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Marine Noise Pollution - Mitigation and the Need for Wider Protection

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(ASOC)

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Marine Noise Pollution - Mitigation and the Need for Wider Protection

ABSTRACT

Noise pollution continues to receive increasing attention in international fora. A number of significant developments since CCAMLR XXIII are documented. The limitations of mitigation measures are discussed and the role of Marine Protected Areas and alternative technologies, as potential methods to ensure protection of cetaceans and other marine species from the wider impacts of noise pollution, are considered.

I. Introduction

This Information Paper provides a short update on some important developments in marine noise pollution.¹ It addresses impacts from military sonars as well as non-military seismic equipment and other non-military noise sources in the marine environment.

ASOC welcomes the publication of the Proceedings of the Conference on the Impacts of Acoustics on Marine Organisms (Kappen, 2004) and urges all members to review it.

II. Mechanisms of Injury and Death of Marine Mammals

Despite the increasing number of atypical cetacean strandings² that have been associated with military sonar, the mechanism of injury remains unknown (Cox *et al.*, 2004). While this may remain the case for some time, there is emerging evidence regarding the nature of the damage and the sound levels that induce it. It is increasingly apparent that tissue damage and strandings may be induced at received sound levels that are lower than had previously been anticipated. In particular, at levels lower than those that induce auditory damage, and, most significantly, lower than those currently being used as an acceptable level for management guidance - often a received level of 180 dB re 1 μ Pa, or a radius of 500 metres (for example, JNCC, 2004).

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). These authors provide evidence of a new atypical beaked whale mass stranding in the Canary Islands that coincided with an international naval exercise known as 'Majestic Eagle'. This was conducted more than 100 km north of the Canary Islands in July 2004. Although the whale bodies retrieved were too decomposed to allow gas embolisms to be detected, systematic fat embolisms were found in these animals. These were also characteristic of the stranded beaked whales associated with an earlier exercise, 'Neo-Tapon', in 2002. Méndez *et al.* (2005) examined the incidence of this pathology in lung samples from 115 cetaceans of 17 different species stranded around the Canary Islands between 1995 and 2003 and found that 18 animals of six different species showed 'diverse lung fat embolism grades'.

The probability that the animals associated with the 'Majestic Eagle' exercise died at sea is extremely high (Fernández *et al.*, 2005). This increases the concern that other animals affected during similar events are also dying at sea but are not being discovered and examined.

¹ A similar Information Paper was submitted to the ATCM in Stockholm, IP 59, [A Note On The Vulnerability Of Cetaceans In Antarctic Waters To Noise Pollution](#).

² An atypical cetacean strandings is a stranding event involving more than two whales (including one or more species) that strand approximately simultaneously but not in the same location (Frantzis 1998).

While incidences involving military sonar arguably provide the most conclusive evidence of noise impacts to date, it remains to be determined which characteristics of noise are the most significant (Weilgart and Whitehead, 2004). Consequently, the potential of all intense noise sources to adversely affect cetaceans, other marine mammals, as well as fish and other marine life, should be considered.

A number of mechanisms whereby noise pollution leads to bubble activation in cetaceans, causing injury, and potentially death, have been proposed (see Figure 1). The first suggests that noise triggers a behavioural response resulting in tissue damage 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).

One line of potentially related evidence comes from a recent study of North Atlantic Right Whales, *Eubalaena glacialis*, which showed that they responded negatively to auditory-alerting stimuli (Nowacek *et al.*, 2004). Five of the six animals exposed to the alert signal significantly altered their regular behaviour and did so in an identical fashion. Received sound levels were as low as 133dB re 1 μ Pa. The energetic consequences associated with these responses include losing foraging time and expending energy during the rapid ascent and subsurface swimming that was precipitated. In the Southern Ocean, might other species, particularly beaked whales, respond in a similar manner? This is currently unknown.

At least some deep-diving beaked whales have a dive profile not previously observed in other marine mammals and they may therefore chronically accumulate nitrogen in a manner not dissimilar to human 'saturation divers' (Cox *et al.*, 2004).

The alternative mechanism for bubble activation may be through the direct ensonification of the individual. Ongoing discussions have led to experiments that suggest that even modest acoustic intensities can trigger bubble formation under supersaturated conditions. Bubble nucleation occurred in *ex vivo* bovine blood, liver and kidneys when supersaturated tissues were sonicated (Crum *et al.*, in press). Crum also reported that the sound source caused previously stabilized, pre-existing microscopic bubbles to be activated. Further investigations into the mechanism of bubble formation are now underway (for example Cox *et al.*, 2004; SMRU, 2004).

III. Mitigation Measures and Their Limitations

Various authorities have suggested that mitigation of impacts to marine life can be achieved by avoiding exposure to sounds at a level that causes auditory damage. For example, Kremser *et al.* (2005) suggested that auditory damage is only likely if animals pass the source transducer at close range and that the impact on marine mammals can therefore be mitigated by implementing prior detection and shut down procedures. However, given the most recent findings related to the deaths of beaked whales, which point towards non-auditory damage (for example Jepson *et al.*, 2003; Freitas, 2004; Fernández *et al.*, 2004; Fernández *et al.*, 2003), this is arguably not the case.

While on-board mitigation measures remain the primary method of protecting cetaceans from noise pollution, there is an urgent need to strengthen and standardise these, and, critically, to investigate their effectiveness. ASOC concurs with the SCAR Report, 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 in this paper.

Although precautionary on-board mitigation measures are critically important, their practical limitations are being widely recognised. Barlow and Gisner (in press) conclude that the overall probability of detecting beaked whales during 'mitigation monitoring' is likely to be 24 to 48 times *lower* than that achieved during dedicated population surveys. They calculate that less than 2% of beaked whales 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. Similarly, the recent international workshop on the effects of anthropogenic sound on beaked whales concluded that current monitoring and mitigation methods for beaked whales are ineffective in the detection and protection of these animals from adverse sound exposure (Cox *et al.*, 2004).

Other issues relating to mitigation limitations identified by Barlow and Gisner (in press) include the relatively early stage of development of the new detection methodologies, such as active sonar, and lack of evidence of the efficacy of commonly-used mitigation measures (e.g., ramp-up). Even simple interpretation of animal behaviour in response to human activities is fraught, as recently commented upon by Beale and Monaghan (2004), who emphasised that the stronger response to disturbance may actually be made by the less vulnerable animals rather than, as may be assumed, the most vulnerable.

Therefore, in line with other parts of the world such as Australia and Brazil, it is important to consider wider measures to protect cetaceans and other marine species from the potential impacts of noise pollution, and particularly seismic activities, in the Southern Ocean.

IV. Marine Protected Areas

Hoyt (2005) has recently provided a substantive review of Marine Protected Areas (MPAs) as they relate to cetacean conservation. He concluded that, if well designed and managed, MPAs could play a key role in the conservation of cetaceans and marine ecosystems. MPAs have the potential to incorporate into their management regimes cumulative and synergistic impacts of a variety of noise sources.

The designation of properly-managed MPAs focused on protecting cetaceans and/or other marine species is likely to assist in the collation of baseline distribution and population data. They could also contribute to the identification of areas that are vital to the successful feeding, breeding or calving of populations or that provide habitat to especially vulnerable populations of animals. In this context, the proposal to protect the Ross Sea is welcome, and we look forward to CCAMLR considering it over the next few years.

ASOC welcomes the recent initiative by CCAMLR to hold a first MPA workshop, regrets not having been invited to participate, and looks forward to the results as well as to future development of the MPA concept by CCAMLR and Antarctic Treaty Consultative Meetings.

V. Alternative Technologies

There is an urgent need to develop alternative technologies to those that currently employ or produce loud marine noise. Some already exist and could be deployed more widely. For example, Southall (2005) reported on a US shipping and marine mammal symposium that discussed the development of ship-quieting technologies – already in use in military circles. A further example is the marine vibrator, which has been developed as an alternative to the use of airgun arrays in seismic surveys of the seabed, and which has a lower peak amplitude, slower rise time and significantly less energy above 100Hz (Deffenbaugh, 2001).

VI. Relevant Legal Proceedings and International Findings 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 2004 the International Whaling Commission's Scientific Committee conducted a noise symposium that reached a unanimous conclusion: 'there is now compelling evidence implicating military sonar as a direct impact on beaked whales in particular.' (IWC, 2004).³ The Committee went on to identify increases in seismic noise and shipping as "cause for serious concern". It emphasised the importance of applying the Precautionary Principle in addressing the issue and made a number of specific recommendations for reducing impacts of seismic exploration.⁴ A seismic workshop will precede the IWC meeting in 2006, which would be a good opportunity for joint CCAMLR-IWC work.⁵

³ 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. Previous ASOC Information Papers presented to CCAMLR and the ATCM have covered this legal saga in some detail. Since Antarctica is currently quarantined from the effects of LFAS by the court decision, major Antarctic-related problems are likely to be experienced only if this military sonar is deployed on migratory routes of cetaceans.

⁴ "On the general topic of potential impacts from commercial oil and gas exploration and production activities (referred to as industrial activities) as well as those seismic activities associated with academic research (referred to as academic activities), the SWG [Seismic Working Group] recommends the following monitoring guidelines. These are motivated by the SWG's serious concerns over seismic survey impacts on cetaceans coupled with the increase in initiatives, particularly by the industrial community but also the academic community, to conduct seismic surveys in regions that overlap with critical habitats for cetaceans. The IWC SWG believes there is an urgent need for coordinating and implementing mitigation and monitoring guidelines and protocols and therefore recommends: (1) Global identification and monitoring of critical habitats for cetaceans. (2) Access to information on timing, distribution, extent (nautical miles for 2D surveys, or square nautical miles or square kilometers for 3D surveys) sound source levels for past and planned seismic surveys carried out in critical habitats. (3) Description and results of any marine mammal observer programs or other faunal observation programs carried out in conjunction with previous seismic surveys. (4) Continuous acoustic monitoring of critical habitats on sufficient temporal and spatial scales in relation to pre and post seismic activity. (5) Independent monitoring of critical habitat (from survey vessels and from independent platforms) to evaluate displacement from critical habitat and/or disruption of important behaviors related to whale presence in critical habitat. (6) Increased effort to monitor strandings that occur at times and in places where seismic activity is conducted. (7) That these recommendations be presented to IWC member governments, representatives of geophysical exploration and petroleum industries, and various committees and agencies. (8) That seismic operators should seek ways to mitigate their potential impacts (e.g. to reduce the power of their sources). Furthermore, the SWG strongly recommends that: ... (2) All seismic surveys in large whale critical habitats should be planned to coincide with the movement of migratory cetaceans out of phase with whale presence in their critical habitat;... (4) In situations when displacement of whales does occur in a critical habitat, surveys should be stopped."

⁵ On the general topic of anthropogenic noise impacts on cetaceans the SWG recommends: (1) a workshop on the impacts of seismic exploration (including both industrial and academic activities) at the 2006 meeting. (2) Integrated and coordinated international research to study and describe acoustic ecologies. (3) The establishment of a working group to derive a series of hypotheses to test for synergistic impacts on long lived species. (4) Inclusion of anthropogenic noise assessments and noise exposure standards within the framework of national and international ocean conservation plans (e.g. consideration during designation of critical habitats, MPAs and ocean zoning. (5) Support for multinational programs to monitor ocean noise and the development of basin, regional and local scale underwater noise budgets.

In October 2004 the European Parliament formally requested 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.⁶ Citing evidence linking the use of military sonars 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.⁷ 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 the 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 hydro-acoustic 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 Defense 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

⁶ ACCOBAMS, Report of the Third Meeting of the Scientific Committee, Cairo May 13-15, 2005, SC3/Doc 20, Recommendations and guidelines to address the issue of the impact of anthropogenic noise on marine mammals in the Mediterranean Sea: toward a permit system for the area.

⁷ RESWCC3.068 (2004), Undersea noise pollution, www.iucn.org.

from these waters, the Spanish government recognized that military training could be undertaken without risking the most vulnerable species and habitats.⁸

VII. Conclusions

There is no doubt about the significance of the Antarctic as the world's largest marine mammal feeding ground, and as the 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 five 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.

The latest studies support the conclusion that it is no longer realistic to limit mitigation of potential impacts, both auditory and non-auditory, to within a small radius of the sound source. This has serious implications for protection of cetaceans and other marine species. Given the limitations of on-board mitigation measures, it is essential that wider protection is seriously considered as a management option, including the creation of MPAs that take noise pollution into account. Such measures should ensure protection of areas of critical and productive habitat, and particularly of vulnerable and endangered populations.

While on-board mitigation measures remain the primary method of protection, there is an urgent need to strengthen and standardise these, and, critically, to investigate their effectiveness. For example, having dedicated cetacean observers on board seismic and fishing vessels in the Southern Ocean would help achieve this aim.

As we are only beginning to consider potential population-level effects, CCAMLR Members and ATCPs must commission more long-term monitoring. On-board mitigation measures cannot provide us with an understanding of the impacts on populations. Tangible conservation outcomes for cetaceans will be secured only through ongoing population monitoring. Similarly, more information is needed about other species potentially under threat from noise sources in the Southern Ocean, which can be obtained through longer-term monitoring.

Therefore, ASOC recommends that:

1. On-board mitigation measures should be standardised and implemented throughout the Southern Ocean by CCAMLR and the ATCM acting in tandem.
2. CCAMLR should move expeditiously to create MPAs in the CCAMLR Area, and the identification and management of those MPAs should take noise pollution into account in order to better protect various species in the Southern Ocean marine ecosystem.
3. Since ongoing population monitoring is critical to the protection of cetaceans in the Southern Ocean, and will be useful for protecting other species, CCAMLR should take the necessary steps to establish such monitoring programs.
4. CCAMLR should participate in the IWC Seismic Workshop in 2006 in order to lay a better foundation for assessing noise pollution issues in the Southern Ocean and measures to protect marine species from adverse impacts of seismic and other forms of noise pollution in the region

⁸ 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.

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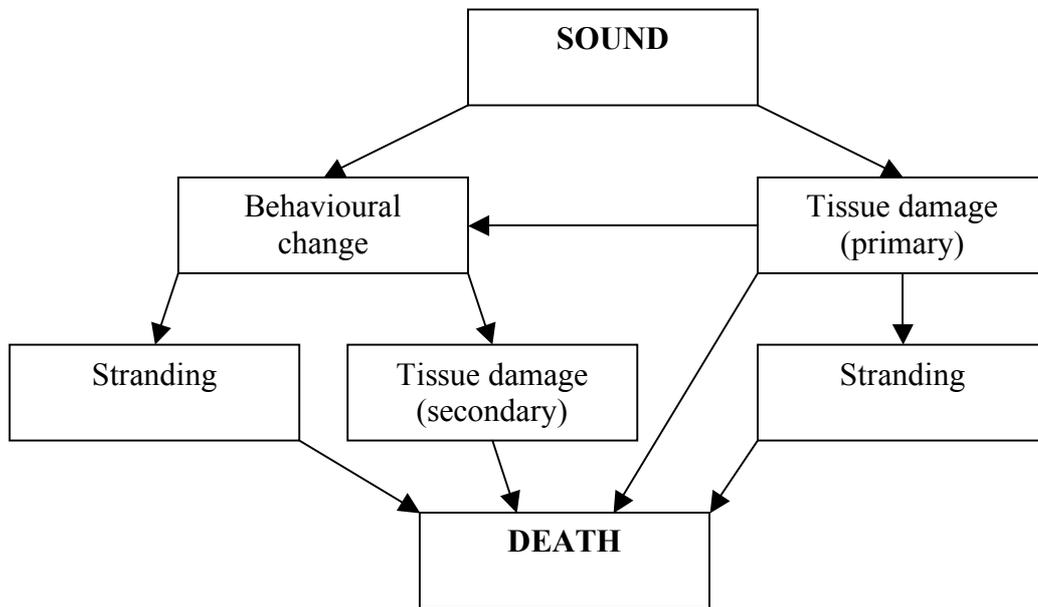
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Figure 1.

Potential mechanistic pathways by which beaked whales are affected by sound (from Cox *et al.* 2004).⁹



⁹ Cox *et al.* (2004) highlighted that the end result can be stranding, without necessarily leading to death.