

Effects of Sound in the Ocean on Marine Mammals ESOMM-2014 International Meeting

Guest Editors: Frans-Peter A. Lam¹ & Petter H. Kvadsheim²

¹*Netherlands Organisation for Applied Scientific Research (TNO),
Acoustics & Sonar Research Group, PO Box 96864, 2509 JG, The Hague, The Netherlands
E-mail: Frans-Peter.Lam@tno.nl*

²*Norwegian Defence Research Establishment (FFI), Maritime Systems Division, NO-3191, Horten, Norway
E-mail: Petter-Helgevd.Kvadsheim@ffi.no*

During the last several decades, there has been a significant overall increase of underwater anthropogenic noise, leading to increased background noise levels and more frequent exposure to high-intensity impulse sounds. Potential negative effects of sonars on marine mammals have received particular attention after several atypical mass strandings of cetaceans in connection with naval sonar activity, mostly, but not exclusively, involving beaked whales. These events triggered a significant research effort, which initially was strongly focused on acute effects of noise such as hearing impairment. Based on this research, accepted noise criteria for injury have been established, and most regulators currently base their management of effects of noise on marine mammals on criteria for acute effects.

However, stranding events might be directly or indirectly caused by behavioural responses. Furthermore, behavioural responses to anthropogenic disturbance can also lead to other negative effects on vital rates such as habitat exclusion or cessation of important activities—for example, feeding, migration, or reproduction. Since cetaceans generally have very sensitive hearing in the frequency range of naval anti-submarine warfare sonars (0.2 to 10 kHz), such responses might be triggered at much lower levels than acute effects, and, thus, the potential for population-level effects cannot be ignored. To properly consider how behavioral responses to anthropogenic noise impact marine mammals there is a need to establish behavioral impact criteria as well. We, therefore, have seen a gradual switch of the science focus the last 10 years from research on acute effects on individuals to a stronger focus on research on behavioral responses and long-term population-level effects. At the same time, there are still fundamental gaps in our understanding of the hearing ability of marine mammals, particularly for the baleen whales, and on how intense anthropogenic sound sources might inflict acute

injury to these animals. Finally, to establish effective management regimes and mitigation procedures that minimize the effect of anthropogenic sound on marine mammals, we not only need to understand the impact of the sound, but we also need to know how animals are distributed in time and space and to enhance our ability to detect them at sea. Development of new technology and research methodology has led to significant improvement in all these fields of science during the last decade.

The 5th International Meeting of Effects of Sound in the Ocean on Marine Mammals (ESOMM-2014) was organized in Amsterdam from 7-12 September 2014. This meeting was held for the second time in Amsterdam, after the first three times in Lerici, Italy, starting in 2005. The first meetings were initiated as a NATO meeting in order to align the “defense issue” to deal with underwater sound and the environment following several stranding incidents in the 1990s. Gradually, the meetings have been expanding to a larger group of different stakeholders who are dealing with research on and management of underwater acoustics.

The ESOMM-2014 international meeting was a great success. Over 150 participants of 14 different nationalities were welcomed, representing all relevant stakeholders: scientists, government regulators, navies, industry, and nongovernmental organizations (NGOs). The plenary programme consisted of in total 54 oral presentations, 18 posters, and one Skype conversation. There were multiple discussion rounds for different topics, apart from the many occasions to have informal discussions. The meeting was formally opened by Rear-Admiral Rob Bauer of the Royal Netherlands Navy (director for NL-MOD future plans and investments), emphasizing the need for a better understanding to responsibly use military sonar systems. The scientific kick-off was performed by Professor Walter Munk with a breath-taking

opening talk in which he looked back at the historical development of long-range acoustic systems for worldwide climate monitoring (see the Munk “Historical Perspectives” essay in this issue). This was the first project (in particular, the Heard Island feasibility test in 1991) that seriously encountered an environmental concern for using acoustics in the ocean. It is an interesting fact that the initial discussion was triggered by a climate study rather than a military or industrial activity. Here, there is a conflict in both understanding and conserving the underwater environment, and Professor Munk was calling on the ambition to achieve both.

An essential characteristic of the ESOMM meetings is that all stakeholders have the opportunity to present their perspectives of the story. This provides a very interesting atmosphere of what has been achieved by science projects as well as what is needed for managing and regulating the problem. Both the meeting and this special issue show the mix of topics presented: fundamental and more applied research, research on different sound sources, management, and mitigation. Scientific highlights from the meeting included presentations of new research on behavioral responses, dose response functions, population-level effects, and hearing ability of baleen whales. Furthermore, recent developments at the management level also were presented and discussed such as the United States’ noise strategy and the implementation of noise as indicator in the European Union’s Marine Strategy Framework Directive.

For the first time in the ESOMM meeting series 2005 through 2014, participants were given the opportunity to submit a research paper on their topic. This special *Aquatic Mammals* issue is the result of that and reflects the ESOMM community very well. This issue is a rich collection of papers from different stakeholders, especially NGOs and, of course, science, but with different levels of direct applicability for regulation and management, and with quite different topics:

- A trend-watch of regulation, policy, and its future development (Dolman and Jasny)
- Efficacy of using visual observers for mitigation (Leaper et al.)
- Impact of higher frequency sonar used by some navies and the fishing fleet on harbor seals (Kastelein et al. a) and harbor porpoises (Kastelein et al. b). These studies also include a comparison of signals with and without sidebands.
- The first full science paper of the BRAHSS project, looking at the effect of seismic airguns on migrating humpback whales in Australia (Dunlop et al.)

- A new masking tool, baptized the Maskogram (Erbe)
- Evaluating the varying daily and seasonal detection ranges for different acoustic receivers in a dynamic soundscape (Miksis-Olds et al.)
- The effects of pile driving (both impact and vibratory) on bottlenose dolphins detected in Fremantle, Western Australia (Paiva et al.)
- Severity of behavioral responses to navy sonar in three different species in Norwegian waters (Sivle et al.)
- Evaluation of impact of explosions from munition clearance on harbour porpoises in Dutch waters (von Benda-Beckmann et al.)
- An essay on the development of acoustic climate monitoring and the first confrontation with environmental concerns of effects of sound on marine mammals (Munk)

The rich diversity of topics and stakeholders and their interaction appeared to be very fruitful, if not essential, for properly addressing the issue. However, there is still a lot of important work to be done, and progress is exciting and stimulating. We are confident this ESOMM community will meet again!

The contribution of all the participants of the ESOMM-2014 meeting were critical to achieve such a fruitful meeting. FPL thanks his co-organizers of the team (see group photo on p. 529): René Dekeling and Marije Siemensma, who received great help for logistics from Sacha van Zanen, Kristianne Dreteler, Mathieu Colin, Joke Buijs, Connie van der Bijl, and Peter van Holstein, together with many TNO colleagues.

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The authors and reviewers of the papers included in this special edition and the *Aquatic Mammals* journal editors, Kathleen Dudzinski and Elizabeth Henderson, have been critical to the completion of this special issue on this important topic.