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Anthropogenic Noise in the Southern Ocean: an Update

Anthropogenic Noise in the Southern Ocean: an Update

An Information Paper submitted by SCAR

Summary

This paper reports progress in the 2017-18 intersessional period in developing an update for the CEP on anthropogenic noise impacts on Antarctic marine wildlife. A comprehensive literature review has been completed, an expert panel convened and consulted, and input from a variety of sources considered. These inputs have been combined in a draft Background Paper that will continue to be revised and refined until final submission to ATCM XLII – CEP XXII in 2019.

Introduction

1. Questions regarding the impacts of underwater noise on Antarctic marine wildlife have been of interest to the CEP for more than two decades, with substantive discussion first occurring in 1999 (ATCM XXIII-CEPII), when some Parties expressed an interest in understanding the state-of-knowledge on various topics that might inform evidence-based permitting procedures. Following these discussions, SCAR submitted a review of the state-of-knowledge to the Committee in 2000, on the Impacts of Acoustic Techniques in the Marine Environment (IP042 SATCM XII).
2. A workshop was convened by SCAR in 2001 and reported on in 2002 (WP023, IP024 ATCM XXV – CEP V). SCAR provided another update in 2003 (IP077 ATCM XXVI – CEP VI) and, based on the findings of a second international workshop in 2004, another report was submitted to the Committee in 2004 (IP078 ATCM XXVII – CEP VII).
3. Following discussion at ATCM XXVII, the Committee requested that SCAR bring a further report to ATCM XXIX. SCAR subsequently convened its third international workshop in 2006 and reported back to the 2006 meeting (WP041 XXIX – CEP IX).
4. In response to a CEP request in 2014, SCAR agreed to coordinate a further update on anthropogenic noise in the Southern Ocean with a focus on impacts on Antarctic marine wildlife.
5. This review was originally scheduled for the 2017 meeting (ATCM XL – CEP XX), however, while producing the report in the 2015-17 intersessional periods, it became clear that additional time was needed to complete the review. Therefore, SCAR delayed submission of the report.
6. In the 2017-18 intersessional period, SCAR has made considerable progress in finalizing a report and the process adopted is detailed in this Information Paper.

Progress Report

7. Definitions - In considering the available literature and expert guidance, the term 'noise' was differentiated from the broader term 'sound' as defined by the International Organization for Standardization (ISO). ISO 18405:2017 defines the terms and expressions used in the field of underwater acoustics, including natural, biological and anthropogenic (i.e., human-made) sound as follows:

3.1.1.1 Sound - alteration in pressure, stress or material displacement propagated via the action of elastic stresses in an elastic medium and that involves local compression and expansion of the medium, or the superposition of such propagated alterations.

- Note 1 to entry: The medium in which the sound exists is often indicated by an appropriate adjective, e.g. airborne, water-borne, or structure-borne.
- Note 2 to entry: In the remainder of this document, the medium is assumed to be a compressible fluid.

- Note 3 to entry: A sound wave is a realization of sound.
- Note 4 to entry: The word “sound” may also be used as part of a compound noun, in which case, it is a synonym of “acoustic”. For example, “acoustic pressure” and “acoustic power” are synonyms of sound pressure (3.1.2.1) and sound power (3.1.3.14).

3.1.1.2 Ambient sound, sound (3.1.1.1) that would be present in the absence of a specified activity

- Note 1 to entry: Ambient sound is location-specific and time-specific.
- Note 2 to entry: In the absence of a specified activity, all sound is ambient sound.
- Note 3 to entry: Ambient sound includes ambient noise (3.1.5.11).
- Note 4 to entry: Examples of specified activity include the act of measuring the underwater sound and the radiation of sound by specified sound sources.
- Note 5 to entry: Ambient sound can be anthropogenic (e.g. shipping) or natural (e.g. wind, biota).

3.1.5.9 Noise - time-varying electric current, voltage, sound pressure (3.1.2.1), sound particle displacement (3.1.2.9), or other field quantity except the signal (3.1.5.8) or signals

8. The focus of SCAR's review is anthropogenic noise. To any potential receiver (i.e., an individual of a species or a population) there are three categories of acoustic energy of interest: i) ambient sound, ii) biological sound – self-generated signals (e.g., vocalizations) or signals from potential predators or prey; and iii) noise - sound energy generated by human activities that is known to cause negative effects in the receiver. Noise as a term is ubiquitous in the scientific literature documenting the occurrence of impacts, or the lack thereof, in the presence of unwanted acoustic energy.
9. Experts advised SCAR that within the audiology and auditory physiology communities, noise is defined as "an aperiodic signal that interferes with the perception of sound..." For noise exposures a distinction is made between sound as a physical phenomenon and noise as an unwanted sound that is dependent upon the perception of a receiver. The anthropogenic sounds of interest to policy makers are the signals that are corruptive to ecological processes, communication, perception, and/or behaviour. Not all signals produced by human activities can be perceived by all species and responses are species and environmental setting specific. A signal is a sound that becomes noise only and when a receiver determines it to be disturbing, unwanted, or stressful.
10. During the 2015/16 and 2016/17 intersessional periods SCAR coordinated an external review of literature by experts on the issue of underwater anthropogenic noise, and the potential for impacts on and interactions with underwater sound and Antarctic marine wildlife.
11. In October 2017, SCAR engaged external experts in the issue of underwater noise impacts, to lead a review of the peer-reviewed literature on the subject.
12. SCAR then convened an expert committee in late 2017 to provide further advice on this issue and bring all relevant information together to produce a Background and Working Paper. The expert panel was led by Professor Emeritus Mahlon C. “Chuck” Kennicutt II, past SCAR President (2008 to 2012), who oversaw the submission of the last SCAR update on this issue to the CEP in 2012. The panel members consisted of nine global experts (Appendix A) with a diverse range of expertise and viewpoints.
13. The first draft of the literature review was completed in early January 2018 and informed discussions within the expert committee. Further discussion and detailed input were facilitated by a questionnaire (Appendix B). The literature review and associated discussions focussed on advances in knowledge since the 2012 update by SCAR to the CEP.
14. Following the first round of input from the expert committee, the Chair of the committee consolidated all responses and inputs, and in further consultation within SCAR, prepared a draft Background Paper. To date the committee has provided comments on the first version of this draft paper, and a second draft will have been completed by 16 April 2018.

15. Discussions within the committee covered a broad and diverse range of topics associated with this subject, and a range of perspectives was brought to bear on the matters under discussion. SCAR recognises this diversity of perspectives and is consolidating these inputs for the 2019 submission.
16. As of 1 April 2018, nearly 130 peer-reviewed publications on the issue have been identified in the time period between 2012 and 2017. Topics covered in the draft background paper include: sound sources in Antarctic marine environments (e.g., natural/ambient and anthropogenic noise), marine wildlife responses to anthropogenic noise (e.g., hearing threshold shifts in marine animals, behavioural and physiological responses to noise exposure in various species), sound sensitive Antarctic species and sound “hotspots”, cumulative impacts, mitigation and management practices, and final comments, information gaps and future directions.

Next Steps

17. SCAR, together with the Chair of the expert committee, will continue to refine and revise the Background Paper, seeking further expert advice as appropriate on specific issues. The Background Paper will form the basis of a Working Paper. SCAR intends to submit these to ATCM XLII – CEP XXII in 2019.

Appendix A

Anthropogenic sound in the Southern Ocean – Expert Committee Members (alphabetical)

Professor Mahlon C. “Chuck” Kennicutt II (Chair), Professor Emeritus

Dr. Olaf Boebel, Alfred Wegener Institute, Germany

Professor Daniel C. Costa, University of California Santa Cruz, USA

Dr. Heike Herata, German Environment Agency, Germany, CEP Representative

Dr. Stephanie Langerock, Belgian Government, Belgian IWC, CCAMLR

Mirjam Müller, German Environment Agency, Germany

Dr. Douglas Nowacek, Duke University, USA

Dr. Rachel Przeslawski, Geosciences Australia

Dr Michelle Rogan-Finnemore, Council of Managers of National Antarctic Programs

Professor Peter. L Tyack, University of St. Andrews, United Kingdom

Dr. Aleks Terauds (ex officio), Chief Officer of SCAR-SCATS, Australia Antarctic Division

Professor Steven Chown (ex officio), President of SCAR, Monash University, Australia,

Appendix B

Expert Committee Questionnaire

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Attachment 1 - Scientific Synthesis on the Impacts of Underwater Noise on Marine and Coastal Biodiversity and Habitats, 2012, UNEP/CBD.

Attachment 2 - Underwater sound and marine wildlife: a review of recent information and developments relevant to Antarctic waters, 2017, Russell Leaper and Susannah Calderan.

Sound and its Impact in Antarctic Marine Environments – Questionnaire

1. Introduction

Thank you for agreeing to participate in SCAR's preparation of a paper for the 2018 Antarctic Treaty Consultative (ATCM) meeting on sound and its impact in Antarctic marine environments. In this first phase of the activity, the committee is tasked with assessing the current state-of-knowledge in regard to underwater sound and marine wildlife in the Antarctic partially based on a UNEP/Convention on Biodiversity scientific synthesis (2012, Attachment 1) and a solicited updated review by Leaper and Calderan (2017, Attachment 2). Discussions will be electronically conducted and form the basis of a submission to the Committee on Environmental Protection (CEP).

1.a The Process

To gather input from experts such as yourself, please complete the following questionnaire. The questionnaire has four parts: (1) a series of questions on the current status of the state-of-knowledge of sound and its impacts in Antarctic marine environments, (2) a critique of the Leaper and Calderan paper (optional), (3) a distillation of the most important conclusions based on the current state-of-knowledge of sound and its impacts in Antarctic marine environments and (4) the potential next steps that SCAR might pursue.

1.b The Output

Once questionnaires are completed the Chair will summarize the outcomes and provide a draft paper for consideration by the committee. While unanimous agreement on conclusions is the goal, any dissenting opinions will be duly noted in the final report.

2. Part 1: Expert Assessment

Based on your review of the UNEP/CBD and Leaper and Calderan papers, and your own expert knowledge, please provide brief answers to the following questions (a yes or no may be sufficient

but an explanation will be helpful in clarifying and summarizing expert opinions). [Add space as needed].

1. **What is your expert opinion on the current state-of-the-knowledge of sound and its impacts in Antarctic marine environments?** Please quantify by a score of 0 to 10 with 0 - a complete lack of information and 10 - a level of knowledge sufficient to recommend policy actions. If you feel you do not have the expertise to comment please indicate so by an IK (Insufficient Knowledge):
 - a. Sources and types of anthropogenic sound in the Antarctic – 0 to 10
 - b. Studies that have investigated impacts of underwater sound – overall - 0 to 10
 - i. Marine mammals – overall - 0 to 10
 1. Cetaceans – 0 to 10
 2. Pinnipeds – 0 to 10
 - ii. Seabirds – 0 to 10
 - iii. Fish – 0 to 10
 - iv. Invertebrates – 0 to 10
 - c. Mitigation and Management – 0 to 10
2. **Are there significant gaps in the state-of-knowledge of sound and its impacts in Antarctic marine environments?** If yes, what are they? Please be specific.
3. **Has the review overlooked important sources of information on sound and its impacts in Antarctic marine environments?** If yes, please provide full citations.
4. **Do the conclusions in the UNEP/CBD and Leaper and Calderan’s papers logically flow from the knowledge base and are they supported by the evidence?** Since there are multiple conclusions your assessment of robustness might differ amongst topics so please be specific.
5. **Are the track record and assessments of the effectiveness of mitigation and management options sufficient to propose justifiable policy and/or management actions?** Are mitigation and management practices and experiences elsewhere in the world ocean applicable to Antarctic marine environments? If no, is it possible to extrapolate to “lesson learned” elsewhere to Antarctic marine environments? Are there accepted/proven international mitigation/management standards that could be recommended for or adapted to Antarctic marine environments?
6. **At a species level, is there sufficient knowledge to discern “sound-sensitive Antarctic species” as a high priority for mitigation/management?** If yes, what species are those? Is there a confluence of harmful sound producing activities in areas of the Antarctic marine environment that include critical habitat and/or ecosystems that are particularly vulnerable to sound interferences – “soundscape hot spots”?
7. **What role, if any, is habituation likely to play in lessening the impact of sound in the Antarctic marine environment?** Are there species that are more likely to express habituation increasing resilience? If yes, what species are they?
8. **Is there adequate knowledge to assess cumulative impacts from multiple sound sources (including natural sounds) in Antarctic marine environments?** Are multiple sound-producing activities geographically and/or temporally concentrated due to the intrinsic nature of human activities in Antarctic marine environments? If yes, what are the mitigation/management implications?

9. **Are there critical, future research/knowledge needs that will incrementally improve policy making decisions and/or contribute to garnering consensus to act?** If yes, what are these critical research/knowledge needs?
10. **Amongst the many threats being experienced by marine environments in the Antarctic where do the impacts of anthropogenic sound rank on a relative priority list?** High priority, medium priority, or lowest priority? Elements that effect priority might include the intensity/scale of impact, the pervasiveness of the threat, the future trajectory of the threat, the urgency of the threat (ongoing damage), the ability to mitigate the threat by actions under the remit of the ATPs, etc.

3. Part 2: Review of the Leaper and Calderan paper (Optional)

While the intent is not to revise or edit the solicited Leaper and Calderan paper, it will be useful to the discussions if the committee reviews the report in its entirety (it will most likely be provided to Antarctic Treaty Parties as a resource) as if it were to appear as a peer-reviewed scientific paper. If you wish to, please provide a short review (e.g., 500 words) of the Leaper and Calderan paper in regard to quality, topical content, comprehensiveness and/or other criteria you believe are important. The anonymity of individual reviewer comments will be maintained in any use of this material.

REVIEW.... (500 words or less):

4. Part 3: Conclusions

The end product of this exercise will be a paper submitted to the ATCM/CEP. Procedures require these reports to be succinct and to the point for ease of communication to Antarctic Treaty Parties (who in most cases are not scientists). To this end, the summary of this committee's discussions will highlight the most important conclusions drawn by scientific experts that will potentially inform those responsible for policy actions. Based on your review of the UNEP/CBD and Leaper and Calderan papers and your knowledge of the subject, please briefly describe the 3 to 5 most important messages you believe should be communicated to policy/decision makers:

- 1) Conclusion #1:
- 2) Conclusion #2:
- 3) Conclusion #3:
- 4) Conclusion #4:
- 5) Conclusion #5:

Add additional conclusions as warranted.

5. Part 4: Future Directions

An assessment of the current status of the state-of-the-knowledge of sound and its impacts in Antarctic marine environments is only the first step in fulfilling SCAR's role as a scientific advisor to the ATS (SCAR also advises its own community in regard to best practices). There are several possible future directions that might be undertaken (e.g., SCAR code of conduct, SCAR risk analysis, exhortation for scientific funding to fill critical gaps, etc.). Given the current state-of-knowledge – what do you consider as the highest impact and/or most important next steps that SCAR might wish to consider?

- 1) Activity #1:
- 2) Activity #2:
- 3) Activity #3:

Add additional activities as warranted.

6. Concluding Remarks – please use this page to express any concerns and /or questions about any or all aspects of the committee’s activities. Also if there are any topics, comments or other items not covered in Parts 1-4 that you feel should be considered, please explain them here. Notes in explanation of answers above can also be entered in this space (please indicate which of parts 1 to 4 your comments refer to for clarity).