

MARINE SCIENCE CO-ORDINATION COMMITTEE (MSCC)

**Minutes of the Underwater Sound Forum meeting held at the University of Exeter,
Living Systems Institute on Tuesday 21 May 2019**

Chair: Professor Peter Liss	University of East Anglia
Secretariat: Anne Brazier	MSCC
Attendees:	
Nikhil Banda	Seiche
Harriet Bolt	UKHO
Tetienne Box	JNCC
Wendy Brown	IOGP
Ken Collins	University of Southampton
Julie Cook	BEIS
Andy Cooper	Thales
Nick Crawford	NPL
Ross Culloch	Scottish Government
Peter Dobbins	Institute of Acoustics
Clare Embling	Plymouth University
Gaynor Evans	BODC
Adrian Farcas	Cefas
Mike Forbes	Ace Aquatec
Phil Gibbs	Swale Technologies
Tim Gordon	University of Exeter
Ed Harland	Chickerell BioAcoustics
Dick Hazelwood	R & V Hazelwood
Vincent Janik	University of St Andrews
Rod Jones	MoD
Sally Kazar	GoBe
Jen Learmonth	Royal Haskoning
Paul Lepper	Loughborough University
Stephen Lloyd	Loughborough University
Natalia Lopez	Orsted
Claire Ludgate	Natural England
Francesca Marubini	Hartley Anderson
Sarah Marley	University of Portsmouth
Fiona McNie	Natural England
Nathan Merchant	Cefas
Emma Milner	Gardline
Sophie Nedelec	University of Exeter
Phil New	GoBe
Julie Oswald	Scottish Oceans Institute
Harriet Rushton	MoD
Steve Simpson	University of Exeter
Lorelei Smith	Royal Haskoning
Carol Sparling	SMRU Consulting
Gemma Starmore	RHDHV
Elaine Tait	Scottish Government
Leah Trigg	University of Portsmouth
Ursula Verfuss	SMRU Consulting
Emma Weschke	University of Exeter
Matthew Witt	University of Exeter

1.0. Welcome

- 1.1 The Chair welcomed attendees to the Forum meeting and expressed his pleasure at seeing the number of attendees.
- 1.2 Steve Simpson welcomed attendees on behalf of the host organisation, the University of Exeter's Living Systems Institute (LSI). The LSI opened in Autumn 2016 and provides an innovative space for more than 200 researchers with complementary expertise in biosciences, medicine, physics, engineering, mathematics and computer science looking for transformative solutions to global problems. The building also provides access to the Aquatic Resources Centre, which has 14 aquaria rooms, including the recent addition of a 3000 tank zebra fish unit. Steve's team research (amongst other subjects) bioacoustics, ecoacoustics and underwater noise and many of his team were present at the Forum meeting.
- 1.3 The day before the Forum meeting, the University of Exeter had declared an environment and climate emergency and had established a team to focus on the actions required based on evidence and science. A forthcoming event will be a large debate at the campus on what actions are required.
- 1.4 The Chair thanked Steve and the University of Exeter for hosting the meeting.

2.0. Apologies

- 2.1 Apologies had been received from Defra, JASCO, Ultra, ABPmer, Wildlife Trusts, SEA, Natural Resources Wales, IAGP, Environment Agency, QinetiQ.

3.0. Minutes of previous meeting held on Wednesday 21 November 2018

- 3.1 These were agreed to be a true and accurate record of the meeting and were therefore approved.
- 3.2 It had been agreed at previous meetings that a 'Media' page be added to the Underwater Sound Forum website. Any Member who wishes to be listed on this page as a media contact in their own right, and not on behalf of the Forum, to advise Anne **ACTION: Members.**
- 3.3 The Forum, as a partnership initiative of the Marine Science Co-ordination Committee (MSCC) is obligated to report back to this parent body and to undertake tasks as and when required. The MSCC is about to publish its Road Map which contains nine high-level science and evidence priorities, the responsibility for which will be spread across the MSCC's portfolio of sub-groups. The Underwater Sound Forum have been allocated responsibility for:

High-level science and evidence priority 2 – Better understand the structure, function, resilience and variability of marine ecosystems (responsibility will be shared with the Marine Assessment and Reporting Group)

High-level science and evidence priority 7 – better understand cumulative and in-combination impacts on the capacity of marine systems to supply food, energy and mineral resources as well as mitigate against the risk effects of natural hazards (responsibility will be shared with the Marine Assessment and Reporting Group and the Marine Climate Change Impacts Partnership). The Forum has been nominated a member of the MSCC Secretariat – Anne Brazier - who will be its point of contact. Further information will be issued to the Chair of the Forum in due course and he will work closely with Anne, Nathan Merchant and Stephen Robinson going forward. It is currently anticipated there will be no change to the Forum holding meetings twice per annum.

4.0. Themed Presentations

4.1. The changing song of the sea

Tim Gordon, University of Exeter

Tim described how fish hatched on coral reefs wash into the sea until adulthood when they then attempt to find their way to a reef through the use of sight, smell and sound. Sight and smell can only be used if a reef is close by and/or the wind is in the right direction but the sound of a reef should be useful at greater distances. However, climate change and warming seas have decimated reefs to a bleached mass full of algae. What should be a noisy soundscape is too often silent.

Tim, and a team of collaborators, made fake coral reefs and played back the sound of both healthy and degraded reefs and it is clear that a healthy-sounding reef will attract more fish. Fish are an important part of reef ecology and their lack can lead to further degradation. It may be that by playing the sound of a healthy reef will encourage fish to come into degraded reefs to help eat the surplus of algae.

Members asked about the amount of life on restored reefs. Quick growing coral will soon repopulate but the species of fish returning is surprising and this is now being looked at in more detail. Members thanked Tim for his fascinating presentation and wished him luck in his PhD.

4.2. A review of noise abatement systems for offshore wind farm construction noise and the potential for their application in Scottish waters and for UXO clearance

Ursula Verfuss, SMRU Consulting

SMRU consulting are to undertake a review of noise abatement for Scottish Natural Heritage. This has been triggered by extensive plans to expand the number of offshore renewables, the increase in pile diameters and the increase in hammer energy. In 2012 the average diameter of a pile was two metres. The average today is eight metres.

In Germany there is currently a noise threshold for piling. SMRU Consulting looked at noise abatement systems which are currently used for pile

installation and those which are under development and sent out a questionnaire to both suppliers and users of these systems. Responses were clarified through the use of interviews.

Currently SMRU Consulting are not in a position to share results with the Forum but it is hoped they will present at the November 2019 Forum meeting to provide an update **ACTION: Anne**. Members did ask if seabed vibration had been considered. It had not. Members also asked where measurements were taken in the water column as fish without swim bladders are often found on the sea bed. Measurements were taken a few metres above seabed with nothing used to mitigate seabed noise.

4.3. Key Underwater Noise Issues from Offshore Developments

Gemma Starmore, Royal HaskoningDHV

This presentation challenged Members to think about the actual noise generated by windfarm development as opposed to noise models. Piling is seen as one of the biggest generators of underwater noise and therefore worst-case scenarios are used when modelling. However, this may be far from accurate and Dudgeon Offshore Wind Farm actually only used 21% of the piling time that was predicted. This inaccuracy can also be seen in reference to UXO noise and there seems to be too much modelling at the mid-ocean column.

Marine Scotland stated that they would rather still use the worst-case scenario when modelling. Members also wished to point out that the conditions for piling can have a huge effect on the time required. Dudgeon was relatively easy to pile, hence the 21% of piling time, but other sites may require more time. Members queried which data was used. Only data from the first four piles were recorded, and whilst it would be preferable to have data from all piles, this would be more onerous for contractors.

4.4. Marine mammal reactions to startling impulse sounds

Vincent Janik, Scottish Oceans Institute

Vincent opened his presentation with praise for the Forum and its ability to bring people together from many different backgrounds. Vincent presented on behavioural response studies (BRS). BRS can be experimental or non-experimental (observational) and on captive or free animals. It is much harder to do experimental work with free-ranging animals but some of the key projects at the University of St Andrews do use free-ranging animals.

Currently, impact assessments use different risk criteria for impulsive and non-impulsive sounds but as impulsive sounds dissipate they potentially lose hazardous features and become non-impulsive at some distance from the source. A lack of data on range-dependent characteristics currently limits their inclusion in impact assessments. However, this can have huge effects on animals. Sound can startle an animal and lead to a deep dive. A repeat of the startle sound can lead an animal exaggerating their response each time,

for example, diving deeper, swimming faster and not clicking. Impulsive sound can lead to a complex interaction based on sound level, recovery periods etc., and can therefore strongly affect the risk of hearing damage. Auditory damage studies and impact assessments must therefore consider the ranges at which sound may lose some of their potentially hazardous characteristics.

4.5. Creating a temporary marine mammal exclusion zone around offshore sites
Mike Forbes, Ace Aquatec

Mike advised Members that his presentation would be from the perspective of commercial interests in sound in the sea. Mike presented FaunaGuard, an innovative acoustic device, which can be tuned for different species, to help protect marine fauna near construction activities. Originally only used by Van Oord, the porpoise module of FaunaGuard is now commercially available, and Ace Aquatec and Van Oord will bring other modules to market as and when available.

A low-frequency seal deterrent is also available and a fish deterrent has already been successfully deployed at the Gemini Offshore Wind Park. A matter of urgency is a turtle deterrent due to the amount of marine construction near to sea turtle habitats. This has been tested in Brazil and is now undergoing peer review. Members were particularly interested in the turtle deterrent and it is hoped this can be presented to the forum in more detail in due course.

4.6. Shipping Noise Maps in UK waters
Adrian Farcas, Cefas

Adrian is an Ecosystems Modeller at Cefas which has created the first UK map of shipping noise through the use of microphones placed on the seabed for an 18-month period, with audio recorded at specific locations for a continuous three-month period. Ships' propellers were the most widespread cause of underwater noise, with the loudest areas busy shipping lanes such as the Strait of Dover.

This data can be used in the modelling of underwater noise for environmental assessments. As ships move, different source frames and noise frames were required to produce a spatial representation. Satellite AIS data was used for the position of ships. When noise and position is coupled it should be possible to look at which species of marine life are affected most in shipping noise hotspots.

4.7. Identification of dolphin species in acoustic recordings
Julie Oswald, Scottish Oceans Institute

The ability to identify delphinoid vocalisations to species in real time would be an asset during surveys. Passive acoustic monitoring is commonly used but is not backed up by associated visual observations. An automated system, Real-time Odontocete Call Classification Algorithm (ROCCA) has

been developed to provide real-time acoustic species identification in the field. This Matlab-based tool automatically extracts ten variables from whistles and uses classification and regression tree analysis (CART) and discriminant function analysis (DFA) to link whistle to species. Schools are classified based on running tallies of individual whistle classifications, thus providing a method for identifying schools that are difficult to approach and observe. ROCCA was created for use in the Pacific Ocean and there are therefore gaps such as the North East Atlantic, North Sea and Mediterranean.

Members were encouraged to read *Seasonal and diel acoustic presence of North Atlantic minke whales in the North Sea*¹. The sound of the minke whale had been recorded for the first time off Scotland's coast. Findings were drawn from data collected by Marine Scotland Science as part of the East Coast Marine Mammal Acoustic Study (ECOMMAS) array of underwater sound recorders. Denise Risch used software she and colleagues from Cornell University developed to pick out the minke whale's pulse trains. Denise will be using the same methodology to monitor minke whales on the west coast of Scotland as part of the Collaborative Oceanography and Monitoring for Protected Areas and Species (COMPASS) project.

4.8. Impacts of motorboat noise on the Great Barrier Reef

Sophie Nedelec, University of Exeter

Where humans inhabit coastal waters, small boats provide a ubiquitous source of anthropogenic disturbance (it is expected that there will be 0.5 million recreational motorboats using the Great Barrier Reef by 2040) and there is evidence that some fish species can be affected by this noise, including behavioural changes to foraging, nest caring and predator avoidance and physiological changes such as increases in plasma cortisol concentrations, oxygen consumption and ventilation.

A field-based experiment investigated the effects of repeated exposure to the playback of motor boat noise over three weeks. In the short term, fish displayed both behavioural and physiological responses to motor boat noise playback. Hiding behaviour can impact fitness as there will be less time available for foraging and which could lead to starvation, reduced ability to escape predators and fewer or poorer offspring. Additionally, fish that become habituated to motorboat noise are more at risk from fishing.

Members asked about the use of odour. An odour is emitted by fish skin when a fish is injured so fish will then avoid this area as it means a colleague has been eaten. Members also asked about the effects of noise on predators

¹ <https://www.nature.com/articles/s41598-019-39752-8>

and whether they find it easier to eat. Some do and some may be so deaf that motorboat sound no longer affects them.

4.9. International Technical Workshop on Quiet Ship Design

Dick Hazelwood, R&V Hazelwood Associates

Members had asked for feedback from the 'Quieting Ships to Protect the Marine Environment' technical workshop which had been hosted by Transport Canada in January 2019 at the IMO, London. The workshop was an opportunity to share knowledge and advance work on quiet ship designs and technologies to help protect the marine environment. One outcome of this workshop was a report by Vard Marine on 'Ship Underwater Radiated Noise (URN)' which contained a matrix of URN mitigation measures (and has been circulated to Forum Members). Some of the key policy and research recommendations that came out of the event include:

Recognition that a biological limit for underwater noise levels applicable to all species, in all regions of the world, is challenging to develop at this time. Therefore, a ship-based limit was recommended.

Ensuring that the feasibility of noise mitigation measures also aligns with efforts to improve energy efficiency and reduce Greenhouse Gas (GHG) emissions in line with the Initial IMO Strategy on Reduction of GHG Emissions from Ships (Resolution MEPC.304(72)) and the Paris Agreements.

Continue to gather data and in situ measurements of vessels and the noise they emit in order to further the understanding of this issue and its consequences. This also relates to validating modelling measurements, establishing biological limits and the alternative of feasibility-based limits;

The potential value of explicitly identifying underwater vessel noise as a form of pollution in the relevant maritime and environmental conventions;

Advancing research on some of the specific technological solutions identified over the course of the workshop, and develop a guide for shipbuilders on available technologies (such as Air Bubble Systems and noise mitigation for machinery);

Development of a comprehensive framework of international standards for precision measurement in shallow water and for ships-of-opportunity, as an enabler to establish policy objectives for quieter ships; and

Increasing education and outreach efforts with ship owners, ship designers, shipbuilders, machinery, and equipment manufacturers to better inform them of the issue of underwater noise and feasible mitigation measures. In addition, encourage companies to begin measuring the underwater noise emitted from their vessels in order to establish baselines.

4.10. Characterisation of acoustic fields generated by UXO removal

Paul Lepper, Loughborough University

Members were advised of this new initiative with the engagement of the community very much in mind. Currently there is not much published data on underwater sound generated during the detonation of UXO. Unexploded ordnance is a real problem to the offshore wind and cable industries. The sheer volume of unexploded ordnance is best seen via ORDTEK's mine map (<https://www.ordtek.com/mine-map/>) and the issue for developers is whether to leave ordnance alone or to detonate it. Detonation makes a very large bang but this can be reduced through deflagration.

NPL, Hartley Anderson and Loughborough University have been funded, via BEIS's Offshore Energy SEA projects, to look at the sound generation of different types of UXO detonation with an aim to deliver a guidance protocol for those undertaking measurements. There will be controlled field trials to study sound generation and long-range propagation. The three partners wish to collect and analyse measurements made during a variety of UXO removals so if you have been involved in UXO removal please get in touch with Paul Lepper, Stephen Robinson of NPL or Francesca Marubini of Hartley Anderson.

5. **Any Other Business**

- 5.1. Members were reminded of the forthcoming IOA Sixth International Conference on Bio-Acoustics which will take place on August 13 – 14 2019 at Holywell Park Loughborough University. More detail can be found at <https://acoustics.ac.uk/events/ioa-sixth-international-conference-on-bio-acoustics/>

6. **Date and venue of next Forum meeting**

- 6.1. The next meeting of the Forum will take place on Wednesday 20 November 2019 at Marine Scotland, Victoria Quay, Leith, Edinburgh. Grateful thanks to Elaine for this kind offer to host. Offers to present on updates to ADEON, JOMOPANS, ambient noise data from Cefas monitoring sites will be gratefully received, as will other presentations.