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A Note On The Vulnerability Of Cetaceans In Antarctic Waters To Noise Pollution



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I. Introduction

Noise pollution continues to receive increasing attention in international fora. Since ATCM XXVII, there have been a number of important developments, which are documented below.

ASOC welcomes the publication of the Proceedings of the Conference on the Impacts of Acoustics on Marine Organisms (Kappen, 2004).

II. Recent Developments

Despite the increasing number of atypical cetacean strandings¹ that have been associated with military sonar (see Table 1), the mechanism of injury remains unknown, and is likely to remain so for some time. However, there can be no doubt that, in some cases, the atypical strandings that result in deaths of beaked whales, is occurring at received sound levels that are lower than had previously been anticipated. Such levels are lower than those that induce auditory damage, and lower than those currently being used as an acceptable level for management guidance (often a received level of 180 dB re 1 μ Pa).

The mechanism of injury and death, at least in some cases, appears likely to be initiated by a behavioural response. It is no longer acceptable to consider only auditory impacts within a small radius of the sound source. We must now consider the evidence that some animals are responding negatively, and to lethal effect, to lower sound levels than cause auditory damage. Here we present some evidence to support this case.

At ATCM XXVII, ASOC introduced publications regarding the pathologic studies of those animals whose deaths have been associated with military activities. Since this time, discussions have led to experiments that suggest that even modest acoustic intensities can trigger bubble formation under supersaturated conditions (Crum *et al.* 2004).

Work that has been ongoing as a result of an atypical mass stranding event in the Bahamas has shown that the noise levels received by those beaked whales that died as a result of the military exercise was much lower than could be expected to cause auditory injury.

It seems likely that the mechanism leading to injury and death is resulting from either:

1. Too rapid an ascent from a deep dive; or
2. Spending more time at the surface than is natural, possibly to escape higher sound levels below the surface ((Potter 2004, Houser *et al.* 2001).

Further evidence of decompression type sickness in beaked whales has been identified by Arbelo *et al* (2005). Espinosa *et al* (2005) and Fernández *et al.* (2005) presented evidence of a new atypical beaked whale mass stranding in the Canary Islands that coincided with the international naval exercise, Majestic Eagle 2004, which was conducted more than 100km north of the Canary Islands in July 2004. Although the animals were too decomposed to observe gas embolism, systematic fat embolism was detected in these animals, as it was in those associated with an earlier exercise, Neo-Tapon 2002. 18 of

¹ An atypical cetacean strandings is a stranding event involving more than two whales (including one or more species) that strand approximately simultaneously but not directly in the same location (Frantzis 1998, Brownell *et al.* 2005).

115 cetaceans stranded around the Canary Islands showed lung fat embolism. The majority of these cases were associated with either ship collisions or naval military exercises (Méndez *et al.* 2005).

The probability that the animals died at sea is extremely high (Fernández *et al.* 2005). This has very serious implications for those animals that suffer intense noise pollution but will not make it close to shore and strand. It seems increasingly evident that many more animals are dying than we currently take account of.

Cetaceans have stranded in association with military activities around the Canary Islands on at least 6 occasions (see Table 1). Brownell *et al.* (2004) reported to the IWC Scientific Committee that six out of ten mass strandings with more than two whales each were considered atypical strandings with whales scattered over a large area. All the mass strandings occurred in either Suruga Bay or Sagami Bay on the central Pacific coast of Honsa, in the region of the command base for operations of the US Navy's Pacific Seventh Fleet. In contrast, individual strandings occurred throughout the Japanese Archipelago.

Table 1 is a reprint of a table produced in Taylor *et al.* (2004). It details all the known atypical mass strandings of beaked whales, one of which occurred during seismic research activities in the Gulf of California*. Incidences involving military sonar provide us with the most conclusive evidence of impact to date, yet, it remains to be proven which characteristics of noise make it dangerous (Weilgart and Whitehead, 2004).

Airgun pulses were clearly heard from survey vessels operating in the mid-Atlantic Ocean even though they were located 3000 km from a hydrophone array (Nieukirk *et al.* 2004).

A study of North Atlantic right whales showed that they responded negatively to alerting stimuli (Nowacek *et al.* 2004). The energetic consequences include losing foraging time and expending excess energy during the high-powered ascent and subsurface swimming. The cost to the animals is not known.

Last year, a report from the International Whaling Commission's Scientific Committee, representing over 100 marine biologists, reached a unanimous conclusion about the state of the science: **that there is "now compelling evidence implicating anthropogenic sound as a potential threat to marine mammals, [a threat that is] manifested at both regional and ocean-scale levels that could impact populations of animals."** The report went on to identify increases in seismic noise and shipping as "cause for serious concern" and emphasized the importance of applying the precautionary principle in addressing the issue; and it concluded by making a number of specific recommendations for reducing impacts of seismic exploration on cetaceans.

Kremser *et al.* (2005) suggest that auditory damage is only likely if animals pass the transducer at close range. Similar findings have been shown by Boebel *et al.* (2004) in their risk analysis for the hull-mounted Hydrosweep multibeam sonar. Subsequently Kremser *et al.* (2005) concluded that the impact on marine mammals can be mitigated by implementing prior detection and shut down procedures. While this seems like a reasonable mitigation approach for auditory damage (including TTS), given the most recent findings related to the deaths of cetaceans, including beaked whales and other species listed in Table 1, non-auditory physiological injury and behavioural impacts such as those identified above can not be ignored.

At the 19th conference of the European Cetacean Society in La Rochelle, France 3-7 April 2005, and a special associated "Ziphiids and Active Sonar Workshop" the most recent knowledge on this issue was presented. Especially new findings from the attachment of acoustic recording tags on two individuals of Cuvier's and Blainville's beaked whales have revolutionised the knowledge about the ecology of these elusive animals, with implications on mitigation management and hypothesis of possible impact mechanisms.

As the tourism industry is growing faster in Antarctica than anywhere else in the world today, there is growing concern for its impacts on the local wildlife (Widolf, 2002). As the shipping industry is the world's largest contributor to ocean noise, it is important that noise is considered in discussions about impacts from increasing tourism in the region.

III. Relevant Legal Proceedings Relating To Noise Pollution

There is a growing international consensus that ocean noise presents a significant threat to marine mammals and other marine species and must be addressed multilaterally.

In October 2004 the European Parliament formally called on its twenty-five member states to restrict the use of high-intensity active naval sonar until more is known about the harm it inflicts on whales and other marine life. Noting the growing body of scientific research that confirms such sonar poses "a significant threat to marine mammals, fish and other ocean wildlife," the resolution calls on the European Union and member states to "adopt a moratorium on the deployment of high-intensity active naval sonars until a global assessment of their cumulative environmental impact" has been completed. It also calls on member states to establish a Multinational Task Force for developing international agreements on sonar and other sources of intense ocean noise; to exclude and seek alternatives to the harmful sonars used today; and to "immediately restrict the use of high-intensity active naval sonars in waters falling under their jurisdiction."

In November 2004 the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) approved a resolution calling for "extreme caution" in conducting activities that produce intense underwater noise, including seismic research. Citing evidence linking the use of military sonar to the "strandings and deaths" of whales as well as concern over the general increase in noise levels in the world's oceans, the parties directed their Scientific Committee to develop common guidelines for the generation of harmful underwater noise in the Mediterranean and Black Seas. Moreover, the parties recommended that activities producing harmful noise ideally "would not be conducted" in those areas pending the development of such guidelines.

Also in November 2004, the IUCN-World Conservation Union adopted a comprehensive Resolution calling for action by states to reduce the impacts of ocean noise on marine life, which was adopted by consensus. The IUCN is the world's leading body for conservation policy, consisting of over 70 national governments and more than 400 non-governmental organizations, and the decisions it takes at its quadrennial meetings set the global agenda for conservation over the next four years. The 2004 Resolution recognizes undersea noise as a form of pollution; calls on states to avoid the use of intense noise sources in the habitat of vulnerable species or where marine mammals and endangered species may be concentrated; and urges states to work through the United Nations Convention on the Law of the Sea to develop mechanisms for the control of this emergent problem.

Additionally, it is worth noting that the IMO has included noise within a definition of "substance". Resolution A.927(22) (2001), which sets out the guidelines in relation to Special Areas and PSSAs (Particularly Sensitive Sea Areas), uses the terms "substance" and "pollutant" interchangeably and expressly identifies noise as a type of pollutant (Scott 2004).

Domestically, the assessment of the impacts of hydroacoustic devices on marine mammals by the German Federal Environmental Agency is currently pending review by the Berlin Administrative Court. This is due to concerns that proposed activities would result in "*more than a minor or a transitory impact*" and therefore requests a Comprehensive Environmental Evaluation under the Act Implementing the Environmental Protection Protocol.

In 2004, the Spanish Ministry of Defence announced a prohibition of all active sonar exercises for 50 nautical miles off the coast of the Canary Islands, the site of many whale strandings coincident with military training exercises. This is the first governmental action of its kind to exclude all active naval sonar from waters that have been shown to shelter particularly sensitive species, and it provides a

helpful example of the sort of measures that the international community should be striving to adopt. By restricting military sonar training from these waters, the Spanish government recognized that military training can be undertaken without risking the most vulnerable species and habitats.²

The U.S. Navy has developed a sonar system known as SURTASS LFA. In 2002, a number of US environmental organisations brought suit in U.S. court challenging this proposed deployment on environmental grounds—and prevailed the following year. Citing “the certain harassment and possible injury of marine mammals and other sea creatures, many of them endangered,” that would result from “the extremely loud and far-traveling LFA sonar,” the court issued a permanent injunction limiting the Navy’s training with such sonar to certain areas of the western Pacific ocean, pending further environmental review. This restriction remains in force today.

IV. Mitigation Measures and their Limitations

ASOC concurs with the **SCAR Report on Marine Acoustic Technology and the Antarctic Environment** in its section on Mitigation Measures that ‘*uncertainties were such that mitigation measures similar to those suggested in the first SCAR report should be used for individual surveys using higher risk equipment such as large airgun arrays*’. The ad hoc mitigation measures currently in place for scientific work in the Antarctic do not reflect the escalating international concern regarding the impacts of noise pollution, as summarised above. This global concern is intensified as the true magnitude of sonar’s effects on beaked whales and other marine mammals remains unknown.

We can only begin to understand potential population-level effects if we can recognise the experiences and reactions of individual animals. Therefore, with our minimal knowledge of cetacean distribution and abundance in the southern ocean, only an understanding of the impacts upon individuals will lead to tangible positive outcomes for populations. Further, these two things can not be achieved in isolation. **As a matter of some urgency, ASOC submits that the Committee on Environmental Protection should:**

- 1. Focus attention on gathering much more accurate data on cetacean distribution and abundance in the Southern Ocean,**
- 2. Encourage parties to develop mitigation measures,**
- 3. Monitor and mitigate impacts on individual cetaceans, and**
- 4. Develop common guidelines for the use of high intensity hydro-acoustic equipment and associated obligatory mitigation methods.**

A combination of acoustic and behavioural data would enhance our ability to monitor whales over large regions and long time periods (Širović *et al.* 2004). Such research has already proved successful in the Antarctic (for example, Leaper *et al.* 2000, Širović *et al.* 2004). Therefore efforts should be made by all countries involved in Antarctic science to collection of baseline data on cetacean distribution and abundance.

The objectives of mitigation and the effectiveness both need to be seriously considered. On board mitigation measures need to be strengthened and standardised throughout the Antarctic. ASOC suggests that, in an effort to mitigate potential impacts, experienced and independent Marine Mammal Observers be placed on all vessels conducting scientific work involving such ‘higher risk equipment’.

ASOC also urges that countries planning to undertake research activities that involve the introduction of intense noise pollution apply early for permits through the CEP as well as national legislation, where this applies.

² However, during the ECS conference in La Rochelle it was announced that another naval exercise was being scheduled for April 2005 in the Canaries, possibly using active sonar. ASOC is not aware as yet whether that exercise occurred and if so, what type of equipment was used.

Although mitigation measures are critically important, their practical limitations have to be acknowledged. Barlow and Gisiner (in press) have analysed US research survey data and have concluded that the overall probability of detecting beaked whales during mitigation monitoring is likely to be 24 to 48 times *lower* than for research vessel surveys. They calculated a track-line detection probability of 0.2–0.02% for beaked whales that would be detected during mitigation monitoring – if the animals were directly in the path of the ship. This detection would drop to zero by ~1 km from the trackline.

New data on bioacoustic activity and dive profiles of Cuvier’s and Blainville’s beaked whales showed that their vocalizations only started at depths of at least 200m or 600m respectively and are mainly focused downwards in a narrow beam (Tyack et al. 2005a, Aguilar de Soto et al. 2005, Tyack et al. 2005b). This poses massive restrictions on the possibility of passive acoustic detection from a moving survey vessel. While beaked whales are deep diving, and so the figures are likely to be most extreme for this species, it certainly highlights the limits of mitigation monitoring.

Significantly, Beale and Monaghan (2004) report that variation in individual state, both in relation to individual condition and the perception of habitat quality, will influence behavioural responsiveness to disturbance; and therefore individuals appearing least responsive may be those with the most at stake. They continue that if this is the case, current measures of sensitivity to disturbance are likely to be inaccurate and, consequently, the management procedures applied may be inappropriate. This supports a case for wider management measures to be promptly introduced. Such wide-scale measures should ensure protection of areas of critical and productive habitat, and of particularly vulnerable and endangered populations.

V. Marine Protected Areas

The collation of baseline distribution and population data would assist in our identification of ‘hot spots,’ areas that are vital to the successful feeding, breeding or calving of individuals and populations or that provide habitat to especially vulnerable populations of animals. As the world’s largest feeding ground, there is no doubt of the significance of the Southern Ocean for cetaceans, and improving our understanding of the processes that drive successful foraging will help to improve our protection mechanisms considerably.

With this in mind, ASOC welcome the efforts by CCAMLR to consider Antarctic Marine Protected Areas (MPAs). If well designed and managed, MPAs can play a key role in the conservation of cetaceans and marine ecosystems (Hoyt, 2005). To date, marine habitat protection is limited and lacking in cohesive management in the Antarctic. There is no protection specifically for cetacean critical habitat. The IWC-Southern Ocean Whale Sanctuary, combined with the various Antarctic Treaty System conventions and protocols and a network of MPA reserves within the same area, has at least a chance of being the stepping stone toward effective, significant protection for cetaceans as well as for the entire ecosystem (Hoyt, 2005).

VI. Recommendations

1. The ATCM should focus attention on gathering data about cetacean distribution and abundance in the Southern Ocean,
2. The ATCM and CCAMLR should work together to introduce standardised mitigation measures for all vessels undertaking scientific research in Antarctic waters,
3. The ATCM and CCAMLR should require Marine Mammal Observers on all vessels undertaking scientific research in Antarctic waters,
4. Countries planning to undertake research activities that involve the introduction of intense noise pollution should be required to apply early for permits through the CEP as well as under relevant national legislation, and

5. The ATCM and CCAMLR should work together to create MPAs as a large-scale option to protect marine mammals, and particularly cetaceans, inter alia, from exposure to noise pollution.

VII. Conclusions

There is no doubt about the significance of the Antarctic as the world's largest marine mammal feeding ground, and as entire home range for many marine mammal species. In addition, the dependence of some cetacean species on the region requires special consideration with regard to noise pollution. Beaked whales are particularly vulnerable. At least two species of this whale family are known to inhabit the Southern Ocean, and yet little is known about their distributions and population status in the region.

We do not know the mechanism that leads to death of individuals that are exposed to intense noise pollution. Further, we do not have information on the status of populations in the Southern Ocean. Therefore, currently, the risk to populations and individuals as a result of noise exposure cannot be confidently estimated. It is imperative that wider management measures, including Marine Protected Areas be proposed and agreed on, in addition to strengthening and standardising on-board mitigation measures.

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Table 1

Year	Location	Species (numbers)	Correlated activity
1914	US (NY)	<i>Ziphius cavirostris</i> (2)	
1963	Italy	Zc (15+)	
1965	Puerto Rico	Zc (5)	
1968	Bahamas	Zc (4)	
1974	Corsica	Zc (3), <i>Stenella coeruleoalba</i> (1)	Naval patrol
1974	Lesser Antilles	Zc (4)	Naval explosion
1975	Lesser Antilles	Zc (3)	
1980	Bahamas	Zc (3)	
1981	Bermuda	Zc (4)	
1981	US (AK)	Zc (2)	
1983	Galapagos	Zc (6)	
1985	Canary Islands	Zc (12+), <i>Mesoplodon europaeus</i> (1)	Naval maneuvers
1986	Canary Islands	Zc (5), Me (1)	
1987	Canary Islands	Zc (group), Me (1)	
1987	Italy	Zc (2)	
1988	Canary Islands	Zc (3), Me (1), <i>Hyperoodon ampullatus</i> (1), <i>Kogia breviseps</i> (2)	Naval maneuvers
1989	Canary Islands	Zc (19+), Me (2), Md (3)	Naval maneuvers
1991	Canary Islands	Zc (2)	Naval maneuvers
1991	Lesser Antilles	Zc (4)	
1993	Taiwan	Zc (2)	
1994	Taiwan	Zc (2)	
1996	Greece	Zc (12)	Naval maneuvers
1997	Greece	Zc (3)	
1997	Greece	Zc (8)	
1998	Puerto Rico	Zc (5)	
2000	Bahamas	Zc (8), Md (3), Ziphiid sp. (2), <i>Balaenoptera acuturostrata</i> (1), <i>Balaenoptera</i> sp. (2), <i>Stenella frontalis</i> (1)	
2000	Galapagos	Zc (3)	R/V Ewing seismic
2000	Madeira	Zc (3)	Naval maneuvers
2001	Soloman Islands	Zc (2)	
2002	Canary Islands	Zc, Me, Md (15-17)	Naval maneuvers
2002*	Mexico	Zc (2)	R/V Ewing seismic
2004	Canary Islands	Zc (4)	Naval maneuvers
2004	US Hawaii/Hanalei Bay	melon-headed w. (200)	Naval sonar exercise
2005	US North Carolina	Pilot (+34), <i>Balaenoptera acuturostrata</i> (1), dwarf sperm (1)	Naval anti-submarine exercise

