Ship strikes in the Mediterranean Sea: assessment and identification of conservation and mitigation measures

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Introduction

Collisions between ships and whales, both odontocetes and mysticetes, are nowadays regularly reported from all the world's oceans, with evidence of ship collisions with at least 11 species of large whales (Laist et al. 2001, Jensen and Silber, 2003; Van Waerebeek et al., 2007). Of these, the fin whale (*Balaenoptera physalus*) is most commonly recorded as being hit by ships worldwide. Ship strikes in the Mediterranean Sea are rather common and most likely represent the main anthropogenic threat for fin whales and sperm whales (*Physeter macrocephalus*), with unusually high fatal rates reported every year (Panigada et al., 2006).

The Mediterranean Sea is particularly susceptible to ship-associated impacts due to a high-volume of shipping routes, long history of use, sensitive deep sea ecosystems and genetically and reproductively differentiated cetaceans populations. Over the past half century, shipping has greatly expanded in the Mediterranean Sea. Between 1985 and 2001, a 77% increase was recorded in the volume of ship cargo loaded onto and unloaded off Mediterranean ports. Every year, 220,000 ships greater than 100 tons cross the Mediterranean basin and approximately 30% of international sea-borne volume originates from or is directed towards the 300 ports in the Mediterranean Sea. These values are expected to grow three or four fold in the next 20 years (Dobler, 2002). Furthermore, a total of over 9,000 vessels, including ferries, fast ferries and hydrofoils, as well as military, fishing, pleasure and whale-watching boats, navigate the waters of the Western Basin daily (Scot, 2004).

The reported levels of marine traffic, the forecasted increase in the commercial marine traffic, coupled with the current threats the cetacean populations living in the Mediterranean Sea regularly face (noise, presence of noxious manmade pollutants in the marine food web, increasing disturbance, interactions with fisheries, depletion of prey and habitat degradation and, more recently, interrogations about impacts of global changes) suggest the urgent need for proper mitigation measures. In addition, most of the species regularly occurring in the Mediterranean Sea belong to genetically isolated populations, with little gene flow with the north Atlantic conspecifics (Reeves and Notarbartolo di Sciara, 2006); exposing these species to such high anthropogenic pressures may lead to a severe loss at population or sub-population levels.

Analysis of available data

Fin whales

Records concerning 287 fin whales stranded along the Mediterranean coasts, caught on the bow of a ship or found floating at sea, have been examined (Panigada et al., 2006). Of these, 46 (16.0%) were confirmed to have died because of a ship strike. Between 1972 and 2001, 43 whales were killed, yielding a mean fatal strike rate of 1.43 animals per year. In addition, nine out of 383 photo-identified whales (2.4%) had wounds positively attributed to a ship strike. The low reported number of live whales presenting evidence of collisions may indicate that few animals survive a ship strike or that collisions with small boats are less frequent; moreover it is likely that the vessels involved were of small enough size and weight to allow the whale to survive the consequences of the collision, otherwise deathly.

Moreover, the analyzed data suggest that the Pelagos Sanctuary, the Gulf of Lions and the adjacent waters are high-risk areas for whale collisions.

Sperm whales

According to the research and data of Pelagos Cetacean Research Institute during the last decade (1997-2007), 1.4 sperm whales strand per year along the Greek coasts. At least 70% of the stranded whales have clear propeller marks on their body and their death is likely to have been provoked by a collision with large ships. Propeller marks have been observed also on live, photo-identified animals (at least three) of the same population unit (Hellenic Trench). Considering the small number of sperm whales inhabiting the Hellenic Trench (recently estimated at about 180 animals; Frantzis et al. in preparation), and the Mediterranean Sea in general (Lewis et al. 2003; Notarbartolo di Sciara et al. 2006), the rate of vessel collisions with sperm whales appears of serious conservation concern for the endangered population of this species in the Mediterranean Sea.

The recorded levels of marine traffic, its forecasted increase, and the likely high occurrence of unreported fatal strikes, combined with the other anthropogenic threats (noise, xenobiotic contamination, disturbance, mortality in fishing gear, prey depletion, habitat degradation and the effects of climate change), suggest the urgent need for a comprehensive basin-wide conservation strategy, focused on ship strike mitigation measures, like real-time monitoring of whale presence and distribution to re-locate ferry routes to areas of lower cetacean density, reducing ship speed in high cetacean density areas, designate exclusion areas, etc.. Moreover, the fact that most of the cetacean species from the Mediterranean Sea belong to genetically and reproductively isolated populations, renders this action particularly needed.

Occurrence and frequency of collisions can be either underestimated (unnoticed or unreported events, incomplete or lacking necropsies, masking of fatal ship strikes by advanced carcass decomposition, inadequate data collection techniques) or overestimated (e.g. carcasses struck post-mortem) (Pesante et al. 2000; Laist et al. 2001; Clapham, 2002). Considering all the biases possibly affecting the Mediterranean Sea dataset, there is consensus that reported numbers are more likely to be strongly underestimated rather than overestimated. This assertion suggests that the real number of fatal collisions is likely to be higher than that reported one, as also suggested for North Atlantic right whales, where high values of underestimation for human-caused mortalities were suggested (Kraus et al. 2005).

Many different solutions have been proposed to reduce the risk of collisions, ranging from instruments mounted onboard ships to detect whales (e.g., sonar, or night vision devices), to acoustic alerting devices to warn whales of approaching boats (Nowacek et al., 2004), bottom-anchored passive sonar systems designed to detect whales locations, and specially trained observers onboard ferries. None of these solutions alone will provide a complete solution to avoid ship strikes. Some proposed solutions have undesired side-effects (such as introducing additional underwater noise pollution) or are only effective in particular situations (e.g., during day time, during specific weather conditions, only when the whales vocalize, only at short distances or within certain angles from the ship's bow). Particularly, acoustic alerting devices may not be the most appropriate solution, since in high-density shipping areas the noise present may disturb or block the animals' acoustic perception in regards to approaching vessels, or their timely alertness of warning signals emitted from a ship; moreover, the frequency of a warning signal may benefit one species, while another - with a different acoustic window - may suffer from the effects of the signal itself. Behavioural responses to acoustic alerting devices may also not reduce risk if the whales' response is to come to the surface (Nowacek et al., 2004).

It appears likely that a suite of measures that each contribute to a reduction in risk will offer the best approach to minimizing the number of collisions between whales and vessels in the Mediterranean.

The only management measures currently taken in the Mediterranean Sea are the Notice to Mariners to protect cetaceans from the risk of ship collisions in the Strait of Gibraltar and the new location for the "Cabo de Gata" Traffic Separation Scheme. In the Gibraltar Strait, a Notice to Mariners has been published on January 2007 by the "*Instituto Hidrográfico de la Marina*" (Spanish Navy Hydrographical Institute under the Ministry of Defense). This Notice establishes a security area characterized by high densities of sperm whales, where crossing ships are recommended to limit maximum speed to 13 knots (following the suggestions by Laist et al. 2001), and to navigate with particular caution. The same notice will be broadcasted regularly by VHF radio from April to August and included in the Nautical Charts (Tejedor et al. 2008). In the waters off the Natural Park of Cabo de Gata – Nijar (an extremely valuable and sensitive coastal habitat and one of the most important Special Areas of Conservation for the bottlenose dolphin (*Tursiops truncatus*) and the loggerhead turtle (*Caretta caretta*) within the framework of the European Union's Habitat Directive), the Spanish Maritime Authorities promoted, inside the IMO, the repositioning of the TSS of Cabo de Gata from 5 to 20 nautical miles off the coast. The new location, operating since the 1st of December 2006, was published in the Notice to Mariners and International Nautical Charts (Tejedor et al. 2008).

Aims and objectives

Scientists and research Institutes from Italy, France and Spain (e.g Alnitak, Tethys Research Institute, and Souffleurs d'Ecume, etc.), within the framework of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) are joining efforts to asses and suggest conservation and mitigation measures to address ship strikes affecting large cetaceans within the Mediterranean context. This will cover the following steps:

- Synthesize the knowledge of ship strikes in the Mediterranean and place them in a local and global context;
- Discuss and prioritize mitigation and management measures that might effectively be employed to address the issue.

Action 1 - Document mortality from ship strikes to obtain reliable estimates of rates of human-caused removals, to generate a database for analysis, including data from: 1) interviews with captains and crews to obtain information on known ship strikes (past, present and future), using an agreed protocol (still to be implemented); 2) existing strandings networks (including detailed necropsies); and 3) ongoing photo-identification studies (photographs may contain evidence of non-lethal encounters with vessels). The database would be developed in collaboration with the IWC global ship strikes database (Van Waerebeek and Leaper, 2007).

Action 2 - Map the temporal and geographic distribution and abundance of large cetaceans in relationship to similar information on vessel traffic to identify potential higher risk areas. Use the data to develop models to explain and predict fin and sperm whale distribution and abundance, also in relation to maritime traffic, and to refine existing estimates of abundance

Action 3 - Use AIS (Automatic Identification System) data collected during cetacean surveys with radio receivers (or available through other sources, e.g. Port Authorities) to describe patterns of shipping density and relate them to whale presence and distribution and risk of ship strikes. Existing sources of AIS data (like the archives collected from shore based stations) will be explored to identify if there are gaps in geographical coverage that could be filled by collecting data from dedicated vessels. Operators of suitable vessels will then be approached to provide support in collecting these missing data. Vessels involved in whale studies will also be encouraged to collect AIS data which facilitates direct comparison of whale and shipping distribution patterns (Leaper and Danbolt, 2008). Further analytical methods to generate estimates of shipping density by combining different sources of AIS data will also be developed during the project. These should also be applicable to other areas.

Action 4 - Conduct feasibility studies to assess the efficiency of onboard dedicated observers to detect whales (a) to collect data and (b) as a mitigation measure. Please refer to Annex 1 for details of one possible experiment involving onboard observers on ferries. This involves switching between two route options on consecutive transits, depending on what is seen by observers. This approach relies on patterns of spatial distribution of whales that persists for at least the length of time between ferry transits, but does allow the risk reduction to be quantified. Thus, a decision on whether this was a useful approach for reducing risk could be made on the basis of the data collected during the experiment. The use of dedicated observers will require co-operation from shipping companies and approaching such companies will be the first task. A review of whale density and seasonal distribution patterns in areas where dedicated observers may be used will also be necessary for some kind of power analysis to determine how much observer effort is likely to be required.

Action 5 - Test and adopt mitigation measures such as training of crew members and increase awareness of collision risk and importance of reporting strikes by programs of Education of Enforcement Officials (Coast Guard, Port officials, Maritime Traffic Managers, etc.). Further develop and implement real-time networks between commercial ships to report the position of large cetaceans to limit collision risks (REPCET).

Action 6 – Promote effective regional coordination, especially for those countries that share cetaceans' populations susceptible to a ship strikes. This coordination may include: 1) identification and exchange of information on threats to the identified cetaceans of concern and their habitat and coordination in the event of an emergency situation involving a ship strike including collaboration on recovering carcasses found at sea and in conducting necropsies and sample analysis to determine the cause of death and to improve our understanding of the interactions between ships and whales; 2) Draft a common (ACCOBAMS wide) protocol to assess ship strikes and report on evaluation of the number of ship strikes and associated details; 3) designing and implementing measures to reduce and minimize the risk of ship strikes, including the development of education and outreach materials and other guidance, and joint management plans; 4) list of areas with high shipping density and assessment of the potential risks of collision with cetaceans; 5) facilitation of cooperative research and unfettered exchange of scientific data on the species of concern, including monitoring the species' distribution and occurrence particularly in relation to vessel traffic; and 6) coordination and, where possible and appropriate, development of proposals for specific measures at international organizations such as the International Maritime Organization;

Action 7 – Contribute, as appropriate, to the current international (e.g. initiatives within International Maritime Organization and International Whaling Commission) and regional momentum for reducing and minimizing ship strikes of cetaceans through a proper implementation of existing policy recommendations and actions, including suitable evaluation to promote compliance by ships flying their flag and, if necessary, adjust the measures accordingly.

The project will be managed jointly by the participants of the Steering Committee, established under the auspices of the ACCOBAMS Scientific Committee and the Pelagos Sanctuary Secretariat. This will allow placing the

effort into a global context, to provide the necessary expertise from other contexts and to assist in identifying research priorities and select mitigation actions.

The work carried out will ultimately lead to the creation of a network, including different research institutes and concerned shipping companies to build a central data base on ship strike data, to facilitate information exchange and data sharing and to apply and test the suggested mitigation measures.

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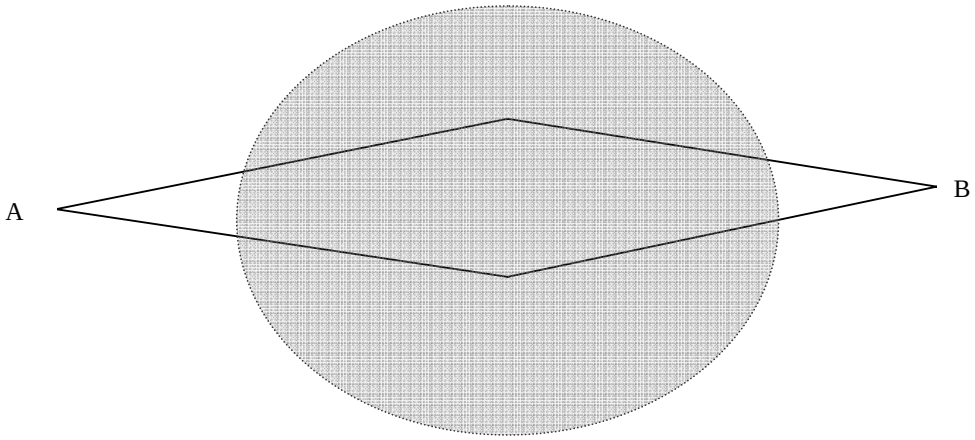
Annex 1: A possible experiment to assess the potential for small scale route switching based on visual observation effort to reduce collision risk between cetaceans and fast ferries

Ferry operators are constrained by commercial pressures and particularly running to time tables which limits the options for reducing collision risk. The following is a suggestion for an experiment which uses data from visual observers on ferries to switch between two alternative routes of equal distance. This has the advantages that time tables are not affected and also that risk reduction can be quantified. The extra distance travelled need only be quite small – a few %. In addition, the ferry could still operate a system of avoiding imminent collisions based on observer sightings without compromising the experiment.

Consider a hypothetical ferry route between ports A and B, which are 100km apart and running through an area of potentially high whale density (indicated by the grey oval). On the basis of whatever data were available, two possible routes could be chosen. If these were as indicated in the diagram such that at the furthest point they were separated by 20km then this would add 2% to the total travel distance compared to the straight line between A and B.



Visual observers would be placed on the ferry which would initially alternate between the two routes. After a number of transits it would be possible to generate an expected number S for the number of sightings dependent on some simple categorical variables related to sighting conditions (e.g. sea state). A decision rule would then be developed such that if the number of sightings on a transit was less than S then that transit would be repeated and if it was more than S then the ferry would switch to the alternative route. The effectiveness of route switching would be assessed by comparing the observed number of sightings on each consecutive pair of transits. After some time it would be possible to estimate the time period over which aggregations of whales persist at the spatial scale of the two alternative routes. If whales pass through the area quickly then there would be no benefits to this approach but for species which tend to remain in a limited area for periods of several hours or days (as indicated by some whale watching data) then the risk reduction could potentially be quite high.

Ideally this approach would be initiated at the start of the study, but it is possible that ferry companies may wish to see more data on which to base the experiment before being prepared to operate on two different route options. Preliminary data could be collected on the ferries usual route in order to assess the likely mean and variance of sighting rates. These values would be useful in deciding how many experimental ferry trips would likely be required. Under very good conditions, fin whale blows may also be detected at ranges of up to 9km (Leaper and Gordon, 2001) from a high observation platform on a large vessel using 7x50 binoculars. These ranges of detection might be adequate in order to identify distribution patterns of whales persistent over spatial and temporal scales that would allow an assessment of whether route switching might be an effective measure for risk reduction. This analysis could be as simple as finding consistent patterns of more sightings on one side of the vessel track than the other on consecutive transits. This finding would be sufficient to be able to propose a small shift in route in response to sightings with some quantification of the likely risk reduction achievable. However, consideration needs to be given to co-variates such as wind direction, lighting conditions and observer differences that could confound the results.