MARINE SCIENCE CO-ORDINATION COMMITTEE (MSCC)

UNDERWATER SOUND FORUM

Minutes of the meeting held on Wednesday 3 May 2017 at Newcastle University

Meetings Chair: Professor Peter Liss **University of East Anglia**

Attendees:

Argent, Claire	Natural England
Bell, Sean	Ultra Electronics
Berggren, Dr Per	Newcastle University
Brack, Jennifer	DONG Energy
Brazier, Anne	MSCC Secretariat
Carter, Dr Caroline	Scottish Natural Heritage
Collins, Dr Ken	University of Southampton
Cook, Dr Julie	BEIS
Diele, Karen	Edinburgh Napier University
Dobbins, Dr Peter	Institute of Acoustics
Downing, Jonathan	RN Maritime Warfare Centre
East, Sam	Subacoustech
Evans, Dr Gaynor	MEDIN
Findlay, Charlotte	JNCC
Fitzsimmons, Dr Clare	Newcastle University
Flack, Helen	Ultra Electronics
Gillespie, Dr Doug	Sea Mammal Research Unit
Gordon, Dr Jonathan	Sea Mammal Research Unit
Harland, Ed	Chickerell BioAcoustics
Hawkins, Dr Tony	Loughine Limited
Hazelwood, Dr Dick	Institute of Acoustics
Hedley, Claire	MMO
Hughes, Dr David	QinetiQ
Jamieson, Alice	MMO
Kirk, Paul	MMO
Marten, Dr Kerry	HR Wallingford
Mason, Tim	Subacoustech
Nilova, Marija	Natural England
Risch, Dr Denise	Scottish Association for Marine Science
Roberts, Dr Louise	University of Hull
Starmore, Gemma	RHDHV
Sweeting, Dr Chris	MMO
Tait, Adrian	Scottish Government
Temple, Andrew	Newcastle University
Tickner, Conor	AECOM
Winkes, Jasper	Fistuca

1. Chair's Welcome

1.1 The Chair thanked attendees for making the journey to Newcastle to attend meeting and advised Members there would be no update from the MoD. Members were also advised that due to illness, and the forthcoming election, there would be no update on Standards, nor an update from Defra.

1.2 The Chair also thanked the Marine Management Organisation and Newcastle University for hosting the Forum meeting and for arranging tours of the University's Armstrong Building.

2. Apologies for absence

2.1 Apologies for absence were received from Aceaquatech, AHTI, BDMLR, Cefas, Bakers Consultants Marine, Environment Agency, Dstl, Jasco, NPL, SEA, UKHO, University of Exeter and The Wildlife Trusts.

3. Minutes of meeting held on 7 November 2016 (USF/MIN/2016/02)

3.1 The minutes were agreed to be a true and accurate record of the meeting held on the 7 November 2016.

4. Matters Arising and Actions

4.1 There were no Matters Arising.

4.2 Members were asked to access the Forum's website at https://projects.noc.ac.uk/usf/ and send any comments, thoughts, articles, updates to Anne Brazier.

5. Themed presentations

5.1 *Acoustic monitoring of echolocating cetaceans during the development of the offshore wind farm off Blyth, Northumberland 2016 – 18*
Dr Per Berggren and Andrew Temple, Newcastle University

5.1.1 Dr Berggren advised Members that he was presenting on behalf of all colleagues and students who had collaborated on this research. The National Renewable Energy Centre (NAREC) development site near Blyth, Northumberland, was initially an offshore test facility for wind energy companies. In October 2014, the site was taken over by Blyth Offshore Demonstrator Ltd./EDF Energy who were given consent to develop a three-array 15-turbine commercial 40MW windfarm.

5.1.2 EDF funded a pilot study, conducted between June – September 2015, to look at the spatial and temporal occurrence of harbour porpoise and delphinids through the use of seven C-POD passive autonomous cetacean click recorders. Spatial and temporal differences were recorded. Delphinid occurrence across all sites decreased during hours of daylight and was higher in July and August, when compared to June and September. Porpoise numbers did not decrease during

daylight and there was a decrease in numbers in June when compared to other months.

5.1.3 EDF agreed to fund a further monitoring programme, which used additional acoustic recorders, and covering a large area throughout the year will have greater power to detect potential changes in delphinid and porpoise spatial and temporal occurrence and foraging activity.

5.1.4 This programme is collecting a huge amount of data and to cope with this, a spatially enabled database, analytics and a visualisation platform are being developed. The platform consists of processes and tools to import, manage, interpret and visualise a diverse range of inputs, which will enable practitioners to easily analyse and interpret data in a multi-dimensional framework.

5.1.5 Algorithms for species identification have been developed via clicks and have a 77% probability for identification. This method will now be applied for white-beaked and common bottlenose dolphins that co-occur off Blyth.

5.2 *Problems with Environmental Impact Assessments related to underwater noise*
Dr Tony Hawkins, Loughine Ltd. & Dr Dick Hazelwood, Institute of Acoustics

5.2.1 Dr Hawkins stressed to Members the amount of major developments now taking place off the UK coast, including those for harbour re-development, offshore windfarms, tidal energy and wave energy generators and offshore oil developments.

5.2.2 Whilst great efforts are being directed at examining the effects of underwater noise upon marine mammals, much less attention is being paid to the effects of underwater noise on fishes and invertebrates. Little is being done to investigate those features of underwater sound that fish and invertebrates respond to, and to expressing these impacts in appropriate metrics, as well as to modelling the propagation of sound from the source to the animals and setting sound exposure criteria for fishes and invertebrates.

5.2.3 Members were reminded that within a travelling acoustic wave, particles of water are alternatively forced together and apart – the particle motion, and are accompanied by waves of compression and rarefaction – the sound pressure. Fish are sensitive to particle motion, with only a few being sensitive to sound pressure.

5.2.4 Particle motion is difficult to measure directly, and must often be inferred from the measured sound pressure. Environmental Impact Assessments often emphasise that sounds do not travel well through shallow water. This may be true of sound pressure but may not be the case for particle motion. Fish ears can be sensitive to particle motion

as well as sound pressure, and there are differences between species with some species like dab and salmon being particularly sensitive to particle motion whilst cod and herring are sensitive to sound pressure. The otolith within each ear sits on a membrane of sensory hair cells, and these can respond to being shaken by particle motion.

5.2.5 Measuring the sensitivity of fish only in terms of sound pressure can give rise to very misleading results and can result in Assessments providing a false idea as to how sensitive fish are to sounds. This sensitivity can increase at very low frequencies. Infrasound (below 20 Hz) is often ignored for Assessments even though it is common.

5.2.6 Many marine invertebrates are also sensitive to particle motion. Recent work in Tasmania showed that scallops and lobsters may respond adversely to being exposed to substrate vibration generated by seismic airguns and therefore the sensitivity of fish and invertebrates to particle motion should be considered when setting sound exposure criteria or modelling sound propagation.

5.2.7 Members were informed that as the criteria for particle motion measurement, and the potential damage to fish and invertebrates it can cause, are not set, modelling is difficult to carry out. Additionally, the models that are available to predict particle motion from ground roll are expensive to use and it is hoped that standards authorities will address this problem. The Acoustical Society of America (ASA) will be discussing particle motion measurement standards at their conference in June 2017.

5.2.8 In summary, low frequency seabed vibrations move as seismic ground roll waves, at relatively low speeds across the interface between soil and water, creating comparatively large water particle motions. These motions are very significant to species without good sensitivity to sound pressure waves, such as dabs, crabs, cockles and mussels. Propagation modelling is quite different from that for sound pressure waves, but new research shows a feasible worst-case prediction method. Queries can be addressed to dick@r-vhazelwood.co.uk

5.3 *Securing the engagement of diverse stakeholders in contentious environmental studies of the effects of sonar transmissions on harbour porpoises - questionnaire*
Jonathan Downing, MSc dissertation

5.3.1 Mr Downing explained to Members that the above questionnaire is part of his Open University Master of Science project which seeks to examine the challenges of securing engagement from diverse stakeholders in contentious environmental studies, especially where MoD ranges are within Special Areas of Conservation.

5.3.2 Successful stakeholder engagement needs to be supported by guiding principles designed to establish a working environment based on

learning, trust and action. This can then produce collaborative output which will improve the quality of subsequent decisions and maintain stakeholder engagement.

5.3.3 Mr Downing's questionnaire seeks out the views of stakeholders in contentious environmental studies and asks whether they could commit to being asked to agree, in advance, to accept the outputs from a collaborative process.

5.3.4 Scenarios are provided within the questionnaire and participants are asked to rate their ability to commit to information gathering, information processing, managing acquired knowledge, formulating judgements and making decisions in relation to these scenarios.

5.3.5 Any member willing to complete the questionnaire can do so via https://docs.google.com/forms/d/e/1FAIpQLSfBeIABuT2iEsxRE-T0_79etoY1FP5dHMXdgDGgxgK3-iTlXg/viewform?usp=sf_linkhttps://goo.gl/forms/sx5bSZFnKWgbYtJ22 Members are asked to complete the questionnaire by no later than the end of July 2017.

5.4 *BLUE Piling Technology: the quiet, offshore pile driving technology*
Jasper Winkes, Fistuca

5.4.1 BLUE Piling Technology is a new system for driving large piles offshore via the use of water. The BLUE Hammer consists of a large water tank that contains an open combustion chamber. Energy for driving the pile is created when gas is fed into the combustion chamber. Combustion creates a pressure increase and this causes water to flow out of the combustion chamber, pushing a pile into the seabed. This creates the 'first blow'.

5.4.2 As combustion continues, the water column is forced upwards. This then falls back to its original position causing a 'second blow'. Exhaust gas is then released through an exhaust valve and the cycle is repeated. BLUE Hammer delivers significantly more energy to the pile per blow. This very high energy level increases the pile penetration per hammer impact thereby reducing the number of blows required to reach final penetration.

5.4.3 Members were advised that driving piles with a BLUE Hammer reduces the offshore underwater noise levels at source and results in faster pile driving when compared to conventional pile driving. Due to the very long duration of the blow of a BLUE Hammer, and the gradual increase in the force, the acceleration of the pile wall is reduced causing a reduction of the underwater noise levels by up to 20 dB.

5.4.4 The BLUE Hammer will be tested and demonstrated offshore in the latter half of 2017, and will be available for rent in 2018. Following on from the development of smaller hammers, Fistuca is currently building the BLUE 25M, which will be able to drive the largest monopoles.

5.4.5 Members were advised that the BLUE Hammer can work in all sea

states and in clay and sand. Members asked whether this technology could be used in coastal areas and in harbours. Currently this is not being looked at. Members also asked about ground roll measurement. Currently this has been modelled but not measured in the field.

5.5 *Distribution of acoustic deterrent devices along the west coast of Scotland over a ten-year period from acoustic sampling data*
Dr Denise Risch, Scottish Association for Marine Science

5.5.1 Scotland is the third largest producer of Atlantic salmon in the world, and production is set to increase due to increasing demand and support from the Scottish Government. As the extent of fish farms grows, there is increasing conflict with top marine predators such as grey and harbor seals. Although the lethal removal of seals was agreed under the 2011 Marine Scotland Act, fish farms should seek to use alternative methods such as anti-predator netting, net tensioning, translocation and acoustic deterrent devices (ADDs).

5.5.2 ADDs are active acoustic devices and produce loud and aversive sounds designed to deter seals from approaching fish farms. The most common ADDs used in Scotland operate within the range of 2 – 40 kHz, with higher frequency harmonics up to and above 80 kHz. In recent years, several issues with the use of ADDs have been raised. Currently no license is required to use ADDs and therefore no publically available information exists on the number and type of ADDs being used, their duty cycles, and whether ADDs are turned off during fallow periods.

5.5.3 The goal of this study was to map the spatial extent of ADDs and describe the changes in ADD use across the Scottish west coast between 2006 and 2016, and to document the presence of different types of ADDs between 2011 and 2015. A large existing data set collected by the Hebridean Whale and Dolphin Trust was used.

5.5.4 This data (collected by volunteers) was found to be highly accurate and showed a year on year increase in the proportion of listening stations where ADDs were heard, including within Harbour Porpoise SACs and Grey and Harbour Seal SACs. This means there has been a significant temporal-spatial increase in the presence of ADDs in the last ten years and that ADDS have become a major contributor to the underwater soundscape of the Scottish West Coast with potentially severe impacts for target and non-target species. Although hot spots vary annually, it is clear that better management of ADD use in Scottish aquaculture is required.

5.5.5 Future work will attempt to quantify the contribution of ADDs to underwater ambient noise levels over space and time, and to measure the impacts of different types of ADDs on target and non-target species in terms of injury, behavioral response and habitat displacement. A long-term PAM project (2018 – 2021) in the area will contribute

additional data to the contribution of ADD noise and changes in ambient noise levels.

5.6 Use of baited remote video to investigate fish responses to noise
Dr Louise Roberts, University of Hull

5.6.1 Dr Roberts advised Members the aim of this study was to explore and evaluate the key behavioural responses of coastal UK marine fishes and macroinvertebrates to anthropogenic noise. Work focused upon two key aspects, water-borne acoustics and the relatively unstudied substrate-borne vibration, through a combination of laboratory and field work using grouped and solitary individuals.

5.6.2 Free-ranging individual fish and crustaceans were observed using a baited remote underwater video (BRUV) system. Whilst the use of cameras is common, their use in the study of unrestrained fish and their response to the playback of sound is rare.

5.6.3 The BRUV and sound projector array were deployed from an anchored vessel and from shore. Playbacks were undertaken using a purpose-built underwater transducer array capable of accurately reproducing man-made signatures (shipping, synthetic impulsive sound and 'silence' random choices).

5.6.4 Responses to sound were quantified through the use of a SIMI Motion Analysis software 3D, which is normally used in sports science, and is able to track individual fish movements. Responses to sound were clear, e.g. directional change and acceleration, although were short term (approx. ten minutes), after which fish returned to normal behavior. Responses varied according to the level of sound, the type of school and the species.

5.6.5 The BRUV system has proved to be a useful observation method, successful in examining the behavior of unrestrained fish exposed to sound and it is anticipated that the use of motion-analysis software will continue to reveal interesting results. Moving forward, improvements need to be made in the remote long-term deployment of sound projectors and cameras, with movable camera heads controllable from the surface, and targeted deployments near key breeding sites or dense areas.

5.6.6 Members asked whether there was a problem with crabs eating the bait but this was found to not be a problem as there were not as many crustaceans present as was expected. Members were also curious to know whether the environment changed responses, for example of fish within a kelp bed. Not enough is known at present but it does seem that there is a variation in nocturnal and diurnal responses for some species.

5.7 *Acoustic Monitoring around tidal turbines*
Dr Doug Gillespie & Dr Jonathan Gordon, Sea Mammal Research Unit

5.7.1 Members were informed of results from the use of acoustics for marine mammal monitoring and mitigation. As Members are aware, the use of some activities, such as explosions and pile driving, can pose an acute risk of damaging animals physically. Traditional observational mitigation methods probably do little to reduce risk, especially at night, during bad weather and poor visibility, and can also be expensive.

5.7.2 Aversive sound mitigation could be more efficient and cost effective but animal responses to aversive signals need to be extensively tested if regulators are to have confidence in these methods. A project to test the behaviour of harbour seals, one of the commonest and most sensitive marine mammals to be found at wind farm construction sites, took place within the Ramsay Sound, Pembrokeshire at the site of the DeltaStream tidal turbine.

5.7.3 Active Acoustic Sonar (AAS) was used to detect and track marine mammals in the vicinity of the turbine and a Passive Acoustic Monitoring (PAM) system, mounted on the DeltaStream was used to detect vocalisation from marine mammals. Data was cabled to shore and analysed by PAMGuard. Analysis showed that real-time detection could be used for mitigation as animals were tracked approaching the working turbine and then turning and swimming away, although as the turbine was not turning very much it was hard to measure animal responses. If an animal was damaged turbines could immediately be shut down. A similar system has now been installed at the MayGen project site in the Pentland Firth.

5.7.4 Harbour seals were exposed to sound at two sites and their behaviour noted. Ten seals were exposed within Kyle Rhea in 2013 and 13 seals in the Moray Forth in 2014, (all the seals had already been tagged for other projects). A Lofitech ADD sent out 14.5 kHz blasts lasting 550msec with an unpredictable spacing of 0.6 to 90 seconds between blasts. On deployment of the ADD seals swung away from the sound and, on the ADD being switched off, continued to swim away, only slower. At 1,000 metres from the ADD, 100% of seals responded.

5.7.5 This preliminary study suggests that aversive sound mitigation could be useful in reducing the risk of damage to harbour seals from activities such as pile driving and explosions and provides an indication of how seals might respond to other powerful tonal signals such as military sonar. Next steps would be to repeat the study with other species such as grey seals and minke whales and to move on a stage from proof of concept to real world application.

6. Institute of Acoustics Underwater Acoustic Group Update

6.1 The aim of the Underwater Acoustics Group is to attract the interest and commitment of all professionals from industry, academia and government who work in underwater acoustics. The Group's Committee arranges conferences for the underwater acoustics community, provides feedback to international standards committees, and recommends the recipient of the A B Wood medal for innovative underwater acousticians aged under 40.

6.2 Their most recent conference was the 'Acoustic and Environmental Variability, Fluctuations and Coherence' conference, held at the University of Cambridge in December 2016, which attracted 55 delegates, from ten countries, who presented 37 papers.

6.3 Further information, including that on forthcoming events can be found at http://www.ioa.org.uk

7. Any other business; date and venue of next Forum meeting

7.1 Dr Hawkins raised the issue of the need for better metrics to define and assess the cumulative effects of both continuous and impulsive sound upon marine animals. In the Marine Strategy Framework Directive (MSFD) sound exposure is measured over a 24-hour period but how uneven is this noise? Does it refer to a few big noises or many small noises within the same period which may have the same cumulative sound exposure level?

7.2 Additionally, for continuous sound, noise is averaged over 24 hours but only if operating for four hours a day (and then an average is used). This can lead to a false average. Members agreed this is a complicated subject and that regulations are a pragmatic step as it is very hard to make guidance without harming test animals in the process. Perhaps a metric in addition to Sound Exposure levels (SEL) is required to make measurements more sophisticated.

7.3 Members were asked if further guidance and metrics are required and should a working group be convened to look at the distribution of sound over time? Any Member having a view or views is encouraged to contact Dr Hawkins (a.hawkins@btconnect.com).

7.4 The next meeting of the Forum will be on 22 November 2017 at Cefas, Lowestoft. The Forum's thanks were extended to Dr Nathan Merchant for the kind offer to host. Any Member of the Forum who would like to present at this meeting, or who would like a presentation on a particular subject should contact Anne Brazier in first instance.