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Conservation of marine mammals

Assessing the threat of bycatch in Antalya Bay, Turkey




Johanna Bergman

Arbetsgruppen för Tropisk Ekologi
Committee of Tropical Ecology
Uppsala University, Sweden

Minor Field Study 209
ISSN 1653-5634

June 2018 Uppsala

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Supervisors:
Dr. Cecilia Anderung, Department of Ecology and Genetics, Animal Ecology, Uppsala University, Sweden.
Dr. Christina Geijer, Department of Zoology, Stockholm University, Sweden.
Dr. Aylin Akkaya, Marine Mammals Research Association, Turkey.

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Acronyms and abbreviations

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
BARCON	Barcelona Convention
BERN	Bern Convention
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CPCs	Cooperating non-contracting parties
DMAD	Deniz Memelileri Araştırma Derneği, a marine mammal research association operating along the Turkish Mediterranean coast
EC	European Community
EEZ	Exclusive Economic Zone
EPZ	Ecological Protection Zone
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FPZ	Fishing Protection Zone
GFCM	General Fisheries Commission for the Mediterranean
ICES	International Council for the Exploration of the Sea
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
MAP	Mediterranean Action Plan
MCPA	Marine and Coastal Protected Area
MPA	Marine Protected Area
NOAA	National Oceanic and Atmospheric Administration Fisheries
psu	Practical salinity unit
SAC	Special Area of Conservation
SEPA	Special Environmental Protected Area
SPA	Specially Protected Area
SPAMI	Specially Protected Area of Mediterranean Importance

TED	Turtle Excluder Device
The Code	Code of Conduct for Responsible Fisheries
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environmental Programme

Abstract

The Mediterranean Sea has a high and unique marine biodiversity, with critical habitats for endangered marine species. Interactions between marine mammals and commercial fisheries have occurred for centuries and the interactions do not seem to decline. Bycatch, i.e. the unwanted or incidental catch of species other than the target species, is a severe problem in conservation biology and a potential threat for the future survival of marine mammal populations. The available data based on documented numbers of marine mammal bycatch seldom reflect the true numbers of caught marine mammals since they are often underestimated and negatively biased. Also, biological studies are limited in the Eastern Mediterranean, and especially in Antalya Bay. This is the first study to assess the impact of bycatch on marine mammal populations and to address existing knowledge gaps in the bay. Interviews with local fishermen were conducted with the aim to gather data on (i) fishing activity in Antalya Bay, (ii) interactions between fishermen and marine mammals, (iii) incidental captures of marine mammals and (iv) fishermen's awareness and opinions on current legislations regulating the commercial fisheries and marine conservation. This study identified a conflict between fishermen and marine mammals in Antalya Bay. Results show that marine mammal bycatch is occurring in all kinds of fishing gear, but it is still unclear to which extent. Sea turtles were remarkably the most common bycatch in the bay, a bycatch reported by 95% of the fishermen. This study reveals that the Turkish bycatch reporting system is inadequate and needs to be improved in order to get more reliable data. The marine governance need to be improved in the area as well as education of both fishermen and regulation units. Cooperation between Turkey and adjacent states are required to create a stronger protection for marine species and reduce the numbers of bycatch in the Eastern Mediterranean Sea.

Keywords: Bycatch, Antalya Bay, marine mammals, commercial fisheries, conservation

1. Introduction

1.1. Marine mammals in the Mediterranean and in Antalya Bay

The Mediterranean Sea is considered to be a hotspot for marine diversity (Costello *et al.* 2010, Casale 2011). Nevertheless, there is a general paucity of information regarding the distribution patterns and species population abundance of marine mammals in the Eastern Mediterranean and especially within Antalya Bay. In an effort to understand the distribution of marine mammals in the Eastern Mediterranean and Antalya Bay, their occurrence can be divided into three groups: (i) *regular* or *native species* that are known to reproduce in the Eastern Mediterranean and/or encountered year-round on annual basis, (ii) *visitor species* that do not reproduce within the area but occurs regularly in the region and (iii) *vagrant species* that are only found occasionally within the area (Kerem *et al.* 2012). In total, there are 12 marine mammal species that are regularly present and three species that are consider to be visitors in the whole Mediterranean Sea. Most of the cetacean species that are reported being regular habitants in the Mediterranean are also regular sighted in the eastern part of the sea and have been recorded in Antalya Bay (Table 1).

Since 1983, cetacean species are protected by law in Turkey and dolphin hunting is prohibited (Öztürk 1996). However, distribution and abundance studies are inadequate in Turkish waters and in the Levantine Basin. Estimates of population size for cetaceans are limited and this is a general problem in Mediterranean basin. Few species have a known population trend but most of them have been red listed by the International Union for Conservation of Nature (IUCN) and are regarded as species of conservation importance. The threatened common bottlenose dolphin (*Tursiops truncatus*) together with the vulnerable loggerhead turtle (*Caretta caretta*) can be seen as flagship species and both of these species are present in Antalya Bay (Abdulla *et al.* 2008). Another important marine mammal is the Mediterranean monk seal (*Monachus monachus*). It is one of the most endangered marine mammals in the world with an estimated population of only 350-450 animals of which about 100 are found in Turkish waters. The Turkish Mediterranean coastline, where Antalya Bay is included, is estimated to inhabit 37 monk seals (Güçlüsoy *et al.* 2004, Aguilar & Lowry 2013). The population trend is decreasing and threats like entanglement in fishing gear, depletion of fish population and habitat loss have become more severe since the 1980s (Güçlüsoy *et al.* 2004). Today, fishing nets are made of a stronger material (e.g. nylon threads) which make it nearly impossible for the seals to disentangle themselves from the gear, especially for juvenile seals (Güçlüsoy *et al.* 2004). Entanglement in fishing gear is a world spread problem among marine mammals and is one example of bycatch that will be discussed in the next section.

Table 1. A summary and status of regular, visitor and vagrant marine mammal species within the whole Mediterranean Sea and Levantine Basin (LB) and native species in Turkey (including Antalya Bay). Population size is given as estimated numbers of individuals in the whole Mediterranean Sea. DD = data deficient, LC = least concern, ND = no data or not determined as being native, NT = near threatened, VU = vulnerable, EN = endangered.

Species	Scientific name	Pop. Size[a]	Mediterranean	LB	Turkey[b]	IUCN status	Citation
Common bottlenose dolphin	*Tursiops truncatus*	10 000	Regular	Regular	Native	LC[c]	(Hammond *et al.* 2012b, Kerem *et al.* 2012)
False killer whale	*Pseudorca crassidens*	ND	Visitor	Visitor	Visitor	DD[c]	(Taylor *et al.* 2008c, Kerem *et al.* 2012)
Killer whale	*Orcinus orca*	>30	Regular/Visitor	Vagrant	ND	DD[c]	(Kerem *et al.* 2012, Taylor *et al.* 2013)
Long-finned pilot whale	*Globicephala melas*	>270	Regular	Absent	Possibly visitor	DD[c]	(Taylor *et al.* 2008a, Kerem *et al.* 2012)
Risso's dolphin	*Grampus griseus*	ND	Regular	Regular	Native	LC[c]	(Kerem *et al.* 2012, Taylor *et al.* 2012)
Rough-toothed dolphin	*Steno bredanensis*	ND	Regular	Regular	Native	LC[c]	(Hammond *et al.* 2012a, Kerem *et al.* 2012)
Short-beaked common dolphin	*Delphinus delphis*	95 000	Regular	Regular	Native	LC[c]	(Hammond *et al.* 2008a, Kerem *et al.* 2012)
Striped dolphin	*Stenella coeruleoalba*	>200 000	Regular	Regular	Native	LC[c]	(Hammond *et al.* 2008c, Kerem *et al.* 2012)
Curvier's beaked whale	*Ziphius cavirostris*	ND	Regular	Regular	Native	LC[c]	(Taylor *et al.* 2008d, Kerem *et al.* 2012)
Fin whale	*Balaenoptera physalus*	>5000	Regular	Visitor	Native	EN[c]	(Kerem *et al.* 2012, Reilly *et al.* 2013)
Humpback whale	*Megaptera novaeangliae*	ND	Visitor	Vagrant	ND	LC (increasing)	(Reilly *et al.* 2008b, Kerem *et al.* 2012)
Minke whale	*Balaenoptera acutorostrata*	ND	Visitor	Visitor	ND	LC (stable)	(Reilly *et al.* 2008a, Kerem *et al.* 2012)
Sperm whale	*Physeter macrocephalus*	>1000	Regular	Visitor	Native	VU[c]	(Taylor *et al.* 2008b, Kerem *et al.* 2012)
Harbour porpoise	*Phocoena phocoena*	ND	Regular	ND	Native	LC[c]	(Hammond *et al.* 2008b)
Mediterranean monk seal	*Monachus monachus*	350-450	Regular	ND	Native	CR (decreasing)	(Kerem *et al.* 2012, Aguilar *et al.* 2013)

[a] Estimated population size is received from Notarbartolo di Sciara & Birkun 2010, except for the monk seal (Aguilar & Lowry 2013).
[b] Report by ACCOBAMS and IUCN status have been used to determine if a species is native or not in Turkey.
[c] Population trend is unknown

1.2. Definition of bycatch and how bycatch occurs

The effect of marine mammals bycaught in fishing gear is a severe problem in conservation biology all over the world (Silvani *et al.* 1999). There are many definitions of bycatch (Clucas 1997), and usually the term ”bycatch” only concerns fish and “the fish that are harvested but are not sold or kept for personal use” (Magnuson-Stevens Fishery Conservation and Management Act 2007). Since this definition does not include marine mammals, sea birds or other resources, the National Oceanic and Atmospheric Administration (NOAA) Fisheries have put the word into a broader perspective and are using the following definition for bycatch: “discarded catch of any living marine resource, plus unobserved mortality due to a direct encounter with fishing gear” (NOAA Fisheries 2015). The International Council for the Exploration of the Sea (ICES) is using an even more simplified definition: ”the incidental capture of non-target organisms”. For the purposes of the present thesis, the latter definition will be used and focused specifically on the bycatch of marine mammals and marine megafauna.

Interactions between marine mammals and commercial fisheries have occurred for centuries and these interactions seems to increase in both frequency and intensity (DeMaster *et al.* 2001). This increasing trend is mainly due to human population growth, industrialization of fisheries and their expansion into new areas. The escalating demand of marine protein by human may result in a depletion of fish stocks (Read *et al.* 2006). This in turn could lead to an intensification and displacement of fishing effort and therefore the likelihood of interactions with marine mammals will increase.

The unintentional capture, the bycatch, during fishing operations has become a major issue in fisheries management and marine megafauna conservation globally during the last two decades (Alverson *et al.* 1994, Kelleher 2005). In some areas, marine mammals are captured in fishing gear unintentionally but retained for consumption or sale (Read *et al.* 2006). However, on most occasions the bycatch of marine mammals are truly unwanted and discarded after being caught (Mangel *et al.* 2010). Whilst the exact extent of bycatch is uncertain, it is believed to be the single greatest threat to already threatened marine populations in the future (Read *et al.* 2006, Read 2008). Cetaceans are particularly vulnerable since they have a long life span, late maturation and low reproductive rate which limit the capacity to recover from decline in the population (Mannocci *et al.* 2012, Geijer & Read 2013).

Major knowledge gaps concerning bycatch exist both in industrialized and developing nations and bycatch is in general regarded as one of several issues that challenge fisheries sustainable development. This is a problem in the Mediterranean where the total number of marine mammal bycatch is uncertain and in Antalya Bay still unknown. The available data and actual documented numbers of bycatch seldom reflect the true numbers of caught marine mammals since they are often underestimated and negatively biased (Soykan *et al.* 2008). The bycatch reporting system may lack consistency among the information collected from fishermen and since legal issues might be involved, unwillingness of reporting bycatch exists. True reporting of marine mammal bycatch can cause negative consequences (e.g. fines) for the fishermen, since most of the marine mammals are legally protected and such bycatch is directly forbidden (Moore *et al.* 2010). Sometimes the only available information on bycatch relies on anecdotal reports or logbook accounts, which give skewed estimates that do not reflect the true magnitude of marine mammal bycatch. Today there are only a few countries that have an effective bycatch reporting system of any marine species (Read *et al.* 2006), but Turkey is not one of them.

1.3. Fishing gear: impact and regulations

There are many kinds of fishing gear that are used either directly from the fishing boat, such as trawl, purse seine and long line, or passively by floating or being anchored at the sea bottom like gillnets (Figure 1).

Gillnets are vertical nets which can be placed either by the surface, in mid-water or on the bottom (Figure 1a). Gillnets can be very selective in targeting specific species or the size of the fish depending on the placement in the water column (pelagic or demersal species) and the mesh size of the net (FAO 2001b). Pelagic gillnets are referred to as *driftnets* when the net is just floating without being attached to the bottom or the boat. In the open seas, these nets can be joined together and creating a "net curtain" up to 50 km long in the water column where whales and dolphins can easily get entangled. These types of nets have had major incidental captures in the past, and are still responsible for major incidental catches and entanglements of endangered species such as sea turtles and marine mammals in the Mediterranean and worldwide (FAO 2001b). Driftnets exceeding 2.5 km have therefore been banned by the United Nations since 1991, the European Union (EU) since 1992 and by the General Fisheries Commission for the Mediterranean (GFCM) under a binding resolution since 1997. In 2002, the EU introduced a total ban on driftnet fishing on larger pelagic species and since 2006 the nets are also banned in Turkey (Akyol *et al.* 2012). Notwithstanding, driftnets are still used illegally in several parts of the Mediterranean and cause incidental death of cetaceans every year (Silvani *et al.* 1999, Pace *et al.* 2008, Cornax & Pardo 2009, Bearzi *et al.* 2011).

A ***trawl*** is a cone-shaped net, often with two lateral wings that extend the opening of the net (Figure 1b). The trawl can be towed in the mid-water or along the sea bottom by one or two boats, and are targeting pelagic, bottom and demersal species. Bottom trawling is known for creating a harmful impact on the sea bottom and mid-water trawls can cause incidental catches of marine mammals such as common dolphin (*Delphinus delphis*) and common bottlenose dolphin (*Tursiops truncates*) (Morizur *et al.* 1999, FAO 2001a, 2001d, 2001f).

Purse seine consists of a large net wall that is pulled out from the fishing boat in a circle and catches the fish by surrounding them from both sides and from underneath (Figure 1c). This is one of the most effective gears to catch aggregated pelagic fish species since the fish cannot escape by diving downwards. Purse seine and mid-water trawls are, compared to bottom trawls and gillnets, generally characterized by low bycatch and discards rates since they have clear target species; small pelagic fish (Tsagarakis *et al.* 2012) However, purse seine is still responsible for incidental capture of dolphins worldwide, especially in tuna purse seine nets (FAO 2001e).

Longlines are designed with one or many hooks attached in a certain way along a line (Figure 1d). The line can either be attached and hauled out from the boat, be set as bottom, mid-water or surface line, or drifting. The fish is attracted with or without natural or artificial bait placed on a hook at the end of a line. Longlines can be used in a very wide range of depths, either pelagic or demersal and are targeting both pelagic, demersal and benthic species (FAO 2001c). This type of gear is associated with a high number of incidental catch of sea turtles (Lewison *et al.* 2004, Deflorio *et al.* 2005, Báez *et al.* 2007, Casale *et al.* 2007, Casale 2011).

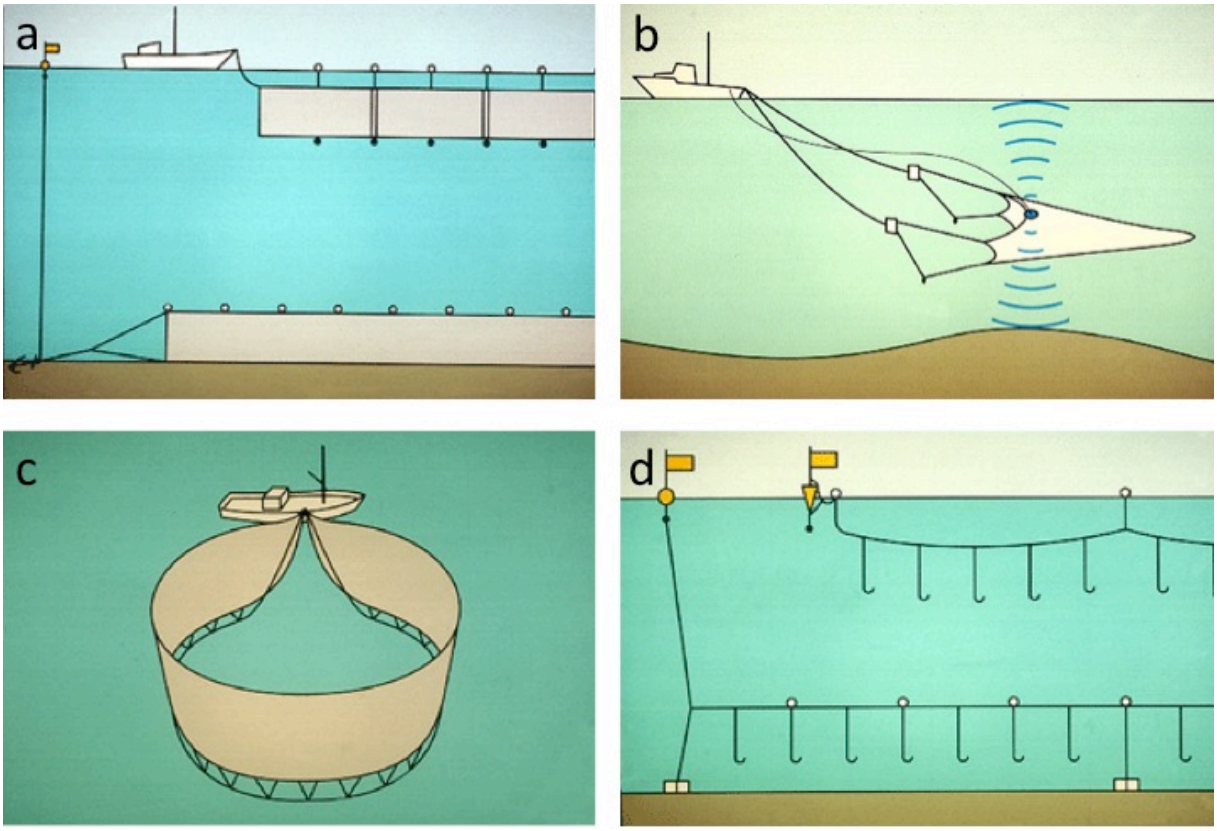

Figure 1. Example of fishing gear used in the Mediterranean Sea: (a) gillnets anchored at the bottom or drifting from boat, (b) mid-water trawl, (c) purse seine net, and (d) set bottom and surface longlines. Sources: FAO 2001b, 2001c, 2001d, 2001e.

1.4. Fishing industry in the Mediterranean Sea

In order to get an overview of the fishing industry in the Mediterranean Sea, the fisheries operating in the Mediterranean Sea can be divided into three categories: (i) trawling that include bottom and pelagic trawling performed by semi-industrial or industrial vessels, (ii) seining; mainly purse-seiners operating either day or night-time depending on the target species, and (iii) small-scale fisheries that integrate coastal and artisanal fisheries (Papaconstantinou & Farrugio 2000). All the different categories can be operating on demersal, small pelagic and large pelagic resources.

The small-scale fisheries consist of smaller vessels (up to 12 m), which tends to use a variety different kinds of fishing gears, such as longlines and gillnets, switching between them during one trip (Johnson 2005, Tsagarakis *et al.* 2014). Artisanal or traditional fisheries are often used to define fishermen with low capital investments and small-scale fisheries with low levels of technology (Johnson 2005). Although the small-scale fisheries produce more than half of the world's annual marine fish catch and employs 50 of the world's 51 million fishers (Berkes *et al.* 2001), the information of the structure and functioning of this type of fishery is limited on both national and regional level (Carvalho *et al.* 2011). The fishing fleet in the Eastern Mediterranean is dominated by small-scale and medium size vessels that are exploiting inshore grounds, except in Turkey where larger trawlers and purse-seines dominate the fisheries (Papaconstantinou & Farrugio 2000). However, fishing activity is still strongly associated with cultural traditions in Turkey, for example fishing swordfish with gillnets (Akyol *et al.* 2012).

Industrial fisheries have larger technological vessels, more crewmembers and operate further offshore, normally around the continental shelf where fish are more abundant. However, they

are only representing around five percent of vessels fishing on the continental shelf (Berkes *et al.* 2001, Smith 2005).

Seining vessels and smaller trawlers are somewhere in between small-scale fisheries and industrial fisheries, with larger boats than small-scale fisheries but are not operating further offshore as industrial fisheries. Purse seine and mid-water trawls are together with bottom trawls and gillnets responsible for the majority of landings in the whole Mediterranean basin. Bottom trawling is prohibited two nautical miles (NM) off the coast all year around in the Antalya Bay, and during the "closed" fishing period 15 April-25 September the prohibition is extended to 12 NM where the Turkish territorial waters ends (Özbek *et al.* 2013).

1.5. Bycatch in the Mediterranean and in Antalya Bay

Globally gillnets have shown to have the highest bycatch, with over 200 000 cetaceans bycaught each year (Read *et al.* 2006, Pace *et al.* 2008, Cornax & Pardo 2009, Bearzi *et al.* 2011, Brown *et al.* 2013, Geijer & Read 2013). In the Mediterranean Sea, bycatch and driftnets are the major threats against marine mammals (Figure 2, IUCN 2012). The total bycatch of all marine species in the Mediterranean Sea have been estimated to around 18-21% of the total catch, in some cases the discard rates were found to exceeded 50% of the total catch (Davies *et al.* 2009, Tsagarakis *et al.* 2014). As most of the knowledge on cetacean bycatch in the Mediterranean Sea is based on historical data, there are no figures on the extent of annual marine mammal mortality due to entanglement in fishing gear (GFCM 2008). There is also a skewed balance of data within the basin, where data from the north-western part is more extensive whilst there are considerable knowledge gaps in the Eastern Mediterranean, including Turkey. The only available data on cetacean bycatch in the Levantine Basin were presented by Kerem *et al.* (2012), where gillnets had the highest bycatch rate including incidental catches of striped dolphin (*Stenella coeruleoalba*), rough-tooted dolphin (*Steno bredanensis*) and sperm whale (*Physeter macrocephalus*).

As a contrast, there is more available information for the bycatch by Turkish fisheries in the Black Sea. More than 200-300 common bottlenose dolphins per year are believed to be accidently caught in fishing nets, especially when bottom set-gillnets are used (Öztürk *et al.* 1999). Even if the total number of cetacean bycatch in Antalya Bay and in the rest of the Mediterranean Sea is still unknown, it seems like all fisheries affect all species present in the regions at different degrees (GFCM 2008).

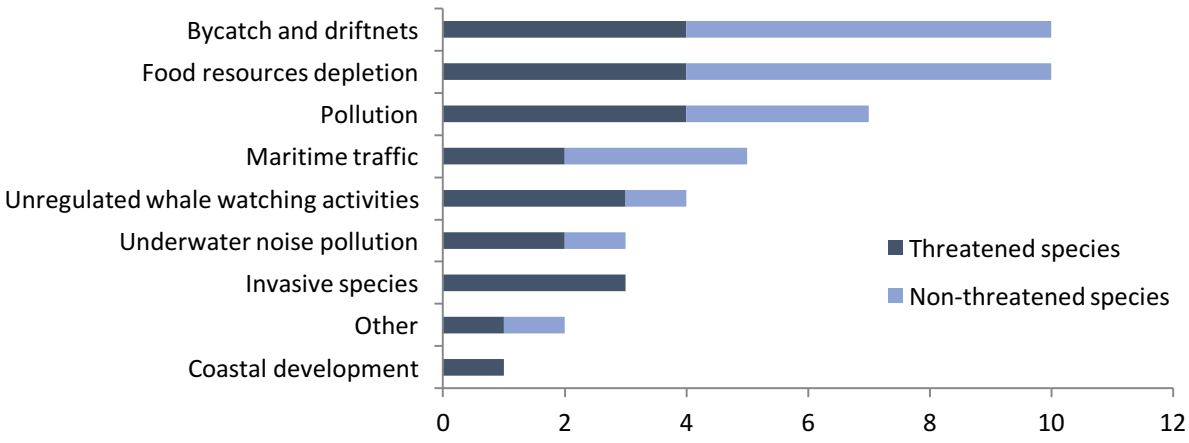

Figure 2. The major threats to resident marine mammals of the Mediterranean and Black Seas. Picture modified from IUCN 2012.

One of the most prominent species that is bycaught in most of the different fisheries (regardless if pelagic purse seine, driftnet or trawls are used) is the common dolphin (Hammond *et al.* 2008a). This is in part due to that common dolphin have a shared feeding ecology with the target species of the fisheries, like large migratory fish species such as tuna (CMS 2015a). Even the largest cetacean in the Mediterranean, the fin whale (*Balaenoptera physalis*), is occasionally bycaught in fishing gear (Reilly *et al.* 2013). Gillnets have previously been and are the largest threat for sperm whales (*Physeter macrocephalus*) in the Mediterranean Sea (Tudela *et al.* 2003, Reeves & Notarbartolo di Sciara 2006), but longline gear can also be a severe problem. Sperm whales among other toothed cetaceans species have a tendency to depredate (take fish from gear) of longlines and this interaction can result in entanglement and subsequent death for the whales. This phenomenon have been recorded to occur in many regions worldwide such as Alaska, Chile, and the North Atlantic (Donoghue *et al.* 2002, Taylor *et al.* 2008c). The reason for depredation is uncertain, but a possible explanation could be that there is an increased ecological competition and spatial overlaps with fisheries as the case with common dolphin. Another theory is that toothed cetaceans, as opportunistic predators, are quick to find "new" food resources in their environment and have started to associate the sound from the hauling with food. Depredation could also be a consequence of an increase of abundance or change in distribution patterns of some cetacean species (Donoghue *et al.* 2002). Regardless the reasons, depredation lead to loss of catch that has both economic and environmental consequences. As already mentioned, the major concern regarding cetaceans is that depredation lead to modification of natural behaviour and incidental death of cetaceans. Beyond that, fisheries loose their income due to loss of catch and their gear might get damaged or destroyed due to the interactions with cetaceans. Since the losses due to depredation is seldom accounted in the processes of assessing fish stocks and setting quotas, this can also lead to increased fishing effort and a larger take out of natural resources from the sea (Donoghue *et al.* 2002). This will in turn lead to an even higher ecological competition between fisheries and cetaceans.

Besides bycatch of marine mammals, the incidental catch of sea turtles has raised a great concern worldwide, and is a severe problem in the Mediterranean with over 132 000 captures and 44 000 incidental deaths per year. More than 12 900 sea turtles are estimated to be bycaught annually in Turkish fisheries (Casale 2011). The longlines fisheries have specifically been identified as the most severe threat against the sea turtle populations in the Mediterranean (Lutcavage *et al.* 1997, Lewison *et al.* 2004, Deflorio *et al.* 2005, Báez *et al.* 2007, Casale *et al.* 2007, Piovano *et al.* 2009, Casale 2011). Today there are three sea turtle species present in the Mediterranean Sea, which are listed as vulnerable or endangered by the IUCN; green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*) and loggerhead turtle (*Caretta caretta*) (Casale & Margaritoulis 2010). Even though Turkey host one of the most important nesting areas in the Mediterranean Sea for green and loggerhead turtle (Deflorio *et al.* 2005, Casale *et al.* 2007, Casale & Margaritoulis 2010, Casale 2011), detailed studies about abundance and bycatch are still lacking including the area in Antalya Bay.

1.6. Regulations and conventions concerning bycatch globally, in the Mediterranean Sea and Turkey

The conservation mechanisms to protect cetaceans generally concern national, regional and international policy frameworks and agreements (Brown *et al.* 2015). These could be industry-specific regulations that restrict human activities such as the fishing industry but generally the regulations concern habitat and/or species protections. Since the middle of the 20th century, there have been protection plans for the global oceans and the Mediterranean Sea (Table 2), whereof Turkey have joined half of them.

1.6.1. International conventions and organisations

The high number of countries within the Mediterranean basin makes it difficult to standardize different fishing gear, fishery statistics system and share data set (Casale 2011). The Eastern Mediterranean is a complicated area for management due to geopolitical complexity in delineating and establishing Exclusive Economic Zones (EEZ). EEZ is an area beyond the territorial sea, up to 200 NM outside the baseline (the mean low water mark) (UNCLOS Article 57, 1982; FAO 1987). The absence of EEZs allows international fishing activities to occur close to the coast of the nations, often overlapping with preferred cetacean habitats (Geijer & Jones 2015). Turkey has not yet established their EEZ.

The *International Whaling Commission* (IWC) was one of the first organisations for marine mammal conservation. It is a global organisation working towards conservation of whales and management of whaling. One mission of IWC is to bring together leaders of established national disentanglement programs and thereafter share the knowledge further. The legal framework of the convention was formulated in 1946 and has currently 88 members, but Turkey is not one of them (IWC 2015).

More organisations and conventions were initiated after IWC. *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) started in 1973, this is an international agreement and treaty with aim to ensure that wild animals and plants are not threatened to extinction due to international trade. CITES is legally binding to the contracting parties but is more considered to be a framework since it does not take the place of national laws. Cetaceans and sea turtles are examples of species that are protected by CITES from over-exploitation (CITES 2015b). Turkey joined the treaty in 1996.

In 1982 one of the most important conventions, the *United Nations Convention on the Law of the Sea* (UNCLOS), was launched to: "regulate all aspects of the resources of the sea and uses of the ocean" (UNCLOS 2015). According to the convention, all the contracting parties should collaborate and cooperate with the aim to conserve marine mammals, and in the case of cetaceans the conservation management should be led by appropriate international organizations (UNCLOS Article 65, 1982). The integration of EEZ was an important development by UNCLOS in 1982 (UNCLOS Article 57, 1982; FAO 1987). The aim with implementing EEZ was to provide a new framework for better management of marine resources and thereby create a more sustainable fishery (FAO 1995). Put simple, the coastal state has sovereign rights for conserving, exploring and utilizing natural resources within the EEZ, to which other states need to comply (UNCLOS Article 58, 1982). These laws and regulations shall be consistent with the convention (UNCLOS Article 62 1982). However, Turkey's lack of defined EEZ and not having signed UNCLOS allows international fishing activities to occur closer to the Turkish coast of other nations and there are no current convention regulating bycatch.

The Convention on the Conservation of European Wildlife and Natural Habitats, which is more known as the *Bern Convention*, came in force 1982. It aims to protect and conserve wild plant and animal species including their natural habitats and regulate the exploitation of these species. With Turkey included the convention also aims to increase cooperation between the contracting parties (Council of Europe 2015a, 2015b). The Bern Convention protects many of the cetacean species found in the Mediterranean and imposes legal obligations on the parties to protect the species (Bern Convention 1979).

The *Bonn Convention,* or more correct: *Convention on the Conservation of Migratory Species of Wild Animals* (CMS) aim to conserve migrating cetaceans among other terrestrial, aquatic and avian migratory species throughout their range. All cetacean species that are present in the Mediterranean are protected under this convention and contracting parties should take actions to ensure protection of these species within the states' national jurisdictional boundaries. However, Turkey has not yet signed the convention that was implemented in 1983 (CMS 2015b).

The *Habitats Directive* is an agreement between the members of the EU since 1992, protecting over 200 habitat types and over 1000 animals and plant species that are of European importance. The directive also applies to territorial waters, but for non-EU members as Turkey, Lebanon, Syria, Israel and countries in North Africa this convention does not apply (European Commission 2015b). It is the member states own responsibility to implement the Habitat Directive and to achieve the objectives. Still, the designation of protected areas may not be suitable for conservation for marine mammals since it is difficult to identify important habitats for migrating species that are crossing both national and international boundaries. However, the fundamental purpose of the directive is to establish a network of protected areas, *Special Areas of Conservation* (SACs), throughout the European Community (EC). The network of SACs is more known as Natura 2000 (Spencer *et al.* 2000).

Convention on Biological Diversity (CBD) is an environmental treaty under the United Nations Environmental Programme (UNEP) that came into force 1993 (CBD 2015a). The contracting parties, including Turkey, shall as far as possible identify and preserve biological diversity by implementing appropriate conservation management and national strategies. They shall also develop public awareness program that encourage understanding of the importance of conservation and sustainable use of biological diversity (CBD 1992). It is uncertain to which extent this is implemented in Turkey or Antalya Bay.

The *Code of Conduct for Responsible Fisheries* is a framework created within the Food and Agriculture Organization of the United Nations (FAO) in 1995. The Code, as it is referred to, sets out principals and international standards concerning conservation and development of aquatic resources, and has constructed international guidelines on bycatch management and reduction of discards (FAO 1995, 2011). The member states should for example "collect reliable and accurate data which are required to assess the status of fisheries and ecosystems, including data on bycatch, discards and waste" (FAO Article 12 4§, 1995). The Code does not specifically mention bycatch of marine mammals or cetaceans, but advice how to manage problems that are associated with bycaught marine mammals. The member states should for example ensure that a range of tools to manage and reduce bycatch should be available as well as improve the design and use of fishing gear with bycatch mitigation devices (FAO 2011). The Code is aimed at both members and non-members of FAO and other organisations involved in conservation of fishery resources and management of fisheries.

Table 2. States bordering to the Eastern Mediterranean Sea and their ratification of international and regional treaties relevant to cetacean conservation. ACCOBAMS = Agreement in the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic Area, BARCON = Barcelona Convention, BERN = Bern Convention, CBD = Convention on Biological Diversity, CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora, CMS = Convention on Migratory Species , GFCM = General Fisheries Commission for the Mediterranean, IWC = International Whaling Commission, UNCLOS = United Nations Convention on the Law of the Sea.

	INTERNATIONAL CONVENTIONS						MEDITERRANEAN CONVENTIONS		
Mediterranean states	**IWC[a]**	**CITES[b]**	**UNCLOS[c]**	**BERN[d]**	**CMS[e]**	**CBD[f]**	**BARCON[g]**	**GFCM[h]**	**ACCOBAMS[i]**
EU States									
Cyprus	X	X	X	X	X	X	X	X	X
Greece	FM	Acc	X	X	X	X	X	X	X
Non-European states									
Egypt	FM	Acc	X	NS	X	X	X	X	X
Israel	X	X	NS	NS	X	X	X	X	NS
Lebanon	NS	NS	X	NS	NS	X	X	X	X
Syria	NS	Acc	NS	NS	X	X	X	X	X
Turkey	NS	Acc	NS	X	NS	X	X	X	NS

Key

X = ratified/contracting party — FM = former member

Acc= accession — NS = not signed/not a contracting party

Sources: Geijer & Jones 2015, [a]IWC 2015, [b]CITES 2015a, [c]UNCLOS 2015, [d]Council of Europe 2015a, [e]CMS 2015c, [f]CBD 2015b, [g]European Commission 2015a, [h]GFCM 2015, [i]ACCOBAMS 2011

1.6.2. Mediterranean conventions and organisations

The first convention concerning the Mediterranean specifically was the *Mediterranean Action Plan* (MAP) implemented in 1975, later replaced by the *Barcelona Convention* (BARCON) in 1995. One of the main objectives of BARCON is to ensure sustainable management of natural marine and coastal resources. The objectives highly concern the fishing industry and Turkey signed the convention 1981 (European Commission 2015a). BARCON is arguable the most important and the influential convention for marine mammal conservation in the Mediterranean. This is mainly because BARCON can address issues concerning the high seas and in the absence of national policies. BARCON can form international platforms for cooperation between member states and induce political pressures to comply. Still, BARCON cannot isolate and regulate industries and their activities that are a threat against cetaceans, and cooperation with other organisations is essential. For example the Mediterranean is one of the most heavily navigated seas in the world, but BARCON cannot control the shipping or fishing activity in the Mediterranean (Geijer & Jones 2015). However, there are other conventions like the *General Fisheries Commission for the Mediterranean* (GFCM) that can control a part of the vessel traffic: in this case, the fishing activities.

GFCM has currently 24 members; 22 Mediterranean and Black Sea states, Japan and the EU (GFCM 2015). In GFCM's recommendations and resolutions, it is stated that "the contracting parties and cooperating non-contracting parties (CPCs) shall take actions to study, monitor, prevent, mitigate and, to the extent possible, eliminate incidental taking of cetaceans during fishing operations" (GFCM 2012). This also includes reporting of numbers of cetacean bycatch and which species are affected species, the fisheries concerned, gear type characteristics as well

as time and location of the catch. To mitigate the bycatch of cetaceans the CPCs prohibited gillnet fisheries that used monofilament greater than 0.5 mm, and this had to be compiled with before the 1st January 2015. The CPCs also require that the fisheries have to release alive and unharmed cetaceans that have been incidentally caught by the vessels (GFCM 2012). When it comes to conservation plans and management decisions, these are generally constructed on limited information and involve sweeping assumptions and simplifications (Lonergan 2011). The ratification of BARCON and GFCM of all states would allow an opportunity for cooperation and possibility to address the issue of bycatch in the Eastern Mediterranean to a much greater detail.

Agreement in the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) is a cooperative platform for conservation of marine biodiversity with the aims to reduce threats to cetaceans in the Mediterranean and the Black Sea as well as to improve the knowledge of these animals (ACCOBAMS 2015). The member states are required to implement a detailed conservation plan to achieve and maintain a favourable conservation status for cetaceans. They shall also in the future provide information towards assessment of the interactions between human activities and cetaceans. Important habitats are supposed to be protected by establishing *Specially Protected Areas* (SPA). SPAs are areas of importance for the cetaceans' food resource and in areas where pollution should be minimised through legislation. These areas shall also work as an opportunity to increase the awareness of the public and stakeholders through education (ACCOBAMS 2009). However, ACCOBAMS has a weakness since it does not have any legal enforcement power as other conventions do, which makes for example the implementation of SPA more difficult. Most of the countries, in total 23 states, bordering to these areas has signed the agreement, except six states which includes Turkey (ACCOBAMS 2011).

1.6.3. Turkish conservation management and monitoring in Antalya Bay

Although Turkey has not signed up the ACCOBAMS cooperation or applies to the Habitat Directive, today, more than 346 000 hectares of marine areas are legally protected in Turkey within 31 marine and coastal protected areas (MCPA). Nevertheless, that represents only 4% of the Turkish territorial waters (Turkish Ministry of Environment and Urbanization 2012). Around 24% of the Turkish coast is in some way managed or protected and so far, Turkey has 12 declared MPAs and thereby a legal protection of almost 2000 km^2 water surface Though, an investigation showed that no management plan have been developed for none of Turkey's MPAs (Abdulla *et al.* 2008). In comparison with other Mediterranean countries, Turkey is together with Greece (2300 km^2) and Italy (2700 km^2) the ones that are protecting the largest marine surface area in the Mediterranean Sea (Abdulla *et al.* 2008). However, this is not even close to the international protection of the Pelagos Sanctuary outside Italy, covering 87 500 km^2 or 4% of the Mediterranean Sea (Abdulla *et al.* 2008, WWF 2016). The sanctuary is defined as a Specially Protected Area of Mediterranean Importance (SPAMI) and is an agreement between Italy, Monaco and France for the protection of marine mammals (Pelagos Sanctuary 2016). Since 1972 only one MPA is located inside Antalya Bay at the Olympos-Bey Mountains, meaning that most of the water inside Antalya Bay is not protected.

In 1990, the Turkish government an established Special Environmental Protected Areas (SEPA), in Kas Kekova in the East of the Antalya province. At first only protecting land area for archaeological heritance, but later due to the rich marine biodiversity the area was extended in 2006. Today the SEPA of Kas Kekova is protecting a marine area of 166 km^2, which has a potential to become a MCPA in the future. This is the second protected marine area within the

Antalya province, however, non-sustainable fishing activities is still a problem (Mangos & Claudot 2013).

1.7. Aim of study and research questions

The main objective of this thesis was to assess the impact of bycatch on marine mammal populations in Antalya bay, Turkey. The specific research questions were:

i. Which marine mammal species are taken as bycatch in Antalya Bay?
ii. Which types of fishing gear contribute to bycatch in Antalya Bay?
iii. Does bycatch represent a conservation issue for marine megafauna in Antalya Bay?
iv. What policy provisions are in place to reduce bycatch in Turkey and the Eastern Mediterranean?

An overall aim with this study was to assess the existing knowledge gaps and how the bycatch issue in the Eastern Mediterranean and specifically in Antalya Bay can be addressed. For this, recommendations have been included on how to mitigate marine mammal bycatch more effectively.

2. Materials and methods

2.1. Study area

Antalya Bay is a large oligotrophic bay located in the North-eastern Levantine Sea in the eastern Mediterranean Sea covering an area of approximately 6500-10 000 km^2 (Figure 3, Tezcan & Okyar 2006). The Levantine Sea has in general low nutrient supply to the upper surface layer but hydrographical features and cyclonic gyres in the area creates upwelling of deep nutrient waters that results in patches with high primary production (McGill 1961, Murdoch & Onuf 1973, Salihoğlu *et al.* 1990). The sea floor topography in Antalya Bay is distinct with a narrow and steep continental shelf and a canyon, Antalya Canyon, reaching from the northwest to southeast. Antalya Bay is deep with a maximum depth of 2600 m and has low tidal amplitudes, with only 17 cm difference between the low sea-level seasons in April-May and the high-season in July-August (Alpar *et al.* 2000, Tezcan & Okyar 2006). The seawater temperature is high and varies seasonally with the lowest mean temperature 18°C in the winter and the highest 29°C during the summer. Salinity is also high and increases across the bay, with 34 psu in the west and 39 psu in the east (Özbek *et al.* 2013). The bay includes larger cities but is perhaps best known for the main seaside resorts of the Turkish Riviera, such as Antalya, Alanya and Manavgat.

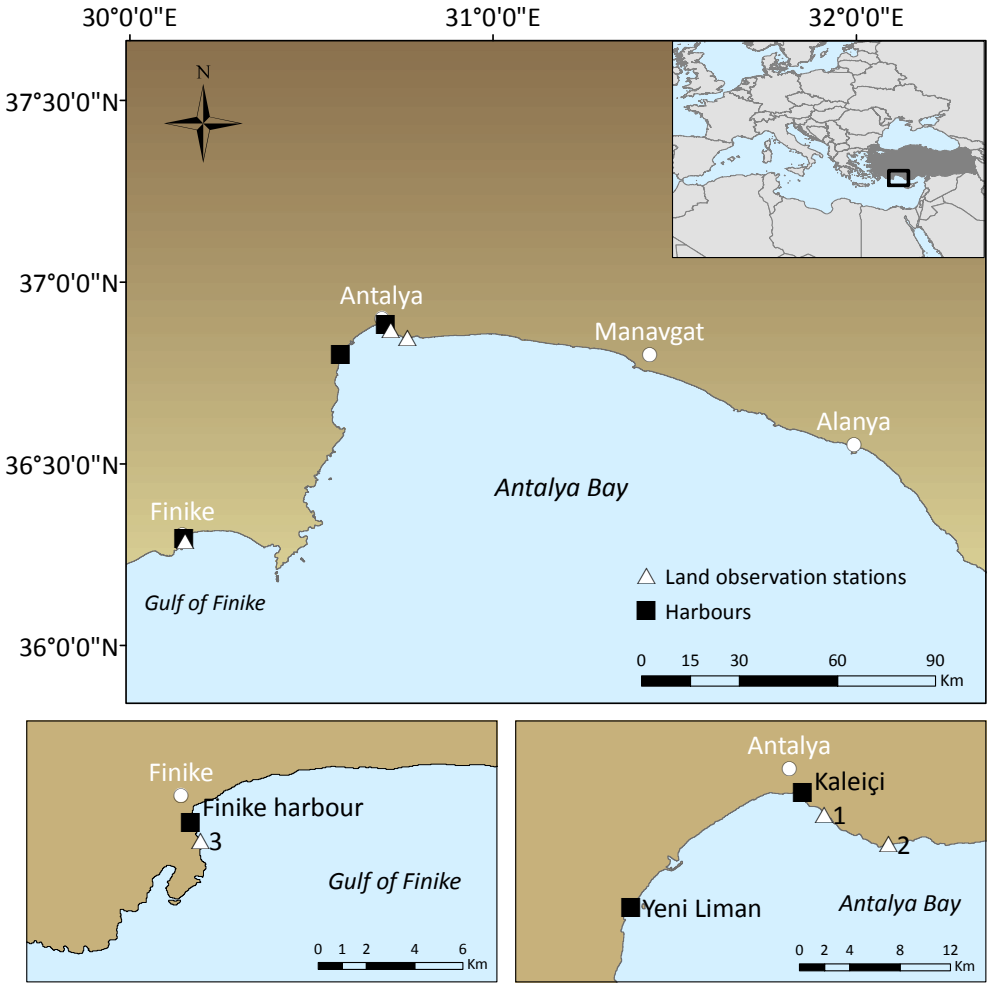

Figure 3. Study area Antalya Bay including Gulf of Finike, land observation stations 1, 2 and 3, and harbours (Finike harbour, Kaleiçi and Yeni Liman) where interviews were conducted. Background map: Lantmäteriet Gävle (2014): Permission i2014/00601.

2.2. Data collection

2.2.1. Interview survey and questionnaires

Due to the lack of quantitative data on bycatch in Antalya Bay, an interview survey was chosen for this study. Interview studies have been recommended as a tool for studying bycatch of marine mammals and are becoming more widely used in ecology and conservation research (Moore *et al.* 2010). It has proven to be an effective methodology and suitable tool for approaching certain topics, such as ecological managements, studies of human impacts on wild species and interdisciplinary studies that include ecological and non-ecological components (White *et al.* 2005), all which makes this approach suitable for this study.

The study was also complemented with a questionnaire, this since questionnaires have been proven successful in previous studies of bycatch (López *et al.* 2003, Lauriano *et al.* 2009, Moore *et al.* 2010, Cruz *et al.* 2014, Goetz *et al.* 2014, Cook *et al.* 2015). The use of questionnaires can especially be helpful when attempting to quantify human behaviour and attitudes towards conservation strategies and implementation of environmental conservation directives (Kerr & Cullen 1995, White *et al.* 1997, White *et al.* 2001, Jim & Xu 2002, Obiri & Lawes 2002, White *et al.* 2003). Questionnaires are low in time and costs, which makes them a useful tool in any part of the world (White *et al.* 2005), and especially in countries where no bycatch estimates are officially available, as the case in Antalya Bay.

Sampling of fishermen to be interviewed followed a similar stratified random procedure used by Lauriano *et al.* (2009), Goetz *et al.* (2014) and Goetz *et al.* (2015) where harbours and fishing gear were selected consciously and then the fishermen were chosen opportunistically, i.e. any fishermen that were present and available for interviewing were addressed. Between July 16th and August 20th 2015, 22 face-to-face interviews were conducted in three different ports in Antalya Bay: Yeni Liman (Antalya), Kaleiçi (Antalya) and Finike harbour (Table 3). The time of the interviews varied between 15 min to 1 hour.

Table 3. Summary of the 22 interviewed fishermen, date of interview and port. The Quote ID will be used as a reference when fishermen are cited in this report.

Quote	Date	Port
F01	2015-07-22	Finike
F02	2015-08-19	Finike
K01	2015-07-22	Kaleiçi
K02	2015-07-22	Kaleiçi
K03	2015-07-22	Kaleiçi
K04	2015-07-22	Kaleiçi
K05	2015-07-22	Kaleiçi
K06	2015-07-28	Kaleiçi
K07	2015-07-28	Kaleiçi
K08	2015-07-28	Kaleiçi
K09	2015-07-28	Kaleiçi
K10	2015-07-28	Kaleiçi
K11	2015-07-28	Kaleiçi
Y01	2015-07-16	Yeni Liman
Y02	2015-07-16	Yeni Liman
Y03	2015-07-16	Yeni Liman
Y04	2015-07-16	Yeni Liman
Y05	2015-07-24	Yeni Liman
Y06	2015-07-24	Yeni Liman
Y07	2015-08-20	Yeni Liman
Y08	2015-08-20	Yeni Liman
Y09	2015-08-20	Yeni Liman

With the aim of collecting primary data on cetacean-fishery interactions in Antalya Bay waters this study used methodologies employed in previous studies (López *et al.* 2003, Moore *et al.* 2010, Cruz *et al.* 2014, Goetz *et al.* 2014, Cook *et al.* 2015) and designed a questionnaire with 49 questions in total (Appendix 1). Great care must be taken when designing the questionnaire. Closed-ended questions (simple question-and-answer format) are used in order to maximize accuracy of the collected data and information by minimizing possible bias caused by misinterpretation by respondents or researchers (White *et al.* 2005, Gomm 2004, Moore *et al.* 2010, Fowler 2013). On the other hand, in order to optimize the interview data and get a better understanding for the respondents' behaviour and motivations, open-ended questions need to be included (White *et al.* 2005). Therefore, both closed-ended and open-ended questions

were included in order to increase the strength of the study, to get an as true as possible overview of the scale of marine mammal bycatch, and to account for fishermen's opinions and own suggestions to avoid possible interactions with marine mammals.

The questionnaire was divided into three parts. The first section included questions relating to the fishermen and their fishing activity, e.g. type of gear, target species, daily average catch, main fishing grounds and fishing hours. The second section covered the fishermen's sightings, interactions and bycatch of marine mammals, e.g. species, number of animals sighted, how often they see cetaceans, how often bycatch occurs and which species are bycaught. The last and third section included questions relating to awareness of current legislations and regulations and the fishermen's own suggestions to reduce the interaction and conflict with marine mammals.

Illustration cards of the most common marine mammal species in Antalya Bay were used to help the fishermen to identify sighted and caught species (Appendix 2). In order to understand the fishermen's knowledge about marine mammals the pictures were not labelled with the species name, only the body length of the species in question.

2.2.2. Observer data from land and boat surveys

Abundance and distribution data on marine megafauna (cetaceans, pinnipeds, sea turtles) were collected in July-August 2015 together with the non-governmental organisation Deniz Memelileri Araştırma Derneği (DMAD) – a marine mammal research association operating along the Turkish Mediterranean coast. In total 18 land observation surveys were carried out at two stations located on the coastline of Antalya city: nine observations at Station 1 (36°52'5.9"N 030°43'6.3"E) and eight observations at Station 2 (36°50'49.4"N 030°45'52.5"E). The stations were surveyed twice per week, alternatively in the morning (06:00-11:00) or in the afternoon (15:00-20:00). One land observation survey was also carried out in Finike at Station 3 (36°17'15.5"N 030°09'06.4"E) in the afternoon (15:00-20:00). Individual positions of sighted marine mammals were recorded through FOIF LP215L theodolite. At the same time species, group size and behavioural data were collected. Boat and vessel traffic were also included as well as environmental and survey weather conditions continuously during the surveys. The theodolite readings were transformed into geographic positions using Pythagoras Version 1.2 software.

Following randomly selected track lines inside Antalya Bay, four boat surveys (minimum 6 hours) were carried out on July 9th, 16th, 24th and July 31st. The positions of sighted marine megafauna were recorded with logger software to save the GPS points of the survey track.

2.3. Data analysis

The study's aim was to obtain species-specific data monthly and generate annually bycatch estimates but there were factors that obstructed the estimates in practice. First, the fishermen were not able to identify different species of cetaceans even though an illustration card was used during the interviews. Second, it was not easy to get a monthly or annually bycatch estimate since some of the fishermen were not willing to answer these types of questions. Therefore, the obtained bycatch data from the interviews was summarized and restricted to taxonomic groups and ranked into order (dolphins, whales, seals, shark, tunafish, sea turtles and others). Furthermore, fishermen were asked how often they think cetaceans are bycaught in fishing gear, and due to inconsistent answers regarding estimates either monthly or annually, the bycatch data was compiled and presented on yearly basis.

The interview survey data were compiled into an Excel database and described the results following a similar design as Cook *et al.* (2015). Basic statistical analyses were used as the dataset allowed. Only completed interviews were used in the data analysis part. However, in the discussion part all fishermen's opinions were taken into account.

The observation data of marine megafauna from the land and boat surveys in July-August were compiled into an Excel database. The geographic positions of cetaceans from the land surveys in July-August and previous data collected in March-June 2015 by DMAD were analysed in ArcMap software version 9, where the presence of common bottlenose dolphin (*Tursiops truncatus*) were plotted together with the highest density of fishing boats sightings during the surveys.

3. Results

3.1. Interview data

In total 22 interviews were conducted at ports in Antalya and Finike, two interviews were removed from the analysis due to incomplete interviews or the interviewee was not fishing for a living. All respondents were fishing within Antalya Bay except the two fishermen (F01 and F02) interviewed in Finike, whom mostly were utilizing the waters inside the Finike Bay. Since they on regular basis visit the waters within Antalya Bay they were included in the analysis. Only the captains of the boats were addressed during the survey, except one interview where only the sailor of the boat could be interviewed.

In order to categorise and divide the fishermen, the most commonly used fishing gear was to divide between them (Table 4). Longlines (n = 13) dominated as gear type in this study, after purse seine (n = 4) and trawl (n = 3). None of the fishermen reported the use of gillnets, although different kinds of net were visible on the quay. Longlines were in general a fishing method that was targeting more different species while other fishing gears were more species specific targeting fewer species.

Table 4. Information retained from interviewees in Antalya Bay on fishing boats, characteristics of fishing gear, the six most common target species per gear and the average daily catch. Only answers from respondents included in the analysis are displayed.

	LONGLINES	PURSE SEINE	TRAWL
No. of interviewed fishermen	13	4	3
Boat length	6.3-9.7 m	11.2-20 m	11.6-24 m
Gear characteristics	#5-15 hooks size, 115-1200 hooks, 100-2000 m long, sinking/bottom longlines.	9-12 mm mesh size, 350-384 m long, 3,5-6,4 m net width.	22 mm mesh size, 16-25 m long, 1.5-6 m net opening. Bottom trawling at 2.5-3 NM/h.
Target species	Red mullet, shrimp[1], white grouper, common pandora, goldblotch grouper, blue whiting	Chub mackerel, European pilchard, leerfish, red mullet, horse mackerel, Atlantic bonito	Red mullet, shrimp, common pandora, monkfish/anglerfish, European squid, striped red mullet
Average daily catch	>50 kg	225 – 750 kg	375 – 750 kg

[1]Shrimp is probably a secondary target since it can only be harvested using a net e.g. set or drifting net, shrimp trawl or bait trap/basket.

3.1.1. Fishing habits

Fishing for a living is an all year around occupation for the fishermen in Antalya Bay, except for the trawlers who cannot fish during summer due to current regulations. The fishermen were 27-68 years old and most of them started fishing at a young age and have been fishing for a major part of their lives (Table 5). The daily catch is sold directly from the boat, at fish markets in the harbours, at larger city markets or directly to restaurants in Antalya.

Even though the fishermen landed fish almost every day, many of them pointed out that the fish populations have decreased and that some fish species cannot longer be found inside the bay. Some of the fishermen blamed trawlers that belong to ports outside of Antalya for almost

depleting the fish populations. Others said that the current fishing policy is unsustainable and that decisions makers are for example not aware of fish life cycle and allows fishing during critical periods, for example during fishes spawning seasons.

All fishermen showed awareness of fishing restrictions and current legislations. All interviewed fishermen except one knew that there are areas where fishing is not allowed inside the bay and the fishermen pointed out that there are still illegal fishing methods taking place in Antalya Bay. One fisherman (K02) using longlines, said that the Antalya Dolphinarium Dolphin Park was paying him to fish specific fish species even though these species are banned to catch during specific times of the year due to spawning. According to him Antalya Dolphinarium Dolphin Park do not care about the regulations.

Table 5. Fishing habits for fishermen using longlines (n = 13), purse seine (n = 4) and trawlers (n = 3). Due to incomplete answers from the fishermen, the percentage numbers do not always add up to 100% on certain questions. Percentage can add up to >100% due to multiple response questions.

	LONGLINES		**PURSE SEINE**		**TRAWL**	
	n	**(%)**	**n**	**(%)**	**n**	**(%)**
Harbour						
Finike	1	(7.7%)	1	(25.0%)	0	(0.0%)
Kaleiçi	10	(76.9%)	0	(0.0%)	0	(0.0%)
Yeni Liman	2	(15.4%)	3	(75.0%)	3	(100.0%)
Years fishing in Antalya Bay						
0-10	0	(0.0%)	0	(0.0%)	1	(33.3%)
10-20	1	(7.7%)	0	(0.0%)	0	(0.0%)
21-30	5	(38.5%)	0	(0.0%)	1	(33.3%)
31-40	4	(30.8%)	0	(0.0%)	0	(0.0%)
> 40 years	3	(23.1%)	4	(100.0%)	1	(33.3%)
Depth of hauls (meters)						
0-50 m	1	(7.7%)	1	(25.0%)	0	(0.0%)
50-100 m	9	(69.2%)	3	(75.0%)	1	(33.3%)
100-200 m	0	(0.0%)	0	(0.0%)	0	(0.0%)
>200 m	1	(7.7%)	0	(0.0%)	2	(66.7%)
Seasons fished[a]						
Winter	13	(100.0%)	3	(75.0%)	3	(100.0%)
Spring	13	(100.0%)	3	(75.0%)	3	(100.0%)
Summer	13	(100.0%)	0	(0.0%)	1	(33.3%)
Autumn	13	(100.0%)	3	(75.0%)	3	(0.0%)
Time of day for fishing[a]						
Early morning (00:00-06:00)	10	(76.9%)	0	(0.0%)	1	(33.3%)
Morning (06:00-12:00)	2	(15.4%)	0	(0.0%)	2	(66.7%)
Afternoon (12:00-18:00)	2	(15.4%)	0	(0.0%)	0	(0.0%)
Evening (18:00-24:00)	6	(46.2%)	3	(75.0%)	0	(0.0%)
No. of times gear is set and retrieved per trip						
1	6	(46.2%)	0	(0.0%)	1	(33.3%)
2-5	2	(15.4%)	2	(50.0%)	2	(66.7%)
>5	0	(0.0%)	2	(50.0%)	0	(0.0%)

[a] Multiple response question

3.1.2. Fishermen - marine mammal interactions

There are currently 11 resident marine mammal species in the Mediterranean Sea, but how many of them that are present in Antalya Bay are uncertain. When I asked the fishermen how many cetacean species they know of in their fishing area 45% replied that one or two species existed, 35% did not know while 20% of the fishermen did not answer the question. Many of the fishermen were confused and could not distinguish the different species when I showed the drawings over the most common cetaceans in Antalya Bay. They often mixed up striped dolphin

with common bottlenose dolphin. Even though most of the respondents (70%) encountered cetaceans almost daily during fishing activity and even more animals now in recent years (Table 6), only 30% answered that they could differentiate the cetaceans. However, when showing the illustration cards there were only three fishermen that could point out the right species. I assumed that they have probably all sighted common bottlenose dolphin, which is the most sighted species by DMAD inside the bay. Nevertheless, this points out an existing basic knowledge gap about which cetacean species that are present in Antalya Bay among the fishermen.

The cetaceans sighted were reported swimming towards the fishing boat during the fishing activity and have been seen in proximity to fishing gear (Table 6). During the interviews, many of the fishermen complained over gear damage caused by cetaceans, especially dolphins. Dolphins were reported to once or several times damaged fishermen's fishing gear while trying to steal fish from the gear. This was a topic the respondents got emotional and upset about and I could easily define this as an existing conflict (Table 6). Many fishermen said that dolphins consciously attack their gear and the fishermen's emotional upset can be explained by the economic costs involved. Fishing gear such as purse seine and gillnets are more expensive to buy, also more complicated and costly to repair than for example longlines that are 10 times less expensive (250 TRY compared to 2600 TRY[1]). One fisherman (K11) said that he had to switch from using nets to use longlines, this because dolphins destroyed the net and it was too expensive to repair or buy a new one. The interviewee said he experiences fewer interactions with dolphins when using longlines. Another fisherman (Y09) said he used an old purse seine net outside the new one to protect the new net from being damaged by dolphins.

This conflict between fishermen and dolphins has led to illegal acts from the fishermen. One of the fishermen (K05) said that illegal fishing methods are being used in Antalya Bay, including firearms for killing the dolphins that are approaching the fishing gear. This phenomenon appears in other parts of the world, especially by longlines fisheries where cetaceans have tried to remove fish from the gear and thereafter being shot by the fishermen. Similar situations have been reported from Sri Lanka, the Caribbean and Indonesia involving Risso's dolphins (*Grampus griseus*) (Taylor *et al.* 2012) and in Alaska and Chile involving killer whales (Donoghue *et al.* 2002, Taylor *et al.* 2013).

[1] 1 TRY ≈ 3 SEK ≈ 0.32 €

Table 6. Interactions between fishermen and marine mammals in Antalya Bay. Due to incomplete answers from the fishermen, the percentage numbers do not always add up to 100% on certain questions. Percentage can add up to >100% due to multiple response questions.

	LONGLINES		PURSE SEINE		TRAWL	
	n	(%)	n	(%)	n	(%)
Sighted cetaceans during fishing						
Every day	2	(15.4%)	2	(50.0%)	3	(100.0%)
Almost every day	7	(53.8%)	0	(0.0%)	0	(0.0%)
Every week	3	(23.1%)	0	(0.0%)	0	(0.0%)
Couple of times per month	1	(7.7%)	1	(25.0%)	0	(0.0%)
Abundance of cetaceans today compared to when fishermen started fishing						
Higher	9	(69.2%)	3	(75.0%)	2	(66.7%)
Lower	2	(15.4%)	0	(0.0%)	0	(0.0%)
The same	2	(15.4%)	0	(0.0%)	0	(0.0%)
Cetaceans behaviour when sighted from fishing boat[a]						
Feeding	1	(7.7%)	2	(50.0%)	1	(33.3%)
Swimming away from the fishing boat	0	(0.0%)	0	(0.0%)	1	(33.3%)
Swimming towards the fishing boat	11	(84.6%)	2	(50.0%)	1	(33.3%)
Don't know	0	(0.0%)	0	(0.0%)	1	(33.3%)
Fishermen use cetaceans to locate fish						
Yes	3	(23.1%)	0	(0.0%)	0	(0.0%)
No	10	(76.9%)	2	(50.0%)	3	(100.0%)
Don't know	0	(0.0%)	0	(0.0%)	0	(0.0%)
Cetaceans seen in close proximity to gear						
Yes	13	(100.0%)	3	(75.0%)	3	(100.0%)
No	0	(0.0%)	1	(25.0%)	0	(0.0%)
Don't know	0	(0.0%)	0	(0.0%)	0	(0.0%)
Existing conflict between fishermen and cetaceans						
Yes	5	(38.5%)	2	(50.0%)	0	(0.0%)
No	6	(46.2%)	1	(25.0%)	0	(0.0%)
Don't know	0	(0.0%)	0	(0.0%)	0	(0.0%)

[a] Multiple response question

3.1.3. Marine mammal bycatch

In general, there was an unwillingness to answer questions about cetacean bycatch. Fishermen would admit they had at least once encountered a larger animal in their gear, but they did not tell how often these events occurred (Table 7). Even though most of them claimed that they have not encountered cetaceans in their gear, some could explain and demonstrate how they would release a dolphin if they would catch one. For example, three of the fishermen Y02, Y03 and Y04 who are using longlines and purse seines, described thoroughly how they usually put a rope around the dolphin's tail while they try to disentangle the dolphin from the gear. These three fishermen said this right after they claimed that they have never bycaught any marine mammal species. All fishermen said that if they ever encounter a larger animal entangled in their gear, they try to release the animal back to the sea.

Table 7. Fishermen's opinions on bycatch and reported interference with marine mammals. Due to incomplete answers from the fishermen, the percentage numbers do not always add up to 100% on certain questions. Percentage can add up to >100% due to multiple response questions.

	LONGLINES		PURSE SEINE		TRAWL	
	n	(%)	n	(%)	n	(%)
How many cetaceans the fishermen thinks are bycaught per year in Antalya bay						
0	8	(61.5%)	1	(25.0%)	1	(33.3%)
1-5	0	(0.0%)	1	(25.0%)	2	(66.7%)
6-10	0	(0.0%)	1	(25.0%)	0	(0.0%)
>10	0	(0.0%)	1	(25.0%)	0	(0.0%)
In which gear fishermen think cetacean bycatch is most common						
Gillnet	1	(7.7%)	0	(0.0%)	1	(33.3%)
Trawl	1	(7.7%)	1	(25.0%)	1	(33.3%)
Longlines	0	(0.0%)	0	(0.0%)	0	(0.0%)
Purse seine	7	(53.8%)	1	(25.0%)	1	(33.3%)
Other (specify)	2	(15.4%)	1	(25.0%)	0	(0.0%)
Why cetaceans are bycaught in fishing gear[a]						
Cetacean steal fish from gear because they are hungry	7	(53.8%)	4	(100.0%)	1	(33.3%)
Cetaceans eat the fish from the gear because it is easy	2	(15.4%)	4	(100.0%)	1	(33.3%)
Cetaceans don't pay attention to the boat	0	(0.0%)	0	(0.0%)	0	(0.0%)
The fishing boat goes towards the cetaceans	0	(0.0%)	0	(0.0%)	0	(0.0%)
Other	1	(7.7%)	0	(0.0%)	2	(66.7%)
Don't know	0	(0.0%)	0	(0.0%)	0	(0.0%)
Fishermen ever encountered other species in their gear						
Yes	12	(92.3%)	4	(100.0%)	3	(100.0%)
No	1	(7.69%)	0	(0.0%)	0	(0.0%)
No. of cetacean bycaught today compared to when fishermen started fishing						
Higher	5	(38.46%)	2	(50.0%)	2	(66.7%)
Lower	0	(0.0%)	0	(0.0%)	1	(33.3%)
The same	2	(15.4%)	2	(50.0%)	0	(0.0%)

[a] Multiple response question

According to the fishermen, cetacean bycatch events are rare and always accidental in Antalya Bay (Table 7), 50% of the respondents said that no cetacean is bycaught each year. However, 95% of the fishermen said that they have at some point encountered larger animals such as dolphins, whales, seals, tuna fish, sharks and/or sea turtles. Among all fisheries, excluding the ones using trawlers, sea turtles were the most common bycatch (Figure 4); 90% said that they at least once have encountered a caught sea turtle. This is alarming since sea turtles are listed as being endangered in the IUCN Red list (IUCN 2012). The number of fishers that said they accounted cetaceans was 35%. Three of fishermen using longlines said that they have only had bycatch of larger marine species while using other type of gear (i.e. not longlines), such as either purse seine (one fisherman) or other types of nets (two fishermen).

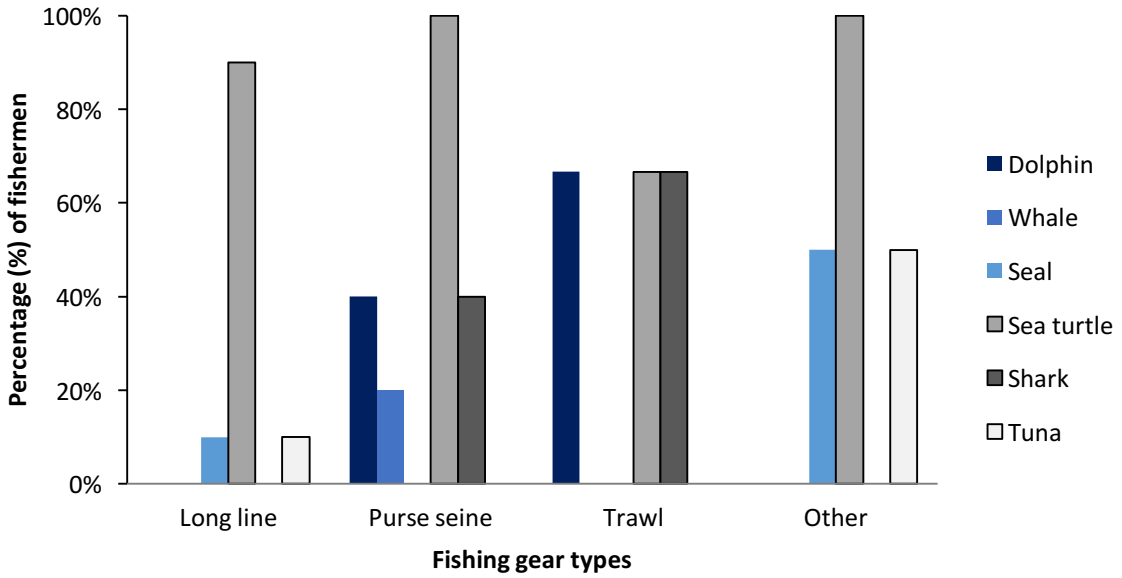

Figure 4. Marine megafauna bycatch reported by fishermen when fishing with longlines (n = 10), purse seine (n = 5), trawl (n = 3) or other gear (n = 2) in Antalya Bay.

3.1.4. Awareness and opinions on marine policy and conservation

There was a general positive attitude among the fishermen regarding cetaceans and the majority of the respondents agreed that it is important to protect cetaceans (Table 8). However, many of the fishers complained over destroyed gear due to dolphins as already mentioned. As interviewee Y03 put it; "Fishermen do not really like dolphins because they destroy or damage the fishing gear", and fisherman K02 who said; "I generally respect the dolphins but I have a negative opinion because they destroy my gear and eat the fish". Few fishermen reported their incidental catches of marine megafauna, even though they knew it is mandatory to report bycatch (Table 8). It is also alarming that 30% of the fishers still do not know that it is illegal to catch marine mammals and that cetaceans are protected by law, considering that the legalisation has been in force since 1983.

Out of all respondents 14 (70%) used some kind of mitigation measures to avoid contact or interaction with marine mammals (Table 8). Six fishers using longlines admitted that they have used firecrackers, which they throw into the water to scare dolphins away from their gear. Only one fisherman (Y09) used a pinger[2] to keep dolphins at a distance, but unfortunately the dolphins got used to it, he said. Fisherman K10 pointed out this problem as well and claimed that it is no use in taking any measures such as pingers, since the dolphins will get used to them sooner or later.

The fishermen's own suggestions and ideas on how to reduce the interactions and solve the conflict with dolphins were concerned with management of the fishing industry (Table 8): (i) implement a more sustainable fishery policy, (ii) protect and increase the fish population or (iii) use sonar or pingers to scare away dolphins. Still, others claimed that there is no point in taking any measures since nature has its own rules and dolphins will attack the gear anyway if they are hungry, regardless what actions that are taken.

[2] A pinger is an acoustic device placed on the fishing gear (such as purse seine nets). The pinger is emitting a signal in a frequency within marine mammals hearing range and acts as an alarm and alerts the animals about the presence of the pinger and the gear.

Table 8. Fishermen's opinions on current marine policy and conservation measures, and their suggestions on how to reduce the interactions with cetaceans. Due to incomplete answers from the fishermen, the percentage numbers do not always add up to 100% on certain questions. Percentage can add up to >100% due to multiple response questions.

	LONGLINES		PURSE SEINE		TRAWL	
	n	(%)	n	(%)	n	(%)
Do fishermen know if they have to report cetacean bycatch						
Yes	10	(76.9%)	1	(25.0%)	1	(33.3%)
No	3	(23.1%)	2	(50.0%)	1	(33.3%)
Don't know	0	(0.0%)	1	(25.0%)	1	(33.3%)
Do fishermen report their own bycatch						
Yes	2	(15.4%)	0	(0.0%)	0	(0.0%)
No	8	(61.5%)	0	(0.0%)	0	(0.0%)
Fishermen take measures to avoid interactions with cetaceans[a]						
Acoustic devices	0	(0.0%)	1	(25.0%)	1	(33.3%)
Navigate away from cetaceans to alternative fishing grounds	3	(23.1%)	0	(0.0%)	0	(0.0%)
Postpone fishing operation until cetaceans leave the area	1	(7.7%)	0	(0.0%)	0	(0.0%)
Reduce fishing time	0	(0.0%)	0	(0.0%)	0	(0.0%)
Scare the cetaceans away	5	(38.5%)	0	(0.0%)	0	(0.0%)
Other	3	(23.1%)	0	(0.0%)	0	(0.0%)
Don't take any measures	2	(15.4%)	3	(75.0%)	2	(66.7%)
Do fishermen know that cetaceans are protected by law						
Yes	8	(61.5%)	3	(75.0%)	3	(100.0%)
No	3	(23.1%)	1	(25.0%)	0	(0.0%)
Don't know	2	(15.4%)	0	(0.0%)	0	(0.0%)
Do fishermen think it is Important to protect cetaceans						
Yes	8	(61.5%)	3	(75.0%)	2	(66.7%)
No	2	(15.4%)	1	(25.0%)	1	(33.3%)
Don't know	1	(7.7%)	0	(0.0%)	0	(0.0%)
Fishermen general feelings about cetaceans						
Positive	8	(61.5%)	3	(75.0%)	3	(100.0%)
Negative	4	(30.8%)	0	(0.0%)	0	(0.0%)
Neutral	1	(7.7%)	0	(0.0%)	0	(0.0%)
Own suggestions to reduce interactions with cetaceans						
Fishing in different seasons	0	(0.0%)	0	(0.0%)	0	(0.0%)
Fishing in different areas	2	(15.4%)	2	(50.0%)	2	(66.7%)
Others	6	(46.2%)	0	(0.0%)	0	(0.0%)

[a] Multiple response question

3.2. Observational data

No marine mammals or other marine megafauna were observed during any of the surveys at Station 1. At Station 2 four larger marine species were observed; common bottlenose dolphin (*Tursiops truncatus*), Mediterranean monk seal (*Monachus monachus*), loggerhead turtle (*Caretta caretta*) and green turtle (*Chelonia mydas*) (Table 9, Figure 5). Only one survey at Station 2 did not include any observation of larger species. One sea turtle was observed during the land observation survey in Finike.

During the four boat surveys, common bottlenose dolphins were observed during three surveys, sea turtles during two and an unknown shark species once (Table 9). During the first survey (July 9th) a group of six dolphins were observed but could not be species-determined due to long sighting distance. Due to rough sea one boat survey finished earlier than planned and no larger marine species were observed.

Table 9. Marine megafauna observation data from land and boat surveys conducted in July and August in Antalya Bay.

Species name	Scientific name	No. of sightings	Group size range	Total number of individuals	
				Min	Max
Common bottlenose dolphin	*Tursiops truncatus*	3	2-8	13	20
Unidentified dolphin	*NA*	2	1-6	3	9
Mediterranean monk seal	*Monachus monachus*	4	1-4	1	4
Loggerhead turtle	*Caretta caretta*	4	1	4	4
Green turtle	*Chelonia mydas*	3	3	3	3
Unidentified sea turtle	*NA*	3	3	3	3
Unidentified shark	*NA*	1	1	1	1

NA = Not applicable

Figure 5. Mediterranean monk seal, common bottlenose dolphin (with a tourist boat in the background) and loggerhead turtle sighted during land and boats surveys in Antalya during July and August 2015. Photo: © Johanna Bergman, @DMAD - Marine Mammals Research Association.

The observation cetacean data collected during July and August (Table 9, Appendix 4) were combined with previously collected (unpublished) data by DMAD in order to analyse the presence of dolphins compared with the presence of fishing boats. Only the highest densities of fishing boats were included in this analysis. The 95% presence of common bottlenose dolphins observed during land surveys between March to August 2015 at Station 1 and Station 2, overlaps with the core zone of observed fishing boats at the same time. As seen in Figure 6, dolphins and fishing boats seem to utilise the same region of the inner part of Antalya Bay, explaining that interactions are likely to occur. This result also correlates with the fishermen's perception of the situation in the bay.

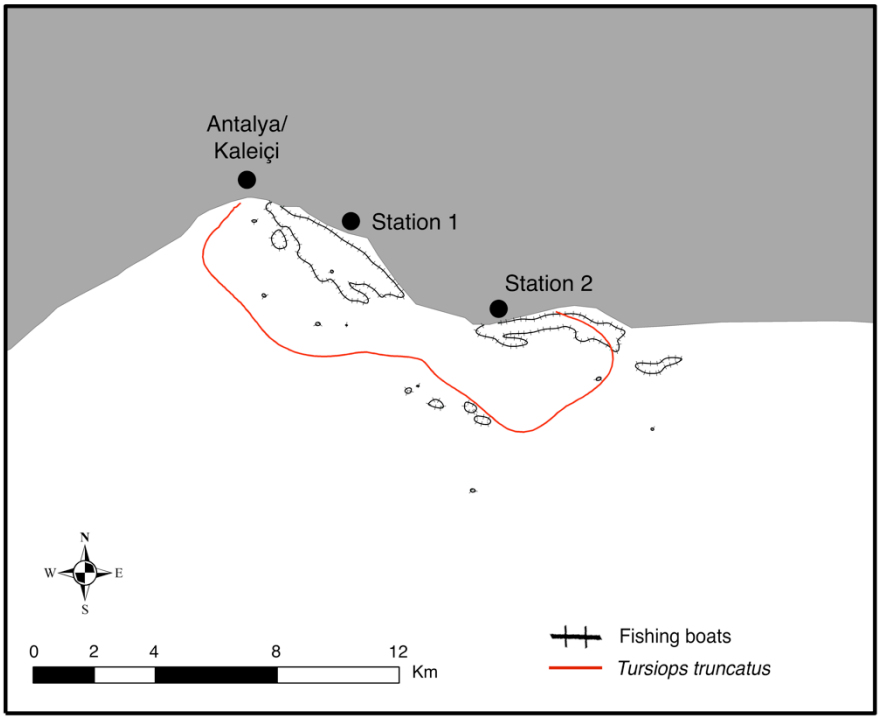

Figure 6. Map over the inner part of Antalya Bay, where 95% of the presence of common bottlenose dolphins (*Tursiops truncatus*) observed during land surveys is shown with the red line and the highest density of fishing boats is shown with the black striped line. Data obtained at Station 1 and Station 2 during May-August 2015 by DMAD. Figured modified by Johanna Bergman, originally created by Aylin Akkaya, DMAD - Marine Mammals Research Association 2015.

4. Discussion

4.1. Fishing gear and fishing activity

Being a fisherman in Antalya Bay is a lifelong occupation for the interviewees and this long experience adds credibility to the fishermen's perception of how the ecosystem in the bay has changed over time. This study found that the most common gear used was longlines, which was unexpected since purse seine nets and trawlers dominates the Turkish fisheries. I thought that gillnet would be more present since it is a common traditional gear in Turkey and in the Mediterranean (Papaconstantinou & Farrugio 2000) but none of the interviewed fishermen mentioned that they use gillnets. Though, other possible gears that were used might be underrepresented or simply not recorded in this study due to difficulty to intercept fishermen using other types of gear. I can assume this from my finding based on that only two fishermen using longlines said they sometimes used shrimp net or other types of net, since the second most common target species for long line fishermen are shrimps, which only can be harvested using a net e.g. set or drifting net, shrimp trawl or bait trap/basket. Although, long line fishing can sometimes include the use of bait traps instead of hooks, it is remains unclear if the fishermen in Antalya Bay are using this method.

4.2. Marine mammal bycatch and interactions with fisheries in Antalya Bay

4.2.1. Which marine mammal species are taken as bycatch in Antalya Bay?

Due to unwillingness of the fishermen to report marine mammal bycatch in Antalya Bay, it was difficult to access figures on how many marine mammals are bycaught per year. The fishermen also had difficulties of distinguishing between different marine mammal species, which made it unfeasible to assess bycatch data on species level. However, this study can conclude that dolphins, whales and seals (most likely the Mediterranean monk seal since it is the only seal species present in the area) have been bycaught in Antalya Bay by fishermen.

This field study shows that the present data is likely an underestimation of the current marine mammal bycatch in Antalya Bay. I can see this through the false, incorrect, reluctant and underreporting of bycatch by the interviewees. For example, three interviewees claimed that they had not bycaught any marine mammals, but they could readily describe and demonstrate in detail how they would release an animal from their fishing gear.

There is a possibility of misinterpretation of the questions regarding bycatch such as if the caught animal is released back to the sea alive, it is not considered as bycatch. Fishermen with this interpretation will not have to report the incident as bycatch and will thereby avoid further consequences. However, the interviewees did indeed say they were aware in general that they have to report marine mammal bycatch, but still, most of them did not report it. This underreporting is cumbersome in many ways, it will generate incorrect data making it difficult to assess the scale of the bycatch problem as well as making it difficult to improve current fishing methods in order to avoid incidental catch.

To access more reliable bycatch numbers, there is a need for unbiased bycatch observation system, as in the one in place in the U.S., where independent on board observers record information on fishing effort, target catch and bycatch per-vessel (Moore *et al.* 2010). With reliable data, the bycatch can be quantified and used to develop policies and guidelines regarding methods used, species targeted, seasons and areas exploited. Since a consistent and reliable reporting system of bycatch is lacking in Turkey, I still think that this study has been

useful. Together with DMAD, I collected the first bycatch data in Antalya Bay and got an insight into the conflicts between fishermen and marine mammals in the area.

This study also recorded the perception amongst the fishermen that larger marine species seems to be more abundant and more frequently caught in fishing gear compared to the 20th century. Sea turtles were the most common bycatch in this study, the only marine megafauna species reported in all types of gear. This was a surprising finding, since the initial research plan of this study was to investigate marine mammal bycatch. This finding is considered as an "emerging topic" in my report as it is the first documented prevalence of sea turtle bycatch in Antalya Bay and it highlights the need to further investigate the sea turtle bycatch in Antalya Bay.

Great concern have been raised regarding sea turtle bycatch in longline fishery (Deflorio *et al.* 2005, Báez *et al.* 2007, Casale *et al.* 2007) and the use of longlines by small-scale fishers are responsible for more sea turtle deaths than larger industrial vessels (Casale 2011). Furthermore, all the sea turtle species that are present in the Mediterranean Sea (green turtle, leatherback turtle and loggerhead turtle) are listed as vulnerable or endangered by the IUCN red list and conservation management are therefore highly needed (Casale & Margaritoulis 2010). Since the use of longlines is dominating as gear, is overrepresented by small-scale fishermen in Antalya Bay and the fact that we observed both green and loggerhead turtle during our surveys, I emphasize that the situation in the Bay can be severe, should not be ignored and that appropriate conservation measures should be taken. Especially since almost half of the interviewees in this study reported sea turtle as bycatch in longlines.

4.2.2. Which types of fishing gear contribute to bycatch in Antalya Bay?

Although I identified contradictions amongst the answer I received, I can conclude that all types of fishing gear used by the respondents in Antalya Bay (longlines, purse seine net, trawl and other nets) are causing bycatch of marine megafauna such as cetaceans, seals, sharks, sea turtles and tuna. When the fishermen were asked in which type of gear they thought had the highest marine mammal bycatch, purse seine gained the most attention, which was also shown to have the highest bycatch rates among all species in this study. Though, since this gear was only used by a few fishermen in this study, it shows that it can sometimes be difficult and misleading to divide respondents into different groups.

4.2.3. Conflict between fishermen and marine mammals in Antalya Bay

This study identified a conflict between fishermen and marine mammals, especially dolphins, in Antalya Bay. The conflict was due to the fact that fishermen and dolphins are utilizing the same fishing grounds (Figure 6) and probably because they are targeting the same fish species. This was confirmed when fishermen admitted that they used the location of dolphins to locate good fishing grounds. Dolphins are known for being curious and approach unfamiliar objects to learn about them. Cetaceans may approach fishing gear to steal fish and might at the same time damage the gear (Donoghue *et al.* 2002, Taylor *et al.* 2008b). This phenomenon was also reported by fishermen in Antalya Bay. Economic loss, i.e. the cost of mending expensive fishing gear and the financial loss of lost catch, was the driving force behind the negative attitude towards dolphins and using illegal ways of mitigating the contact with dolphins in the bay. The conflict was reported by several fishermen in Antalya Bay and have increased according to the interviewees, correlating with the fishermen's perception of increased numbers of marine mammals in the bay.

Although this study focused on small-scale fisheries, we also observed tourist boats (Figure 5) as well as high speed boats near areas where we also observed marine megafauna. For example,

different types of boats were travelling at high speed through the same area where we observed Mediterranean monk seal and sea turtles during the field observations at Station 2. This highlights that the conflict between humans and marine mammals in Antalya Bay might be even more severe. To reduce this conflict and to protect the important habitats, a simple solution would be to enforce a speed limit within the areas where humans and marine mammals interacts, which GFCM could imply. Even better would be to create a marine protected area (MPA) or similiar. Organisations and conventions like ACCOBAMS and the Habitat Directive cannot enforce Turkey to implement a SPA or SAC since Turkey is not a member. BARCON and the Bern convention are the only ones that have legal obligations to force Turkey to protect threatened marine species.

4.3. Is bycatch a conservation issue in Antalya Bay?

The limited extension of this study and the absence on abundance and distribution studies, as well as previous collected data on bycatch of marine mammals in Antalya Bay, makes it difficult to determine if bycatch of marine mammals could be a potential threat against the populations' survival in Antalya Bay. However, this study points out an existing conflict between marine megafauna and fisheries, which in other parts of the Mediterranean have led to population declines of both marine mammals and sea turtles.

I strongly believe that the fishermen's attitude towards cetaceans could be improved. Even though the majority of the respondents had a positive feeling towards cetaceans, it is not sustainable that fishermen use firearms or other illegal fishing methods to avoid contact between dolphins and their gear. Although inspections by the police or coast guard are required to get along with this problem, it is not the best and only solution. To my great surprise and a bit ironic, the Antalya Dolphinarium Dolphin Park does not contribute to a sustainable fishery, if they are encouraging fishermen to catch and sell protected fish species, as fisherman K02 revealed. The dolphinarium would otherwise be a suitable place to spread information about bycatch and other examples of human impacts that damage the marine ecosystem in the bay and the rest of the Mediterranean Sea. Education is one of the key stones in ecosystem-based management and Turkey, as a member of CBD, is obligated to increase the public awareness and encourage the understanding of conservation and sustainable use of natural resources.

4.4. Conservation measures to reduce bycatch in Antalya Bay

4.4.1. How to address the bycatch issue more effectively in Antalya Bay

To mitigate the negative effects of incidental catches in Antalya Bay I support four alternatives, as suggested by Casale (2011), that can be implemented: (a) modifications of fishing gear, (b) modifications of fishing operations, (c) fisheries closures and (d) increase awareness and education of fishermen.

(a) To modify the fishing gear could be a simply and relative inexpensive way to reduce marine megafauna bycatch. The general problems with bycatch are that marine megafauna get easily entangled in fishing gear that is not used in a "proper way". As a member of the Code, Turkey can find advice on how to improve design of fishing gear or use mitigation measures. One way of reducing the interactions between marine mammals and fishing gear is to use acoustic advices. Pingers can easily be used to alert marine mammals about the gear is present in the area and are therefore an effective bycatch mitigation measure (Barlow & Cameron 2003, Carlström *et al.* 2009). This implementation could be extended in Antalya Bay to a certain amount. Although there

is a risk that the animals reduce its echolocation encounter frequency or get habituated to the sound after a while, which harbour porpoises have shown to do in previous studies, there might be enough residual effect to keep dolphins away from the gear (Cox *et al.* 2001, Carlström *et al.* 2009). The latter concern was pointed out by fishermen in Antalya Bay during the interviews, but this have not been investigated in the bay. Nevertheless, pingers are only a short-time solution and should be complemented with more long-term solutions. These long-term solutions are only possible if we can get a true picture of the extent of the problem in connection to the types of fishing gear used and which fishing grounds are used. Therefore, it is important with cooperation and trustworthiness between scientist and fishermen so that the most suitable mitigation measure could be implemented.

To decrease the sea turtle bycatch in trawl fisheries, a Turtle Excluder Device (TED) is recommended, which is a grid placed inside the net that diverts large objects towards the exit in the net (Casale 2011). The sea turtle bycatch concerning long line fisheries in Antalya Bay, can be mitigated by changing the design of the hooks. This has been done successful in reducing the bycatch numbers in long line fisheries in the Mediterranean Sea and in the North Atlantic, where a circle hook (most often large 18/0 circle) have been used instead of the more traditional "J"-hook (Watson *et al.* 2005, Piovano *et al.* 2009). Using a wider circle hook makes it more unlikely for the turtle to swallow it and a circle hook cause fewer hooking on the turtles' bodies than J-hook. Changing bait (if so is used) to fish instead of squid could also decrease the probability for the sea turtle to swallow the hook, since the fish often falls of into piece much easier than the squid. Another alternative to reduce sea turtle bycatch is by making the gear more visible. However, this should not be done with light sticks since they attract sea turtles (Casale 2011).

The fishing gear could also be out deeper and further offshore. This has proven to decrease bycatch of cetaceans and sea turtles, especially in long line fisheries (Spencer *et al.* 2000). Longlines could for example be put well below 40 m, since for example sea turtles rarely dive deeper than 100 m in the open waters (Casale 2011). However, it might be impossible for the small-scale fishermen in the bay to go further out to deeper fishing grounds due to limitation of the boat.

(b) Modification of fishing operations can be applicable on all types of fisheries in Antalya Bay. Fishing operations could for example take place at specific suitable times of the day. In Spain where most sea turtle bycatch in long line fisheries occurred during daytime, changing to night-time fishing did not affect the catch of the target species but reduced the sea turtle bycatch (Casale 2011). This could be an alternative for fishermen in Antalya Bay that are not already fishing night time. Conversely, cetacean bycatch has shown to be higher during night time in other studies. Further research needs to be conducted on what time of the day bycatch are most occurring in Antalya Bay to be sure which alternative is preferable. Shortening the duration of sets and the number of sets per fishing trip could also be positive in reducing mortality rates of marine megafauna (Casale 2011).

(c) Fishing closures would be the most suitable choice regarding preserving marine habitats and conservation of specifically threatened populations. Avoiding the areas where interaction occur with either dolphins, monk seals or sea turtles and move to other fishing grounds sounds easy but might not be applicable in reality (e.g. due to limitation

of fishing vessels or loss of income). Fishing operations could be restricted during certain season (e.g. during reproduction seasons) and this have already been shown to be working in Antalya Bay, to some extent. For example, the existing agreement that trawl fisheries are banned during the summer period seems to be respected, which is positive for the conservation management of marine megafauna and the ecosystem as whole. There are some parts of Antalya Bay where fishing activities are banned, but these areas are not well monitored by the coast guard according to some of the respondents. Other solutions are to implement protected areas, such as MPA, ecological (EPZ) or fishing protection zone (FPZ). Again, legal pressure from conventions, like BARCON and GFCM that Turkey has signed, are required to precipitate the implementation.

(d) The most important of all alternatives is to increase the awareness and education of fishermen regarding marine megafauna bycatch. This is also one of the biggest challenges in Antalya Bay. It is vital to inform and educate fishermen about the importance of marine mammals and sea turtles, especially the need to understand why we should protect them, and at the same time try to improve the sustainability of the fishing activities. This is not impossible and as noted by Alverson *et al.* (1994) among others, fishermen's education programs supervised by scientist have helped to reduce the rates of marine mammal bycatch.

4.4.2. Conservation management on political level

The major parts of the waters in Antalya Bay are considered as high seas, meaning that no country has any legal authority over the area (Figure 8). Only the coast and the Turkish territorial waters (12 NM from the coast), are covered by Turkish legislations. If Turkey would give formal consent to the UNCLOS convention and establish their exclusive economic zone (EEZ), FPZ or EPZ, Turkey would have sovereign rights within these areas, which other countries would need to comply. This could prevent industrial fisheries from other countries from exploiting parts of Antalya Bay, which interviewees complained about. The most optional would be to implement an EPZ or FPZ, since they are compatible with international law. Though, the limited geographical space in the Mediterranean makes it almost impossible for each country to establish their EEZ since the maritime boundaries would overlap. The whole basin would thereby be subjected to national coastal jurisdiction (Geijer & Jones 2015).

In the meanwhile, the ratification of BARCON and GFCM allows Turkey and other states in the Eastern Mediterranean to cooperate to address the issue of bycatch in the Eastern Mediterranean. These two regional conventions have the unique power to address the high seas (Geijer & Jones 2015), and can together control fisheries in the Antalya Bay to a certain extent. By ratifying UNCLOS and ACCOBAMS this control could be extended. Nevertheless, ACCOBAMS and UNCLOS cannot force Turkey to follow the treaty of the conventions, as long as Turkey is not a ratifying member. One aspect could be that other countries comply and state an example and more or less force Turkey to follow. These four conventions and organisations are perhaps the best examples of practical measures and enforcement that need to be taken in order to protect both marine species and their habitat. However, none of them are controlling bycatch in the Mediterranean Sea but I encourage Turkey to at least control the bycatch in Antalya Bay.

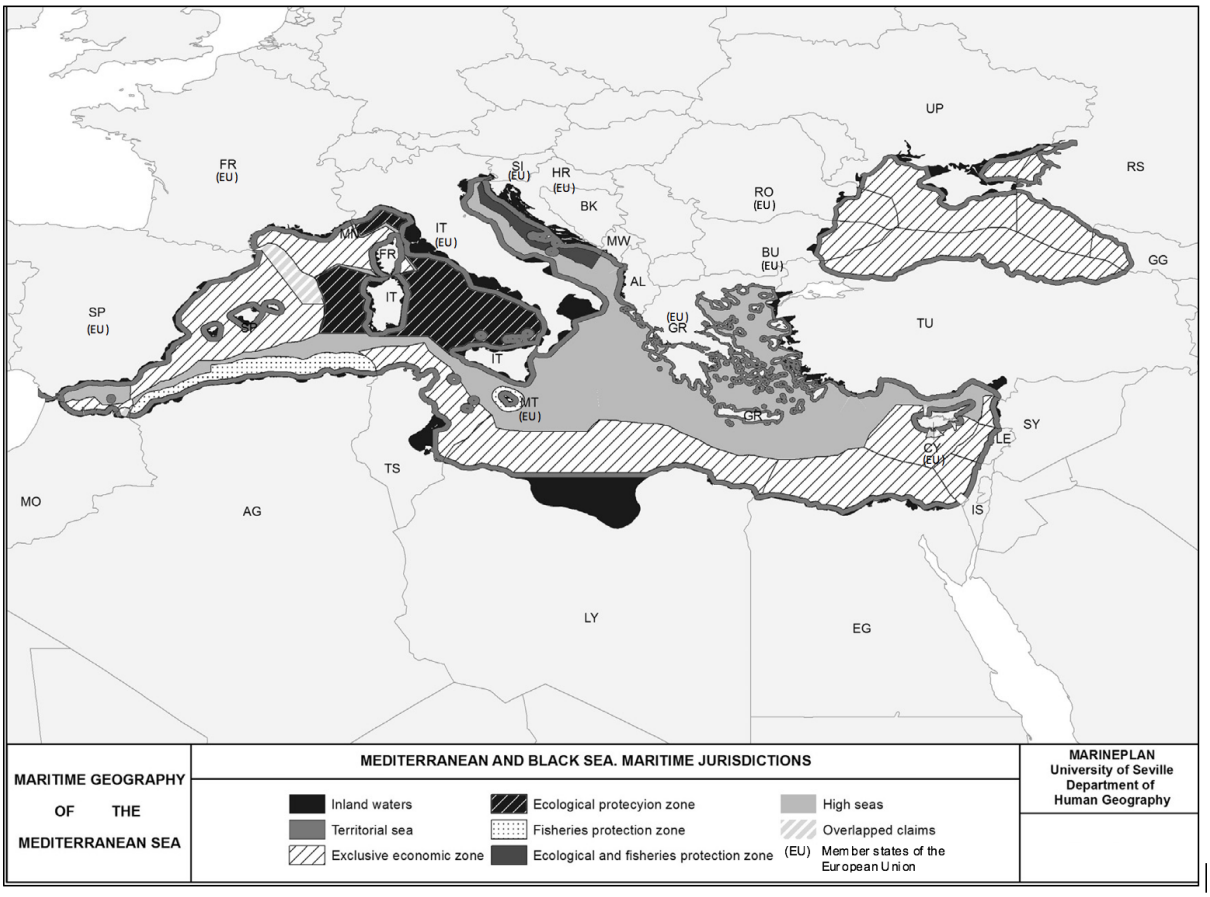

Figure 7. Maritime jurisdiction and zones established in the Mediterranean and Black Sea. Inland waters 7%, Territorial Sea 19%, Exclusive Economic Zone 26%, Fisheries Protection Zone 9%, Ecological and Fisheries Protection Zone 1%, Ecological Protection Zone 8%, High Seas 29%, and Other 1%. Member states of the European Union are marked with (EU). Figured modified from Geijer & Jones 2015.

Since conservation plans and management decisions are generally constructed on limited information, assumptions and simplifications (Lonergan 2011), as it seems in Antalya Bay, it is of great importance to conduct research surveys to collect as much valuable data as possible. Turkey has signed five of nine conventions (BARCON, GFCM, CITES, CBD, and BERN) mentioned in this study and several of these protects marine species that can be found in Antalya Bay. The conventions also demand the contracting party to take conservation actions that is required to avoid extinction of species, increase the public awareness and encourage understanding of sustainable use of natural resources, for example by creating a MPA. Even though around 24% of the Turkish coast are in some way managed or protected and Antalya Bay hosts two marine protected areas (Abdulla *et al.* 2008, Mangos & Claudot 2013), more protection is required. Furthermore, to keep a MPA effective, management plans, human and financial resources are strongly needed. Therefore, and to summarize, I encourage Turkey to create a protected area within the Antalya Bay, since it may host critical habitats for endangered sea turtles and the Mediterranean monk seal that were sighted several times during the observations. I also encourage Turkey to take responsibility and implement bycatch mitigation measures for a sustainable fishery and marine wildlife in Antalya Bay.

4.5. Conclusion and future studies

Bycatch of endangered marine mammals occurs in Antalya Bay when using any of the fishing gears investigated, but it is uncertain to which extent this happens. Longlines seem to be dominating the fishery in Antalya Bay, and are also responsible for high bycatch rates of endangered sea turtles. To gain a better understanding about the current biodiversity and the magnitude of bycatch in Antalya Bay, how bycatch can be avoided and to close the knowledge gap that exist in the Eastern Mediterranean basin, more studies need to be done regarding abundance, distribution and incidental catches in different fishing gear.

The Turkish bycatch reporting system is inadequate and needs to be improved, since fishermen are not always reporting their incidental catches. This study has demonstrated that interview studies can be used to get a better insight in the local fisheries and collect information from fishermen. Sometimes this is the only and best way to collect available data. However, I found that even though the respondents were willing to share information to a certain extent during the interview surveys, the credibility among the fishermen can sometimes be questioned. Sometimes their answers were contradictive. Education and awareness of the importance of conservation management should be put forward by the Turkish government since this is an important keystone to decrease bycatch. It would be beneficial for conservation if Turkey were to ratify more conventions, which would serve to improve marine governance and open for cooperation with other states to create a wider protection for marine species including cetaceans in the Eastern Mediterranean Sea.

Acknowledgement

First, I would like to thank the Swedish development cooperation (SIDA) for founding my Minor Field Study (MFS) and field work in Antalya, Turkey. Thank you, Ronny Alexandersson, for all the support during the application process for the scholarship. I am grateful to Aylin Akkya and Rafet Atan for assisting me during the interviews, for translating and sharing many coups of Turkish tea. Special thanks to Aylin for given me the opportunity to fulfil my study and for supporting me during my stay in Turkey and feedback on my thesis. Great thanks and a big hug to the whole DMAD team for helping me collecting data and making my stay in Turkey the best, full of joy, laughter and memories. Thanks also to all interviewees that participated in my study and the fishing cooperation in Yeni Liman, Antalya, for giving their time to share information. I am also grateful to my family and friends for their love and support, and the shared hours of sweating like pigs in Turkey. Teşekkürler ederim!

Most of all, I would like to thank my supervisors, Christina Geijer for making this master thesis possible and for her great support and pep talks during the whole process, and Cecilia Anderung for her great help, feedback and with revising my report with eyes like an eagle. Without them, I would have been lost in the darkness. Thank you, Bobby Lust, for putting me in contact with Christina in the first place. Stina Hällholm, thank you for supporting me with GIS and making the writing process less lonely. Thanks also to my opponents, Anna Minnefors and Raquel Pereira, and Anna-Kristina Brunberg, for their feedback on my report.

Finally, I would like to give myself a high-five for not given up, for keeping on searching for what I want to do as a marine ecologist, and fulfilling my dream to work with cetaceans.

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Appendix 1

Questionnaire

1. How old are you? _____ years
2. How long have you been fishing? _____ years
3. Do you own your own fishing boat?
   - ☐ Yes
   - ☐ No
4. What is your function on board of the vessel?
   - ☐ Skipper
   - ☐ Sailor
   - ☐ Mechanic
   - ☐ Other crewmember
5. How many fishermen are present on the boat? _____ persons
6. How long is your boat? _____ m
7. What is the horsepower of the motor? _____
8. Do you always land at this port?
   - ☐ Yes
   - ☐ No
     - i. If NOT, what percentage of fishing trips do you land in Antalya Bay? _____%
     - ii. Which other ports do you visit? _____
9. What type of gear do you fish with? Gear characterises:
   - ☐ Gillnet
     - iii. Mesh size:
     - iv. Total net length:
     - v. Net width/depth:
     - vi. Floating or anchored:
   - ☐ Trawl or towed nets
     - i. Mesh size:
     - ii. Bag depth:
     - iii. Opening size:
     - iv. Tow method and speed:
   - ☐ Longlines
     - i. Hook size:
     - ii. Nr hooks per line:
     - iii. Line length:
     - iv. Floating or sinking lines (bottom or surface):
   - ☐ Beach seine
     - i. Mesh size:
     - ii. Total net length:
     - iii. Net width/depth:
     - iv. Distance from shore:
   - ☐ Purse/surround seine
     - i. Mesh size:
     - ii. Total net length:
     - iii. Net width/depth:
   - ☐ Other

10. Number of fishing trips per month

Winter	Spring	Summer	Autumn
☐ 0-5	☐ 0-5	☐ 0-5	☐ 0-5
☐ 6-10	☐ 6-10	☐ 6-10	☐ 6-10
☐ 11-15	☐ 11-15	☐ 11-15	☐ 11-15
☐ 16-20	☐ 16-20	☐ 16-20	☐ 16-20
☐ 21-25	☐ 21-25	☐ 21-25	☐ 21-25
☐ 26-30	☐ 26-30	☐ 26-30	☐ 26-30

11. Duration of trips

Winter	Spring	Summer	Autumn
☐ 0-10 h	☐ 0-10 h	☐ 0-10 h	☐ 0-10 h
☐ 10-24 h	☐ 10-24 h	☐ 10-24 h	☐ 10-24 h
☐ 1-2 days	☐ 1-2 days	☐ 1-2 days	☐ 1-2 days
☐ 3-5 days	☐ 3-5 days	☐ 3-5 days	☐ 3-5 days
☐ >5 days	☐ >5 days	☐ >5 days	☐ >5 days

12. Number of times gear is set and retrieved (hauls) per trip: _____
13. Where do you fish? (Draw locations on map and take a photo)
    - ☐ During winter
    - ☐ During spring
    - ☐ During summer
    - ☐ During autumn
14. Are there areas where fishing is not allowed?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know
15. How does location and/or distance from shore change among seasons?

    _____
16. What time of the day do you fish? _____
17. Durations of trawls/sets: _____
18. Depth of hauls: _____ meters
19. During which seasons do you fish?
    - ☐ Winter (December – February)
    - ☐ Spring (March – May)
    - ☐ Summer (June – August)
    - ☐ Autumn (September – November)
20. In what season do you have the most fishing effort?
    - ☐ Winter (December – February)
    - ☐ Spring (March – May)
    - ☐ Summer (June – August)
    - ☐ Autumn (September – November)
21. Which species do you catch? _____
22. What is the average daily catch? _____
23. How many types of dolphins/whales do you know in your fishing area?

    _____
24. Can you differentiate them?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know
25. Do you recognize the type of dolphins and whales in the picture?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

26. How often do you spot dolphins and whales?
    - ☐ Every day
    - ☐ Almost every day
    - ☐ Every week

- ☐ Couple times per month
- ☐ Once a month
- ☐ Less than every month

27. Compared to when you started fishing, is dolphin/whale abundance today
    - ☐ higher
    - ☐ lower
    - ☐ or the same?
28. Where do you mostly spot dolphins/whales? (Show on the map)
29. What do the dolphins/whales do when you spot them?
    - ☐ Feeding
    - ☐ Swimming away from the fishing boat
    - ☐ Swimming towards the fishing boat
    - ☐ Don't know
30. Do you use the presence of dolphins or whales to locate fish?
    - ☐ Yes

      How? _____
    - ☐ No
    - ☐ Don't know
31. Are the dolphins or whales seen in close proximity to the gear during fishing operation?
    - ☐ Yes

      Which species? _____
    - ☐ No
    - ☐ Don't know
32. Is there any conflict between dolphins/whales and fishing boats?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know
33. Do you feed dolphins/whales?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know
34. Is it common that dolphins/whales are caught in fishing gear?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know
35. Do you know how common it is, how many dolphins/whales that are being caught?

    On average how many in a month
    - ☐ 0
    - ☐ <1
    - ☐ 1-5
    - ☐ 6-10
    - ☐ >10

      Estimate#: _____

    How many in the last year?
    - ☐ 0
    - ☐ <1
    - ☐ 1-5
    - ☐ 6-10
    - ☐ >10

    Estimate#: _____

36. In what type of gear do dolphins/whales get caught most commonly?
    - ☐ Gillnet
    - ☐ Trawl
    - ☐ Longline
    - ☐ Beach seine
    - ☐ Circle/surround/purse seine
    - ☐ Other (specify)_____
37. In which seasons is it most likely that fisheries encounter dolphins/whales in their gear?
    - ☐ Winter (December – February)
    - ☐ Spring (March – May)
    - ☐ Summer (June – August)
    - ☐ Autumn (September – November)
38. Are dolphins/whales caught on purpose or accidently?
    - ☐ On purpose
    - ☐ Accidently
    - ☐ Don't know
39. If fishermen catch a dolphin or whale, do you know what they do with it?
    - ☐ Eat
    - ☐ Sell
    - ☐ Use as bait
    - ☐ Other use
    - ☐ Discard at sea(dead)
    - ☐ Bring back to harbour (dead)
    - ☐ Release (alive)
40. Why do you think dolphins/whales are getting caught in fishing gear?
    - ☐ They steal the fish from the gear because they are hungry
    - ☐ Eat the fish from the gear because it is easy
    - ☐ The dolphin/whale doesn't not pay attention to the boat
    - ☐ The boat goes towards the dolphin/whale
    - ☐ Other (*specify*)_____
    - ☐ Don't know
41. Have you ever seen some larger species in your gear?
    - ☐ Yes
        - ☐ Dolphins
        - ☐ Whales
        - ☐ Seals
        - ☐ Tuna fish
        - ☐ Sea turtles

          In which gear? _____
    - ☐ No
42. If so, do you know which species?
    - ☐ Yes

      Which species? _____
43. Do you know if you have to report dolphins/whales if you catch them in your fishing gear?
    - ☐ Yes

      Do you report your bycatch? Yes No
    - ☐ No
    - ☐ Don't know
44. Compared to when you started fishing, are dolphin/whale capture in fishing gear
    - ☐ higher
    - ☐ lower
    - ☐ or the same?

45. Do you take any measures to avoid interactions (damage to catch/gear and bycatch) with dolphins/whales?
    - ☐ Acoustic devices (specify!) _____
    - ☐ Navigate to alternative fishing grounds away from the dolphins/whales

- ☐ Postpone the fishing operation until the dolphins/whales leave the area
- ☐ Reduce the fishing/soak time
- ☐ Scare the dolphins/whales away from the vessel (specify in what way)

  _____
- ☐ Other (specify!) _____
- ☐ Don't take any measures

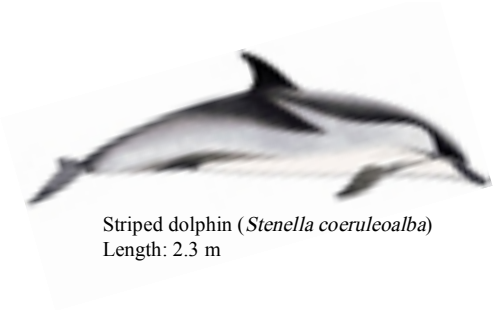
46. Are marine mammals protected by law?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know
47. Do you think it is important to protect dolphins/whales?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know
48. What are your general feelings about dolphins/whales?
    - ☐ Positive
    - ☐ Negative
    - ☐ Neutral
    - ☐ Don't know

      Why? _____
49. What are your suggestions to reduce conflicts/interactions between dolphins/whales and fisheries?
    - ☐ Fishing in different seasons
    - ☐ Fishing in different areas
    - ☐ Others (*specify*): _____

Appendix 2

Illustration card over the most common cetaceans in Antalya Bay

Illustrations made by Massimo Demma, collected from http://www.cetaceanalliance.org/species.htm in July 2015. Permission is obtained from Massimo Demma and Cetacean Alliance/Ocean Care to publish the illustrations in this thesis.



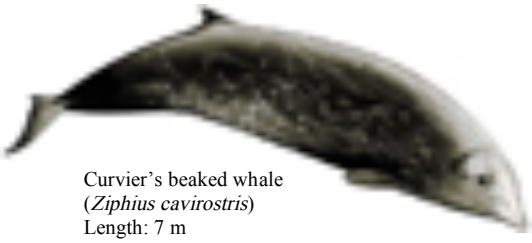
Striped dolphin (*Stenella coeruleoalba*)
Length: 2.3 m

Short-beaked common dolphin
(*Delphinus delphis*)
Length: 2.3 m

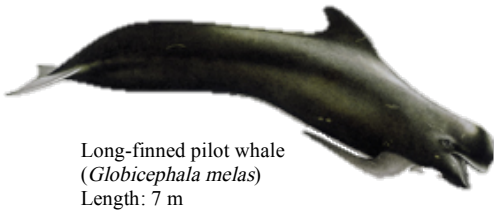
Common bottlenose dolphin
(*Tursiops truncatus*)
Length: 3.5 m

Harbour porpoise (*Phocoena phocoena*)
Length: 1.70 m

Risso's dolphin (*Grampus griseus*)
Length: 4 m

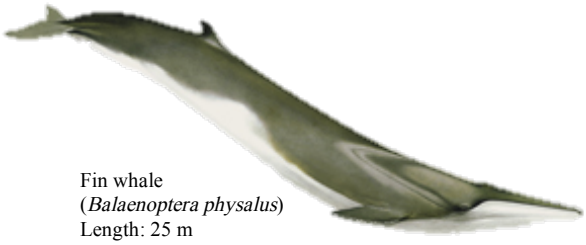


Curvier's beaked whale
(*Ziphius cavirostris*)
Length: 7 m



Long-finned pilot whale
(*Globicephala melas*)
Length: 7 m

Sperm whale (*Physeter macrocephalus*)
Length: 16 m



Fin whale
(*Balaenoptera physalus*)
Length: 25 m