

International Conference on Underwater Acoustics (ICUA) 2024

The four-day International Conference on Underwater Acoustics 2024 was held in June at the University of Bath. The packed programme included speakers from a variety of nations and institutions, from both academia and industry but also included plenty of opportunity for networking and socialising.

By Philippe Blondel (ICUA-2024 chair, UAG member), Andrew Holden (ICUA-2024 co-chair, UAG secretary) and Nikhil Banda (ICUA-2024 co-chair, UAG member)

The Underwater Acoustics Group has traditionally held two-day workshops and conferences, once or twice a year, but some topics are too small for a conference on their own (for example for emerging topics) and others have developed enough to attract large audiences.

Our group had experience of large international conferences, like the European Conference on Underwater Acoustics (ECUA), whose last edition was held in 2012 in Edinburgh, attracting 400 participants (Acoustics Bulletin, September/October 2012), and its next incarnation, the International Conference on Underwater Acoustics (ICUA), whose first edition (2020) was virtual because of [P28](#)

Above:
The University of Bath, venue for ICUA 2024



Right:
ICUA 2024 keynote speakers (L-R) Hans Slabbekoorn and Hanne Sagen

the pandemic, and whose second edition (2022) attracted around 200 international delegates to Southampton (Acoustics Bulletin, vol. 48, no. 5, September/October 2022). The third edition, ICUA-2024, was held on 17-20 June 2024 at the University of Bath, UK. This date was also chosen to coincide with the nearly 10-year repeat period of the seabed acoustics conferences organised in Bath in 1983, 1993, 2005 and 2015. There were 230 delegates from 17 countries and 190 submitted abstracts. This strong international flavour shows the attraction of IOA conferences, and the enthusiastic feedback from delegates encourages us to think about the next editions (2026 and beyond).

The conference was organised into three parallel streams grouped into themed sessions over the four days, ensuring that all delegates could present a talk or a poster as they wished and a selection of the sessions are described in this article. We had planned several social events for informal and relaxed times, very useful for networking, forging new links and making new friends (or catching up with the old ones).

On Sunday evening, a welcome reception at the University of Bath was very well attended. Some of our delegates trialled the new 'buddy system', where

newcomers to the field, or to this series of conferences, could ask for someone to help them network and feel at ease throughout the conference.

On the Monday morning, we were honoured to have the first keynote lecture of ICUA-2024, when Hanne Sagen (Nansen Centre, Norway) talked about *The evolution of multipurpose acoustic networks in the Arctic Ocean*, sharing her impressive field experience in these very challenging environments and showing how underwater acoustics can be used for many objectives, from climate change to biodiversity or shipping.

Polar acoustics

Chaired by Espen Storheim (Nansen Centre, Norway) and Lora van Uffelen (University of Rhode Island, USA), this was a popular topic, with nine talks and two sessions following the keynote lecture. The topics covered both passive and active acoustics in different frequency ranges. The talks included discussion of acoustic propagation through and below the sea ice and presented results of simulations, laboratory measurements and data collected in the field. The speakers discussed the applications and importance of acoustic measurements in the Arctic environment, including the use of sound sources for acoustic

localisation of autonomous platforms under sea ice and the identification and localisation of earthquakes, shipping noise, cryophonics and other biological and anthropogenic sounds in acoustic data collected in the Arctic Ocean.

Sonar, vector sensors and transducer technology

Chaired by Victor Humphrey (ISVR, UK), this session showed the latest advances, with active coatings for low-frequency radiation, developments in calibration of different systems, the generation of plane waves below 2 kHz in water-filled tubes (with a second transducer at the termination to prevent reflections) and the best ways to improve the electro-acoustic efficiency of Tonpitz transducers.

Machine learning in underwater acoustics

Chaired by Philippe Blondel (University of Bath and UAG member), Nikhil Banda (Leonardo, 9UK and UAG member) and Marcus Donnelly (SEA Ltd, UK), this was the most popular theme of ICUA-2024, with 23 presentations scheduled over two days. The first session focused on the application of various AI/ML techniques to sonar imagery, including vision transformers and deep learning. P30





Above:
Delegates aboard
SS Great Britain

The second session showed the diversity of AI/ML approaches to passive acoustics, from the study of marine mammals to ships and fish habitats. The third session summarised the latest advances in water-column applications, from has bubbles to deep-sea currents. The fourth and final session addressed environment variability, algorithm robustness and the challenges of high-dimensional data, with solutions including quantum assisted computing. All sessions showed the broad applicability of AI/ML across civilian and military applications, and the very vibrant community using these techniques across the spectrum of underwater acoustics.

Underwater propagation

Chaired by Adrian Brown (Atlas Elektronik, UK), these two sessions presented papers which showed how the fastest computers in Europe could model the propagation of acoustic energy from detonation of unexploded ordnance (the visual highlights of the sessions). At the other extreme was a paper showing rigorous application of traditional mathematical techniques to the propagation of sound pulses. The interaction between underwater acoustics and oceanography spanned idealised concepts to detailed measurements and models, showing the complexity and the opportunities in this field.

Marine renewables and pile driving

These two connected sessions were chaired by Michael Bellman (Itap, Germany) and Federica Pace (JASCO, Germany). The first session showcased an innovative approach to instrumented micropiles as 'smart' linear receivers to characterise detailed seabed properties and their evolution with time. The second session showed measurements of noise impacts from the installation of monopile foundations with vibro-piling and associated models, and scaling laws for pile-driving sounds (and how they can be used to meaningfully address potential impacts on marine mammals).

On the Monday evening, the Early Careers Event (chaired by Nikhil Banda of Leonardo and an UAG member) included an open discussion of the opportunities and challenges of working in underwater acoustics in industry, government or academia. Around 25 early career scientists could engage with different organisations, participate in a game of guess-the-sound (whales and man-made sounds in particular), and learn about the varied and interesting career paths of other participants. Building on feedback from ICUA-2022, the event was completed with pizza and drinks in the conference foyer, leading to more exchanges.

On Tuesday morning, the conference was honoured to host its second keynote lecture (originally scheduled for the pandemic-affected conference of 2020). Hans Slabbekoorn (Leiden University, Netherlands) talked about *Acoustic climate change: A fish perspective on the Anthropocene*. Solidly anchored in both physics and biology, this presentation showed the importance of underwater acoustics to assess biodiversity and reduce the impacts of human activities in a variety of marine and freshwater environments.

This keynote lecture paved the way for the next sessions on the effect of sound on marine life (chaired by Chris Capus (Ultra Maritime, UK and UAG member), bioacoustics (chaired by Paul Lepper, Loughborough University, UK and UAG member), synthetic aperture sonar (chaired by Alan Hunter, University of Bath, UK) and particle motion (chaired by Sophie Nédélec, University of Exeter, UK).

Radiated Noise

These four sessions were chaired by Tom Smith (UCL, UK) and Alex MacGillivray (JASCO, Canada), covering a wide range of keys topics. Detailed analyses of noise levels from a wide range of vessels were presented alongside the latest developments in measurements techniques. There were some interesting finds across different vessel types, and it is clear that propulsion architecture can be as big a determining factor as speed or vessel size, particularly for smaller vessels. The environmental impacts of shipping together with design and operational strategies for reducing this impact were also covered. One of the key areas featured was measurement techniques and the continued development of an international standard for conducting acoustic trials in shallow water. The session also highlighted the need for a better understanding of uncertainty in both measurements and propagation modelling.

On early Tuesday evening, the historic SS Great Britain was the focus of a tour in neighbouring Bristol. A coach took delegates to enjoy a food and drink reception following by a look around the ship, built by Brunel. When this grand old lady was launched in 1843, she was the largest and most advanced **P32**

ship afloat and the first iron-hulled, screw-propelled passenger liner, akin to the Concorde of her day. The ship was expertly populated with the sights, sounds and smells of the times.

Memorial session in honour of Nick Pace (University of Bath)

Chaired by Kevin Hamson (Frazer-Nash Consultancy, UK and UAG Chair), this session honoured the memory of our dear colleague who started the regular IOA conferences at the University of Bath. We were delighted to share with his immediate family stories of working with him in different roles and at different levels, stories of the breadth of Nick's career, as well as his care for students and co-workers, were an inspiration to many young researchers who attended this session. After formal (and less formal) presentations, this session ended in the exchange of personal stories, all agreeing on Nick having been a role model for underwater acoustics.

Seabed and sediment acoustics

Organised by Gary Heald (Dstl, UK) and chaired by Anthony Lyons (University of New Hampshire, USA), this session consisted of eight interesting presentations covering a broad mix of theoretical and experimental research topics. This included novel theoretical work on the unification of poro- and visco-elastic models for sandy and muddy seabeds, the effects of a small but finite shear rigidity of marine sediments on long-range sound propagation, and two presentations quantifying the importance of rigorous and motivated processing and representation of echosounder backscatter. There were also measurements of sediment variability in the immediate sub-seabed, multi-aspect imaging of sub-surface buried debris, and two talks about long-term monitoring of seafloor backscattering, including seasonal dependence.

There were also two sessions on ambient sound, chaired by Martin Siderius (Portland State University, USA) and David Barclay (Dalhousie University, Canada), and a short session on general underwater acoustics, chaired by Andrew Holden (DSTL, UK), showing real-time sound monitoring in the offshore industry.

A.B. Wood medals

The Institute of Acoustics annually honours people whose contributions to acoustics or to the Institute have been particularly noteworthy.

The medals and awards programme has evolved over the years and is wide ranging in its acknowledgment of academic achievement, practical engineering applications and innovations, student achievement and contributions to the Institute and to the world of science and technology.

The A B Wood medal and attendant prize is awarded in alternate years to acousticians based in the UK/Europe (even years) and in the USA/Canada (odd years). It is aimed at younger researchers, those who are aged under 40, whose work is associated with the sea.

Following his graduation from Manchester University in 1912, Albert Beaumont Wood became one of the first two research scientists at the Admiralty to work on antisubmarine defence. He designed the first directional hydrophone and was well known for the many contributions he made to the science of underwater acoustics and for the help he gave to younger colleagues. The A B Wood Medal was instituted after Albert's death by his many friends on both sides of the Atlantic and was administered by the Institute of Physics until the formation of the Institute of Acoustics. The deadline for nominations for 2025 is 31st October 2024.)

Dr David Barclay is awarded the A. B. Wood Medal for outstanding contributions to the measurement, modelling, and analysis of ocean ambient noise.

Citation:

The 2024 A.B. Wood Medal is awarded for distinguished contributions in applications of acoustics associated with the sea to Dr David Barclay, an exceptionally innovative and productive scientist who has made major advancements in the study of underwater noise and its applications.

Dr Barclay completed an Honours BSc degree in Physics with a Minor in Music Technology

from McGill University, followed by a PhD from the Scripps Institution of Oceanography. As a graduate student, David won multiple scholarships and student presentation and teaching awards, as well as a highly-competitive Graduate Special Research Award in Ocean Acoustics from the Office of Naval Research. He gained diverse experience from three post-doctoral appointments: in the Department of Physics and Physical Oceanography at Memorial University of Newfoundland, working in sediment transport in coastal environments; at the Deep Ocean Exploration Institute of Woods Hole Oceanographic Institution (WHOI), working in ocean noise modelling and observations; and in the Department of Applied Ocean Physics and Engineering at WHOI in 3D ambient noise modelling. In 2015, Dr Barclay was hired as Canada Research Chair in Ocean Technology Systems in the Department of Oceanography at Dalhousie University (Canada Research Chairs are a national distinction 'for exceptional emerging researchers, acknowledged by their peers as having the potential to lead in their field').

Dr Barclay's research is innovative and diverse but generally focused on measuring, modeling and interpreting the spatial and temporal properties of the ambient noise field in the ocean. David's noise studies provide the means to predict the ocean soundscape in time, space and frequency, and to monitor human and biological activity; further, he has used noise as a passive, nonintrusive source to study the natural mechanisms that generate underwater sound and to estimate oceanographic and geophysical properties of the environment. As one of many exceptional achievements, he designed and built 'Deep Sound,' an autonomous, free-falling sensor platform for depth profiling the deep ocean, which he has used to probe ambient noise to the greatest depths ever achieved.

Dr Özkan Sertlek is awarded the A. B. Wood Medal for his outstanding contributions to energy flux modelling and his revolutionary impact on the capacity to generate broadband sound maps for shallow waters.

Citation:

Dr Sertlek received his first PhD degree in Turkey. At Gebze Technical University, he derived expressions based on the direct analytical solution of the wave equation in the time domain. He solved both lossless and lossy wave equations and implemented this approach to calculate the time dispersion in a single layered waveguide for pulse propagation problems. It was during this period that Dr Sertlek still split his time between acoustics and Turkish folk dancing.

Dr Sertlek received his second PhD degree in the Netherlands. At Leiden University, he devoted his time to soundscape modelling by which he provided new insights into the individual contributions of major sound sources to the underwater soundscape, including ships, seismic airguns, ordnance explosions and wind. It was during this period that Dr Sertlek also learned about animals, their hearing curves and behavioural patterns of disturbance and deterrence.

Dr Sertlek has made major contributions to energy flux theory, by introducing Faddeeva functions for superfast shallow water propagation modelling, developing shallow water propagation benchmarks and by applying spatial averaging and acoustic energy density techniques to sound mapping. His creative and innovative approaches contributed to multiple international projects and have been especially useful for the exploration and visualisation of underwater soundscapes of the North Sea and the Adriatic Sea. He is currently using his unique applications to sound maps of all European seas, including the Northeast Atlantic Ocean.

Dr Sertlek worked in research groups of diverse backgrounds, including offshore engineering, geophysics, electromagnetics and animal behaviour. His expertise and character allow him to blend in among people from diverse disciplines, by which he stimulates exchange of perspectives for the benefit of science. His work has guided biologists and policymakers and has led to new research ideas that promise a bright future for him and his collaborators.

Conference dinner

On Wednesday evening, the conference dinner in the historical Pump Rooms started with a cocktail in the Roman Baths, taking in the architecture and the modern wall projections in the side rooms (from which several delegates fascinated by archaeology had to be shepherd back to dinner, so great was their interest). The Georgian Pump Room has been the social heart of Bath for more than two centuries, boasting Jane Austen and Charles Dickens amongst its previous patrons, and we enjoyed a sumptuous three-course meal, and many wonderful discussions with fellow attendees. Definitely an evening to remember!

Target scattering

Chaired by David Nunn (Dstl, UK), this well attended session on target echo strength and scattering, covering both measurements and modelling, provoked lively questions. Unfortunately, a number of papers had to be withdrawn at the last minute due to travelling restrictions, but this did not diminish the superb papers that were well received. With speakers from a variety of nations and institutions, from both academia and industry, this session was a great success.

Unexploded ordnance (UXO)

This short but focused session was chaired by Jose Barradas (Flanders Marine Institute, VLIZ, Belgium). It featured the use of ultra-high-resolution (UHR) 2D and 3D acoustic sub-bottom profiling (SBP) techniques in controlled test environments and successful applications in offshore locations. Another talk explored the application of diverse deep learning techniques to enhance image co-registration from scan sonar surveys, combining it with optical flow in a multi-stage alignment system for best performance.

Sonar performance measurement and modelling

Chaired by Mathieu Colin (TNO, Netherlands) and Kristoffer Engedal Andreassen (FFI, Norway), this session provided insights into future trends and their possible impact on sonar performance, ranging from empathetic AI to climate change. The effect of the environment remains of key importance for

sonar, with presentations covering how to invert sound speed profiles by combining historical and current measurements, using the environmental information to estimate best sonar and target depths and how synthetic data can help find realistic reverberation parameters. The challenges of coordination between different units and sensors were also considered, with a novel detection model for combining multiple types of measurements and a review of modelling underwater acoustic communication.

Habitat mapping

Chaired by Angeliki Xenaki (NATO-STO CMRE, Italy), this session showed a variety of applications, including gas-bubble plumes produced by seagrass meadows and a survey of community research priorities for future efforts in habitat mapping with sonars, which will be used to inform policy and funding strategies around the world.

There were also sessions on specific topics such as signal processing (chaired by Nikhil Banda, Leonardo, UK), geoacoustic inversion (chaired by Hefeng Dong, NTNU, Norway) and acoustic tomography (chaired by Andrew Holden, Dstl, UK).

Student prizes

The student prize was sponsored by the UKAN+ Special Interest Group on Underwater Acoustics (the UK Acoustics Network is funded by the UK's Engineering and Physical Sciences Research Council). To be eligible, the delegate had to have been enrolled as a student in a connected degree, listed as the first author on the submitted abstract and presented their work at the meeting. The prize winners were selected by a panel of ICUA-2024 committee members and the SIGUA committee of UKAN+, led by Duncan Williams (Dstl, UK).

Selection criteria were based upon the originality, clarity and quality of research, and of its presentation. The first prize (£250) was awarded to Laura Redaelli (Marine and Environmental Sciences Centre, Portugal), for her presentation entitled *Acoustic mimicry of plastics with the prey of deep-diving cetaceans: an experimental approach*. The panel's words were: "For an



Above:
A.B.Wood
Medal winners,
Dr Özkan Sertlek
and
Dr David Barclay
with IOA President,
Alistair Somerville

excellent presentation with a clear explanation of the impact of the research and high-quality experimental data. Delivered with passion and enthusiasm for the subject and with a clear demonstration of how underwater acoustics research can really make a positive environmental impact”.

The second prize (£150) was awarded to Madalin Facino (University of Bath, UK), for her presentation entitled *A simplified passive acoustic simulation to research empathetic artificial intelligence (AI) in human-ai teaming*.

The third prize (£100) was awarded to Fabio Frazao (Dalhousie University Canada), for his presentation entitled *Comparing acoustic representations for deep-learning based classification of underwater acoustic signals: a case study with orca vocalisation*.

We extend our heartfelt congratulations to the student prize winners.

Positive feedback

This was a very good and productive international conference, with excellent feedback from the delegates. Like all conferences, but even more so at this scale and with this breadth of topics, its smooth running is attributed to the flawless support and organisation of the Institute of Acoustics (and, in particular, star organiser, Linda Canty), the willingness of colleagues and UAG committee members to chair sessions, and the constant and very hands-on support of the ICUA-2024 organising committee. On-site catering was provided by the University of Bath, whose team was very helpful, in particular in addressing the large number of delegates and the very packed schedule of the conference. We would like to thank all the presenters for their high quality presentations and posters highlighting all their excellent research. Finally, we would like

to thank our co-sponsors; the Acoustical Society of America, the International Commission for Acoustics, the European Acoustics Association, ONRG, the UK Acoustics Network, Tods Technology, Ultra Maritime, NPL and RTsys.

The legacy of the conference is already visible in its scientific production, with many conference papers deposited to the IOA Library and available as open-access. The buddy scheme and Early Career emphasis were good conduits for encouraging our younger colleagues to address the opportunities offered by underwater acoustics careers. Some feedback showed the desire for help for young parents (as already provided by the Acoustical Society of America for some of its conferences, for example). We are now reflecting on all the feedback, and already thinking ahead to ICUA-2026, taking the ‘flag’ of the Institute of Acoustics further. 🌐