POUR LA NATURE


AHE