JOINT ACCOBAMS / PELAGOS WORKSHOPS ON FIN WHALE AND COLLISIONS
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Report of the

Joint ACCOBAMS/Pelagos Workshop on Large Whale Ship Strikes in the Mediterranean Sea

(14-15 November 2005)

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1. Objective of the Working Group

The objective of the working group was to synthesize the knowledge of ship strikes of fin, sperm, and other large whales in the Mediterranean Sea, including the Pelagos Sanctuary for Mediterranean Marine Mammals, and to place them in a global and local context; to determine data gaps vital to a more comprehensive assessment of the issue; to discuss whether mitigation and management measures were necessary; and to discuss what mitigation and management measures might effectively be employed to address the issue.

2. Review of present knowledge on strikes and mortality

Laist et al. (2001) and Jensen and Silber (2004) were acknowledged by the workshop as presenting the best known reviews of ship strikes world wide.

Weinrich presented information on collisions between whales and ferries around the world. World-wide records of collisions between whales and ferries were investigated through a review of existing literature and a request for additional records via a dedicated email list "Marmam" on the internet. Twenty-four collisions were reported, of which 11 (45.8%) were with fast ferries (those traveling at speeds greater than 30 knots). Ten collisions were from the Mediterranean Sea, primarily with fin whales (*Balaenoptera physalus*), and additional records of strikes were found from many other locations. The records reported are likely to be a notable under-representation of the actual number of collisions that took place. More detailed information is needed from these and other areas where high-speed ferries operate, including encouragement of collision reporting and detailed necropsies of beach cast or floating carcasses. Such data will help illuminate the actual risk to whales from this rapidly expanding ferry traffic.

Weinrich also presented information on world-wide collisions with whale watch vessels, both because of the growing whale watch industry in the Mediterranean Sea and the details that could be gleaned from known strike records. Thirty-two collisions were reported, including 17 with humpback whales (*Megaptera novaeangliae*), two with minke whales (*Balaenoptera acutorostrata*), nine with fin whales, one each with gray (*Eschrichtus robustus*), sperm (*Physeter machrocephalus*), and killer (*Orcinus orca*) whales, and one where the species was not known. The entire suite of requested data was not available in all cases. All but one of the records originated from North America. The one exception was a collision with a sperm whale in Norway. The records reported are likely to be an under-representation of the actual number of collisions that have taken place. Records were evenly split between collisions that occurred in transit (14) and while whale watching (14). Three occurred when approaching or leaving whales. The majority of collisions took place with whales that were not the focus of whale watch activities. In 16 cases the whale that was struck was not seen prior to collision; its presence was known in only six. Four of the collisions are known to have resulted in serious injury or mortality, while 15 of the collisions resulted in reports of either no damage to the whale or apparently minor injuries. Of the eight collisions that took place when boats were traveling at speeds of 18 knots or higher, three resulted in serious injury or mortality to the whale, and only one resulted in a minor injury (in three cases the extent of the injury was unknown). Three of the four collisions, which resulted in major injuries or fatalities, involved vessels greater than 30 m in length. The results indicate that whale watch vessels present the highest risk of seriously injuring or killing a whale when larger vessels transit at high speeds, indicating a need for caution as whale watch industries increase the use of larger, faster whale watch boats.

Knowlton presented information on ship strikes of North Atlantic right whales (*Eubalaena glacialis*) along the east coast of North America. Ship collisions with North Atlantic right whales have been identified as the leading cause of mortality in this extremely endangered species. At least 24 of 68 carcasses documented between 1970 and 2005 were from whales that died as a result of ship collision. Typically 1-2 ship struck carcasses are documented each year, a level which is unsustainable for this small population. Efforts to mitigate ship strikes in both the US and Canada have been underway since 1997. Technology, education, and changes in vessel operations have all been reviewed. At this point in time, there are no technological approaches that can mitigate this problem though there are some promising ideas on the horizon. Educational efforts have been underway on two fronts – first making vessel operators generally aware of right whale distribution and precautionary measures to reduce the chance of a strike; second, to provide real-time information to vessel operators of right whale locations. Although educational efforts have been an important step, it has not led to a reduction of risk to right whales. Some recent studies indicate that ship operators are not changing the way they operate in areas with right whales when information is provided to them. Regulated changes of vessel operations have been implemented in Canada with the shifting of the shipping lanes out of the high use right whale area. In the US, speed restrictions and routing changes are being considered all along the eastern seaboard. A proposed rule for these regulatory changes should be published early in 2006 with a final rule to hopefully be implemented in 2007.

Van Waerebeek brought to the workshop information on the upcoming review of ship collisions by the International Whaling Commission (IWC) Conservation Committee (IWC/SSWG, 2006). Ship strikes have increased over past decades due both to an increase in shipping and in the size and speed of the vessels. Mortality is significant and underreporting is suspected to be vast. The IWC's Revised Management Procedure requires accounting of all anthropogenic mortality when setting catch limits for whale stocks. To help estimate mortality the Conservation Committee (CC) initiated the Ship Strikes Working Group (SSWG). Proposed by Belgium it was adopted at the 57th IWC Annual Meeting in Ulsan, Korea in June 2005. Parties who contributed to the first consultative meeting of the SSWG, apart from convening Belgium included Argentina, Australia, Brazil, France, Italy, Luxembourg, New Zealand, South Africa, UK and USA. Denmark/Greenland and Korea acted as observers. The main purpose of the consultative meeting was preparatory, i.e. defining terms of reference and drafting a proposal to the Commission that ship strikes with whales be approved as one of two high priority issues to be implemented in the CC in 2005-06. A brief overview was given of the SSWG rationale, its work plan in preparation for IWC/58, and its aspiration to establish productive working relationships with other international entities that embody technical competence in ship strike issues including ACCOBAMS. The SSWG pretends to address ship strike issues with long-term and global perspectives. It comprehends both an email discussion group addressing mostly policy matters (reports back to the Commission) and a small group of scientists who will work towards the compilation of a global repository of ship strike data, for improved modelling and analysis. Information exchange with ACCOBAMS Parties and scientists is proposed, as well as open avenues of collaborative efforts to develop future mitigation measures.

2.1 General Reporting and detection methods used to obtain estimates of strikes and mortality

2.1.1 From Vessels

One of the participants in the workshop (Capoulade) noted that while working as a Captain aboard a high-speed ferry between mainland France and Corsica, he was aware of several fatal collisions with fin whales that took place while he was aboard. One participant commented that despite attempts to get records of ship

strikes from other ferry companies in both France and Italy that worked in the Pelagos Sanctuary, little cooperation had been forthcoming.

It was noted that often merchant ships would not be able to accurately report strikes unless the whale lodged on the bow, as the vessels were often unaware of the collision when it took place.

Hence, the workshop agreed that while the records that had come from either the ships or the companies that operated them were helpful, they were unlikely to give an accurate picture of the true extent of collisions with large whales.

2.1.2 From Carcass Inspection

Podestà presented information on whale stranding results from Italy. Since 1986 the Italian Stranding Network (Centro Studi Cetcaei) has been collecting data on cetaceans stranded, accidentally caught, and possibly killed by vessel collisions for the whole Italian coasts and its nearby seas. Data were collected by the Natural History Museum of Milan, and an annual report has been published yearly in the scientific journal "Atti della Società Italiana di Scienze Naturali," with a complete list of the information concerning each event. The Mediterranean Marine Mammals Tissue Bank based at the University of Padua also collects and stores samples from these stranded animals. An analysis of this data set showed that fin, minke, and sperm whales were stranded with evidence of a ship strike during the period 1986-2004. Out of 60 total fin whale strandings and reported carcasses, 11 were found with clear evidence of collisions (the majority arrived in port on the bow of a ship). In 2005, three more fin whales were struck by ships. Only six sperm whales out of 125 total strandings during this period, and one minke whale was found with evidence of ship collisions out of four total strandings. Geographical distribution and percentages of the events were also discussed. The number of fin whales fatally struck was very high in the Ligurian Sea: 10 out of 12 fin whales were likely killed by strikes in this area. Data on collisions with smaller species were not significant in comparison to the total of stranded animals. Difficulties on the finding of the collision as the cause of death were presented. Necropsy was usually very difficult to carry out as the local and national authorities destroy whale carcasses as soon as they can. The existing national stranding network can continue to act as a reference body in collecting information on these events, and a special request to the Italian Ministry will be submitted in order to obtain more support from Port Authorities, Coast Guards and local veterinarians. If possible this should be expanded to all ACCOBAMS member states.

Wurtz presented a summary of information on five carcasses off Italy. A floating carcass of a female fin whale was found off Savona-Vado harbour in July 2004. Its fresh condition suggested it had recently died, and the fact that it was found on the shipping route between Savona and Calvi suggested it could have been killed by a collision. A few days later a foetus stranded near Imperia. Genetic analysis showed there was no relationship between the two specimens. In October 2005 a ferry carried on its bulbous bow a large fin whale into the Livorno harbour. Its relatively bad condition suggested it died some time before being struck. Two fin whales were found floating in the Genoa harbour on 24 March 2004, and on 14 September 2005. The first specimen was a male, 11 m long, weighing about 8 tons; the second one was a newborn female 6 m long. The two specimens showed very clear external signs of collision on the skin and because of their fresh condition it was proposed that they were killed by a ship. In spite of the quick response of the Italian Stranding Network staff, because of the pressure by the Port and Sanitary authorities, it was impossible to carry out an adequate necropsy. In the cases like this it is noted that the capability to collect samples is inversely proportional to the animal dimension. It was stressed that in this kind of event it is fundamental to carry out a detailed necropsy in order to determine if the animal is dead before or because of a ship strike. Moreover the possibility to obtain correct tissue samples can help to understand if the specimens were suffering some pathology or environmental stress which can also affect its capability to avoid the collision. Some histological techniques

could be applied to the carcasses, including a test of the cytokeratin expression in the dermal layer structures. A preliminary heavy metal analysis carried out on the muscle of the 11 m specimen showed a higher level of some elements (Zn, Cd, Pb, Fe, Ni, Cu and Cr) than in the striped dolphin from the same area.

The workshop discussed the lack of cooperation from Italian and French national agents in facilitating, or even allowing, a complete necropsy. In many cases, the rush to dispose of the carcass prohibited necessary detail. However, it was agreed that many sources have provided ample evidence that full necropsies are required to determine whether animals, which showed no obvious external wounds from collisions, provided internal evidence (hematomas, broken bones, etc.) of a collision. Alternately, internal examinations are necessary to confirm that external strike wounds took place pre-mortem, and were not the result of collisions with floating carcasses. The workshop agreed that this was a priority item in a more complete understanding of the true extent of ship collisions.

Fernandez presented the workshop a method to evaluate the probability of death from a collision from stranded animals using histopathology. The objective of this study was to evaluate the presence of fat emboli in lung tissues obtained from cetaceans stranded in the Canary Islands. Lung samples from 84 cetaceans of 15 different species from the Canary Islands were studied. The tissues had been fixed in 10% neutral buffered formalin solution. Tissues samples were post-fixed with osmium tetroxide. Routine laboratorial techniques for section and staining (haematoxylin-eosin) were carried out.
Cetaceans of six different species, presented diverse lung fat embolism grades characterized by clear drops (H/E), black-stained with OsO_4 in the lumen of small and medium sized pulmonary vessels: *Kogia breviceps, Kogia sima, Mesoplodon densirostris, Physeter macrocephalus, Tursiops truncatus)* and *Ziphius cavirostris.* The causes of death of the 14 positive animals were associated with: ship collisions; massive strandings and unknown or natural causes. According to these results, a clear association between lung fat emboli with violent trauma (ship collision) is observed.

The workshop agreed that this technique, if further validated with continued study, represented a promising way to gain further insight into the extent of the ship collision problem.

2.2 Fin Whale Data

Fin whales (*Balaenoptera physalus*) are common in the Mediterranean Sea, where they tend to concentrate in localized, highly productive areas for feeding purposes (Notarbartolo di Sciara et al. 2003; Orsi Relini et al. 1994; Zanardelli et al. 1999). One such aggregation area for fin whales is the Pelagos Sanctuary for Marine Mammals, which lies between Point Escampobariou on the French coast, Fosso Chiarone on the continental coast of Italy, Capo Falcone and Capo Ferro, respectively on the western and north-eastern coasts of the Island of Sardinia. Oceanographic features of this MPA support high levels of prey biomass (Jacques 1990; Astraldi et al. 1995) and a large number of cetaceans (Notarbartolo di Sciara et al. 1993).

Genetic evidence suggests that the Mediterranean Sea population, estimated in the western basin at around 3,500 (Forcada et al. 1996), is resident and characterized by only very limited gene flow with the North Atlantic population (Bérubé et al. 1998; Palsboll et al. 2004). This small and ecologically isolated population faces recent threats, where widespread environmental degradation has taken place in recent years. Acoustic pollution, presence of detrimental man-made compounds in the marine food web, increased human disturbance, interaction with fisheries and depletion of living resources, are among the main problems that affect Mediterranean fin whales (Notarbartolo di Sciara & Gordon 1997).

To assess the impact that ship strikes may have on the relatively isolated population of fin whales in the Mediterranean Sea, Panigada presented a review and analysis of ship collision records from 1897 to 2001 (Panigada et al., in press). Records both from dead and photo-identified free-ranging individuals were collected. Out of 287 carcasses, 46 individuals (16.0%) were certainly killed by boats. The minimum mean annual fatal collision rate increased from 1 to 1.7 whales per year from the 1970s to the 1990s. 82.2% of the fatal strike events were reported in or adjacent to the waters of the Pelagos Sanctuary for Marine Mammals. Among 383 photo-identified whales from the same area, 9 (2.4%) presented marks that were attributed to a ship impact. The reported rates are unusually high for baleen whales. While the estimated rate of fatal strikes is not likely to threaten the population's continued existence, the high likelihood of unreported fatal strikes combined with other anthropogenic threats suggests an urgent need for a comprehensive, basin-wide conservation strategy for this population, including ship strike mitigation requirements.

2.2.1 Ferry Strikes

Panigada was able to find 24 cases from 1972-2001 where he could ascertain the vessel class involved in a strike. Traditional car ferries (large (>80 m) passenger ships traveling at speeds lower than 44.4 kmh^{-1}) were most implicated in 15 strikes (62.5%), while fast ferries (large (>80 m) boats traveling at speeds over 46.3 kmh^{-1}) were implicated in three strikes (12.5%). High-speed ferries were introduced into the area in 1996. In the six years that followed they accounted for almost 50% of the total collisions (n=7; three caused by high speed ferries, three by traditional ferries, and one by a merchant ship).

2.2.2 Commercial Ship Strikes

Panigada reported from the same review that merchant ships (between 70 and 320 m long traveling at speeds up to 27.8 kmh^{-1}) were implicated in four (16.7%) of the strikes.

It was noted that in some cases where merchant ship collisions took place, the carcasses of fin whales and other rorquals would lodge on the bulbous bow of ships and be brought into harbors (Felix and Van Waerebeek 2005). Panigada found this to be the case in 20 of 46 carcasses used in his study. Laist et al (2001) noted that this was most common in fin whales, and uncommon for more buoyant species of baleen whales with thicker blubber layers (e.g., right and humpback whales). The workshop agreed that if it were possible to determine the circumstances in which this took place, it might be possible to model a realistic exposure risk of animals to merchant ship strikes in general.

2.2.3 Other Vessel Strikes

Panigada also reported that other than the classes of vessels described above, he only found two cases (8.3%) where yachts (leisure boats from 15 to 80 m long, reaching 64.8 kmh^{-1} in speed) were involved with fatal collisions. He also suggested that the scars found on nine living photo-identified fin whales from the Mediterranean Sea suggested that the animals may have been struck by smaller vessels.

2.2.4 Total known strikes (age and sex class)

Panigada noted from his review that there appeared to be an apparent bias in the database towards males (19 of 26 stranded animals, or 73.1%), despite the lack of a known sighting bias of sexed animals or a known bias in distribution by sex. He also reported that 33 of 35 (94.2%) measured carcasses were below the lengths of sexual maturity for fin whales given by Aguilar et al (1988). However, whether or not the animal had been mature was not confirmed by an examination of the carcasses. Since the criteria used by Panigada for length at sexual maturity come from data obtained during whaling operations, they may be biased upwards compared to the population today (Panigada *et al*., in press). In humpback whales off of New England, Stevick (1999) showed that known age mature animals were of sizes that would have been classified as immature when

compared with published values from whaling carcass studies. However, a disproportionate number of juvenile animals have also been implicated in strike records of humpback and Southern right whales (*Eubalaena australis*) (Best et al. 2001; Laist et al. 2001).

2.2.5 Estimates of total mortality

While it was agreed that the absolute number of ship collisions detected was likely a significant under-representation of the total number of strikes, there was no agreed upon method to obtain a more accurate number. Kraus et al. (2005) suggested that only 17% of right whales that died from ship collisions and entanglements were actually recorded as carcasses. If the same rate were to hold for fin whales in the Mediterranean, Panigada's data would suggest that 8.4 animals per year were likely struck from 1972-2001. Panigada also suggested that it may be possible to derive an estimate of the total number by comparing the number of ship struck to non-struck animals in stranding data. The current best estimate for the fin whale population for the Mediterranean Sea is 3,500 animals (Forcada et al., 1995). Natural mortality for baleen whale populations is generally thought to be between 0.04 and 0.06/annum (Clark 1982; De la Mare 1985; Buckland 1990), so the non-struck animals would represent the number that died in natural mortality. However, the ship strike mortality should be separate and additive to the natural mortality, but the likelihood of finding a carcass of a struck animal should be equal to that of a non-struck animal. In total, 46 of 287 (16.0%) stranded animals were found to have died from a ship collision from 1972-2001. If the remaining 241 animals represent the 140-210 natural mortalities per year from the entire population (0.04-0.06 of the population of 3,500), it suggests that 27-40 whales per year were likely killed by ship strikes.

2.2.6 Trends in strike rates

Panigada noted that when ship collisions were broken into decadal intervals from 1972-2001, the confirmed strike rate per year was 50% higher in the latter two decades than in the first (1.0 animals per year from 1972-1981 vs. approximately 1.5 animals per year in the latter decadal periods).

No other information on trends was presented or discussed during the workshop.

2.2.7 Distribution in relation to shipping

While no quantitative analysis of this topic was presented, it was noted that the majority (82%) of the whales killed by ship strikes were detected in the Pelagos Sanctuary for Mediterranean Marine Mammals during the spring and summer. The sanctuary is heavily used during this time by ferry traffic between the coasts of mainland France and Italy and the island of Corsica. Given the number of recorded ship collisions from ferries in cases where the vessel type was known, this would suggest that the Pelagos Sanctuary is of high risk to whales. However, the proximity of this area to high levels of both vessel and observer traffic leave open the possibility of simple bias in detection when compared with merchant ship routes further offshore in the Mediterranean. Further work is necessary to delineate existing relationships between these two variables.

Two fin whale strikes were reported from the Straits of Gibraltar, where all of the merchant traffic entering or leaving the Mediterranean Sea passes regularly. Although only a limited number of sightings of fin whales have taken place in the area, the high amount of shipping traffic is thought to present an unusual risk to those animals that may be present.

2.3 Sperm whale data

Sperm whales are wide-spread through the Mediterranean Sea. Gannier et al. (2002) showed peak abundances in the Northwestern portions of the Mediterranean, especially near the Gulf of Lions, and in eastern coastal

areas of the Ionian Sea, especially off the Greek Islands. While there are no precise abundance estimates for the area, genetic research has indicated that the animals present are part of a relatively distinct population.

While observer coverage and stranding network reports are likely to detect ship struck carcasses in the Northwestern Mediterranean, they will be less likely detected in the eastern areas, including the Ionian Sea. However, identification photos of several animals with scars likely to have originated from ship collisions indicate that these animals are susceptible to at least non-fatal collisions (A. Frantzis and S. Panigada, unpublished data), and fatal collisions likely occur as well.

Sperm whale strike data was not prominently discussed during the workshop. Podestà indicated that in her database six sperm whales out of 125 total strandings (4.8%) during 1986-2005 were animals that were likely killed by ship collisions.

2.3.1 Ferry Strikes

Ritter presented the case of fast ferry strikes off the Canary Islands. Since high speed ferries were introduced in the Canary Islands in 1999, their number has grown steadily, and collisions with cetaceans have been reported ever since. Different types of fast ferries are operating in the archipelago, including small and large wave piercing catamarans and the world largest ferry trimaran (118 m length, max. 1290 passengers & 280 cars, travel speed 35-40 kn). While true numbers of collisions remain unknown, estimations range from approx. 10-30 cetaceans killed every year. Present knowledge indicates that the sperm whale is the species most frequently hit, but baleen, beaked and pilot whales are affected, too. There is a considerable overlap between known primary habitats/designated Special Areas of Conservation (SACs under the EU Natura 2000 programme) and fast ferry transects, with some of these areas receiving the highest number of fast ferry travels (up to 9.000/year; total number in the Canary Islands Archipelago approx. 17.000/year). Different types of scientific studies (e.g. investigation of stranded animals, land-based observations) as well as public education efforts currently address the problem. However, a substantial conflict of interests between the development of tourism and conservation efforts made potential mitigation measures unlikely, ineffective or impossible up to now.

De Stephanis also presented the case of a sperm whale strike during early September 2003 in the Straits of Gibraltar. The animal was seen to be struck by a ferry when the researchers were approximately 200 m from the animal. After the collision the animal was unable to dive, had numerous open wounds, and was spouting blood. Death followed within 30 minutes. He is also aware of one other strike which took place in the same area, although he did not present further details.

2.3.2 Commercial Ship Strikes

Data on sperm whale strikes are very limited, and in most cases have not been broken down by ship type. However, no participants specifically identified sperm whale collisions that were known to be caused by merchant vessels.

2.3.3 Other Vessel Strikes

No data on other vessel strikes was presented during the workshop.

2.3.4 Total known strikes (age and sex class)

Because the data on sperm whale strikes are so limited, no data on age and/or sex classes were presented. It is unlikely that the current sample sizes would allow for detection of any age/sex trends, even if they exist.

2.3.5 Estimates of total mortality

Although there is no way to estimate the total mortality of ship strikes of sperm whales from the present data, the lower percentage of stranded carcasses that died from a ship collision when compared with fin whales (4.8% as opposed to 16.0%) suggests it is less likely to be a population-level problem in the area for which there is good reporting of stranded animals. However, the presence of whales in the eastern Mediterranean Sea where stranding coverage is less comprehensive suggests that more data are required before this statement can be validated throughout the range.

2.3.6 Trends in strike rates

The existing data are insufficient to determine if there are trends in sperm whale strikes.

2.3.7 Distribution in relation to shipping

No information was presented during the workshop to examine areas or the extent of overlap between whales and ships.

2.4 Other species

The only other species of large whale reported as being struck was a minke whale (*Balaenoptera acutorostrata*) reported by Podestà. Of the four minke whales she examined, one (25%) contained evidence of a ship collision. Given the lack of sighting and/or stranding records of other species of large whales in the Mediterranean Sea, it is unlikely that the problem is wide-spread beyond the two primary species discussed above.

3. Review of present knowledge and identification of information gaps that prevent proper evaluation of the situation

3.1 Shipping

Because of the limited time of the workshop, a review of the knowledge of commercial shipping in the Mediterranean Sea was judged to be outside of the purview of the workshop. However, the group felt it was important to gather as much information on this topic as possible for future review (see item 4.1.2 below).

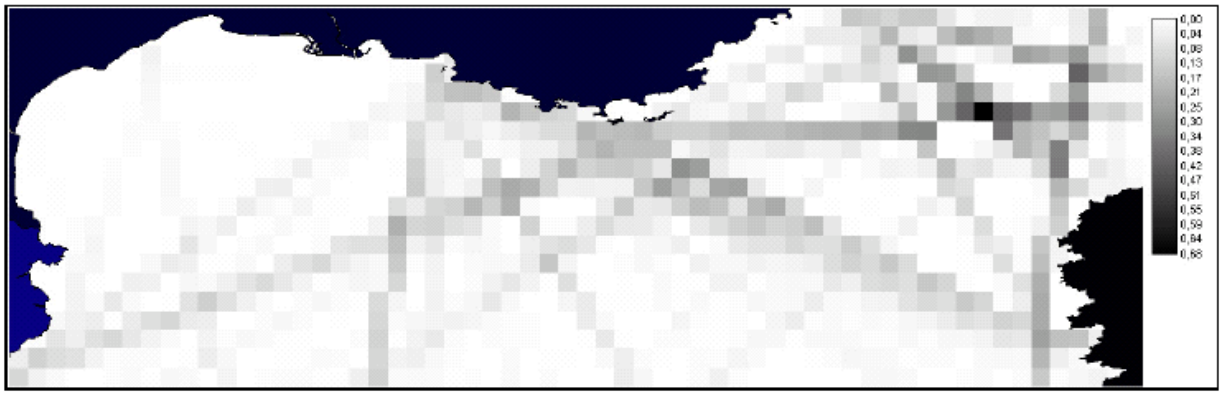
3.2 Whale Distribution

Workshop participants felt that there were many gaps in the understanding of whale distribution, especially outside of the Pelagos Sanctuary area. The recent work by Canese on wintering fin whales off Lampedusa in southern Italy, was one such example of what now appears to be a high-use area that has only recently been the focus of scientific study. Other identified data gaps included the northern African coast and the eastern Mediterranean Sea. However, it was acknowledged that the planned upcoming basin-wide survey for abundance and distribution of cetaceans would add greatly to this body of knowledge, much of which could be used to help assess the risk of strikes throughout the region. However, the survey as currently planned will not look at seasonal variations in use, and/or winter distribution of species of concern.

3.3 Factors affecting the risk of collision

David presented information on an evaluation of the risks of collision between fin whales and maritime traffic in the Northwestern Mediterranean Sea in summer. She took into account the relative abundance of fin whales (expressed as the number of animals seen per hour of effort, based on data from 1993 to 2001: 38,000 km, 520 sightings) and the levels of traffic intensity (expressed in the number of km of distance covered, based on 2001 data: 11,000 passages of ferries and HSC and 5002 passages of merchant vessels) in a 0.1° x 0.1° regular grid using G.I.S technology and software.

Collision risks appeared very high in the centre of the Ligurian Sea, halfway between the mainland and Corsica. These risks were due to both the high use of the area by the whales (rate of contact: 0.5 to 0.7 animals/hour) and a strong intensity of traffic of sizeable ferries and high speed crafts (up to 500 to 800 passages during the summer). The risks are also high offshore from Provence, from the longitude of Marseilles to that of the islands of Hyères. There too fin whales are abundant, as are many ships bound for Corsica (ferries and merchant vessels) and for Spain (merchant vessels). On the other hand the risks are relatively small in the Gulf of Lions, characterized by a wide continental shelf, and in the south of our study area probably due to lack of observer effort.



David's presentation of a collision risk analysis between fin whale and large ships (ferries+HSC+trading vessels) in summer in ther northwestern Mediterranean Sea.

In term of frequency of collision David used a simple model introduced by Nick Tregenza for the Canary Islands (Tregenza *et al*. 2002) to estimate that on average three fin whales will be in front of the stem of a ship each day during the summer within the Pelagos Sanctuary.

In order to reduce these risks, David and her colleagues proposed various levels of solution, based on difficulty of implementation and potential cost constraints:

- Two solutions that would be relatively easy and fast to implement by the maritime companies and relatively inexpensive would be to place a specialized observer aboard, or to train the navigating staff of ships to the observation of cetaceans; and the second would be to invest in instruments assisting in the detection of cetaceans, if proper technology exists.
- Two other solutions are more difficult and require a longer period to implement, and the cost still remains to be determined. The first would be a reduction of the speed in the sectors of maximum concentration of fin whales; the second would be to re-route shipping lanes in order to circumvent these sectors and to minimize the zone of contact between large ships and fin whales.

Effect of ship strike on populations

3.4 Mitigation Measures

Mitigation measures were discussed in detail in section 5.2.2 below.

4. Methods to address information gaps

4.1 Information on shipping

4.1.1 Levels of traffic by vessel class

While much of this data was not presented at the workshop, participants felt that it was important both to gather as much of the existing data as possible, and for the ACCOBAMS secretary to be informed of any rules or regulations which are likely to change existing patterns or trends. In particular, the group recommended that the ACCOBAMS secretary contact the International Maritime Organization (IMO) in order to establish a communication link between the two parties.

4.1.2 Present trends

While time constraints prevented the workshop from considering the existing data on ship traffic in the Mediterranean, it was noted that there is a significant body of information available. The group felt it appropriate for ACCOBAMS to play a leading role in gathering this information. [

4.1.3 Possible future trends

The ACCOBAMS Secretariat should be specifically aware, through a proposed linkage with the IMO, of any proposals to create shipping lanes in the Mediterranean Sea. Input on the overlap of any proposed lanes with whale habitats should be examined by the ACCOBAMS Scientific Committee.

Workshop participants were also specifically concerned about possible development of the marine highway system; one link, between Barcelona and Genoa, already seems to be in place. This could lead to multiple crossings of high-use whale habitats by high-speed vessels, substantially increasing the risk of collision.

Finally, one workshop participant noted that the IMO already has a sub-committee that is looking at environmentally friendly ways of designing ships, and suggested that it might be possible to incorporate concerns about whale collisions to this group. Whether current knowledge exists to request specific modifications that might reduce the risk of collision is questionable, but this may be a productive avenue in the future.

4.2 Whale distribution and abundance

The workshop noted that the recently prepared report by Canadas et al.(2005), combined with the workshop on fin whales held in conjunction with the strike workshop being reported on here recently summarized

present knowledge of whale distribution and abundance, and the workshop did not need to further expand on these efforts. This includes information on agenda items 4.2.1 (Distribution of whales, including small scale) particularly in relation to ship traffic and ferry routes), 4.2.2 (Abundance of whales), and 4.2.3 (Predictive modeling of whale distribution and abundance).

4.3 Response of whales to boats

4.3.1 Ability of whales to detect vessels

Workshop participants agreed that the distribution and behaviour of fin whales in the Mediterranean was somewhat unique. Panigada's limited data on diving behaviour of tagged whales showed the animals commonly using depths of up to 500m to obtain sufficient prey, far below the levels typically accessed by baleen whales. This deep diving, with a rapid ascent after the dive, may affect the whale's ability to detect vessels, especially if they complete their ascent with a gliding phase similar to that of other baleen whales (Nowacek et al. 2001).

Gannier presented information on the ability of whales to detect vessels acoustically through the year. Oceanographic conditions shift from a non-stratified situation in winter to strongly stratified situation from late spring to mid-autumn and lead to distinct near-surface sound propagation modes. Propagated levels from a sub-surface 1 kHz source in summer and winter in the central Ligurian Sea showed that the levels received by a whale from a vessel-like source vary dramatically. In March, the received level from a closing boat increases evenly at most depths. However, a shallow -20 dB "deaf" ring exists at a range of 600-4000 m from the sound source, but whale sound reception suffers this 20 dB hiatus only down to 25 m below the surface. During deeper dives, the whale has access to noise levels consistent with boat ranges. In summer, the "-20 dB deaf area" extends to more than 40 km in range and includes all depths, rendering the propagated sound constant as the vessel approaches the whale to approximately 1.5-2 km. When translated in terms of modelled time before vessel contact, these results indicated that a 45 knot ship may not be detected as an approaching vessel until it is at about 30 seconds from the whale, which allows the animal a very short time for completing an escape dive sequence. In the case of a conventional 18 knot boat this time increases to 2 minutes. Fast motor-yachts and ferries may then represent a particular collision threat in areas of high whale density.

The workshop also heard a presentation of the results published by Nowacek et al. (2004). To assess risk factors involved in ship strikes, they used a multi-sensor acoustic recording tag to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The whales reacted strongly to the alert signal, they reacted mildly to the social sounds of conspecifics, but they showed no such responses to the sounds of approaching vessels as well as actual vessels. Whales responded to the alert by swimming strongly to the surface, a response likely to increase rather than decrease the risk of collision.

Workshop participants discussed the importance of understanding the ability of whales to detect and respond to vessels. Some involved felt that whale reactions appeared to depend upon a number of unpredictable factors, including the whale's age class, its behavioral state at the time of the encounter, the sound properties of the approaching vessels, and other factors. Hence it was difficult to model or predict a whale's reaction, and it was unlikely that general patterns would appear until notable sample sizes were obtained. Others felt that a better understanding of the whale's response could be vital in developing workable and effective

mitigation strategies. The workshop recognized that obtaining detailed information on the behavior of whales in relation to vessels is difficult and expensive and not a high priority at this time. However, it agreed that such information was potentially valuable and encourages further work in this regard.

4.4. Determining true strike and mortality rates

Numerous participants felt that obtaining a precise estimate of the true strike and mortality rates was the most important task of those the workshop was to discuss, and should receive the highest priority. This is especially true in light of the planned basin-wide survey, which will allow a much more precise estimate of the population levels. Having obtained such population parameters, a model could be developed that would assess the level of strike at which the population would become impacted.

4.4.1 Reporting from vessels: crews and/or observers

Several participants noted that in the case of merchant ships, often the crews were unaware of a whale strike unless the animal became lodged on the ship's bow and was detected when the vessel arrived at its destination. Hence, increased reporting from crews is unlikely. The idea of increased reporting from observers is discussed in detail in Item 5.2.1 and Appendix E in this document. While training courses of ferry captains and crews may help increase reporting of ferry strikes, the lack of cooperation of many ferry companies to allow examination of past strike records suggests that future cooperation may also be unlikely. It is therefore suggested that a compulsory regulation, including a reporting system, should be introduced. However, setting up an international database through ACCOBAMS (discussed in 4.4.3 below), combined with encouragement to report from member governments, may facilitate a level of cooperation that has not been present to this date.

4.4.2 Reporting via carcass inspection

This item is discussed in detail in sections 2.1.2 and Appendix D in this document and was not further discussed under this agenda item.

4.4.3 Value of central database

The participants of the workshop suggested that forming an international database of vessel strikes was critical, and expressed a strong desire to make sure that it could interface with the ACCOBAMS sightings database that is currently under development. The ACCOBAMS Secretariat should do everything possible to encourage all countries to report all strikes, and the circumstances surrounding those strikes, whenever possible.

4.4.4 Methods of extrapolation to obtain total estimates

Leaper presented information on using modeling to better determine true rates of ship collisions. Data on collisions between whales and vessels come from a number of sources (e.g. direct observations of collisions, damage to vessels, scars on living animals and strandings) but the information is invariably very limited. There is a general lack of data to indicate both the extent of the problem (e.g. whale mortality) and to understand the mechanisms involved in the interactions. Computer modelling can potentially provide greater insights by allowing the synthesis of different data sources. Such models can be directed at a number of questions and vary in spatial scale from interactions at ocean basin level to the detailed hydrodynamics of a

whale within a few metres of a vessel. Models incorporating patterns of whale and shipping distribution may be used to assess relative risk based on the expected number of interactions assuming no response of whales to vessels or vessels to whales. These indices may be compared with data such as the proportion of strandings attributed to collisions with vessels, to assist in evaluating whether these are representative of total mortality due to vessel collisions. Simulation models can also be valuable in predicting the effectiveness of vessel manoeuvres in response to sightings of whales and in providing advice on the best avoidance procedure for a specific vessel type and whale species. However, current data are insufficient to allow the proportion of collisions that are avoided due to a response by the whale to be modelled in a quantitative way.

Participants noted that this exercise would be a good one in which to interface with the Scientific Committee of the International Whaling Commission, which has also shown an interest in developing appropriate models.

4.5 Potential mitigation measures

Weinrich presented a summary of the results of a recent review of Vessel Strike management options. In 2004, the Stellwagen Bank National Marine Sanctuary (SBNMS), located off Massachusetts Bay, New England, USA, formed a series of issue-based working groups as part of a management plan review. One group dealt exclusively with vessel strikes of marine mammals, especially baleen whales. The team consisted of SBNMS staff, researchers, conservationists, and representatives of the whale watch, fishing, ferry, and merchant traffic industries. The team met regularly for six months. Many issues were discussed, including which vessel classes presented greater or less risk, whether managing vessel speed and routing would be effective, and contemplating how to best getting information on whale positions to mariners. Final recommendations included: Creating a central information source where shippers could get near-real time positions of whales; voluntary speed restrictions which were more restrictive at night and during reduced visibility; slightly shifting the existing Traffic Separation Scheme (TSS) approaching and leaving Boston Harbor into areas where data showed lowered whale use; increased enforcement of existing whale watching guidelines (which include speed restrictions upon closer approach); and having the SBNMS partner with the boating community for greater outreach and education. Given that there are similarities between the SBNMS and the Pelagos Sanctuary both because of ship collision problems and long-term management philosophy, there may be similarities in the management strategies that the areas could use to effectively reduce the risk of vessel strikes to whales.

Workshop participants also noted both the special nature of the Pelagos Sanctuary for Marine Mammals and the risk that whales in the sanctuary faced from high speed and other vessel traffic. They suggested that this would be a good “testing ground” for mitigation measures. While there was some question as to what vessels could be influenced by such actions in the Sanctuary, the general consensus was that the vessels of any country that were party to the Specially Protected Areas and Biological Diversity Protocol would be controlled.

4.5.1 Shipping lanes

Knowlton reported on a shift of shipping lanes in the Canadian waters of the Bay of Fundy. Until recently, right whales aggregated to feed around a deep-water basin that was in the middle of the shipping lanes. By shifting the lanes to the east by only a few miles, a notable reduction in risk of collision took place. This IMO approved shift was put into place in 2004, and appears to be working well. A similar effort is being undertaken for the lane across Roseway Basin, on the Nova Scotian shelf, where a similar conflict exists.

De Stephanis also discussed a proposed development in the Straits of Gibraltar, where both fin, sperm, killer, and pilot whales are regularly seen.

4.5.2 Dedicated Observers

Mayol presented information on the programs at EPHE (Ecole Pratique des Hautes Etudes, Laboratoire de Biogéographie et Ecologie des Vertébrés, Université Montpellier) for visual detection of large cetaceans from high speed craft (HSC) in order to limit the risks of collision. The presence of a scientist onboard during a working season has shown how whales were detected from the decks of these HSC. Their findings indicated that dedicated observers were better at mid-range sightings and those off of the immediate track-line, while the on-duty officer was more efficient at sightings in the path of the vessel and at close range. This information is essential in order to establish some proposals to improve the safety of HSC to whales (e.g. ergonomic modifications, presence of a specialised observer onboard). Subsidiary applications could limit the risks of collision and be applicable to all types of merchant ships. These applications include a system of positioning reports for Large Cetaceans (REPCET), using a Automatic Identification System (AIS) to provide near-real time positions of whales between the commercial ships (work in progress) and training the staff of the watch at the National School of Merchant Marine in Marseilles since 2004. A synthesis of the actual technological developments was presented for their interests when visual detection is limited (e.g. night time observations).

Weinrich reported that The Whale Center of New England had also placed dedicated observers on high-speed ferries between Boston and Provincetown, Massachusetts, USA, since 2001. In 2005, they recorded who first saw a whale during the transits. Of 311 large whale sightings, 211 (67.8%) were made by the dedicated observer, 87 (27.9%) were made by the Captain, and 13 (4.1%) were made by other crew members. No whales have been struck since dedicated observers were placed aboard, but one strike of a fin whale took place in a competing company taking the same route without similar sighting efforts. Unlike Mayol's work, the range and bearing to the whale had not been consistently recorded upon first sighting, so it was impossible to compare the results.

4.5.3 Speed Restrictions

Workshop participants agreed that speed was an important component in the risk of vessel collisions. While limiting speed may be an effective means of reducing that risk, the realistic feasibility of implementing such restrictions was questioned. Like other mitigation measures, consideration was tasked to a working group (see Section 5.2.2 below).

4.5.4 Remote detection of whales in the path of vessels

The idea of remotely detecting a whale in the path of a vessel in time to take appropriate actions to avoid a collision is a goal of shippers world-wide. Methods that have been tested to date include forward and side-scan sonar and acoustic monitoring, but none have been shown to give satisfactory results.

4.5.5 Real time alerts on whale positions

Because whale watching is growing in popularity throughout the region, in areas where such boats were operating there was hope that such a program could be possible. In at least a few cases where whales had been seen along the routes of ferries, whale watch boats had informally notified the captains of the ferries of

the whale's position with some success. Whether it was feasible through either a wider area, outside of immediate coastal areas, and in a more formal institutionalized program was less certain.

4.5.6 Others (e.g. Training courses and education)

Although representatives from the shipping companies were not numerous, those that were there stressed how important it was to educate captains and crews on the vessels involved. Many are unaware of the problem, and would likely undertake any practical measures they can to avoid collisions, both for the protection of the whales and the vessels themselves. In a test course that had been undertaken aboard one high-speed ferry company in France, Mayol suggested that interest and attendance in training courses had been high. The workshop was encouraged by this, as suggested by the high ranking given to vessel and crew training as a mitigation measure in section 5.2.2 below.

4.6 Effects of ship strikes on whale populations

4.6.1 Comparison of estimated ship strike mortality rates with estimated abundance (population modeling)

Participants noted that even with a more precise estimate of the true rate of ship collisions, understanding the effects on the population would require knowing many other demographic parameters including the population's birth and juvenile mortality rates. Some participants also felt that collision mortality can be treated like takes in whaling models (RMP) as by-catches should; then regularly updated abundance estimates and strike mortality estimates can indicate the sustainability of total mortality. It was suggested that without additional data, such parameters may be most effectively included as variables in a more comprehensive population model.

4.6.2 Synergistic effects

The populations of all marine mammals, and especially the endangered whales, face myriad threats in the Mediterranean Sea. Anthropogenic impacts include fishing gear entanglements (likely a larger problem for sperm whales than fin whales), disturbance by vessels, a growing local whale watch industry, depletion of potential prey resources from over-fishing, and pollutant loading in their environment and climate change. The presentation by Fossi at the fin whale workshop, which immediately preceded the collision workshop, and the results of Wurtz in section 2.1.2 showed that Mediterranean fin whales can carry toxin burdens high enough to be in the range of those usually considered for odontocetes (who typically feed at higher trophic levels). Isaac outlined some of the possible impacts anthropogenic climate change might have on fin whales and their planktonic prey, and later circulated a paper on ocean acidification to the group. Hence, the impacts of mortality from vessel collisions may be most relevant when thought of as one of a suite of stressors, rather than an exclusive and separate pressure, on these populations.

5. Recommendations

5.1 General principals in developing and prioritizing research and management recommendations

Workshop participants agreed that:

- Everything should be done to get a more precise estimate of the actual number of animals killed by vessel strikes;
- The mechanics of a strike are poorly understood, and increasing our understanding may make modeling the actual number of strikes more practical. One area that deserves special consideration are the factors which might lead to a carcass lodging on the bulbous bow of a vessel;
- Where possible, management considerations should proceed according to a precautionary principal;
- Data gathered from the proposed basin-wide survey will be very helpful in determining where and when risk exists for ship collisions, and to suggest what mitigation measures may be appropriate, for at least a portion of the year;
- Mitigation measures should focus on those vessel classes which are suspected to be most heavily involved in fatal strikes (e.g. high-speed ferries and/or those vessels that consistently transit high-use whale areas).

5.2 Specific recommendations

5.2.1 Related to filling information gaps

One working group of workshop participants spent part of the last day discussing priorities necessary to fill the many information gaps for those research items identified as a priority earlier in the workshop. The aim of the working group was to discuss each recommendation, prioritize it, evaluate its feasibility and relate it to other recommendations. The results of the discussion are summarized in the following table.

1. ***Recommendation****: The ACCOBAMS Secretariat should investigate the most appropriate way in which it can bring cetacean issues to the IMO and obtain relevant information from them.* The group did not have a specific discussion of this, although all thought it was a good idea and should be done as soon as possible. In addition, it was suggested to liaise with the Ship Strike Working Group of the IWC when approaching IMO.

2. ***Recommendation****: Complete basin wide survey of marine mammal distribution and abundance in the Mediterranean Sea.* The group felt that this had been sufficiently discussed by the participants in the fin whale workshop, and should be related to the Basin Wide Survey Working Group.

3. ***Recommendation****: Assess population trends through monitoring*. The group felt that this had been sufficiently discussed by the participants in the fin whale workshop, and should be related to the Basin Wide Survey Working Group.

4. ***Recommendation****: Test acoustic propagation models through seasons*. This refers to section 4.3.1 above. The group did not consider this a priority since its applicability to mitigation measures was not clear. However, the group suggested conducting simple propagation models *in situ*, measuring the sound field collecting data on the spot.

5. ***Recommendation****: The ACCOBAMS Secretariat will work with riparian states to investigate the best way to obtain accurate numbers of ship strikes (and associated details).* The group considered this an important point, as they viewed the need to establish a dialogues between ACCOBAMS, France, and many other riparian states as essential to obtain better reporting of ship strikes in order to better understand the full extent of the problem.

6. ***Recommendation****: Conduct thorough necropsies of carcasses to determine true cause of death.* This was viewed as critical in order to establish a conclusive link between a pre-mortem strike and the cause of death of a carcass. Some participants suggested that cetacean carcasses should be flensed to the bone where possible. Some participants also suggested establishing a link to U.S. stranding networks, and using a protocol similar to that used for North Atlantic right whales. Data would then be reviewed by an expert panel for an unbiased and conclusive cause of death. This work might initially focus on the Pelagos Sanctuary. Training for scientists conducting necropsies in all countries should be conducted to ensure consistency; a pilot program to do this is currently underway in France. A specific action plan for this item was prepared by a sub-set of the group and is attached as Appendix D.

7. ***Recommendation****: Undertake a feasibility study to examine whether information from cases where carcasses are lodged on bulbous bows can be used to model likelihood that struck whales become lodged and if this can be used to obtain estimates of true strikes.* While participants felt this was a very important and worthwhile effort, some felt this would be a very hard model to prepare, as it requires a lot of data and infers a large number of variables. Some participants felt that a trend analysis of cases where carcasses were draped over bulbous bows could provide a good minimum measure of mortality frequencies from large merchant monohull vessels for at least some species (e.g. fin, sei, and Bryde's whales).

8. ***Recommendation****: Interview captain and crews to obtain all information on known ship strikes (past, present and future), using an agreed protocol.* This was considered as a high priority. It was suggested that some effort should be undertaken to render the data on known strikes available in a format most useful for the scientific community, as the French are already doing (with SNCM). It was suggested to prepare a standardized interview with a minimum set of rather simple questions to be asked to the ship captains.

9. ***Recommendation****: Feasibility study to assess the efficiency of dedicated observers to (a) detect ship strikes and (b) as a mitigation measure.* The group considered this as a high priority issue. A specific action plan for this item was prepared by a sub-set of the group and is attached as Appendix E.

10. ***Recommendation****: Create an international database of ship collisions in co-ordination with the propose sighting/effort database for the ACCOBAMS area.* The idea of creating a comprehensive data base was endorsed by the working group participants. Several participants (Panigada, Guinet, Robert) suggested that they had data which could help contribute and/or help form such a database. It was suggested that the database liaise well with the ACCOBAMS sightings database that is currently being constructed, and that it might be appropriate to convene a workshop specifically dedicated to this project. A co-ordination with IWC SSWG was also recommended in order to set up a global and standardized database.

11. *Run a population model once information from the basin wide survey becomes available.* This exercise would lead to describe what level of removal is significant at the population level.

	ecommendation	Objective (NB general link to management objectives/success of mitigation measures)	Feasibility	Time-frame	Costs	Links with other reccs	Priority 1=high
	Shipping						
	The ACCOBAMS Secretariat should investigate the most appropriate way in which it can bring cetacean issues to the IMO and obtain relevant information from them	To obtain better information on a variety of aspects of shipping for work on examining threats and potential mitigation measures, and for bringing cetacean issues to IMO discussions on shipping lanes	Yes	Short-term	Minimal		1
	Large Cetacean Distribution and Abundance						
	Complete Basin Wide Survey	Already covered by ACCOBAMS SC and a detailed recommendation was developed at the fin whale workshop.					1
	Assess population trends through monitoring	ditto					1
	Response of Whales to Boats						
	Test acoustic propagation models through seasons	The subject is interesting but it does not have direct management implications.	Yes	Short-term	Low		3
	Determining true strike and mortality rate						
	The ACCOBAMS Secretariat will work with riparian states to investigate the best way to obtain accurate numbers of ship strikes (and associated details)	Essential information for evaluating population level effects	Yes	Short-medium	Low for ACCOBAMS		1
	Conduct thorough necropsies of carcasses to determine true cause of death	See detailed proposal	Yes	Short-long	See proposal		1
	Further test histopathological techniques to determine cause of death						
	Encourage ACCOBAMS member states to report carcasses						
	Obtain support from port authorities and coast guard to facilitate necropsies						
	Feasibility study to examine whether information from cases where carcasses are lodged on bulbous bows can be used to model likelihood that struck whales become lodged and if this can be used to obtain estimates of true strikes	If feasible will provide estimates of mortality; and good data for a trend analysis using relative incidence	?	Medium	Medium		2
	Interview captain and crews to obtain all information on known ship strikes (past, present and future), using an agreed protocol	May provide information relevant to total mortality and mitigation measures	Yes	Short-long	Low	6	1
	Feasibility study to assess the efficiency of dedicated observers to (a) detect ship strikes and (b) as a mitigation measure	May provide information on total mortality and mitigation measures (also relevant to obtaining information on distribution and abundance)	Yes	Short-medium	See detailed proposal	Relevant to basin wide survey	1
	Create International Database of Ship Collisions in co-ordination with the proposed sighting/effort database for the ACCOBAMS area	Provides information on total mortality and links with tissue samples etc	Yes	Short-medium	One full time person	5,6,8,9	1
11	Run a population model once information from the basin wide survey becomes available	Examine what level of removal is significant at the population level	Yes	Medium	Low	Most	1

While time was limited during the workshop, the group felt that each of the topics should ideally be developed in a step-down outline with specific tasks, time-lines, and personnel assignments. Several people from this sub-group developed an example outline on one task that had been identified as a priority: a more accurate determination of cause of death of carcasses. Their results are attached as Appendix 2. In addition, Donovan and Leaper developed a similar step-down list to assess and model the effectiveness of dedicated observers both a way to get a more accurate assessment of the actual frequency of ship strikes and as a mitigation

measure. Their report is attached as Appendix 3. In both cases, time prevented the sub-group or the workshop as a whole from reviewing and commenting on either step-down procedure.

5.2.2 Related to developing mitigation measures

A second working group of workshop participants spent half of the last day discussing mitigation measures to reduce the risk of fatal ship collisions to whales. This included measures suggested by speakers during presentations, identified during discussions of the workshop, or known to be considered in other areas. The group decided that for each item listed they would not only discuss the topic, but at the end give it a general priority (high, medium, or low) based on independent scoring.

The group had also been tasked with determining the feasibility, time frame, and cost of each proposed management measure. However, the group agreed that for many of these suggestions, the *feasibility* depended on the political will to actually see the measure implemented. It was further determined that in such a forum it was unrealistic to gauge either the *time frame* for implementation or the *actual costs* for each item, given the range of measures that each item could entail.

Although representatives from the shipping companies were not numerous, those that were present stressed the importance of education for captains and crews on the vessels involved. Many are unaware of the problems, and would like to undertake any practical measures they can to avoid collisions, both for the protection of the whales and the vessels themselves. In a test course that had been undertaken aboard one high-speed ferry company in France, interest and attendance in training courses had been high. The group was encouraged by this, as suggested by the high ranking given to vessel and crew training in the table below.

The representatives of the ferry companies also noted that the high-speed ferries that had been used in the past several years were likely to be replaced in the near future by “fast” ferries. These vessels would still travel quickly, but at 20-25 knots instead of the 40-50 knots of the high speed ferries used in recent years. The suggestion was made that the newer “fast” ferries were better in all sea and weather conditions than the high-sped craft. It was suggested that this shift alone to slower vessels may help reduce the number of fatal ferry strikes.

The possibility of real-time reporting of whale positions was discussed. Because whale watching was growing throughout the region, in areas where such boats were operating there was hope that such a program could be possible. In fact, in at least a few cases where whales had been seen along the routes of ferries, this had been tried with some success. Whether it was feasible through the wider area, and outside of immediate coastal areas, was less certain. Some participants agreed that near real-time reporting of whale positions could be developed with the contribution of merchant marine ships too.

The group judged any action to reduce the risk of collision by hydrofoils as low, because the vessel’s ability to operate and maneuver was so closely tied to its speed. Hence, its lack of priority given to management of such vessels reflected the general conclusion that it was impossible to manage this class of boats. Since the number of such vessels currently being used is small, they were not viewed as a major source for anthropogenic mortality.

Finally, it was noted that many of the suggestions were not mutually exclusive. Rather, a number of the lower cost/impact measures could be instituted simultaneously, and should be encouraged. Follow-up on all

measures was judged to be important to assess whether there was compliance with the mitigation measure, and whether it had been effective in reducing the risk of striking a whale.

The work of the group resulted in the following table:

	Recommendation	Objective (NB general link to management objectives/success of mitigation measures)	Feasibility	Time-frame	Costs	Notes	Priority
	Mitigation Measures						
	Education and Training Course for vessel crews	Awareness of collision risk, knowledge of how to avoid collisions	High	Immediate		Requires attendance by captains and crews	High
	Independent Observers on Ferries	1) Alert captain of whale presence and at risk of collision 2) Presence of whales in front of boat 3) Record and report collisions when they occur	High	Immediate		Limited applicability at night (possibility of using night vision systems), need to link with educational program	High
	Education of Enforcement Officials (Coast Guard, Port officials, Maritime Traffic Managers, etc.).	Awareness of collision risk, importance of reporting strikes	??	Immediate			High
	Provide managers with advice on high-use areas by species and season without specifying the exact course of action		High in some areas, low in others	Immediate in some areas, long in other areas		Need further data in some areas and seasons	High
	Vessel Notification	Awareness of collision risk	??	Immediate		Can work with hydrographic office to put Pelagos on nautical charts, Sailing instructions, etc.	Medium
	Use Pelagos Sanctuary and Straits of Gibraltar as a Model and Testing Ground for Mitigation Measures		High	Immediate		Seems Obvious (??)	Medium
	Shipping Lanes - Create Area to Be Avoided		Low, High in some limited areas	Immediate in some limited areas, long in other areas		Can create confusion in traffic around areas	Medium
	Encourage daytime transit for high speed and fast ferries	Increase ability to detect whales	Low				High

	Recommendation	Objective (NB general link to management objectives/success of mitigation measures)	Feasibility	Time-frame	Costs	Notes	Priority
	Real time alerts to ferries and other vessels on whale positions	Provide knowledge of whale locations to Captains	High in areas with whale watching or researchers, low otherwise			AIS provides good way of providing info to vessels, but whale distribution is highly variable in time in fine scale	Medium
	Remote detection of whales in path of vessels	Avoid collision of unseen whale	??	Long term		May depend on stratification of sea for sonar; no cheap practical system at present; should continue to be explored+ acoustic harmful effects (generally, the low target strength of cetaceans implies to increase the sound emissions).	Low
	Dedicated/trained observers on bridge aboard merchant ships (likely a trained crew member, as opposed to an independent observer).	1) Alert captain of whale presence 2) Presence of whales in front of boat	Medium	Immediate		Merchant ships, quality of data lower than independent observers	Low
	Speed restrictions – Ferries in high risk area	Reduce number of collisions (allow whale to avoid boat, allow captain more time to avoid collision)	Unknown – Technically easy	Immediate		Laist et al. (2001) suggest 13 knots or less to avoid fatal collisions; no difference in risk between all categories – can also be applied to merchant ships	Low
	Shipping Lanes - Create New Lanes in the Mediterranean		Low	Immediate in some areas, long in other areas			Low
	Explore ways of designing ships to minimize risk of collision to whales (and minimize injury to whales if they are struck)	Lower risk of collisions		Long term		IMO has an existing ad hoc sub-	Low

	Recommendation	Objective (NB general link to management objectives/success of mitigation measures)	Feasibility	Time-frame	Costs	Notes	Priority
						committee of IMO for environment ally safe ship designs	
	Speed restrictions – hydrofoils					These vessels appear to have no ability to slow down	Low

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Appendix A - Workshop Agenda

Workshop on Large Whale Ship Strikes in the Mediterranean Sea (14-15 November 2005)

1 Objective of the Working Group

2 Review of present knowledge on strikes and mortality

2.1 General Reporting and detection methods used to obtain estimates of strikes and mortality
- 2.1.1 From Vessels
- 2.1.2 From Carcass Inspection

2.2 Fin Whale Data
- 2.2.1 Ferry Strikes
- 2.2.2 Commercial Ship Strikes
- 2.2.3 Other Vessel Strikes
- 2.2.4 Total known strikes (age and sex class)
- 2.2.5 Estimates of total mortality
- 2.2.6 Trends in strike rates
- 2.2.7 Distribution in relation to shipping

2.3 Sperm whale data
- 2.3.1 Ferry Strikes
- 2.3.2 Commercial Ship Strikes
- 2.3.3 Other Vessel Strikes
- 2.3.4 Total known strikes (age and sex class)
- 2.3.5Estimates of total mortality
- 2.3.6 Trends in strike rates
- 2.3.7 Distribution in relation to shipping

2.4 Other species

3 Review of present knowledge and identification of information gaps that prevent proper evaluation of the situation

3.1 Shipping

3.2 Whale Distribution

3.3 Factors affecting the risk of collision
- 3.3.1 Effect of ship strike on populations

3.4 Mitigation Measures

4 Methods to address information gaps

4.1 Information on shipping
- 4.1.1 Levels of traffic by vessel class
- 4.1.2 Present trends
- 4.1.3 Possible future trends

4.2 Whale distribution and abundance*
- 4.2.1 Distribution (including small scale) particularly in relation to ship traffic and ferry routes
- 4.2.2 Abundance
- 4.2.3 Predictive modeling

4.3 Response of whales to boats

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Appendix C - Summary table of potential research recommendations by subject (detailed rationale in report)

	Recommendation	Objective (NB general link to management objectives/success of mitigation measures)	Feasibility	Time-frame	Costs	Links with other reccs	Priority 1=high
	Information on shipping						
IS1			Yes	Depends whether dedicated or opportunistic	Depends whether dedicated or not. Analysis dependent	Relevant to most recommendations	1
IS2	Collect and review information from other techniques that may provide insights into population structure e.g. stable isotopes, pollutant profiles, individual recognition data. Requires co-ordination wrt laboratory and statistical analysis for some data types, central catalogue for photo-identification data.	To supplement genetic studies (see above)	Yes	Some e.g. pollutants can be through biopsy. Others (baleen plate stable isotopes) must be opportunistic		To PS1	2
	Management oriented measures						
DM1	Undertake synoptic basin wide systematic survey. Major ACCOBAMS initiative already underway.	To provide broad synoptic overview of distribution during the summer in a particular year, and especially to provide information for areas where no little or no information exists at present. Fundamental baseline information	Yes	Summer 2007 or 2008	See Valsain report	Relevant to most recommendations	1
DM2	Platform of opportunity (e.g. ferries, merchant ships), effort-based observations of fin whales in areas where little or no information exists, preferably over wide temporal scale (inter- and intra annual). Requires co-ordination with e.g. ship owners associations. Possible co-operation with other vessels (e.g. Greenpeace; IFAW)	To provide information on distribution of fin whales in areas and/or times of the year for which little or no information exists. To provide information on variability in distribution over time	Yes	Before or during Summer 2006	Observers	Great help in DM1, may help with A4, A5	1
DM3	Co-ordinate and expand studies that utilise spatial modelling, recognising that such approaches can incorporate both systematic and non-systematic survey data but are data intense. Workshop to develop guidelines and examine case studies	To provide explanatory and predictive models of distribution of whales at various spatial scales and provide information on potential critical habitat.	Yes	Long-term	Co-ordinating workshops	Part of DM1, A4, A5,	2

Appendix D - An Action Plan to conduct thorough necropsies of carcasses to determine true cause of death

Title: (a) assess ship strike mortality through thorough necropsy and (b) subsequent histological analyses.
(N.B. this is relevant to Recommendations, Shipping [to be numbered later])

Objectives and expected results in the short – medium - and long term

The objectives for this recommendation are to evaluate the percentage of mortality that can be attributed to ship strike, as opposed to other causes. The information from necropsies and subsequent analyses are needed to determine the seriousness of population threats from ship strikes. To achieve these goals we need to:

(a) develop public (boaters, residents of coastal communities, vacationers) and official (coast guard, harbourmaster, port authorities, sanitary officials, veterinarians, etc.) awareness that strandings need to be reported and provide them with the contact information they need to notify the necropsy team before the carcass is removed or destroyed,

(b) to establish new stranding networks or improve existing stranding networks within the ACCOBAMS/Pelagos area,

(c) to build capacity in these networks for large cetacean necropsy, including personnel training, equipment.

(d) develop standardized response protocols, including communications plans, sampling procedures, eyewitness interviews, preservation techniques, data recording forms. Ensure response protocols are consistent with protocols used worldwide.

(e) apply protocols as needed

(f) prepare final report

(g) disseminate report to all relevant parties

This could be done in stages, allowing for immediate action with existing capabilities, and increasing capability over time.

Appendix E - Step-down outline of a feasibility study to assess the efficiency of dedicated observers to (a) detect ship strikes and (b) as a mitigation measure, when compared with the crew alone

Objectives and expected results in the short- medium- and long term

The objectives of this study are to examine the value of placing dedicated cetacean observers on board vessels to detect ship strikes and to act as a potential mitigation measure. In the short-term the feasibility study will provide information on ship strikes as well as information valuable for modelling a number of aspects of this problem, including whether they are likely to be an effective mitigation tool and how best they are to operate (e.g. searching method, nature and timing of advice to crew). For the feasibility study it is important to choose areas of known high density of fin whales (or sperm whales?) and choose vessels that are suspected to be most likely to be involved in ship strikes. Minimum sample size needs to be examined. The PELAGOS Sanctuary is proposed as a good candidate area. The experiment should also include indipendent cetacean observers. The dedicated observer will act in 'tracker platform' mode scanning the zone close to the trackline where whales might be at risk of collision. AIS will be onboard and the output downloaded to a hard drive. This will provide data on other vessels which may limit the potential for the target vessel to manoeuvre.

Supporting institutions etc.

ACCOBAMS Scientific Committee, ACCOBAMS Parties, IWC Scientific Committee