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Effects of Sound in the Ocean on Marine Mammals

ESOMM-2018 International Meeting

Frans-Peter A. Lam[1] and Koen C. Bröker,[2, 3] Guest Editors

[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]*University of Groningen, Groningen Institute for Evolutionary Life Sciences, PO Box 11103, 9700 CC Groningen, the Netherlands*
[3]*Shell Global Solutions International B.V., Carel van Bylandtlaan 23, 2596 HP, The Hague, the Netherlands*
E-mail: koen.broker@shell.com

In September 2018, the ESOMM community gathered in The Hague for the 6th international meeting on the Effects of Sound in the Ocean on Marine Mammals, as already announced in the introduction of the 2015 special issue of Aquatic Mammals (41.4). The objective of the ESOMM meetings is to link science to policy and regulation by inviting combined representation of the navy, industry, research, conservation, and regulatory communities, and to facilitate multi-stakeholder interaction and discussion. This 2019 special ESOMM issue includes an impressive selection of contributions from last year's (2018) conference.

It has been four years since the 5th ESOMM meeting in 2014; and in this time, an extraordinary amount of research progress has been made as was evident during the 2018 meeting (see www.esomm.org for full programme details). New management challenges and regulatory developments have appeared during this period as well. Despite these new learnings, including on behavioral responses, strandings of groups of odontocetes continued to occur. Most notable was a major event in northwest European waters around the time of the ESOMM meeting in 2018 (McKenzie, 2018). The exact cause for these strandings is still not completely understood.

Historically, ESOMM focused primarily on the impacts of naval anti-submarine sonar on marine mammals, although other anthropogenic activities were included. Similar to the significant navy-funded research efforts of impacts of sonar on marine mammals, the oil and gas exploration and production (E&P) industry has funded numerous studies to better understand and mitigate E&P industry impacts as well. Apart from the organizations involved, a key difference between the navy and E&P industry-funded research programs are the types of sources being used, with naval sonar sources generating, in general, higher frequency sound (0.2 to 10 kHz) in comparison to airgun arrays used in the E&P industry (main energy below 250 to 500 Hz). For this reason, the mid- and high-frequency hearing marine mammal species, especially beaked whales, are generally considered to be of more importance in naval studies as compared to the E&P industry where focus tends to be on lower-frequency hearers such as baleen whales. Both industries, however, have the ability to affect a range of species, and there are numerous similarities in navy and E&P industry-funded research in terms of types of impacts in these studies (e.g., TTS, disturbance, and masking); monitoring and mitigation technologies and techniques; applicable regulatory requirements; and the involvement of stakeholder communities such as conservation organizations, regulatory agencies, and the research community.

Conference organizers for ESOMM-2018 in Scheveningen/The Hague (*Back Row* [left to right]: Frans-Peter Lam, Maik Zandvliet, and Marije Siemensma; *Front Row:* CDR René Dekeling and Patricia Bauer); *Inset:* Koen C. Bröker, guest editor, JIP PRM co-organizer.

To encourage the exchange of knowledge between different communities with similar overlaps of impacts and research programs, the ESOMM-2018 meeting was jointly organized with the 3rd Programme Review Meeting (PRM) of the International Association of Oil and Gas Producers (IOGP) Joint Industry Programme (JIP) on Sound and Marine Life, and is referred to as ESOMM/JIP-2018. The meeting took place from 9 to 14 September 2018 in a location with a view of the North Sea in Scheveningen/The Hague. After a combined first day, the remaining four days were divided between morning PRM and afternoon ESOMM sessions. This joint meeting format provided an excellent opportunity to have navy and industry representatives as well as regulatory and academic communities learn about the latest research on impacts of anthropogenic sound on marine mammals. In total, over 170 participants from at least 15 different nationalities attended the meeting.

This was the 6th ESOMM meeting, following three meetings in 2005, 2007, and 2009 organized by the NATO Undersea Research Center (NURC, now named CMRE) and two meetings in 2011 and 2014 in Amsterdam, the Netherlands. (The ESOMM-2014 meeting is represented in the 2015 special issue of *Aquatic Mammals* [41.4].) These meetings have proven to be very helpful in bringing the various relevant naval, industry, regulatory, and academic stakeholders together to jointly review scientific achievements, and in discussing existing and new management, regulatory, and policy challenges. Apart from the main meeting, there were numerous side-meetings, social activities, a conference dinner, a guided walk, a bootcamp, yoga, and morning dips that provided ample opportunity for participants to catch up, discuss the latest and greatest in marine mammal science, and build relevant relationships.

In our field of studies on impacts of anthropogenic sound on marine life, we observed a three-dimensional expansion in focus in terms of (1) the sources being used, (2) the types of impacts, and (3) the marine species being investigated. Whereas historically the majority of marine noise studies focused on pulsed military and E&P sources (such as sonar and airgun arrays), impacts of pile driving, drilling, other geophysical sources, shipping, etc., are increasingly being studied over the past years as well. Research on marine mammals is still the key focus area, but there is increased funding to learn more about noise impacts on fish, invertebrates, and even plankton. Lastly, in the past decade, there has been an apparent expansion in focus from physiological impacts to behavioral responses, disturbance, and masking, and to the population-level impacts of these types of impacts. This expanded focus was reflected at ESOMM/JIP-2018 with excellent presentations and posters on a wide range of topics focusing on sources (i.e., continuous and pulsed sonar, airgun arrays, pile driving, and vibroseis), impacts (TTS, behavioral responses, stress, masking, and Population Consequences of Disturbance), and marine species (marine mammals and fish). Additionally, presentations were given on acoustic standards, marine mammal hearing studies, updates to hearing impact criteria, and monitoring and mitigation techniques and technologies.

As was the case during the previous ESOMM meetings, participants of the 6th ESOMM and 3rd JIP PRM were encouraged to submit a contribution to this special issue of *Aquatic Mammals*. We are pleased to announce that this call resulted in an impressive selection of one overview and nine research articles. Despite the above-mentioned wide range of topics involved, most of these articles (7) focus on the relationship between naval sonar activity and marine mammal behavioral patterns, along with modeling studies of marine mammal hearing aimed at improving our understanding of mysticetes' ability to hear sound. Specifically, this special issue includes the following topics:

1. A summary of potential impacts of oil and gas exploration and production on marine mammals and associated monitoring and mitigation measures (Bröker)
2. Quantification of behavior of humpback whales and potential responses to sonar (Henderson et al.)
3. Behavioral responses of a harbor porpoise to simulated low-frequency sonar sounds (Kastelein et al.)
4. Foraging behavior and disruption in blue, fin, and humpback whales in relation to sonar exposure and the importance of contextual information (Harris et al.)
5. Changes in the spatial distribution of acoustically derived minke whale tracks in response to navy training (Harris et al.)
6. Positional uncertainty when modeling received levels for tagged cetaceans exposed to sonar (Schick et al.)
7. Fin whale call behavior in the context of environmental conditions (Miksis-Olds et al.)
8. The effect of a bubble screen on the behavioral responses of captive harbor porpoises exposed to airgun sounds (Kastelein et al.)
9. The role of material properties in cetacean hearing models: Knowns and unknowns (Tubelli & Ketten)

10. Aligning basilar membrane spirals to two-dimensional images of point stiffness experiments (Voysey et al.)

A highlight of the previous ESOMM-2014 meeting to many of the 150 participants was the impressive keynote talk by the well-known American physical oceanographer Professor Walter H. Munk, based on his long and fruitful academic career, which included a personal account of the Heard Island experiment. Professor Munk also contributed to the 2015 special ESOMM issue of *Aquatic Mammals* with an essay on the development of acoustic climate monitoring and the first confrontation with environmental concerns regarding the effects of sound on marine mammals. Walter Munk passed away in February 2019 at the age of 101. A tribute to him is included in this special edition.

Finally, the ESOMM and JIP organizations would like to thank all the participants for their valuable contributions. As in previous years, René Dekeling and Marije Siemensma both played significant roles in the organization of another successful ESOMM meeting as did the TNO logistical support staff.

The 6th ESOMM meeting would not have been possible without the financial support of the Office of Naval Research, Living Marine Resource program, Fleet Forces Command, Bureau of Ocean Energy Management, National Oceanic and Atmospheric Administration (all USA), The Netherlands Ministry of Defense, the Dutch government, and The Hague municipality. The 3rd JIP PRM was funded and organized by the IOGP JIP on Sound and Marine Life. We thank these sponsors for their generous contributions.

Aquatic Mammals journal editors Kathleen Dudzinski and Elizabeth Henderson have done an outstanding job in managing the development of this special edition. We thank them, as well as all the authors and reviewers, for their significant contributions.

Since the closing of the ESOMM-2018 meeting, planning for the 7th ESOMM meeting has been initiated. Preliminary plans include the possibility of having the next ESOMM meeting in North Carolina (USA) during the first week of November 2020; this will be subject to future announcements. For now, we hope you enjoy this special edition and find these contributions useful. Hopefully, they will contribute to an enhanced understanding of impacts of anthropogenic sound on marine mammals, and an improved ability to further minimize or avoid these impacts!

Literature Cited

McKenzie, S. (2018). Investigations into whale strandings in Scotland and Ireland. *BBC News*. Retrieved from https://www.bbc.com/news/uk-scotland-highlands-islands-45342576

Overview of most of the participants of ESOMM-2018 just before the conference dinner at the Spanish Court in The Hague