SCOR Working Group Proposal Template

(max. 6250 words, excluding Appendix)

Title: Advancing Vibroacoustics: Future directions for underwater sound particle motion and substrate-borne vibration measurements

Acronym: Vibroacoustics

Summary/Abstract (max. 250 words)
Animals living beneath the ocean's surface have evolved to detect and use acoustic and vibrational waves ('vibroacoustic waves') for functions that are key to their survival. Sound waves comprise both pressure and particle-motion (PM) fluctuations, yet while mammal hearing and ocean acoustics research focus on sound pressure, most aquatic animals, particularly fishes and invertebrates, sense sound via PM. In seafloor and interface habitats, substrate-borne vibrations (SV) also propagate and are sensed by these animals. Anthropogenic noise is a global pollutant, and there is growing evidence of its harmful effects on fishes and invertebrates, yet the contribution of PM and SV to these impacts remains poorly understood due to a lack of enough direct measurements. PM cannot be reliably derived from sound pressure in many shallow and shelf-sea environments most marine life inhabits, and SV cannot be derived from water-column pressure measurements at all. Although instrumentation is becoming more accessible, modelling of PM is progressing, and novel approaches such as fibre-optic sensing are emerging, researchers still lack standardized guidance on instrument selection, calibration, data collection, and reporting. This working group will address that gap by standardizing PM and SV measurement methods, contributing to the ISO standard for underwater acoustics, mapping global monitoring efforts, and building capacity in developing countries and among early-career researchers. Its outputs will provide the evidence base needed for effective regulation of anthropogenic noise and better protection of the ecologically and socioeconomically vital species that depend on vibroacoustic sensing.

Scientific Background and Rationale (max. 1250 words)
Vibroacoustic waves (acoustic and vibrational waves) carry valuable information about the nature and location of entities and events in the ocean and the seabed. Animals that live beneath the surface of the ocean have evolved the ability to detect and use vibroacoustic waves for a range of functions key to their survival. While the sound pressure of acoustic waves is well studied, particle motion (PM) and substrate-borne vibration (SV) hold untapped potential for generating the data, information and knowledge needed for more robust science-informed policies that contribute to a well-functioning, productive, resilient and sustainable ocean (UN Ocean Decade, 2021). At a time of accelerating anthropogenic change and accelerating development of ocean technology, this Working Group will address the urgent need for standardization of PM and SV measurements, implementation of the Global Ocean Observing System's Underwater Sound Essential Ocean Variable (Martín Míguez et al., 2026) and breaking down barriers that are impeding the advancement of vibroacoustics in ocean science.

Sound waves in water and in the substrate comprise both pressure and PM fluctuations as the material displacement that occurs during the propagation of sound waves results in the vibration

of particles of the medium in which the sound is propagating. An ear is an animal organ that converts sound into electric signals during the process of hearing. While mammal hearing is based on detection of sound pressure and the study of ocean acoustics is well developed from the perspective of measurement of sound pressure, fishes and invertebrates (i.e. most aquatic animals) hear sound using PM (Hawkins et al., 2021; S. L. Nedelec et al., 2016). However, few studies of underwater acoustic ecology have measured the PM facet of sound.

Substrate-borne vibrations influence the sensory ecology of fishes and invertebrates living in, on, or close to the seafloor. SV may be sensed directly or cause sound to radiate into the water column, and similarly may be elicited by sound in the water above. Non-compressional vibrational waves, including shear waves, Scholte waves, and interface waves, propagate through the substrate and must be considered when modelling sound propagation between the seabed and the water column. A vast diversity of species produce and utilise PM and SV to communicate, locate resources, reproduce, and sense their surroundings (Hill et al., 2022; Hill & Wessel, 2016). Mismatches between sound detection abilities and sound production observed in decapod crustaceans and certain fish species may be explained by use of the substrate-borne channel, a signal not measured in most studies (Radford & Stanley, 2023; Roberts & Rice, 2023).

As well as being sensitive to PM and SV, fishes and invertebrates are socio-economically important. Fishes and aquatic invertebrates constitute a critical source of dietary protein for millions of people in coastal and island nations, where access to alternative animal protein sources is often limited. Small-scale and artisanal reef fisheries support food security by providing locally available, affordable, and nutritionally valuable protein. Dependence on reef fisheries is especially pronounced in many Low-Income Food-Deficit Countries in the tropics, where economic constraints, geographic isolation, and limited cold-chain capacity may restrict access to imported or farmed protein sources (Golden, 2016; Landrigan et al., 2020).

In some cases, PM can be calculated from sound pressure. However, sound pressure and PM are directly related only under specific conditions or where detailed properties of the source and the propagation conditions are known, which may not be met in the shelf seas and shallow waters that most aquatic life inhabits (e.g. < 10 m distance from source (Jézéquel et al., 2025)). In these environments, boundary effects and multipath propagation can cause the acoustic field to deviate from plane wave assumptions. As a result, the vector nature of particle motion can be influenced by reflections, refraction, or even sediment properties. This means that pressure-only measurements cannot reliably describe the signals perceived by fishes and invertebrates without specialist knowledge of sound propagation, or in some cases at all. Similarly, SV must be measured directly and is highly dependent upon the substrate conditions that the sensor is attached to. This disconnect underscores the need for capacity building for modeling and direct measurement of PM and SV to assess anthropogenic noise impacts more accurately, along with characterizing the biologically relevant sound fields (Guan et al., 2025).

Recent publication and citation trends demonstrate both the timeliness and need for a SCOR working group to bring together related disciplines and address barriers to progress in this field. It is a decade since publication highlighted particle motion as the ‘missing link in underwater acoustic ecology’ (S. L. Nedelec et al., 2016). This paper has been cited 315 times and a fraction of these publications have measured and reported underwater acoustic PM levels. The

fact that many more papers have cited this research than have measured PM demonstrates the interest in this topic but the barriers still faced by the research community in making measurements and reporting. A best practice guide published in 2021 (S. Nedelec et al., 2021) has been cited 48 times, with a larger proportion making measurements, demonstrating progress in the field.

It has been eight years since '*Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos*' highlighted substrate-borne vibration (vibrational noise) as an overlooked aspect of underwater noise (Roberts & Elliott, 2017). The review has been cited 123 times since then. Another review on the topic 'Substrate vibrations and their potential effects upon fishes and invertebrates' (Hawkins et al., 2021) has been cited 81 times since publication, further indicating the growing interest in the topic. There have been c.a. 20 papers since 2021 around the topic of SV (Roberts et al., 2026), and recent assessments of anthropogenic noise sources incorporating SV in addition to PM (e.g. Guan et al., 2025; Williams et al., 2023; Popper et al., 2023).

Different techniques exist for measuring PM and SV and a SCOR working group will ensure standardization across these diverse approaches. Accelerometers can provide high fidelity 3-axis acceleration measurements in the water column and the substrate, geophones and seismometers can detect low frequency SV within the detection ranges of benthic and demersal animals. Emerging Distributed Acoustic Sensing (DAS) systems use subsea fibre optic cables allowing distributed detection of sound over kilometre scales. More conventionally, hydrophones can be used in array configurations to spatially resolve pressure fields. For SV in particular, the seafloor's acoustic complexity and mechanical diversity (in terms of coupling) require these varied approaches. These technologies will allow quantification of both the magnitude and direction of PM and SV, improve understanding of how animals experience vibroacoustic waves in marine and seafloor habitats, and enable observation of how anthropogenic noise propagates through the water and across the seafloor.

An ISO standard for the measurement of PM and SV for biological applications is in development (ISO 25796). Several members of this proposed SCOR group are also participants in the working group developing this ISO standard (Nedelec, Roberts, Guan, Martin, Širović and Nikolaou). Global participation in this SCOR group will aid the development of a standard that is inclusive and widely accessible.

This topic is a priority for ocean science because anthropogenic noise regulation is currently lacking an adequate evidence base. Regulating noise can improve local conditions rapidly and at low cost, making it an excellent intervention for enhancing the resilience of benthic habitats such as coral reefs that are under severe and accelerating pressure from climate change. A SCOR working group is the ideal mechanism to bring together disparate methodologies and expertise to advance vibroacoustics for ocean science during the UN Ocean Decade.

Terms of Reference (max. 250 words)
The Terms of Reference are broad objectives for the Vibroacoustics working group. Reaching these objectives will be achievable within the time and budget provided for SCOR working groups (4 years, $45,000), leveraging contributions from researchers in the Working Group from their own research budgets already held (e.g. £1.8m Royal Society Dorothy Hodgkin Fellowship; Dr Nedelec).

1. Standardize underwater particle motion and substrate-borne vibration measurement via the International Standards Organization (ISO).
2. Document the state of the science of ocean vibroacoustics and the importance of this topic for scientific understanding and ocean management.
3. Develop capacity for PM and SV measurements in developing countries and for early career researchers by providing online training materials, open access publications and an accessible, comprehensive knowledgebase and network guiding cost-effective best practices for instrumentation, data collection, and analysis methods.
4. Document locations where PM and SV sensors are currently deployed and gather input from practitioners on this topic. Alongside, document any locations where PM and SV are not well predicted from pressure and how this overlaps with threatened species distributions.
5. Initiate plans for an experimental field site where PM, SV and sound pressure are monitored, where biological experiments can take place via collaboration across institutions.
6. Systematically review the literature on particle acceleration levels at which fishes and invertebrates are impacted by anthropogenic noise.
7. Examine vibratory evoked potentials in fishes and invertebrates.
8. Inform policymakers about the findings of the Working Group.

Deliverables (state clearly what products the Working Group will generate. Should relate to the terms of reference. Max 250 words). A workshop is not a deliverable. Please note that SCOR prefers that publications be in open-access journals.

1. Contribution to ISO 25796: Underwater Acoustics – Measurement of sound particle motion and seabed vibration for biological applications. Six Working Group members are National Experts participating in the ISO standard development (Nedelec, Roberts, Guan, Martin, Širović, Nikolaou), with all members contributing expertise. A draft will be submitted 1 February 2027 and the full standard on 1 February 2028.
2. An open access peer reviewed publication based on requirements and recommendations in the Best Practice Guide (Nedelec et al 2021) and ISO 25796, including review of vibroacoustics from separate backgrounds to future visions for cohesion.
3. Training materials will be made openly available online following a workshop. These could be published on GitLab.
4. An open access peer reviewed publication detailing global distribution of PM and SV monitoring and locations of threatened species inhabiting zones where PM and SV cannot be derived from single point in-water sound pressure measurements, with an associated online updateable map (map could be published on GitLab).
5. Submit a funding application for an experimental field site where PM, SV, sound pressure and animal responses can be measured.
6. An open access peer reviewed publication on weighted particle acceleration levels for effects of noise on fishes and invertebrates.

7. An open access peer reviewed publication on vibratory evoked potentials in fishes and invertebrates.
8. A policy brief translating the working group's findings into practical guidance for regulators, including the EU Marine Strategy Framework Directive and IMO shipping noise guidelines.

Working plan (logical sequence of steps to fulfil terms of reference, with timeline. Max. 1000 words)

The Vibroacoustics Working Group will operate over four years from January 2027 to December 2030, with a rhythm of two online meetings per year (March and September) and one in-person meeting per year in Years 1–3 each June. The Year 1 in-person meeting will be hosted at the National Physical Laboratory (NPL), UK, leveraging Harris Nikolaou's affiliation and NPL's world-leading expertise in acoustic calibration and standardisation. Workplan activities are organised around the seven deliverables and terms of reference, with contributions from members sequenced to make best use of existing funded research programmes, including co-chair Dr Nedelec's Royal Society Dorothy Hodgkin Fellowship.

Year 1 (2027): Foundations, standardisation, and scoping

The first year focuses on establishing the group's working practices, accelerating the ISO standard, and scoping the state of the science.

The March online meeting will launch the working group, agree roles and responsibilities, and establish writing teams for each deliverable. Shane Guan and Sophie Nedelec will co-chair throughout.

The June in-person meeting at NPL will be the group's most intensive session and is timed deliberately to coincide with a critical stage of ISO 25796 development. The six National Experts within the group who are members of the ISO working group developing the standard (Nedelec, Roberts, Guan, Martin, Širović, and Nikolaou) will use this meeting to progress the standard in person. Harris Nikolaou, Yi Chen and Markus Linné will lead sessions on sensor calibration. Gopu Potty will draw on his prior ISO experience to guide the writing process. A draft standard will be submitted on 1 February 2027, ahead of the meeting, giving the group a concrete document to work from. The September online meeting will review progress and coordinate final contributions ahead of the full standard submission deadline of 1 February 2028.

In parallel, the scoping work for Deliverable 4 (global monitoring map) will begin. All members will contribute data on known PM and SV monitoring locations. Bruce Martin and Julien Bonnel will lead the technical assessment of where PM and SV cannot be reliably derived from pressure measurements. The biologists and ecologists in the group will contribute biological expertise to identify threatened species distributions overlapping these zones.

Year 2 (2028): Publication, training, and mapping

Year 2 focuses on consolidating the ISO standard, completing the best practice publication, launching training materials, and advancing the monitoring map.

The full ISO 25796 standard will be submitted in February 2028, representing completion of Deliverable 1. The March online meeting will mark this milestone and pivot the group's attention to Deliverable 2, the open-access best practice publication. Writing will be led by Nedelec and Roberts, integrating contributions from across the group to synthesise vibroacoustic measurement approaches from biological, physical, and engineering perspectives. Solé will contribute sections on dose-response methodology and the AquaVib system. Martin and Potty will cover hydrophone array approaches and modelling respectively. Paul White and Peter Sigray will contribute acoustics and sensor deployment expertise.

The June in-person meeting in Year 2 will include a training workshop, the materials from which will form Deliverable 3. The workshop will cover instrument selection, calibration, deployment, and data analysis, with a particular focus on cost-effective approaches accessible to under-resourced institutions. Training materials will be published openly on GitLab following the meeting. The September online meeting will finalise the best practice manuscript for submission.

Work on Deliverable 4 will continue throughout the year, with the global monitoring map taking shape as an updateable online resource, also hosted on GitLab.

Year 3 (2029): Biological effects, field site, and map publication

Year 3 shifts emphasis towards the biological deliverables and initiates planning for the experimental field site.

Vasconcelos will lead Deliverable 7, a publication on behavioural sensitivity and vibratory evoked potentials in fishes/invertebrates. Solé and Roberts will contribute fish and invertebrate data. The manuscript will be drafted ahead of the June in-person meeting, which will be used to finalise and review it.

Sophie Nedelec will lead Deliverable 6, the systematic review of weighted particle acceleration levels at which fishes and invertebrates are impacted by anthropogenic noise. Guan will contribute regulatory and compliance perspectives, and Radford will contribute auditory threshold data for fishes and invertebrates. A draft will be circulated to all members by September.

The June in-person meeting will also include a dedicated session on planning the experimental field site (Deliverable 5). Roberts will lead this session to scope a site where PM, SV, sound pressure, and animal responses can be co-measured. The group will identify potential host institutions, equipment requirements, and potential funding sources, with the goal of submitting a funding application before the end of Year 3.

Deliverable 4 will be finalised for submission as an open-access publication, with the accompanying online map launched publicly.

Year 4 (2030): Synthesis, dissemination, and legacy

The final year focuses on completing outstanding manuscripts, submitting the field site funding

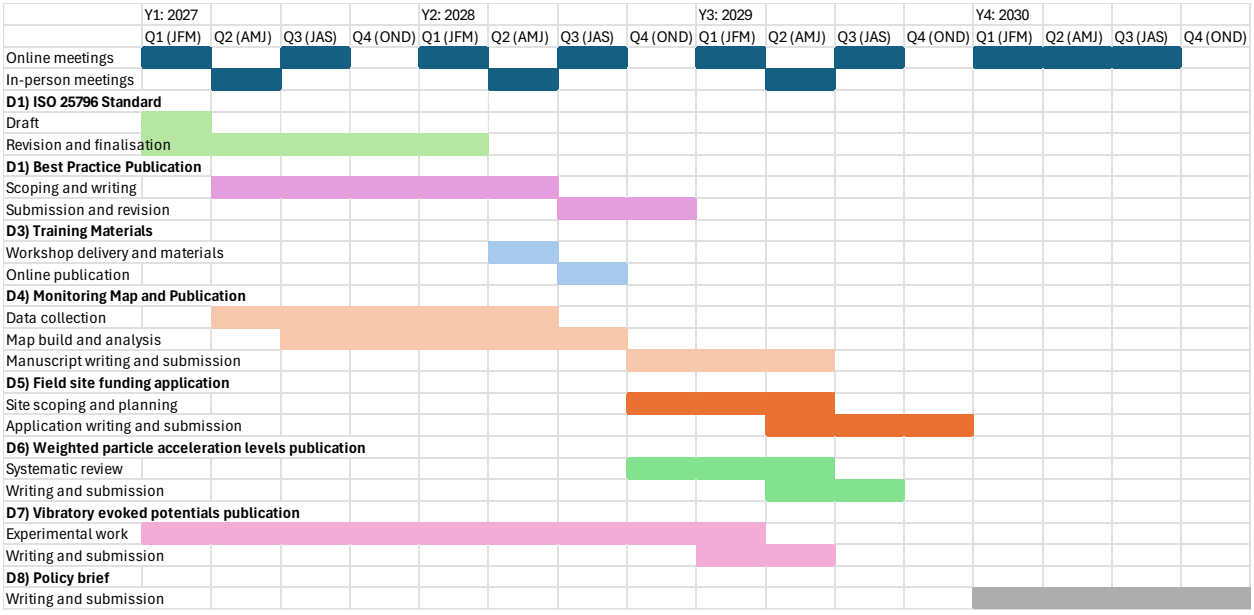
application, and ensuring the group's outputs have lasting impact.

Deliverables 2, 6, and 7 will be submitted for publication if not already. The March online meeting will review the status of all deliverables and coordinate final revisions. The funding application for the experimental field site will be submitted in the first half of the year. The September online meeting will serve as the group's closing session, reviewing outputs, agreeing on legacy maintenance of online resources, and identifying priorities for future work.

Throughout Year 4, all members will contribute to dissemination; presenting working group outputs at international conferences, engaging with policymakers and environmental managers, and ensuring that the knowledgebase and monitoring map remain accessible and updatable by the wider community beyond the group's formal end date.

This workplan is designed to be realistic within the four-year timeframe and $45,000 budget, with in-person meetings funded by the SCOR budget and research activity funded through members' existing grants and institutional resources.

Table 1: Gantt chart.



Capacity Building (How will this Working Group build long-lasting capacity for practicing and understanding this area of marine science globally. Max 1500 words)

Particle motion (PM) and substrate-borne vibration (SV) measurements represent a specialized and relatively understudied field, despite their critical importance for understanding and mitigating anthropogenic underwater sound impacts on fishes and aquatic invertebrates. Many of these species are also socioeconomically important species that support the livelihoods of many local communities. However, progress in this area is hindered by numerous technical challenges, including limited access to appropriate instrumentation, uneven training

opportunities, and disparities in expertise related to experimental design and research methodologies across the global research community. To address these issues, this working group is bringing together leading bioacousticians and biotremologists to take a structured approach for synthesizing best practices in PM and SV measurements. The groups' process and outputs aim to build lasting capacity by targeting early-career researchers, scientists in developing countries, and the broader ocean science community. Additionally, these products are expected to guide the development of an ISO standard for the measurement of PM and SV for biological applications and contribute to the improvement or revision of the Acoustical Society of America (ASA) standard on fish acoustic injury criteria. Capacity development is not an add-on to this group's work, it is central to its purpose, since the barriers that have slowed progress in vibroacoustics are fundamentally barriers of access: to equipment, to knowledge, and to networks.

An internationally distributed working group

The working group is deliberately international in composition, spanning ten countries across Europe, North America, Asia, and Oceania, and includes members from academic institutions, government agencies, and industry. Full members are drawn from the University of Exeter (UK), University of Saint Joseph (Macao, China), Universitat Politècnica de Catalunya (Spain), University of Liverpool (UK), Swedish Defense Research Agency (Sweden), NTNU (Norway), Hangzhou Acoustics (China), Catholic University of America (USA), University of Rhode Island (USA), and JASCO Applied Sciences (Canada). Associate members extend this reach further, including the National Physical Laboratory (UK), University of Southampton (UK), University of California San Diego (USA), University of Auckland (New Zealand), University of Brest (France) and the Royal Institute of Technology (Sweden). This geographic breadth ensures that the working group's outputs are developed with diverse scientific expertise, regulatory contexts, and environmental priorities in mind, and are therefore more likely to be adopted globally. We will make use of existing networks to expand our Working Group to include more early career researchers e.g. from the SEASOUNDS network of 8 PhD students across Europe with which Dr Nedelec has connections (https://seasounds-dn.cnrs.fr/).

Training and skills development

The working group will hold at least one in-person training workshop during its four-year programme, timed to coincide with a working group meeting to maximise efficiency. The workshop will provide hands-on training in PM and SV instrument selection, deployment, calibration, and data analysis, with a particular focus on practical approaches accessible to researchers with limited budgets. Training materials will be made openly available online following the workshop, ensuring that the benefits extend beyond those who attend in person. Where possible, working group meetings will be held in developing countries or regions where reef fisheries and benthic habitats are of high socioeconomic importance, such as tropical coastal nations, to directly engage regional scientists with locally relevant challenges and to lower the barrier to participation for researchers who may not otherwise be able to attend international meetings.

Supporting early-career researchers

Early-career researchers will be meaningfully involved in the working group's activities, not merely as attendees but as contributors. Specifically, early-career scientists will be invited to contribute to the global monitoring map (Deliverable 3) and to the publication on threatened species distributions (Deliverable 4), providing real research experience and co-authorship opportunities. The working group will apply for SCOR travel grant funding to support early-career and developing-country scientists from outside the working group to attend any workshops. The SCOR Visiting Scholar programme and the POGO-SCOR Fellowship Programme offer additional mechanisms to fund extended visits, enabling early-career researchers to spend time with working group members and gain hands-on experience with PM and SV measurement techniques in established laboratories. Harris Nikolaou (NPL, UK), exemplifies an early-career member of the associate group that this group aims to support and develop.

Open and accessible resources

A central pillar of this group's capacity development strategy is open access. All peer-reviewed publications will be published in open-access journals. The review and guide on international standardization (Deliverable 2), the global monitoring map (Deliverable 3), and the threatened species distribution map (Deliverable 4) will be freely available online with Deliverables 3 and 4 designed to be updated and expanded by the community over time. By making instrumentation guidance accessible, the working group aims to incentivise uptake among early-career researchers and institutions in lower-income countries who may currently be excluded from this field by cost and complexity.

Addressing the broader ocean science community

Beyond specialist vibroacoustics researchers, this group will raise awareness of PM and SV among the wider ocean science and environmental management community through several targeted activities. All publications will be open access, and plain-language summaries will be prepared for each paper and shared via the working group's social media pages and through the networks of member institutions across ten countries. Working group members will present findings at major interdisciplinary ocean science conferences to reach audiences beyond the vibroacoustics community.

The socioeconomic importance of fishes and invertebrates, particularly for food security in coastal and island nations, combined with the threat of anthropogenic noise, means that better regulation of anthropogenic noise has human health implications, and this framing will be central to our engagement with policymakers. To reach regulators specifically, the working group will produce a policy brief in Year 4 translating key findings into practical guidance on incorporating PM and SV into existing underwater noise frameworks, including the EU Marine Strategy Framework Directive and IMO shipping noise guidelines. The brief will be disseminated directly to relevant regulatory bodies and submitted to policy-facing outlets such as the Convention on Biological Diversity (CBD) and OSPAR noise working groups. Working group members with existing regulatory relationships particularly Peter Sigray (EU MSFD) will facilitate direct engagement with environmental management agencies. Together, these activities will help translate technical advances in vibroacoustics into practical tools for ocean governance, contributing to the goals of the UN Ocean Decade.

Working Group composition (as table). Divide by Full Members (10 people) and Associate Members (max. 10 people), taking note of scientific discipline spread, geographical spread, gender balance, and participation by early-career scientists. Proponents may also include a short rationale for the composition and balance. (max. 500 words)

Full Members (no more than 10, please identify chair(s))

Name	Gender	Years since degree*	Country and institution of affiliation(s)	Expertise relevant to proposal
1 Sophie Nedelec Co-chair	F		UK, University of Exeter	UW pm measurement – biology background
2 Shane Guan Co-chair	M		USA, The Catholic University of America	UW PM & SV applications for compliance, project management, Co-chair
3 Raquel Vasconcelos	F		China, University of Saint Joesph Macao and Portugal, Lusófona University & Marine and Environmental	UW pm measurement – ecology background

			Sciences Centre (MARE-UL)	
4 Gopu Potty	M		USA, University of Rhode Island	UW pm and SV measurement and modelling
5 Marta Solé	F		Spain,Universitat Politècnica de Catalunya	PM vs pressure experiments
6 Yi Chen	M		China, Hangzhou acoustics	Sensor calibration
7 Louise Roberts	F		UK, University of Liverpool	SV measurement – biology/ecology background
8 Markus Linné	M		Sweden, Swedish Defense Research Agency (FOI)	UW pm measurement and calibration
9 Ana Širović	F		Norway, NTNU	UW pm measurement
10 Bruce Martin	M		Canada, Jasco	UW pm measurement – hydrophone arrays and directionality

* Field only required for members identified as early career: 10 years or less post-degree, not counting time off for family leave.

Associate Member (no more than 10)

Name	Gender	Years since degree*	Country and institution of affiliation(s)	Expertise relevant to proposal
1 Ian Jones	M		USA, Interim Director - Center for Acoustics Research and Education	PM measurement
2 Peter Sigray	M		Sweden, KTH - Royal Institute of Technology	PM measurement, instrument design
3 Harris Nikolaou	M	2	UK, NPL	PM measurement and calibration – physics background
4 Paul White	M		UK, University of Southampton	PM measurements - acoustics background
5 Julien Bonnel	M		USA, University of California San Diego	Modelling
6 Craig Radford	M		New Zealand, University of Auckland	UW pm measurement and auditory responses of fishes and invertebrates
7 Youenn Jézéquel	M		France, University of Brest	Sound detection and production in invertebrates
8				
9				
10				

* Field only required for members identified as early career: 10 years or less post-degree, not counting time off for family leave.

Working Group contributions (max. 750 words)

Dr Sophie Nedelec will contribute to overall scope of the Working Group as well as expertise in PM measurement for biological applications and bioacoustics. Sophie will be working on localization of vocalizing animals using particle motion vectors in habitats that are sensitive to climate change.

Dr Shane Guan will contribute to the overall scope, concept, applications, and environmental compliance aspects of the Working Group efforts.

Dr Louise Roberts (University of Liverpool) provides expertise relating to substrate-borne vibration, particularly vibrational noise, and the sensory ecology and biotremology of aquatic animals.

Dr Marta Solé (UPC) will contribute by establishing dose-response relationships for differential acoustic effects (particle motion and pressure) in marine invertebrates and plant/seaweeds,

using AquaVib (Pla et al., 2025), supporting standardized methods to assess biological sensitivity to underwater sound and improve cross-ecosystem comparisons.

Harris Nikolaou (NPL) will be the point of contact for the National Physical Laboratory (NPL), contributing characterization and calibration of particle motion sensor work, supporting standardization.

Dr Raquel Vasconcelos will contribute from a sensory ecology perspective, especially regarding the perception of substrate-borne vibrations and how these are processed by different organisms.

Dr Gopu Potty will provide expertise on measurement and modelling of PM and SV from an ocean engineering perspective. Gopu has experience producing an ISO standard which will benefit the efforts of the Working Group.

Dr Yi Chen will contribute expertise on the calibration of sound sensors.

Dr Markus Linné will contribute with expertise on measurements and calibration of pm sensors and hydrophones.

Dr Ana Širović will contribute to standardization of PM measurements including calibration.

Dr Bruce Martin will contribute to the group's understanding of the physics of PM, hydrophone array deployments and data analysis and reporting standardization.

Dr Peter Sigray will contribute expertise on sensor specifics, the deployment of PM sensors, and measurement standardisation. He will also contribute management experience in European waters.

Associate members will be extend the geographic reach and the coverage of research areas of the Working Group.

Associate members will contribute to particle motion measurements, sensor calibration, physical and acoustical background of PM and SV measurements, as well as knowledge in sensory biology of fishes and aquatic invertebrates.

We will seek additional associate members if successful, e.g. from the SEASOUNDS network of 8 PhD students across Europe with which Dr Nedelec has connections (https://seasounds-dn.cnrs.fr/).

Relationship to other international programs and SCOR Working Groups (max. 500 words)

ISO Standard: The working group efforts and products will contribute to the development of ISO Standard: Underwater Acoustics – Measurement of sound particle motion and seabed vibration for biological applications (ISO 25796), Several members of this proposed SCOR group are also participants in the working group developing this ISO standard.

Discover of Sound in the Sea (DOSITS): The DOSITS website is an educational platform designed to introduce the science of underwater acoustics and marine bioacoustics to students, regulators, and the general public, and it is widely regarded as one of the most authoritative sources of information on sound in the ocean. As with any scientific field, however, the knowledge it presents continues to evolve. The products of this working group are expected to contribute to this ongoing development by strengthening and updating DOSITS content related to the topics of PM and SV measurements.

ASA Standards: The Acoustical Society of America (ASA) Standard Report S3/SC1.4 TR-2014, Sound Exposure Guidelines for Fishes and Sea Turtles, was originally developed in 2014. However, the acoustic metrics included in this report are limited to acoustic pressure, despite the fact that fishes and many aquatic invertebrates primarily respond to particle motion (PM) and/or substrate-borne vibration (SV). As a result, the standard requires revision to better reflect current scientific understanding. The outputs of this working group are expected to play an important role in informing and supporting efforts to update and improve the ASA standards.

The Technical Group on Underwater Noise (TG-Noise) is an expert group that supports Member States in implementing noise management in European waters. Its work has primarily focused on the impacts of continuous and impulsive noise in open waters. The next step is to address anthropogenic noise in shallow waters, where efficient standards and guidance on particle motion (PM) and seabed vibration (SV) are required.

Our Working Group will carry forward the work of the IQOE as it contributes knowledge and capacity development to all four of the themes of the IQOE: Ocean Soundscapes, Effects of Sound on Marine Organisms, Observing Sound in the Ocean, and Industry and Regulation.

Implementation of the Global Ocean Observing System's Underwater Sound Essential Ocean Variable (EOV) will benefit from the activities of our Working Group. PM is a primary ocean sound variable in the EOV and measurements and derived data products are required to meet ocean sound EOV goals. We will expand on this by adding SV.

GLUBS (SCOR Working Group); Dr Sophie Nedelec is an Associate member of this working group and her experience with that group will assist her in co-chairing the current group. GLUBS will also benefit from the work in the current group as PM vectors can be used to identify which animals are making sounds in a soundscape, contributing to the 'unknown sounds' problem addressed by GLUBS.

Key References (max. 500 words, abbreviated formatting can be used)

Golden, C. (2016). Fall in fish catch threatens human health. *Nautre, OECD-FAO Agricultural Outlook*, *534*, 317–320. https://doi.org/10.1787/agr_outlook-2015-en

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Appendix

For each Full Member, indicate 5 key publications related to the proposal.

Sophie Nedelec

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